BOSTON SCHOOL SERIES

THE

# INFORMATION READER

# No. 4.

## MODERN INDUSTRIES

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Boston School Series

THE

# INFORMATION READERS

*NUMBER 4*

## MODERN INDUSTRIES
AND
## COMMERCE

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BY

ROBERT LEWIS, PH.D.

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waste the precious hours of school life can readily be invented, if such waste be desired. No effort has been spared to render information attractive, indeed; but the fundamental aim of the series has not been ignored in a single lesson.

In these books elocution is subordinated to instruction, -- such instruction as will aid the young learner to understand the life of the world around him. How many school graduates of this year can describe the sources from which food is obtained, or can tell how it is marketed? How many appreciate the importance of the railroad as a factor in determining the cost of living in town or country? How many have any knowledge of the processes employed in making cloth? How many know how gas is manufactured? or how steel is produced? or how newspapers are printed?

To the educational public the editors of this series have endeavored to present reading-books the perusal of which will stimulate the perceptive faculties of the pupil, store his mind with practical information, and interest him in various arts and occupations by which hundreds of millions of persons earn their daily bread. Above all, it is hoped that the books will create and foster in the mind of every young reader a just appreciation of the nobility of manual labor.

In the preparation of these volumes several distinguished educators have shown the most friendly interest. The invaluable aid of their counsel and encouragement is gratefully acknowledged.

E. A. B.
H. W. C.
W. G. P.
R. L.

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# MODERN INDUSTRIES AND COMMERCE.

## Lesson I.

### The Days of Barter.

In the earliest times trade was carried on overland. Buyers and sellers did not dare to trust themselves to the waters. Rivers and seas were avoided. Merchants confined their journeys to routes ending at market towns in neighboring countries.

The dangers which beset a lone trader led persons engaged in commerce to travel together in large companies, which started at fixed dates. Protection from robbers was thus insured, and help for any person suddenly attacked by illness was to be had, as well as the enjoyment of the society of friends.

Trading must have started in the far East. Asia was the first abode of the human race. After men learned how to tame the camel, they became able, by the assistance of that animal, to make long journeys, and to carry larger quantities of goods.

The earliest caravan trade of which any records are extant had its center in Egypt, the situation of that country making it a convenient meeting-place for both Eastern and Western merchants. Besides, the fertile valley of the Nile seems to have been, even in very early times, a rich land. It was the cradle of agriculture, of industrial arts, and of commerce.

In time, traders gained courage enough to risk themselves and their wares in boats; and thus traffic was made much easier, so far as the carrying of burdens was concerned. The Nile must have been an artery of commerce at a very remote period.

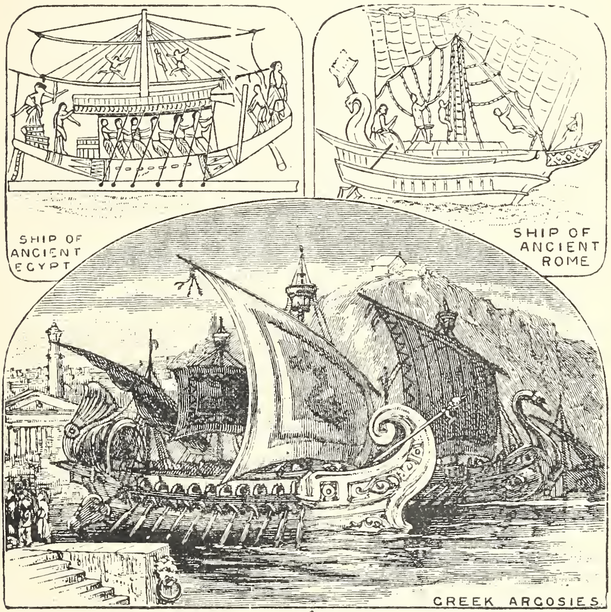
The historians of ancient Greece and Rome have made known to us how valuable was the trade carried on by the help of the Rhone, the Rhine, the Po, the Danube, the Don, and the Volga.

River commerce received a strong impulse after men had learned to sail along the sea-coast. Finally came the day on which, for the first time, some stout-hearted mariners, unmoved by the tears and prayers of their friends, steered some little vessel out to sea. What feelings must have stirred their hearts as they watched the shore of their native land fade slowly from their sight!

Sea commerce arose naturally out of coast traffic.

Where safe harbors were found, men settled on their shores for the purpose of trading.

Goods were carried on the backs of camels to those seaports, or were conveyed in ox-drawn




*Ancient Vessels.*

carts, or were, perhaps, borne on the shoulders of slaves. At the coast settlements the goods could be exchanged for products brought in vessels from foreign lands.

Rendered bolder by increase of knowledge, merchants discovered that they could sail on the

Persian Gulf as safely as on the Tigris. By taking advantage of the wind which blows westwards during certain periods of the year, sea-captains found out that they could voyage to India quite speedily and safely.

Later on, the Mediterranean Sea became the scene of a much more extensive traffic. Yet ocean commerce on a large scale was unknown to the ancients, and could not, perhaps, have been undertaken by them, because the mariner's compass had not been invented.

To the Romans the Mediterranean was litterally the middle of the world. The Atlantic Ocean, broadening out to the west, was filled by their imagination with strange terrors. According to a famous Greek geographer, Ptolemy, our earth had a wall of ice at about 63° north latitude, while near the Equator the ocean became boiling hot, and the land was scorched into sand by the sun's heat!

Experience taught the traders how to improve the means of transport. Luxuries that at first only wealthy people could afford to buy were, by degrees, brought within the means of purchase by the poor.

It is only within the past two centuries that tea, coffee, cocoa, sugar, butter, and potatoes have become common on the tables of our working-classes. The Greeks and Romans never heard of those articles of diet.

Barter, which is the exchange of goods for other goods, is as old as the beginning of history. The earliest records of the Oriental nations date from a very remote past, yet the first reliable information that we have regarding India, Persia, Egypt, and Ethiopia tells us that those nations had an extensive commerce, and enjoyed a high degree of civilization.

Phœnicia was a land of traders. The annals of that country furnish us the best account of the ancient world, whose narrow boundaries were widened by the enterprise of Phœnician merchants. For many generations they gained wealth by trading with every commercial state having a coast washed by the Mediterranean Sea.

Before the Israelites entered the Promised Land, Phœnicia had grown into a powerful nation. It was not a kingdom, but was a close union of several cities, of which Sidon was the metropolis until Tyre outstripped it in population and wealth.

The Phœnicians were a peaceable people, engaged in the pursuits of industry and commerce; yet, when attacked, they defended themselves with extraordinary skill and courage. They founded colonies, not for the sake of extended dominion, but to serve as centers of trade with the mother country.

Although Phœnicia's commerce was largely marine, the inland traffic of the Phœnicians was also extensive and valuable. Their commercial relations with their neighbors, the Hebrews, were highly profitable to both peoples.

But the trade products of Palestine differed widely from those of her maritime neighbor.

The territory of the Jews was in great part a fertile plain, yielding barley, wheat, cotton, and flax; and affording pasturage to thousands of sheep, whose fleeces were much sought by traders. Phœnicia exported timber, glass, cloth, metal goods, glassware, pottery, and carved ivory.

The conquests of David extended the boundaries of the Hebrew kingdom northwards to the Syrian desert, and southwards over the land of Edom to the Red Sea.

On the shore of this body of water, Solomon built the ports of Elath and Ezion-geber. He also founded the famous city of Tadmor, called by the Greeks Palmyra, or the City of Palm-trees.

The name of this city shows that it owed its existence to the oasis in which it flourished. The ruins of that great mart of trade still attest its former grandeur.

Baalath, or Balbec, was enlarged and fortified by the same wise merchant-king. The Greeks gave it the name of Heliopolis, — the City of the Sun. Its splendid palaces and temples, now, of course, in ruins, must have been marvels of human art in stone.

In founding those ports and cities, Solomon was not without a purpose. His subjects had as strong a bent for overland trade as the Phœnicians had for sea commerce.

The Hebrew ruler's care for Palmyra and Balbec proves that the traffic between Babylon and Phœnicia was under the control of the Jews. The most important caravan route then in existence ran through Palestine.

Elath and Ezion-geber were open to Phœnician merchants. These active dealers brought the wares of India and East Africa to the Red Sea ports, and the Hebrews conveyed them thence overland to Phœnicia.

The Jews traded extensively with Egypt also. The zenith of Hebrew prosperity was reached in the reign of Solomon, who, we are told, "made silver to be in Jerusalem as stones."

Transport by sea, in lessening the labor, time, and cost of procuring goods from distant countries, gave new life to commerce, and widened its scope vastly.

The Phœnicians were the first sailors. A thousand years before the beginning of the Christian era they had long been accustomed to navigate the Indian Ocean.

According to the Greek historian, Herodotus, they doubled the Cape of Good Hope about 600 B.C., sailing around Africa in a three years' voyage of exploration. They had visited the tin-mines of Britain and the amber coast of the Baltic before Saul, the first king of Israel, had begun to reign.

To acquire wealth by any and every means, just or unjust, seems to have been the sole object of their traffic. The Phœnicians were always ready to buy any number of captives taken in war, in order to sell them as slaves.

Many of the great commercial cities that rose on the Mediterranean's shores were founded as convenient stations for the merchants of Tyre and Sidon to exchange manufactured articles for the raw materials of North Africa and the south of Europe. It was Phœnician thirst for gain which led to the discovery of the Madeira Islands and of the Azores.

Most of the world's maritime trade came under Phœnician control. Wealth flowed fast into Sidon and Tyre, and the population of those cities rapidly increased.

They sent out colony after colony of keen-witted and enterprising emigrants, who established new marts of commerce on both the north and the south shore of the "Great Sea." Trade and a common system of sacred rites bound the mother country and the colonies together.

Several centuries passed before Phœnicia's ocean traffic was yielded up to ancient Europe's first sea power, — Greece, a country that has produced some of the greatest men that ever lived.

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## Lesson II.

### In Old Empires.

The first traces of civilized society are found on river plains. The Nile, the Tigris, the Euphrates, the Indus, and the Ganges saw the first empires rise along their fertile banks.

Our knowledge of ancient history is, as yet, too limited to enable us to decide whether Assyria was peopled by colonies from Egypt or not ; but the industrial arts of one country closely resembled those of the other. The wedge-shaped letters used by the Assyrians were probably derived from the characters employed in writing by their Egyptian neighbors.

Nineveh, the capital and metropolis of Assyria, was one of the largest cities of the ancient world.

Trade brought wealth, respect, and power to that splendid center of Oriental civilization. But by slow degrees its inhabitants lost their energy and industry. The Medes and Babylonians made war on Assyria, and destroyed Nineveh.


*An Assyrian Picture Tablet.*

The great city of Babylon covered a large area on both sides of the Euphrates River. The territory of Babylonia was an almost rainless region ; yet, under the skillful system of irrigation practiced there, the soil yielded very abundant harvests.

If the first crop of barley raised on the Euphrates plain was allowed to ripen, the heads of grain became too heavy to be supported by the stalks. Therefore, the growing grain was cut twice for hay, before the heads were permitted to form.

Several ancient historians have filled pages with descriptions of the magnificence and vastness of Babylon, and of the wealth of its citizens. Huge walls, set with a hundred gates of brass, surrounded the city. The palace of the king was accounted one of the great wonders of antiquity.

Bricks, burned and unburned, and bitumen for mortar, were the building materials of the Babylonians. Travelers are amazed at the great numbers of mounds of brick which line the Euphrates for miles even now, though these ruins have been the quarries from which were taken the materials used to construct several large modern towns.

Babylon owed its prosperity to trade. The city was situated on the highway of the early traffic between the East and the West.

The Euphrates early became a busy artery of commerce. Food products in the greatest abundance were always ready for merchants who wanted to exchange for them East India silks, spices or gems, Arabian gold or African silver.

At home the manufacture of wool, linen, and cotton was carried to a high degree of perfection. Carpets from Babylonian hand-looms were considered to be worth more than their weight in either of the precious metals. Rank was indicated by the curious device of carrying a walking-cane adorned with carvings of certain fruits and flowers.

The first boats used for navigating the Tigris and the Euphrates were wood canoes covered with rawhide. Large rafts were also employed as freight carriers. Eventually, wind-power was enlisted in the service of trade, and sails enabled merchants to increase, with advantage, the size of their boats.

War broke out between Babylonia and Persia. Under the leadership of their renowned king, Cyrus, the Persians, captured Babylon, "the glory of the Chaldees' excellency;" and it sank to the level of the third capital in the empire of its conquerors. At the beginning of the Christian era the great city had become merely a heap of ruins.

How far back the commercial history of Egypt extends, we know not. We see through the haze of time a nation living for centuries apart from the rest of the world, and at length brought into fellowship with other countries through the persistence of Phœnician merchants, seeking opportunities for barter.

Only in the latter half of this century have China and Japan been opened to modern traders. It was the urgent desire for gain, the pressing demand for the teas and silks and beautiful pottery of those nations, that led the merchants of our own time to make effort after effort to win the privilege of admission into Chinese and Japanese ports.

Long prior to the foundation of Nineveh, ancient Egypt was a civilized land. She did not, however, enter into full intercourse with other nations till after the time of Alexander the Great.

Yet she had coasts washed by the waters of the Indian Ocean and of the Mediterranean Sea. She was united to Asia by the isthmus of Suez; and the Nile formed a grand channel of communication with the south.

The soil of the Nile valley was so fertile that, as we learn from the Old Testament, "all nations came to Egypt to buy corn [grain]." Three months in every year the country was flooded by the rising of its river, and was watered, in districts beyond the Nile's overflow, by a network of canals also.

Although the Egyptians held themselves aloof for many centuries from other peoples, Egyptian work in various arts and handicrafts was, nevertheless, of the highest order of excellence. Specimens of their pottery work now in our museums are made of fine clay, and are very beautiful in shape.

Cotton cloths, muslins, linen, and tapestry were among the products of their looms. The designs of many of their articles of household furniture show remarkably artistic taste.

Buying and selling marketable products fell to the lot of their women, while home duties were attended to by the men. In accordance with this division of work, it was the daughter, not the son, on whom devolved the duty of supporting a helpless parent.

Greek writers assert that Egypt contained at one time 30,000 cities. Large numbers of slaves could be spared from private works to be employed in rearing huge public buildings, and those colossal monuments, the pyramids, whose ruins astonish the modern world.

The rulers of the country fought hard against oblivion. The labor of millions of men was wasted in trying to render immortal the names of monarchs now forgotten; for the pyramids were built to serve as tombs for kings.

To-day the recorded conquests of those monarchs are considerd to be fables. Of all the works of Egypt's greatest sovereign, Sesostris, only the canals which he cut remain. These evidences of wisdom and skill applied to the improving of trade and commerce have outlasted his empire.

## Lesson III.

### The Land of Mind.

Greece proper occupied in ancient times about the same area as the modern kingdom. Three sides of the country are laved by the Mediterranean. The long coast-line is deeply indented, and no part of the land is more than a few hours' ride from the sea.

We possess no authentic record of the founding of Greece as a nation. We know, however, that the inhabitants of that country were the first Europeans to depart from Oriental customs in commerce and the arts.

The Greeks were imbued with a love of freedom, and were bold and enterprising in spirit. They became merchants and colonizers very early in their history. No single city ever contained within its walls wealth equal to that of Carthage or of Tyre; yet Athens in its best days reached an extraordinary degree of prosperity.

Colonists from the Greek states of Attica, Argos, and Corinth made numerous settlements on the islands in the Archipelago, and thus multiplied the marts of trade. The founding of new towns was a striking feature of Greek national policy.

Ephesus and Smyrna in Asia Minor, Cyrene in Africa, Sybaris and Syracuse in Italy, and Marseilles in France, were originally settled by emigrants from Greece.

As soon as the necessaries of life were to be had by all persons in exchange for a moderate amount of labor, a taste for comforts and luxuries soon arose. Architecture, sculpture, and pottery attained in Athens a perfection that modern peoples have vainly tried to rival.

The Greeks paid great attention also to literature and philosophy. Their work in these branches of human effort has ever since strongly influenced all productions along similar lines.

Athens and Corinth were the principal seats of commerce in Greece.

Athens was situated about five miles inland, but was connected with its port, the Piræus, by two high parallel walls. The haven which sheltered the vessels was protected from the violence of the waves by a stone breakwater. This wall was sixty feet high, and wide enough for two chariots to run abreast.

Attica's soil did not yield half enough vegetable food for home use, and grain was, therefore, the most valuable import. It came from Egypt, Palestine, and Sicily; but the main granary of Greece then was Southern Russia.

That region is to-day the chief wheat-raising district of Europe. In the markets of London and Paris, grain from Odessa is sold as low as that from New York, notwithstanding the vastly heavier grain-harvest of the United States.

For two hundred years Athens had the largest share of Greek commerce. Traders from the world's principal cities were to be seen on the streets of the Piræus. Earth's choicest products were for sale in the shops.

In return for the goods which she received, Athens sent forth objects of art, — exquisite creations of the loom, the artist metal-worker's forge, the painter's brush, and the sculptor's chisel. Oil, wax, figs, honey, and marble were also exported in large quantities.

The style of architecture named from Corinth — the Corinthian order — shows that art had attained great perfection in that city. The Romans declared that the place contained more statues than any other town that they had ever taken. There is a legend that during the conflagration which followed its capture, streams of molten silver, and of other metals, became mingled in the streets, and a new compound metal was thus made known to commerce.

But this account of the origin of "Corinth bronze" is plainly fabulous. Long before they submitted to all-conquering Rome, the Corinthians were skilled in fusing gold, copper, tin, and other metals, and in molding the famous bronze into various articles whose grace and beauty made them salable everywhere.

Many of the Greek colonial cities rivaled Tyre in trade and opulence. BYZANTIUM on the Bosphorus was so fortunately situated that its site seems to have been selected with remarkable wisdom. Its harbor is spacious enough to accommodate all the navies of the world, and is deep up to the very quays.

The city formed the connecting link between Asia and Europe. It grew rapidly from a mere fishing village into a great commercial center. For hundreds of years it was the trade metropolis of the globe.

Its caravan traffic placed Byzantium in communication with India and China, and filled its bazaars with silks, precious stones, spices, ivory, gold, cotton and linen goods, and potter's wares.

Grain and hides were obtained from Russia, furs from Siberia, fish and cattle from Mediterranean towns. The articles sent in return comprised olive-oil, coral, amber, glass and metal-work.

Under the name of Byzantium the city flourished for a thousand years. The Romans under Severus captured it after a three years' siege, and destroyed nearly all the buildings. Constantine, Emperor of Rome (A.D. 330), rebuilt it, called it Constantinople, and made the city the capital of his empire.

RHODES owed to its excellent location a commerce much greater than the island's natural resources could support.

A statue of the Roman god Apollo was set up at the harbor's mouth, and was known as the Colossus of Rhodes. 320 tons of bronze were used in the construction of this figure, which took twelve years to complete. Being 105 feet high, it was accounted one of the seven wonders of the world.

The Colossus was thrown down by an earthquake (B.C. 224), after standing fifty-six years. Fragments of it remained for nearly a thousand years where it fell.

They were bought then from the Turkish governor of the island by a Hebrew merchant. The amount of bronze in his purchase was estimated at 900 camel-loads.

Till the Romans captured Rhodes, it continued to be the chief mercantile depot of the Mediterranean trade. It was that city that developed the first system of maritime law, and that gave the commercial world the highly valuable mode of security known as marine insurance.

Colonists from Corinth founded SYRACUSE, a city that eventually became the capital of Sicily. It was one of the most famous Greek settlements. Its wealth and grandeur were the results of a wide-spread commerce.

When most prosperous, the city had a circuit of twenty-two miles. Its public buildings vied in splendor with those of Carthage.

Syracuse is famous as having been the home of the most distinguished engineer of his age — Archimedes. The siege of the city by the Romans was prolonged two years by means of the destructive engines which he invented.

Some of these are said to have been able to lift the Roman war-vessels out of the water. By dropping a galley thus raised, it was broken by its own weight.

When the city was at last forced to open its gates to the Romans, the victorious general was so impressed with the genius of the man who could construct such engines, that he issued strict orders to his soldiers to bring Archimedes, unharmed, into the Roman camp.

Unfortunately for science, the Roman warriors did not know the great philosopher. One of them, entering the house of Archimedes, found him wholly occupied in the study of a problem in geometry, and quite unconscious that the city had changed masters.

On being interrupted, he said calmly, "Soldier do not disturb me." The brutal legionary, however, thrust him through with a spear.

The source of the wealth and power of the Grecian states and colonies was a widely spread industry. But by slow degrees labor became degrading on account of the steady growth of slavery.

All the mechanic arts were finally left to be practiced by slaves. The downfall of Greece was hastened by the political vanity which followed the country's increase in riches and power. Industrial work was neglected, and commerce was allowed to decay. Therefore the Romans found the land an easy conquest.

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## Lesson IV.

### Great by Commerce.

After Alexander the Great had destroyed Tyre, Phœnician commerce dwindled away until only a few coasting vessels were left to represent the immense fleets of the past. By that time the Carthaginians had become the foremost mercantile people of the world. Carthage, the chief offshoot of Tyre, had fallen heir to the principal part of the mother city's trade.

The name Africa, first given to the Carthaginian colony, grew into use as the designation of the southern shore of the Mediterranean Sea, and afterwards of the whole continent. By the time that she had reached the zenith of her power, Carthage had extended her rule over North Africa, Spain, and the islands between the latter country and Italy.

With the citizens of Carthage, as with the Phœnicians, the love of gain was a strong passion. In order that they themselves might be left free to engage in trade, the Carthaginians had their fertile soil tilled by negro slaves, and in war employed foreigners as soldiers.

Carthage was famed for various manufactured wares, such as woven fabrics, and articles made from leather, pottery, and metal ; for the skill of her artisans in dyeing woolen textures, and for tasteful products of the cabinet-maker's art.

As the empire increased in wealth, the system of recruiting the army with natives of other lands became further developed, and slaves were carried over into Spain to work the mines there.

The commerce of the Carthaginians extended some distance along the western coast of Europe, and southwards on the Atlantic shore of Africa. But the extreme limits of the trade outside the Mediterranean were kept profoundly secret.

It is recorded that a Carthaginian merchant-vessel, voyaging to Britain for tin, was followed by a Roman ship. The captain of the former craft, finding that he could not outsail his pursuer, waited till nightfall, and then ran his vessel ashore, wrecking it. The Roman ship, eagerly following, was destroyed also; and, for the time being, the location of the rich tin-mines remained unrevealed.

Carthage paid her bold and ready-witted sailor-citizen twice the value of his vessel and cargo, and the senate bestowed on him public honors.

Cerne, an island near the Atlantic coast of Morocco, was the chief station for trafficking with the people of West Africa. Bargaining between the negroes and the merchants was done in a singular fashion.

The wares were brought ashore, and a fire was kindled. The ascending smoke was a signal to the natives to cross over to the island, if they wished to trade.

Trinkets of copper and silver, glass beads, painted pottery, leather goods, and linen were deposited on the shore by the white visitors. In exchange the negroes offered elephants' tusks, skins of wild beasts, gold-dust, and baskets of fragrant gums and resins, placing all those various articles alongside the merchants' wares, and then withdrawing to the canoes.

The Carthaginians again landed; but, if not satisfied with the proposed barter, they once more retired to their vessels, and waited on board till more gold had been added. When satisfied, they took the native products, and sailed away.

There are many references in history to this mode of silent dealing. Such a manner of trading arose from ignorance of the language spoken by the other party, and from the fear which savage tribes had of approaching strangers whose power seemed so great.

To the acuteness of Carthage's merchants the world of commerce is indebted for the invention of bills of exchange.

Suppose a New York importer should owe one thousand dollars to a London manufacturer. Now, if the Londoner were in debt one thousand dollars to some Chicago dealer, it is not at all likely that the New York debtor would be called on to send one thousand dollars to London, in order that the Englishman might return the money to New York, and have it forwarded from there to his Chicago creditor.

Both debts could be paid with much less risk and trouble. The British manufacturer could send to the Chicagoan a written order directing the New York merchant to pay the Chicago man one thousand dollars. When the New Yorker's check for that sum came into the hands of the dealer in Chicago, accounts would be squared all around.

A written order drawn by one person on another, directing that other to pay a sum of money to a third person, is termed a bill of exchange.

In Carthage the government of the empire was in the hands of a few enormously wealthy families. From them were chosen two officials called suffetes, *shuphetim*, the title which in our version of the Old Testament is translated "judges."

Among other regulations by which the suffetes were bound, was the singularly wise one forbidding them to taste any kind of intoxicating liquor during their term of office.

Three great contests were waged by Rome against Carthage. In the third war the latter power was crushed.

Unseen causes of decay, however, had enfeebled the Carthaginian empire long before the final struggle with Rome took place. Any country is foredoomed to destruction, if its people have so little patriotism as to intrust to foreigners the sacred duty of defending the state on both land and sea.

The life of a nation is industry; but the Carthaginians cast a stigma on labor by their system of slavery. The rich fields of grain, the numerous canals for irrigation, the countless olive-orchards, the fig-plantations, were results of the forced toil of negroes held in bondage solely by the fear of punishment.

When came the last conflict with Rome, the Carthaginians seemed to have no friends. This third Punic War (B.C. 149–146) ended in the capture of the city by the Romans.

They determined to destroy it. For seventeen days fire was allowed to rage in the commercial metropolis of the world at that time. When the stern warriors from Italy began their siege of Carthage, the fated city contained 700,000 inhabitants. After the conflagration had died out, only 50,000 were found alive.

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## Lesson V.

### A Warning for Us.

For a thousand years the Romans made conquest their policy. They were essentially a martial people. War, however, is destructive of the means of commerce and industry.

While, therefore, we must admit that the modern world owes much to Roman skill in the mechanic arts, and to Roman law and the extensive trade it protected, we are obliged to note that much genius, talent, and industrial ability were, by the rigor of Roman rule, prevented from enriching the world.

Patriotism, that sublime spirit which leads men to die gladly for their own land, disappeared from countries conquered by Rome. Civilization received a heavy blow when the half-savage Goths, Huns, and Vandals overthrew the Western Empire (A.D. 476). Europe was left without any strong government, and centuries of barbarism followed.

The first of all occupations, agriculture, was honored in Rome while the republic lasted. In the early days of the state even the chief rulers were farmers.

The famous Cincinnatus was plowing in his little field when the Senate's messengers came to inform him that he had been elected dictator; that is, absolute monarch of the country. Rome was at that time in dire peril from her enemies; and the people felt that some clear-brained, honest man must be granted supreme power, in order that there should be no differences of opinion as to the best method of defending the city.

In later times even Rome's aristocrats did not disdain the profits of commerce. Many of the senators and other influential persons were accustomed to engage in trade under feigned names.

As the capital of civilization, Rome was the center to which traffic was directed through a thousand channels. The city became a depot into which were brought the products of every clime. The means of payment were often the heavy taxes laid on the provinces, — all the conquered countries outside Italy, — and the booty obtained as the first spoils of victory.

Grain reached Rome from Sicily, Sardinia, and Egypt; amber came from the Baltic; tin from Britain; fine cloths from North Africa; silks, spices, and gems from the East Indies.

Products of the soil, the mines, and the forests of every nation, costly works of taste and genius — all were at the command of the city's upper classes — a moneyed nobility, victorious generals, and governors of plundered provinces. The wealth of these favored persons was squandered in a luxury so profuse that it has had no equal since.

More than one private citizen was richer than many a modern king. The extravagance of Rome was copied in other cities. Pompeii and Herculaneum, dug out of their graves of Vesuvian ashes and lava, have made known to us the lavish splendor common in the houses of opulent nobles.

The exteriors of the buildings were plain, but the interiors astonish us with the magnificence of their adornments. In one palace the floor of a room was a glass mosaic consisting of about a million and a half separate pieces arranged in 198 squares.

The subject of this most remarkable work of art was the battle of Issus, fought between the Macedonians under Alexander and the Persians commanded by Darius. Twenty-six warriors are portrayed in full life-size; and their armor, clothing, weapons, hair, and eyes are represented in natural colors.

It was a saying of Crassus, the wealthiest of the Romans, that "no one was rich who could not support an army." He himself had $7,000,000 in landed property alone.

Another Roman citizen, Scaurus, built an amphitheater capable of seating 80,000 spectators. Its half-roof was upheld by 360 costly marble, glass, and gilded pillars, and the walls were adorned with 3,000 statues.

Dining-tables were made often of solid silver. The furniture in the house of the tribune, Clodius, cost $2,000,000.

Lucullus, acting as host of his friends, Cæsar and Pompey, ordered his servants to furnish supper in the room dedicated to the god Apollo. The guests were astonished at the extraordinary luxury of the banquet. Lucullus explained that it was his custom to spend $16,000 on every meal served in that apartment.

Cæsar, when starting for Spain, in order to take charge of the government of that province, was arrested by his creditors. They proved that he owed them $8,000,000! He was released by the intervention of Crassus, who became his surety.

A short term of office enabled Cæsar not only to pay his debts, but also to acquire millions of dollars more. These he spent, on his return home, in buying votes that secured his election to a higher office, wherein he pillaged the public treasury almost at his will.

Cæsar's rival, Mark Antony, embezzled still larger sums. During the few years in which he was governor of Asia Minor, he kept for himself over $200,000,000 out of the taxes. To hide his thievery, he forced the unfortunate people under his rule to pay twice the regular amount of tribute.

Rome's chief service to commerce was the rendering of traffic safe and easy everywhere. The great work of the Romans in road-making benefited nearly every part of Europe. So solidly made were many of their roads, that portions of them still remain entire, though they were constructed 1,800 years ago.

Much of the practice of our modern banks is founded on Roman usages. The symbols which are employed to represent the principal English coins, £. *s*. *d*., are the initial letters of the names of the Roman coins called *libræ*, *solidi*, and *denarii*.

Rome had government banks, loan banks, and private institutions for lending money. Private bankers were regarded with disfavor, because the taking of interest was held to be unjust. The loan banks advanced money on land and on other property, but did not charge interest.

After the conquest of the East, Rome was flooded with ill-gotten wealth. Her citizens made display the chief aim of life. The tillage of the soil was neglected. Free labor fell into disrepute. All manual tasks were given over to slaves.

The poorer citizens refused to work, and forced the government to provide grain for them without cost. Shows and entertainments were also furnished free. A favorite holiday amusement was the spectacle of Christians being torn into pieces by savage lions brought from Africa.

At length all Western Europe was overrun by tribes of barbarians, who trampled in the dust the power of Rome. The imperial city itself was sacked, thus suffering the fate its people had meted out to many a city as proud. The downfall of the Western Empire marks the beginning of a new epoch in the commercial as well as in the political history of the world.

The decay of all the great cities of antiquity may be traced to several causes.

Trade, pursued with diligence and care, brought riches. Then the people slowly gained a taste for luxury and show. An era of spenthrift indulgence and of vain splendor began.

A false sense of security arose from success in war, and wasteful spending took the place of the wise saving practiced in earlier days. Memphis, Thebes, Nineveh, Babylon, Tyre, Palmyra, Alexandria, Carthage, Athens, Corinth, Rome, rose to greatness, and then fell ingloriously.

There is not left even one of the great nations of antiquity. People and wealth have alike vanished. Nature has reclaimed the regions where human life was formerly so active.

The garden has become a wilderness. The desert's sand has spread over the ruins of capitals of once powerful empires. Pestilent marshes occupy sites where aforetime fields of golden grain were wont to gladden the eye.

The contrast between the past and the present of those cities is so striking that we naturally ask what were the agents which produced this lamentable change.

Commerce has, in itself, no evil tendency, nor can wealth, the fruit of commerce, be charged with the destruction of the nations or the cities of old. On the contrary, their decline followed the loss of their wealth. Riches need not be misused. They may just as easily be devoted to great and noble purposes as be wasted in luxury.

Commerce and opulence should not, then, be blamed for results that arose from ill-directed human passions.

Nor did conquest really cause the decay of the great marts of trade, or of the kingdoms of antiquity. More than once were they in the possession of their enemies. Babylon, for example, was conquered successively by the Assyrians, Chaldeans, Persians, Macedonians, and Romans.

The germs of national death were to be found in the sloth, vanity, dishonesty, and love of luxurious living that pervaded all classes of the people. Nations disregarded the moral law, and therefore their ruin was inevitable. But their fate was their own choice. What solemn truth there is in the Scriptural warning that they who do not rule in righteousness shall perish from the earth !

Young Americans may learn some vital truths from the commercial history of the ancient world.

Human well-being is founded primarily on labor, and is increased just in proportion as skill and intelligence devise new means of making that labor more productive. But no genius for war, no ability in government, no vastness of territory, can sustain a nation, if the spring of all human progress, the moral law, is neglected or disobeyed.

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## Lesson VI.

### The Turk's Prize.

After the fall of Rome the Eastern or Greek Empire bridged over the gulf of barbarism between the old and the new civilization. Constantinople, safe from the hordes of savages that desolated Western Europe, kept up a large trade with Asia, and aided the conquered nations to revive art and learning.

The Middle Ages occupy a period of about a thousand years, beginning with the capture of Rome (A.D. 476) by the Goths under their king, Odoacer, and ending with the storming of Constantinople (A.D. 1453) by the Ottoman Turks. The first six centuries of that period, or the time intervening between the fall of the Roman power in the West and the commencement of the first Crusade (A.D. 1096), have been termed by historians, "The Dark Ages."

During that epoch civilization was at a very low ebb indeed in Western Europe. Priceless manuscripts of Latin and Greek works were burned; objects of art in bronze, marble, terra-cotta, and glass were destroyed; palaces and temples, colossal and magnificent, were torn down, and the flower of the Roman race perished by the sword.

Much of Europe in the early part of that gloomy time had no cities nor towns. People led a warlike, unsettled mode of life, and had but slight knowledge of the industrial arts. Agriculture was carried on very unskillfully.

The kings oppressed the tillers of the soil. The nobles who owned the land joined with the kings in maintaining untouched the vast woods and swamps of that era. Forests were needed for wild beasts, these affording the amusement of the chase to the landed aristocrats. The common people were regarded as of but little more value than cattle.

The rearing of hogs was a common occupation in the Middle Ages. The extensive woods supplied acorns, chestnuts, and beechnuts in abundance for feeding those animals. Indeed, forests were valued according to the number of swine that they were considered capable of supporting.

All farm laborers were held by the nobility in a kind of slavery called villeinage, or serfdom. The serfs began to gain a certain amount of independence about the time of the first Crusade.

The higher classes were inspired then with an enthusiastic resolve to free the Holy Land from the yoke of the Saracens, whom the Christians called infidels. Accompanied by their men-at-arms, the great barons sallied proudly forth; but on their return, humbled by defeat, and impoverished by heavy expenses, they were glad to receive help from their social inferiors.

Estates were sold to city merchants who, having remained at home, had acquired wealth by means of trade. Skillful hand-workers, who had saved some of their earnings, were enabled also at the same time to buy their freedom from their lords.

Slowly the commerce between the countries on the Mediterranean increased. It was centuries before traffic became wide-spread and active. Spain, the Italian Republics of Genoa, Pisa, Venice, and Florence, the countries of North Africa, the kingdom of Sicily, and the Greek Empire were the chief commercial nations. But the mercantile vigor of the ancient Greeks was never shown by their later descendants.

The decay which finally blighted Constantinople's commerce was due partly to the struggle for empire between the Greeks and the Turks, a half-barbarous tribe which, coming from Central Asia, had reached the Bosphorus.

The Greek emperors were unable to spare warships to guard merchant vessels across the sea. Italy soon became mistress of the Mediterranean trade.

Traders from the chief commercial cities of Italy had a portion of Constantinople given over to them. The citizens of the different Italian Republics could not, however, live as neighbors in peace.

They fought whenever they met in the streets of the city, and at sea they treated one another's vessels as pirates.

In the ninth century many of the German towns found it advantageous to open direct trade-routes to Constantinople, in order to obtain East Indian wares. The Danube River, as far as its northward turn, was made the highway of Central European commerce.

Before many years a chain of trading towns bound the Black Sea to the German Ocean. Vienna, Ulm, Augsburg, Ratisbon, and Nuremberg were some of the marts of traffic.

After Constantinople was taken by the Turks, the Eastern Empire became a thing of the past.

Trade had greatly enriched the city, splendid from its infancy. When captured, it was opulent with the wealth of ages, and adorned with monuments of Roman empire and of Grecian art. In the libraries were gathered the remains of Greek learning.

But the inhabitants of this metropolis of mediæval civilization were timid and slothful, and had shamefully failed to utilize their city's unequaled situation for attaining commercial supremacy. Lacking spirit and enterprise, they allowed foreigners to wrest away from them their trade. Then their descent into Turkish slavery was rapid.

All history teaches us that the nation which does not advance goes backward. Wealth is the mainspring of progress and the source of power. Industry is the force that creates wealth. What useful lesson should we, young citizens of the United States, draw from these truths?

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## Lesson VII.

### A Great People.

Although their country had been a highway of traffic from time immemorial, the Arabs can hardly be said to have had a national existence till, as Mohammed's disciples, they burst forth from their deserts, and subdued the nations from India to Spain.

But Arabian energy won success in the pursuits of peace also. Inspired by the doctrines of their new religion, the Mohammedans encouraged trade and the arts as works pleasing to God.

The Old Testament has many references to Arab traffic. A company of Midianite merchants journeying to Egypt bought Joseph from his brethren. When the Jews despoiled the Midianites, they took golden collars off the camels, as well as ornaments of gold from the merchants. From the prophet Ezekiel we learn that Edom controlled the land trade with Phœnicia, giving precious stones and purple cloth in exchange for Phœnician wares.

Some historians believe that Southern Arabia was the country called Ophir — the region from which Solomon obtained gold, silver, gems, and sandal-wood. Herodotus says that Arabia was the only land in which frankincense and myrrh were to be found as native products.

In the Middle Ages Arab commerce attained great magnitude. Along the North African coast there were planted numerous Mohammedan trading-stations, communicating with Egypt by caravan routes. For a time Mediterranean commerce was almost entirely under Arab control.

The capital of the Mohammedan empire was Bagdad on the Tigris River. Traders from the East and the West resorted to that city, which was then the world's most splendid mart of traffic. In commercial activity it eclipsed its magnificent predecessor, Babylon.

Indeed, commerce was attracted to every spot where the Arabs settled. They constructed highways, dug wells along them, erected inns, or caravanserais, at convenient intervals, set up landmarks to indicate distances, and established posts where fresh horses or camels could be obtained.

A common language throughout the Mohammedan possessions in Asia, Africa, and Europe helped the progress of trade. Merchants could travel the whole length of the Arab empire certain of an inn every night, and sure of being welcomed, in their own language, in every town.

Arab civilization was far superior to the civilization of Europe in the eighth and ninth centuries. London and Paris were then little more than collections of hovels, while the cities peopled by Mohammed's believers abounded in splendid mosques, and in palaces adorned with the most beautiful objects of art.

The beauty of the Alhambra, the royal palace, constructed by Moorish genius in Granada, Spain, has never been equaled by any similar building. Cordova's chief mosque was 600 feet long by 250 feet wide. 1,100 marble columns supported the roof. This splendid edifice was illuminated by 8,000 lamps, which consumed daily 20,000 pounds of oil.

The palace of Zehra was a still greater triumph of architecture. Its construction required twenty-five years, and the cost was $17,000,000. A town was built out of its ruins, two hundred years after the Moors had left Spain.

The Mohammedan emperors, the Khalifs, bestowed high honors on men of learning. Scholars from many nations were to be found in the great cities, from Bagdad to Granada.

The writings of the Greek philosophers were translated, and eagerly read. Chemistry and astronomy are much indebted to Arab scientists. To the Arabs we owe our numerical system, and the foundations of our science of algebra. The very name, *al gebra*, is Arabic, and means "the science of reduction."

Geographical knowledge was greatly increased by the enterprise of Arab traders. Their caravans ventured through Central Asia into Siberia. Commerce extended still farther east, and merchants penetrated by land to China. Gold, slaves, and skins of wild beasts, were obtained in barter from the natives of the Guinea Coast in West Africa.

One of the results of Arabian commerce was a love of travel. The sons of wealthy merchants were accustomed to journey with the caravans, and often spent months in different cities, far distant from home, in order to study under eminent teachers. A high degree of civilization was thus spread over a wide extent of territory.

Spain fell under the Saracen or Arab yoke in the year 712. The conquerors then were ruder than the Goths whom they vanquished. Crossing the Pyrenees, the Arabs invaded France, and held for some time a district at the base of the mountains. A great battle was fought (A.D. 732) near Tours, between the swarthy hosts of Mohammed and the French under Charles Martel. The Arabs were defeated with great slaughter. They never fully recovered from that blow.

The hardy Spanish mountaineers soon thereafter began a more active fight against the Moors, a fight that was kept up till lasting victory perched on the Christian banners.

Moorish history in Spain is the counterpart of the history of the monarchies of the ancient world. Wisdom and bravery produced in one age fruit that folly and sloth forfeited in the next. Under the hand of industry the land brought forth marvelous harvests.

The arid parts were made fertile by means of irrigating canals and aqueducts. Commerce aided the growth of wealth. Within half a century the wild, fierce, desert Bedouins had become a cultivated people.

By their skill in irrigation they created a new era in European agriculture. The revenue of Moorish Spain, representing chiefly the practical results of farm labor, amounted during the reign of Abderrahman III. to $30,000,000, a sum surpassing at that period (the tenth century) the united revenues of all the Christian monarchs.

We modern people could teach the Arabs of the Middle Ages but little regarding the potter's art. They surpassed all other races in a knowledge of the means of decorating walls with tile-work. The ruins of the interiors of their palaces prove that they possessed extraordinary skill in utilizing glazed clay also. Moorish ware was introduced first into Majorca, and spread thence over Italy, the name being derived from the island "Majolica."

In weaving silk and wool, and also in working metals, the Arabs attained great eminence. But all the other industrial arts of the Middle Ages were vigorously pursued. Along the Guadalquivir the villages were scarcely a mile apart. Cordova had 200,000 families within its limits.

That city, the capital of the Moorish empire in Spain, was famous for its silversmiths' work, as well as for Cordovan leather. Seville contained 130,000 weavers in silk. 400,000 persons quitted the city when the Moors surrendered.

The followers of Mohammed are required by the precepts of their religion to pay strict attention to cleanliness. Those precepts they have always carefully obeyed. In Cordova there were over 1,000 public bathing-establishments. They were free to all men, strangers as well as citizens.

Under Arab rule the commerce of Egypt and North Africa rose to a high degree of prosperity. The city of Cairo was built by the Saracens, as the Eastern Arabs were called. The Soudan was visited for the purposes of procuring slaves, gold-dust, ivory and feathers, in exchange for knives, hatchets, cotton cloth, and glass beads of Arab manufacture.

The laws of the Arabs indicate that the framers were noble, benevolent men. They regulated the price of the necessaries of life, thus vainly attempting to benefit the poorer classes. The overloading of merchant vessels was forbidden, in order to prevent their owners from endangering the lives of the sailors.

Sea-traffic was not an occupation for which previous training had fitted the Arabs; yet, considering the smallness of their vessels, the extent of their maritime commerce may well excite our admiration and surprise.

Almost every trading-port on the east coast of Africa had an Arab origin. The Arab flag could be seen in the commercial marts of Hindustan and

Malaysia. Arab merchants pushed their traffic to still more distant parts, to China and Japan.

In their distant voyages they guided their courses by a needle of brown iron, fastened on a bit of very light wood. This needle had the curious property of pointing northwards under all circumstances. An improved form of this instrument, known as the mariner's compass, has given commerce its strongest impulse, and, more than any other invention, has aided geographical discovery and ocean travel.

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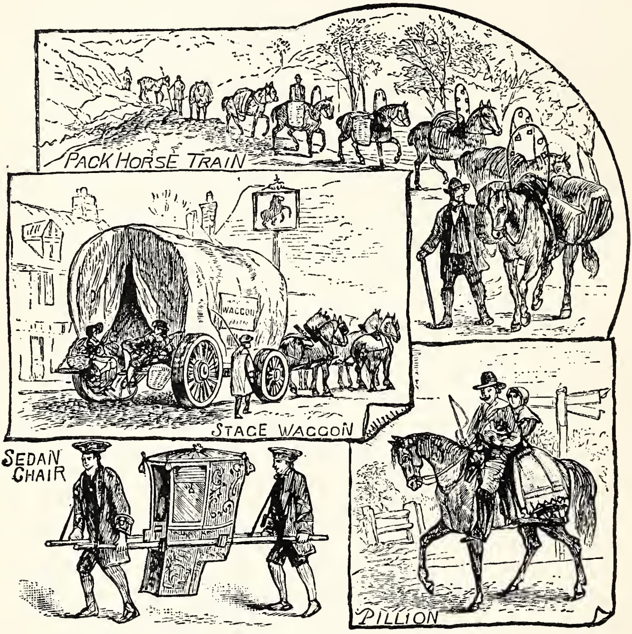
## Lesson VIII.

### In Mediæval Times.

During the Middle Ages the carriage of goods from place to place was often attended with much danger. The main roads were, in many countries of Europe, usually beset with robber knights, who, aided by their men, plundered the merchants whom they chanced to meet.

Those aristocratic thieves often combined to build strong castles out of a common fund; and, relying on the safety afforded by their strongholds, they defied the trading-towns. The emperors were, for many years, unable to clear the roads of the bands of highwaymen, so numerous and powerful had they become.

Occasionally companies of them turned sea-robbers, and their piracies on the German Ocean




*In the Middle Ages.*

and on the Baltic Sea almost put an end, for a time, to commerce on those waters.

To improve the lawless state of affairs within the realm of Germany, the rulers of that land took possession of the cities. A governor for each one was appointed. In the center of the market-place of every town a cross was erected; and on each cross there was fastened a glove, as a token that fighting was forbidden by royal order.

To protect their trading interests, several rich towns united. They hired soldiers to guard the wagon-trains of merchandise sent from the flourishing cities of Germany or Holland, perhaps, to Venice or Constantinople.

The North German towns formed a union that rapidly grew into the most powerful commercial alliance of the Middle Ages. It was called the Hanseatic League, because its members at first were *hanse* cities, or towns having guilds or societies of artisans. Lübeck was the head of the League.

An astonishing success marked its history during the fourteenth and fifteenth centuries. Wherever its warehouses were raised, there commerce throve. The League's care extended to both land and sea traffic. Novgorod, Bergen, Bruges, London, Bordeaux, and Leghorn were some of the Hanseatic foreign members.

Each city was called upon to furnish its quota of men and money to resist unjust taxation, and to punish offenders. Apprentices to mercantile pursuits were sent to Bergen, then the chief commercial city of the Scandinavian Peninsula.

In accordance with the half-barbaric customs of the times, those lads were compelled to undergo the cruel ordeals of "the fire, the smoke, and the scourge," as a part of the training then believed to be absolutely necessary to make a capable merchant.

So strong grew the League, that it did not hesitate to wage war against nations, whenever its own interests called for that final mode of settling quarrels. In the latter half of the fourteenth century, Denmark, then the strongest power in Northern Europe, was completely defeated by the Hanseatic forces.

In order that the League might have troops ready for service at all times, the noblemen and the most distinguished private citizen of each Hanse town trained themselves for cavalry service, while the poorer classes formed the infantry. They were armed with cross-bows, battle-axes, and spears.

In addition to their home militia the larger cities kept paid troops. These were not only employed against German robbers, but were also sent to sea quite often to chastise the pirates, or to fight against the naval forces of foreign countries.

Mercantile book-keeping was, in the Middle Ages, merely a record of purchases and sales. The modern system of credit, the system on which most of to-day's vast trade is conducted, appears to have been unknown. Bills of exchange were not used, and the precious metals had to be carried to and fro in the same manner as ordinary merchandise.

What benefits for commerce were obtained by the Hanseatic League? Security and peace, the vital needs of mercantile prosperity. Kings were taught to keep their hands off the property of their subjects. The common people learned that in union there is strength, and that much can be gained by honorable conduct in business.

Merchants had long felt the need of a code of laws to guide the conduct of men at sea, to decide the ownership of wrecks, to regulate war practices relating to captives and prize vessels, and to settle various questions as to the rights of ship-owners and sailors.

Delegates of the League met at Wisby, the chief trading center in Sweden, and adopted a body of laws, the principles being gathered from the earlier maritime code of Rome. The laws of Wisby were obeyed for many centuries by the sea-traders of Europe. Indeed, the spirit of those laws breathes through all the maritime codes of the present time.

The Hanseatic League arose when much of Europe was half-barbarous, and the will of the strongest was law. In helping to make commerce safe, the League acted as a powerful civilizing agent; but gradually the evils which hampered trade disappeared.

The nations grew wealthy. They formed armies and navies. Traders traveled by sea and land

*Ships of the 14th Century.*

without dread of pirates or robbers. Each city of the League could obtain all needed protection from its home government. By the close of the sixteenth century the League had fallen to pieces, having outlived its usefulness.

Distinction among the nobility in the Middle Ages was measured by the size of their estates in land, and the number of vassals. War was the chief mode of enlarging landed possessions, and bands of idle retainers were kept, ever ready to obey the behests of their lords.

The human intellect was darkened by prejudices, superstitions, and ignorance. The soldier's trade was considered to be the only one worthy of honor. For several centuries master and slave were equally uneducated.

Moorish civilization began to rouse Europe from its trance of ages. One century had sufficed for an obscure tribe of Arabs, called Saracens, to conquer more of the world than had ever owned the sway of the Romans. The advance of Mohammedan power in Southern Europe excited political fear and religious hatred.

Slowly the nations of Europe came to believe that it was their sacred duty to drive the infidels from the continent, as well as to rescue Palestine from their control. Much good was the result of the Crusades. It was about two hundred years after the first one was started (A.D. 1096) before Western Europe fitted out its last army of the Cross, vainly hoping to sweep the Saracens from the Holy Land.

The period of the Crusades saw many important social changes in Europe. The rough Christian soldiers were brought in contact with Arab refinement. They also caught glimpses of the high civilization inherited by the Greek Empire from Rome. Cities increased in wealth, population, and manufactures. Learning commenced to revive, and more liberal ideas were diffused throughout Europe.

The Crusaders were astonished to find that the resources of their own countries bore no comparison with those of Asia. In the West but little more than the necessaries of life were obtained from the soil. Only grain, meat, and salt were to be had in abundance. Fruits were but few, and were far from being as fine in quality as the same varieties of fruit to-day.

For clothing, linens and woolens were the only fabrics woven. Cotton and silk were worn as seldom as diamonds. Our most common spice, pepper, was valued at seven times its weight in gold.

Having become used to Arab civilization, the Crusaders spread throughout Europe a taste for articles of luxury. The trade with India rapidly increased. Silks, gems, ornaments made from the precious metals, spices, damaskeened sword-blades, rugs, porcelain ware, and objects of art, became more common in European marts of traffic.

As religious hatred died out, treaties of commerce were framed with the Saracen rulers of North Africa, and the Turkish chiefs who controlled the overland routes to Persia and the East Indies. Thus trade was extended and improved. The effect on the land traffic of Europe was remarkable. Every Mediterranean port served as a center for the diffusion of the fruits of labor.

The wealth arising from industry and trade was distinguished from landed property by being termed chattels or movable property. The traders and craftsmen in cities, who were naturally anxious to retain the produce of their own labor, learned to take advantage of the necessities of their lords, and to demand more freedom when their masters called on them for aid.

About the end of the thirteenth century the barons and other lords had become reduced in numbers and resources ; the power of the kings had increased, and there had arisen a wealthy middle class, destined to govern Europe thereafter.

The Crusades effected several reforms. A severe blow was given to serfdom, or the right claimed by the owners of the land to hold in a kind of slavery all their work-people. Labor was raised to a higher level in men's esteem. Towns won rights and privileges from kings and nobles, thereby greatly benefiting merchants and mechanics. Personal property, or movable goods, became a source of power equal to real estate.

European manners and customs have ever since been influenced by the refinement then borrowed from Saracen civilization. From the Arabs the Christians learned of the existence of the priceless treasures of Greek and Roman poetry, history, and philosophy. Men ambitious to become learned went to Southern Spain in order to study in the Moorish universities.

It was the Arabs that discovered the value of the pendulum in regulating machinery for marking time. They were the founders of modern physical science. In their chemical researches they sought long and patiently to discover those secret forces of nature which seem to rule all material things.

Intelligent Europeans began to understand that the learning, commerce, and industrial arts of their time were confined within boundaries too narrow for the spirit of progress. Travel and acquaintance with different races had widened the limits of human thought.

Inventions and discoveries that have changed the course of human industry mark this period of history. Gunpowder, first made in Europe (A.D. 1280) by the Englishman, Roger Bacon, or by the German, Berthold Schwarz, rendered old weapons of war useless. From the introduction of this powerful substance is to be dated the origin of standing armies.

Copernicus, a native of Poland, gave a strong impulse to astronomy, by proving that the sun is the center of our solar system. This truth had been taught nearly fifteen centuries before by the Greek philosopher Pythagoras, who learned it from the Egyptian priests with whom he studied. The opponents of Copernicus advocated the erroneous doctrine that the earth is the center of the universe, the sun moving around our planet.

Mediæval commerce resembled ancient commerce in being centered in cities that eventually became seats of political power. But in the Middle Ages trade procured commodities from an area more extensive than the ancient world, and in their distribution sea traffic took a more prominent part.

Land transport was slow, difficult, and costly. It enriched only the towns situated directly on the great routes of trade, and lost importance as soon as Vasco de Gama's fleet found its way to India around the Cape of Good Hope. The discovery of America by Columbus gave a new direction to commerce, and sealed the doom of the capital of the commercial world of his time — Venice.

## Lesson IX.

### Advantages of To-day.

The use of the steam-engine to propel vessels has given rise to a water commerce representing a value beyond the grasp of the human mind. Every large seaport has now swift and easy communication with every other one. Change in the means of transport brought about changes in the old modes of buying and selling. When producers were their own travelers, and went from market to market with their wares, as merchants and dealers, production was slow, and intercourse between distant parts was difficult and irregular. The start given to industry by improved ways of traveling made it better for the producer to employ agents to effect the exchange of goods, while he kept to his own division of labor at home. This method created trade correspondence, in which speed, safety, and cheapness were of vital importance. To trust letters to the hands of strangers requires so much confidence on the one side and good faith on the other, that the government has always taken the whole control of the mails. Orders for goods, samples, books, and parcels are also sent through the mail; and the articles are distributed with a rapidity unknown in a previous age.

To the post-office as a help in production, we have to add the telegraph, which, by sending commercial information with lightning speed, stimulates industry in a wonderful manner. Wherever a want exists, the telegraph tells whence it can be supplied, and active minds are on the alert to supply the goods needed. Formerly in France, for example, famine raged in one province, while there was food in plenty in another province; but no interchange could take place because of the roughness of the roads.

In England, a small harvest has many times raised the price of bread till it got beyond the reach of the poor, while it took months to produce sufficient food supplies. Such calamities are not possible now; for the moment a want is foreseen, wires flash an account of it to Europe, the Indies, and Australia, and the want is met in far less time than it used to require to make it known even at home. The tendency of rapid correspondence is to give life to commerce.

The carrying trade has grown to such vast dimensions, that even the packing of goods is a separate craft. The business of transporting packages by express is large enough to engage the whole attention of gigantic firms; while lesser carriers undertake similar duties confined to short distances.

In all these examples of human labor, we witness the same principles in action, and draw from them instructive lessons. We see intelligence in the work of production, creating wealth in ever greater abundance, while the untiring forces of nature are brought forward, at the command of science, to relieve the army of laborers from manual toil.

Thinkers set millions of skillful hands in motion. We can see the extremes of industry. A motley swarm of swarthy slaves, urged by the lash, draw a huge block of stone for many weary miles over Egypt's burning sands, without, by so doing, adding a loaf to their scanty fare; and, in our own country we see the locomotive speeding along, drawing its train of cars laden with the produce of the earth, enabling the dwellers in every zone to share the blessings which nature gives to each.

In backward order we trace the means of import and export of goods to the men who deliver the coal for the steamer, the merchants whose orders they obey, the train which brings the coal from the mine, and the pitmen who dig the coal. If we consider a sailing-ship, we see that the riggers who supply the sails, the sailmakers who cut, shape, and sew the canvas, the buyers and growers of the hemp fibers, are not separate and independent producers, but are linked together in a chain of labor.

Further, while men navigate ships, they need to live; but neither food nor clothing can be got at sea. These necessaries are provided beforehand; that is, they are saved from the past by the forethought of others.

The meat-canner in Chicago co-operates with the grower of corn in Iowa; the cotton-planter of Texas with the cloth-worker of Massachusetts, in order that the vessel shall be well provisioned. The sailor proceeds on his voyage in full confidence that those workers will continue to provide for him while he is away, and that stores will be ready for his next voyage, while society remains as it is at present.

Our ocean liners are splendid homes on the deep; fitted with princely luxury, adorned with works of art, lighted with electric lamps, supplied with fresh viands and dairy produce. The resources of science are drawn upon to secure our ease and comfort. Telegraphs improve our land communication, and cables flash messages under the sea.

The comforts of even an artisan's home to-day were quite unknown to our forefathers of a few centuries ago. Glass windows, papered walls, whitened ceilings, carpeted floors, painted woodwork, and useful books were to them perfect strangers. Tea and coffee and cocoa had not ap-appeared; sugar, spices, tapioca, potatoes, corn, wheat, rice, currants, and raisins, formed no part of a European's food.

Most of the fruits which are now so common had not then been imported; while silk, satin, cotton, or muslin had not taken the place of the native wool. It is only since the invention of printing that most of the progress of civilization has been made. Through the printing-press, men in one country learned what was being done in another. The steam-engine has brought all parts of the world together in trade.

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## Lesson X.

### Then and Now.

What a contrast there is between the present facilities for transportation between Europe and America and those of years ago! Now, from either side of the Atlantic, there are daily departures of large, well-appointed steamships. The ocean "greyhounds" now land passengers at Queenstown or New York within a week from the day of sailing, and the longest transatlantic voyage can be made in a fortnight.

The voyager has a roomy, well-ventilated stateroom, a liberally appointed table, with liberty to indulge in as many meals as seasickness will allow, the food generally being in keeping with the surroundings, and on a par with the fare at a first-class hotel. He has plenty of space to move about in, without coming in contact with his fellow-passengers.

If he desires privacy, the 300 feet of promenade deck, and the limits of his large stateroom, permit him to isolate himself. If, on the other hand, he wants company to relieve the monotony of a sea-voyage, he can always find some congenial fellow-traveler among the 500 passengers. In fact, a European voyage to-day by any of the standard lines partakes largely of the nature of a luxury of travel.

The great size and power of the present transatlantic steamer make a long passage almost impossible, unless by accident to the machinery.

The arrival of many of the steamers can be gauged to hours. In winter, when strong gales are common in the North Atlantic, if the sea is not too heavy, twenty-four hours will cover all delays on the voyage. When steamers are bound eastward, the westerly and north-westerly winds common on this coast in winter are potent factors in shortening the passage.

The surroundings of the emigrant on the voyage are very far in advance of the conveniences afforded by the old packet-ships. The saloon passenger has better attendance, has luxurious stateroom fittings, and a more dainty bill of fare; but the comfort of the steerage passenger also is assured by legal restrictions imposed on the vessel.

He must have so many cubic feet of room, and a proper quantity of wholesome food. He is debarred from taking his promenade on the quarter-deck, but there is plenty of room forward on these big steamers; and so carefully does the law protect him, that he receives a better return for his passage money than the saloon passenger gets.

The accommodations for passengers on the old packet-ships were much more confined, owing mainly to the smaller size of the vessels. Those ships were of the very best, so far as regards hull, spars, and fittings. In the first cabin there were generally twenty staterooms, comfortably furnished. The fittings of the second cabin had but little to recommend them. The occupants had, however, the privilege of a table to themselves, and were entirely separated from the steerage passengers. The steerage occupied the whole of the space between deck.

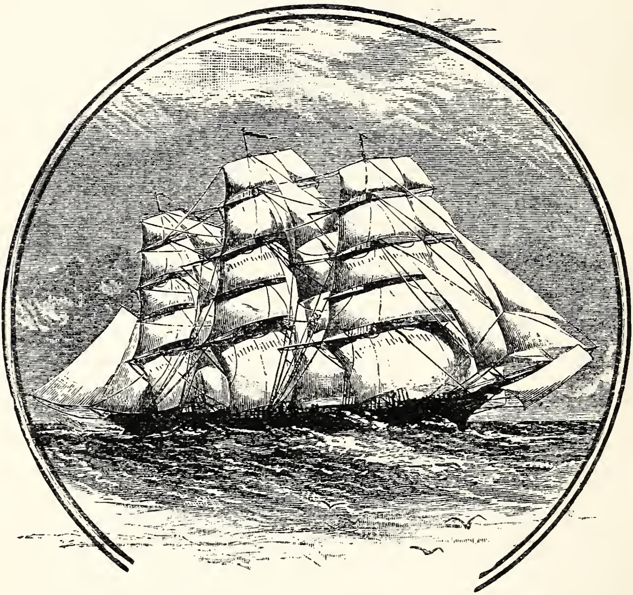
Three weeks either way was considered a good run, and in the winter time ninety days have been consumed in the western passage. The ship might reach soundings on our coast, and be even within sight of Sandy Hook Lightship, when suddenly a heavy north-wester might swoop down, and drive her before it, perhaps hundreds of miles.

She would then have the perilous task of beating back again to Sandy Hook against a heavy head-wind, the thermometer being down to zero perhaps. Contrast that misfortune with to-day's experience of certain arrival, thanks to the steam-engine!

The progress made in railroad traveling since first the locomotive appeared is wonderful. The European passenger of to-day, who in his youth came to this country in the steerage of one of the old packets, can see greater progress in the accommodations for passengers now available by any of the European steamers. The old packet-ships filled all the wants of transit in their day. They are no longer a necessity. Progress has put steamers in place of them.

In their time those sailing vessels were the pride of the New Yorker, and a credit to our merchant marine. They all were American. No foreign flag ever flew at the peak of a first-class packet-ship out of New York. No foreign vessel ever competed successfully for the trade we had made successful.

To-day the improvements in steam machinery, securing greatly increased speed with less expen-



*Merchantman.*

diture of fuel, is forcing into the rear rank many of the steamers which not long ago were considered perfect. It has been shown that the United States can build and equip steamers equal to any afloat in their adaptability to the wants of our domestic commerce. May the time be near when the American flag will be seen at the peaks of the finest steamers in our European trade!

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## Lesson XI.

### The Kernel's Story.

A KERNEL of corn was thrown into a bin of wheat in an Atlantic steamship bound for Antwerp. And as the corn kernel lay there, it recognized a kernel of wheat near by as one that had lain beside it for a whole weary week on the floor of old Farmer Brown's granary out in Kansas.

They were old friends, and had grown up together on the same broad prairie, within half a mile of each other. As chance would have it, a farm-hand swept them up from the floor, and tossed one into a bin of corn and the other into a bin of wheat, and soon after each one was shoveled with millions of its fellows into a wagon, and then was put into a car for the ride of 1,200 miles to the seaboard.

The journey had been disagreeable, but the kernel of corn had had by far the most eventful time. It was not in a happy frame of mind; for it was wan and haggard, compared to the plump, fat specimen it was when it resided in the farmer's granary.

"Yes," said the kernel of corn to the kernel of wheat, "matters went well enough until we reached Buffalo. I did not mind being shoveled into the car, but when we got to Buffalo we were pitched out by a couple of men with a steam shovel, and we fell headlong into a big iron box at the bottom of an elevator.

"Big buckets on an endless, moving belt picked us up, and before we knew it, we had been taken up sixteen stories, I think, to the top floor of the elevator, weighed and dusted, and started on our way down again through an iron pipe. We lay for a few days in a huge bin, with about 70,000 bushels of other kernels of corn, and then a gate was opened, and down we went into cars and canal-boats through a long iron pipe, called a *leg* by the men in charge of it.

"The lower, open end of the leg was moved about on the car, back and forth, while millions of kernels of corn shot through it, until the car was packed full. Boards were put up by the door, as fast as the car filled, in order to keep us from spilling out.

"The leg gave a lurch, and I was flung into one corner of the car, while a friend who had been with me went spinning to the farther end. We shall never meet again. When the car was full the door was closed. The car was backed up, and shoved ahead again, and I was told that we were in a train bound for New York.

"There were many miles of cars in long trains from Kansas, Nebraska, and Missouri; and in Buffalo I saw also many schooners and propellers from Duluth, Chicago, Milwaukee, and other ports on the great lakes. All of the grain was unloaded into the big elevators, and then was reloaded, on trains of cars and canal-boats, for transportation to the seaboard.

"Some of the cars came to New York over the New York, Lake Erie, and Western Railroad; others over the West Shore, and still more cars came by the New York Central. Next to the Central, the Erie Canal carried the largest amount of grain, and some of the boats came through to New York from the lakes.

"My next stop was at the great elevator of the New York Central Railroad, in the metropolis. We were forced to wait a long time before our car was uncoupled from other cars, and was switched first on one track and then on another. The train was divided into two parts of ten cars each, and then each half was run into the big elevator, filling it from end to end. There was room for another train in the elevator, but the space is used for loading cars with grain for the Central or the New England States.

"When the train was in there, the door of our car flew open, and men with steam shovels that were worked from the outside, and were attached to a rope which draws them up to the door of the car and then lets them slide back, hustled us out. I, however, dropped to the bottom of the car, and might have remained there had not a boy with a broom swept out the car, and sent me along with the other kernels. It was the gentlest treatment I received on the whole journey, and it saved one of my eyes, I believe.

"I fell through an iron grating into an iron box which was under the ground-floor of the elevator and was as dark as a pocket. The box will hold the contents of several cars. The elevator is 160 feet high, and we were carried by a bucket-belt up to the top floor in a hurry.

"They had cleaners up there, and scales that can weigh 70,000 bushels at once. We fell first into a garner, right above the scale-bin, and had to wait there while a lot of wheat was being weighed.

"The garner is not so large as the scale-bin, and is so arranged that it can be filled while the scale-bin underneath is being emptied. There is therefore no interruption in the unloading and loading.

"After a while we heard a rustling sound, as if something were giving way beneath us. It was the scale-bin being emptied. When the noise stopped, there was a click, and away all we kernels in the garner went down into the scale-bin. It was an awful fall, and made me dizzy.

"I saw a kernel of wheat trembling on a board that projected a little way into the scale-bin. He was scared half to death, and said that he had been shifted from one bin to another for about a week, and had learned that there are about 250 bins — with a total capacity of 1,500,000 bushels — in the building.

"As he passed out of one bin into another, he was whisked through the cleaner, and was shaken down into one sieve after another, until he lay half conscious on the floor. Before he recovered from his fright, the poor little thing had been picked up and weighed and measured half a dozen times, and hurled headlong down a leg, or tube, nearly 100 feet into a canal-boat.

"He thought that his troubles were then ended, but they had only begun. Some one inside the building decided that the boat would have to be unloaded. The agony of the change, he said, was dreadful. First, the boat was moved to the south end of the elevator. There was a 'h-e-o! h-e-a-v-e!' a clanking of ropes and pulleys, when suddenly the long marine leg of the elevator, with its endless belt of buckets, was ruthlessly thrust into the canal-boat, and began its work.

"Some of the little kernels of wheat were crushed, and all were terrified. The man with the shovel was on hand again, gathering them up from the ends of the boat; and before they knew it, they were all up on the top floor of the elevator again, ready to be weighed and sent through the bins once more into a train of cars bound for New England. The marine-leg was pulled up out of sight when the boat was emptied; and when I saw this little kernel, he was heartbroken at having been left behind by his companions.

"He was a whole fortnight in that elevator; sometimes on the floor, at others in grain-bins; and once he was tossed onto a man's hat-brim, where he lay until he was shaken off into a strange bin of wheat. He told me about a big belt which turns all of the machinery in one end of the building.

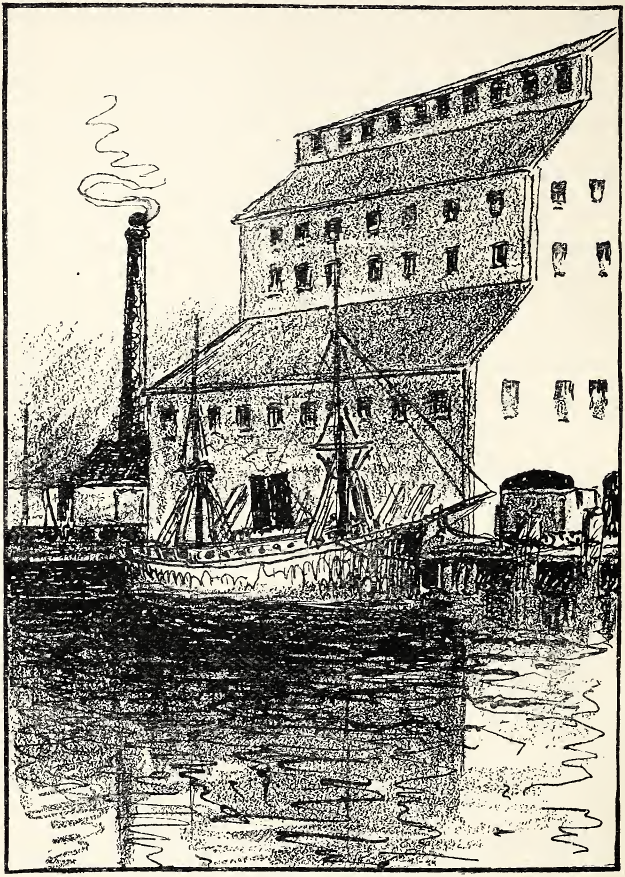
"The belt is 300 feet long and 4½ feet wide. It weighs 2,800 pounds. On the top floor this belt turns a shaft extending the entire length of the building. The shaft is connected with the lofters, which have belt-buckets that do not extend to the bottom floor, and are used in shifting grain from one bin to another, or in sending it through the cleaner into the big hopper above the scales.

"Beneath the hopper he noticed a leg that turned around, so that when the grain runs out of the hopper, it may be sent into any one of the twenty bins at will. This feat is done by putting the mouth of the leg into any one of many shafts all arranged in a circle. One shaft was marked 'S. 4,' meaning that it would lead to shipping-bin No. 4.

"Another was marked 'R. 6,' receiving-bin 6, in another part of the building, and the grain from the hopper could be sent into any bin. The wheat kernel also discovered nineteen endless bucket-belts, running from the ground-floor of the building to the top.

"I learned, upon inquiry, that each one of these belts will raise 5,000 bushels of grain in an hour. On the west side of the elevator, toward the river, are nineteen legs, by means of which canal-boats are loaded. A marine leg is kept in the north wing of the building for unloading canal-boats, when such work is necessary on that side of the elevator.

"There are five scales, with a capacity for weighing about 70,000 bushels of grain each. And from each of the legs on the east side, 1,400 bushels of grain may be poured into a car in five minutes. The flow of the grain is regulated by a gate, and the leg can be swung back and forth so as to



Grain Elevator.

fill the car evenly. Between 100,000 and 200,000 bushels of grain go through the place every day.

"Some of the grain is cleaned before itis weighed, and shafts and buckets on belts are very conveniently arranged for sending it from one end of the building to the other.

"The kernel I was talking to told me that one day being on a man's hat-brim, he rode unnoticed into the scale-room office.

"Along one side of the office is a blackboard, having an outline of the plan of the interior of the building painted on it. The receiving-bins and shipping-bins are connected by chalk marks, showing which ones may be immediately connected for the shifting of grain.

"Below the blackboard are squares numbered after each of the 250 storage-bins in the elevator. Red wheat in red chalk, corn in yellow chalk, green wheat in green chalk, wheat in white chalk, and oats in purple chalk were marked on each square to represent the number of the bin to which it refers.

"Only two of the bins were empty last week, and the superintendent could tell in a twinkling, if he received an order for a number of bushels of any kind of grain, in just what bins he could find it. And below this blackboard was a table covered with marks that looked like a schoolboy's formula for finding the least common multiple.

"By those marks he could tell just what belts and machinery he would have to connect in order to get the grain into the big shipping-bin where it is weighed.

"While he was talking, the scale-bin was emptied again by a man who pulled a gate open, and I left the heartbroken kernel, and was whisked down through a dozen bins without stopping, except to catch my breath. Early one morning, after I had rested half the night, we had to go again.

"This time it was into a canal-boat, or lighter, which was to take us alongside an ocean steamer. Down a long leg we went. You never saw such a fall, and the grain poured out of the leg just as water flows out of a pipe. The dust was suffocating. I struck the side of the boat, and lay on the deck for a moment partly stunned.

"One man held the end of the leg down through which the corn was falling. He had a rope about the leg, and pulled on the rope to guide it. First it filled up one side of the boat and then the other. Another man with a shovel wallowed in the corn on board. He wore a muzzle on his face that made his head look like the head of the biggest one of Farmer Brown's hogs. The other kernels of corn were frightened.

"We were soon pulled out into the river, and were then anchored alongside an ocean steamer. A tug towed a lot of boats hitched together.

"Some of them were left beside 'tramp' steamships. Others were dropped alongside big passenger boats. The boat which I was on was left by this Antwerp steamship, and it was not long before we were on board. But we had to go aboard another vessel first, an elevator boat. And it was the seventh time I had been transshipped since I left the farm.

"At last a tugboat with an elevator built on it, reaching up higher than the side of a vessel, came along, and began to wedge its way in between us and the ocean steamer. Soon after I was swept into the hold of the canal-boat.

"The elevator boat ran a long leg down into the canal-boat, such a marine leg as I told about being in use at the Central Hudson elevator. Then the powerful machinery that is used to move the tug was applied to the machinery in the elevator, and the buckets on the belt began to pick up the corn in the canal-boat at a terrific rate.

"On the elevator floor below the top one there was a brief wait, while we were weighed again, and then we went spinning down into the bottom of a ship's hold. Above the scales was a cleaner; but our lot did not have to go through that, as we were cleaned at the Central elevator. The tug-cleaner is used chiefly for grain that comes on from Buffalo all the way by boat.

"The elevator on board the boat has all the appliances of the railroad elevator, but the ship's hold is the bin into which the corn is sent. When I got down here, severely bruised, I found the steamer's hold divided into bins, some for wheat and some for corn.

"The elevator-leg was swung to and fro. First one bin was filled, then another, just as the freight-cars were filled at Buffalo, and men with shovels evened the grain. In tramp steamships, in which there are no bins, men have a harder time to trim the hold with their shovels.

"When the top is dressed evenly, boards are laid on it, and on them barrels of flour are placed, so that the grain will not shift from side to side, and perhaps not shift back again, when the vessel rolls dangerously. Tramp steamships are in great peril when this accident happens in rough weather."

"Are we going to be hauled out of here in the same way?" asked the wheat kernel, deeply interested in his fate.

"Yes; I guess in about the same manner, when we reach the other side," answered the corn.

"You have no idea of the amount of grain shipped from the United States this year," the kernel of corn said. "As I was sailing down the North River on a canal-boat, I saw the big West

Shore elevator at Weehawken, nearly opposite the Central Hudson elevator — where we went through. It has a capacity of 1,250,000 bushels, and is taxed to its utmost every day.

"Farther down I saw the Erie elevator, in Jersey City, about the same size as the West Shore, and half a dozen smaller private elevators. All of them are rushed with business, being filled up from cars from the West, and emptied again into ocean steamships every day.

"Why, I heard two men say that the export of grain from New York was nearly four times as much as last year. One said that the Central road has brought more wheat from Buffalo than the Erie Canal! Ships enough cannot be found to carry all the grain, so great is the anxiety to obtain the high prices now offered for it in foreign markets. The American grain-dealer never before had so prosperous a year."

The kernel of wheat then told about his voyage from Buffalo on a canal-boat. The trip was only a trifle less exciting than the kernel of corn's experience. He made the bold assertion that a canal-boat will carry as much grain as several cars, showing that 800 bushels of grain, the average for a car, weighs about two tons, while a boat has a tonnage of 100 tons, and even of bulky grain it can carry more than a dozen cars.

Each of the kernels wanted to go where he could do some good in relieving the wants of humanity, and in this generous missionary spirit they both bade the United States good-by.

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## Lesson XII.

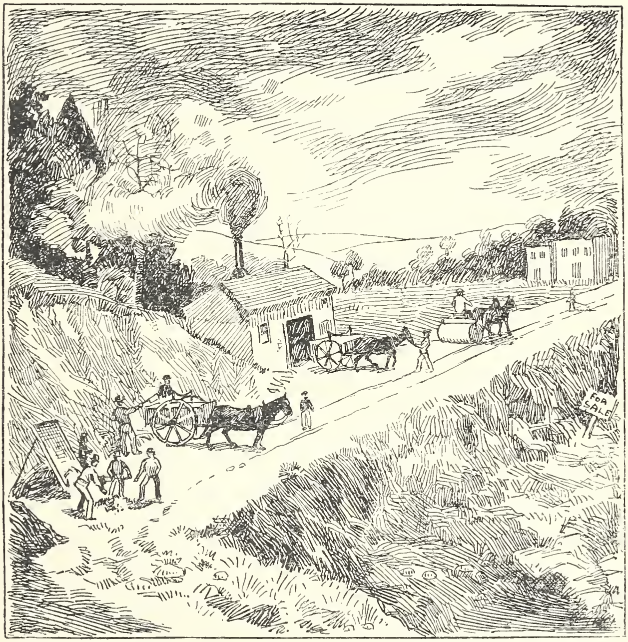
### Highways.

The French Revolution of 1789 is one of the great landmarks of history. It is the date from which we reckon recent as compared with modern progress. The United States had just gained their independence, and started on their marvelous career. Steam had just begun to assert its power, and self-acting machinery to compete with manual labor. Political, social, industrial, and commercial life took a new departure.

War set many skillful hands to work, and productive industry was active beyond example. Increase of wealth meant increase of interchange, and this led to improved means of carriage. Road-making became a study.

Macadam's method of road-making proved of universal benefit. It rendered traveling comparatively pleasant, and the carriage of goods more easy; it saved animal labor, and led to the construction of lighter and better vehicles. Country trips began to be a source of pleasure, and lost their old character of perilous adventure, calling forth courage and powers of endurance.

It would be as hard to meet now with young or




*Road Construction.*

old who do not travel, as once it was to meet with the daring who had ventured far from home. Intercourse causes distinctions of manners, customs, and dialects to disappear, and places the Western States on a level of material, social, and mental advantage with the communities of the East. This fact explains the abundance of merchandise in the most remote inland villages.

On the European Continent, Napoleon, like former military conquerors, cut roads for his armies, and left a network of highways over mountains and plains, finer than ever had been seen before in Europe.

Friction is the main difficulty to be overcome in the carriage of merchandise. A log dragged along a rough road requires a force to be spent that would lift the weight of the timber. Mounted on wheels, it might be drawn at a tenth of that cost of power, owing to the removal of friction.

If the wheels fit into a grooved track of iron, the friction is further reduced, and, if the points of contact be lessened by rounding the rails, the friction is reduced almost to nothing. This principle has its limits, because there must be enough surface in contact for the wheels to "bite" as they roll, or the vehicle would not move forward.

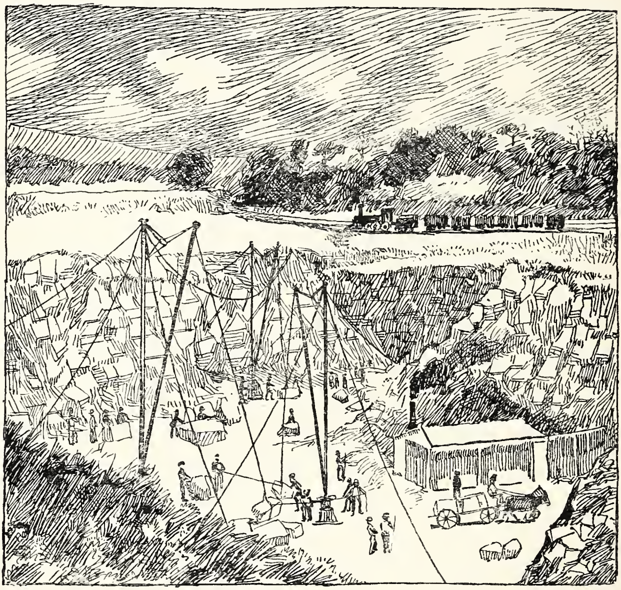
Thus a certain of amount friction must remain. Beyond this amount, the force for draught need only to be sufficient to conquer the inertia of the weight or burden ; that is, the resistance which all bodies at rest offer to a change of state. When speed is sought, as well as mere movement, the resistance of the air has to be taken into account.

Road-making is an art confined to civilized countries. As population increases, there arises a stronger demand for good roads, in order that the products of industry may be readily exchanged. Roads exist only where people live in fixed habitations. Nomad tribes, like the half-wild Arabs of the desert, whose worldly substance consists simply of their horses and tents, know nothing of roads.

Railways have taken the place of roads as the chief means of transit between centers of trade; but the produce of every district must still reach the railways by means of roads. As brooks, by uniting, conduct the water of a wide space to some river, so merchandise is conveyed by the highways, before it pours into a railroad for transit to distant parts.

The greatest road-makers of ancient days were the Romans. The work of Roman engineers in road-making and embanking has never been surpassed. By the forced labor of convicts and slaves, Rome constructed a grand system of highways, radiating to the chief Italian towns.

In their careers of conquest, Roman generals made it their first concern to lay out a system of roads for the rapid marches of their legions; for it was by force that Rome maintained her supremacy over conquered states. The plan of road-construction pursued by the Romans did not differ much in principle from the art as practiced now. The foundation of the road was made by a "pitch" of large stones, bedded evenly. These stones were covered with concrete, broken stones, and gravel.



*Stone Quarry.*

The Gothic Ages were not favorable to road-making. The blow given to civilization by the barbarous tribes who destroyed the Roman Empire left its trace in the destruction of many a Roman work of science and art.

Cortez and Pizarro found in Mexico and Peru a complete system of highways. Prescott the historian describes one of those roads. It passed over the chain of the Andes, and was nearly 2,000 miles in length. The road was built of freestone, cemented with bitumen, which in time became harder than the stone itself. Sierras were cut through, rivers were crossed by suspended bridges, and difficulties that would appal modern engineers were overcome.

As European towns grew in number, and industry began to flourish, the want of better roads for the transit of goods was much felt. Little, however, was done during the turbulent reigns of the mediæval monarchs. Even when wheel-carriages were brought into use in Elizabeth's time, and stage-coaches in the reign of Charles I., the old horse-tracks were rendered barely more than passable. It was not until 1715 that any serious work in road-making was attempted.

General Wade employed his army in the construction of 800 miles of highway, in order to gain easy access to the Scottish Highlands, and to subdue the Highland chiefs, whose fastnesses had always before been secure from approach. The advantages which those roads conferred on the country, when peace once more settled upon the Highlands, were so obvious, that a powerful impulse was given to good road-making throughout Great Britain.

The last one we should think of to set at making a road would be a blind man. Strange to say, however, the pioneer of English road-making was a blind man of Yorkshire, named Metcalfe. This shrewd, ingenious, resolute engineer was one of the many illustrious examples of men whose mind and industry have triumphed over afflictions which, if they had fallen on other other men, would have proved fatal to their success in life.

Metcalfe was engaged from 1765 to the close of the century in designing, surveying, and laying out many of the most important turnpike roads in the north of England.

The present century is the great era of road-making. While Macadam, humorously called the Colossus of Roads, was rendering traffic easy and expeditious, and saving animal labor, by his use of small angular pieces of hard stone, spread on the road, another great road-engineer, Telford, was carrying out his own system in other parts of England.

Both Macadam and Telford began their careers in Scotland, and extended their operations southward. Scotland owes to Telford nearly a thousand miles of highways, opening up the country by a complete road-system, designed to connect the inland parts with the great towns and the fishing-stations on the coast, and to develop the resources of Scotch industry.

Considerably over a thousand bridges were required in the work, owing to the hilly and rugged nature of the country. Telford's line of roads between Shrewsbury and Holyhead is a part of the means of communication between London and the Welsh coast, and is regarded as one of the finest pieces of road-making in the world.

Telford's mode of road-making was copied from methods of the Roman engineers. His first object was to level the bed. Then he laid a solid pavement of stones, carefully cross-bonded, and on this pavement a layer, seven inches deep, of stones, each broken small enough to pass through a ring of two and one-half inches in diameter. Over this layer he strewed a quantity of gravel to fill the spaces between the broken stones.

The result was a firm and solid road which stood for many years without needing much repair. Macadam's roads did not receive the same care and attention. His loose coating of granite was left to grow solid by means of the traffic. Men were set to rake over and to fill up the ruts formed by the wheels of the vehicles. Constant use tended to round the angles and edges, and to convert the stones into smooth pebbles which could not bind.

A depth of three or four inches of moving substance was good for neither road nor passengers, horses nor vehicles ; but was a source of discomfort and annoyance, injurious both to hoofs and springs. Draught was immensely increased, and horse-power wasted. What must the roads have been before, when England went jubilant over Macadam's triumphs of road engineering!

The cost of labor made the macadamized roads, though cheap at first, as costly in the end as the more thoroughly constructed roads of Telford; because material is always cheaper than labor. Macadam's measurement of the broken stones was "the size which the stone-breaker could get into his mouth."

In the present age we are so used to the comfort of good roads, that we view the making of a road as a very simple matter. Road-making is really a great art, based upon science, and requires, in every one of its stages, the most careful calculation.

The fact that, in the history of road-making, we read the names of only two or three eminent engineers, indicates that the art calls for a kind of genius with which few people are gifted. Not merely must the surface be solid and uniform, so that rain cannot penetrate from the top, but the foundation must be of such a nature — of concrete, for example — that the earth cannot be forced up through the road material.

Another important matter is the curve given to the road to carry off the rain to the sides. If too much curved, the road wears badly, and the wheels


*Street Paving.*

of wagons which roll over out of a vertical position tear the surface of the road. Only in the center of such roads can vehicles stand upright, and the whole of the traffic, therefore, passes along one track, and soon produces furrows.

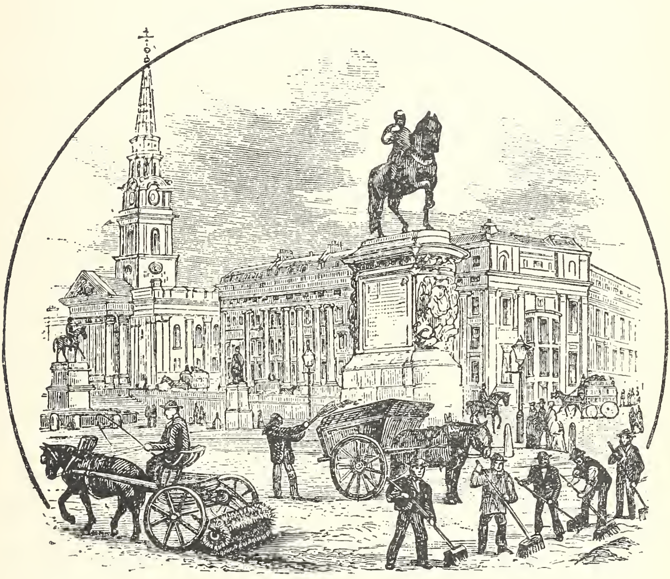
Macadam allowed a fall of three inches, from center to side, in a road eighteen feet in width. Telford, in a road thirty feet wide, adopted a fall of six inches from center to side — the center being flatter than the center of a Macadam road, and the slope greater, as it neared the sides.

Roads being made to render locomotion easy by reducing the traction or drawing force, the question of inclines has to be taken into account. The weight of a load simply rests upon a level road, and the exertion of the horse is directed to overcome the inertia, or the resistance from rest to motion.

The force to overcome this inertia has been computed at 8 lbs. to the ton on a railway, 33 lbs. on a well-made pavement, 46 lbs. on Telford's roads, and 147 lbs. to the ton on a road of earth covered with a thick coating of gravel.

In drawing a wagon-load over a hill, the horses have to do work equal to raising the whole weight to the hill's top, and in the descent, equal to holding back this weight from the same height. The change of effort from one set of muscles to another set affords the animal some amount of ease and rest. To manage properly the slope of a road, requires the practical judgment of a skillful engineer. The general rule in road construction is that the road-slope should be so made that a carriage on the road would not roll down of its own accord. A gradient of one in forty; that is, a rise of one foot to every forty feet, is on good roads the right slope. The more nearly a road approaches this slope the less is the traction.

Traction depends, in the first place, upon the weight of the load to be moved. It varies also with the character of the road. The better the



Street Cleaning.

road the less is the traction. Narrow tires cut up the road, and are, therefore, very detrimental.

Enough has been said to convince us that intelligence holds the same important part in the business of road-making that it holds in every other department of human industry. Let us trace the action of the mind in the hardly less important art of road-repairing. Let us learn a lesson which all the facts of practical life teach, — that it is our duty to strive after knowledge (which is only another name for wisdom) to guide us in whatever branch of industry it may be our lot to labor.

Where there is very heavy traffic, the wear of the hardest roads is continuous, and converts stone quickly into mud or dust. The granite-paved streets of Boston lose two inches in the course of a year. The cubic blocks of stone, therefore, though six to eight inches thick, could last for only a very few years. Long before this period would have expired the surface of a street would be in hollows, and would require to be relaid.

Traffic does not destroy a road more rapidly than mud, which keeps the wind from drying the road in wet weather, and which in summer turns into dust, thus becoming a source of discomfort to both human beings and animals. Only next in importance to good construction, therefore, is the necessity of keeping the roads clean.

Brooms, and manual labor in road-cleaning, have given way to ingenious machines, which do much more work at far less cost than hand-labor. Circular brushes, made to revolve by gearing attached to wheels, and capable of cleaning 15,000 square yards in an hour, sweep the street refuse into lines beside the courses of the machines.

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## Lesson XIII.

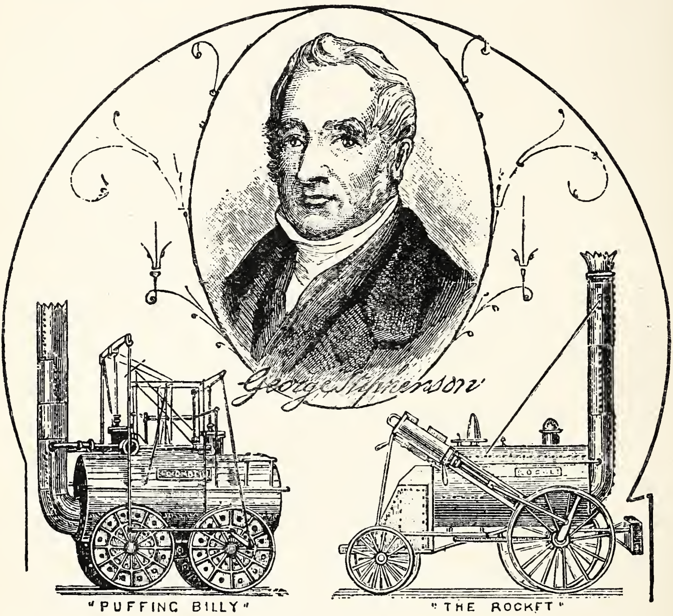
### The Strongest Worker.

The first locomotive came into practical use in 1804. Twenty years before, Watt had patented — but had not constructed — a locomotive engine.

The application of steam to drive carriages was first suggested by Robinson in 1759. The first locomotives were very imperfect, and could draw loads only by means of toothed driving-wheels, which engaged teeth in rails.

The teeth were very liable to break off, and the rails to be torn up by the pull of the engine. In 1813 the important discovery was made that toothed wheels are unnecessary; for it was found that the "bite" of a smooth wheel upon a smooth rail was sufficient for all ordinary purposes of traction. But for this discovery, the locomotive might never have emerged from the humble duty of slowly dragging coal-laden wagons in mines.

The progress of the locomotive in the path of improvement was, however, slow, until about 1825, when George Stephenson applied the blast-pipe, and a few years later adopted the tubular boiler. These were the capital improvements which, at the famous trial of locomotives near Manchester, England, on the 6th of October, 1829, enabled Steph-




*Early Locomotives.*

enson's "Rocket" to win the prize offered by the directors of the Liverpool and Manchester Railway.

The "Rocket" weighed 4½ tons, and at the trial drew a load of tenders and carriages weighing 12¾ tons. Its average speed was 14 miles an hour, and its greatest, 29 miles an hour. This engine, the parent of the powerful locomotives of the present day, may now be seen in the Patent Museum at South Kensington, London. Since 1829 numberless variations and improvements have been made in the details of the locomotive.

Its weight may now be 80 tons, its load 900 tons, and its speed 70 miles an hour. The boiler of a locomotive is not exposed to the air, which would, if allowed to come in contact with it, carry off a large amount of heat. The outer surface is therefore protected from cooling by covering it with a substance which does not permit the heat to pass readily through it.

Nothing is found to answer better than felt; and the boiler is accordingly covered with a thick layer of this substance, over which is placed a layer of strips of wood ¾ in. thick, and the whole is surrounded with thin sheet-iron. It is this sheet-iron alone that is visible on the outside. The level of the water in the boiler is indicated by a gauge, which is merely a very strong glass tube; and the water carried in the tender is forced in, as required, by a pump.

The power of a locomotive, of course, depends on the pressure of the steam and the size of the cylinder; but a very much lower limit is set to the power of the engine to draw loads by the adhesion between the driving-wheels and the rails. By the term "adhesion," nothing more is meant than the friction between the surfaces of iron. When the resistance of the load drawn is greater than this friction, the wheels turn round, and slip on the rails without advancing.

The adhesion depends upon the pressure between the surfaces, and upon their condition. It is greater in proportion as the weight supported by the driving-wheels is greater, and when the rails are clean and dry, it is equal to from 15 to 20 per cent of that part of the weight of the engine which rests on the driving-wheels; but when the rails are moist, or, as it is called, "greasy," the tractive power may be only 5 per cent of the weight.

Suppose that thirty tons of the weight of a locomotive are supported by the driving-wheels, that locomotive could not, probably, be employed to drag a train of which the resistance would cause a greater pull upon the coupling-links of the tender than they would be subject to if they were used to suspend a weight of three tons.

The number of pairs of wheels in a locomotive varies from two to five. Most commonly there are three pairs; and one, two, or all, are driven by the engine, the wheels being coupled accordingly; very often two pairs are coupled.

The pressure at which the steam is used in the locomotive is sometimes very considerable. A pressure equal to 180 pounds on each square inch of the surface of the boiler is quite usual. There is no reason, in the nature of things, why steam of even 500 pounds per square inch should not be employed, if it were found otherwise desirable.

It need hardly be said that locomotives are invariably constructed of the very best materials, and with workmanship of the most perfect kind.

The boilers are always tested, by hydraulic pressure, to several times the amount of the highest pressure the steam is required to have; and great care is bestowed upon the construction of the safety-valves, so that the steam may blow off when the due amount of pressure is exceeded.

The explosion of a locomotive is, considering the number of engines in constant use, a very rare occurrence, and is probably in all cases owing to the sudden generation of a large quantity of steam, and not to an excessive pressure produced gradually. Among the causes producing explosions may be mentioned the deposition on the boiler of a hard crust of stony matter, derived from the water.

This crust allows the boiler to be overheated, and if water should then find its way into contact with the heated metal, a large quantity of steam will be abruptly generated. Or should the water in the boiler become too low, parts of the boiler may become so heated that on the admission of water it would be suddenly converted into steam.

When an explosion does take place, the enormous force of the agent we bottle up in an iron vessel is shown by the effects produced. The thick plates of iron are torn like paper, and the tubes, rods, and levers of the engine are twisted out of shape.

Locomotive engines for propelling carriages on common roads have been invented by several ingenious American mechanics. Such engines do not appear to have found much favor, though the idea of a steam-driven omnibus has been successfully realized in traction engines lately introduced.

Probably the application of steam power to the propulsion of vehicles along common roads fell into neglect on account of the superior advantages of railways, but the common road locomotive is at present receiving some attention.

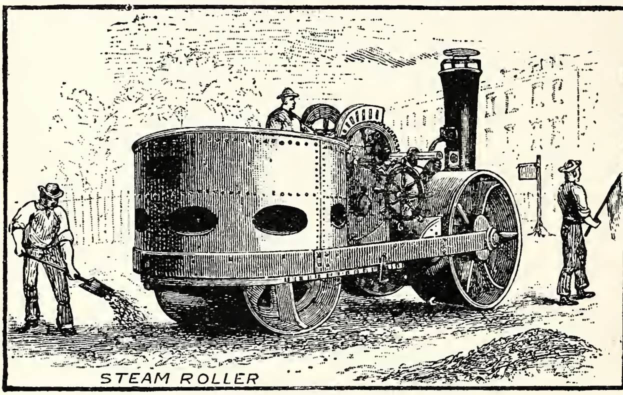
It is not mechanical difficulties that stand in the way of perfecting this system of locomotion, but the prejudices and interests which have always to be overcome before the world can profit by new inventions. The engines can be made noiseless, emitting no visible steam or smoke, and they are under more perfect control than horses.

But city authorities offer such objections as that horses would be frightened in the streets, if the engines made noise; and if they did not, people would be liable to be run over, and the horses be as much startled as in the other case. But horses would soon become accustomed to the sight of a carriage moving without equine aid, however startling the matter might appear to them at first; and the objection urged against the noiseless engines might be alleged against wagons on concrete pavements. It is now, apparently, quite probable that in the course of years, steam-propelled vehicles will displace horse-drawn ones.

The application of steam-power to agricultural operations has led to the construction of engines specially adapted for plowing and threshing. The movable agricultural engine has, like the locomotive, a fire-box nearly surrounded by the water, and is set on wheels, so that it may be drawn by horses from place to place.

Besides the steam-engines already described, there are many other interesting forms of the direct application of steam-power. There are, for example, the steam-roller and the steam fire-engine. The former machine is a kind of heavy locomotive, moving on ponderous rollers which support the greater part of the weight of the engine.

When this machine is made to pass slowly over roads newly laid with broken stones, a few trips suffice to crush down the stones so as at once to form a smooth road. Steam-power is applied to the fire-engine, not to propel it through the streets, but to work the pumps. The boilers of fire-




*Steam Road-Roller.*

engines are so arranged that in a few minutes a pressure of steam can be obtained sufficient to throw effective jets of water.

A cheap and very convenient prime mover has lately come into use, which has certain advantages over even the steam-engine. Where merely a small power is required, especially where it is used only at intervals, the *gas-engine* is found to be more convenient. It is small and compact, no boiler or furnace is required, and it can be started at any moment. As now made, it works smoothly and without noise. The piston is impelled, not by the force of steam, but by that of heated air, the heat being generated by the explosion of a mixture of common coal gas and air within the cylinder itself. Thus a series of small explosions has the same effect as the admission of steam through a valve.

We must keep in mind, when we think of the genius and perseverance of Stephenson, the father of railways, that he had no tools for turning except hand-lathes, no turn-tables, no means of lifting heavy weights, except by ropes and pulleys, and the old-fashioned screw-jack was the only machine he could depend upon for raising the engine. Such were some of the difficulties under which the first really efficient locomotive was built. When we consider the powerful appliances and tools of precision which we now possess, we must admit that our triumphs count as little, compared with those of Stephenson.

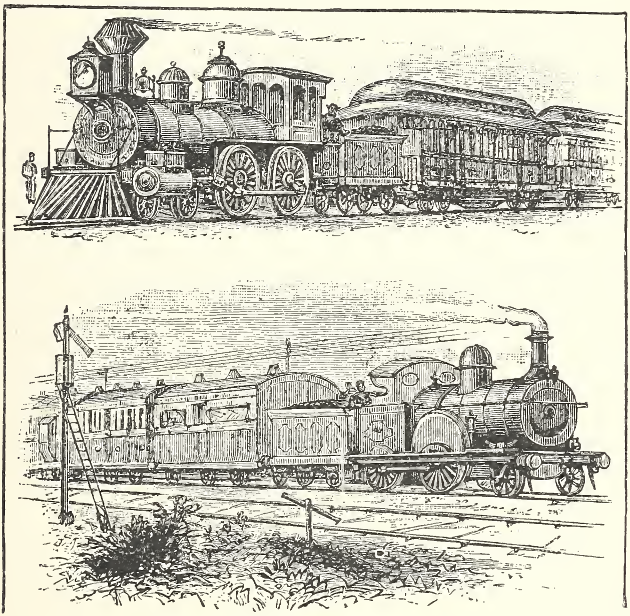
The Rocket is now in South Kensington Museum, London, where it will remain as a record, increasing in interest, — a lesson to all thoughtful boys, showing what the very humblest can do, if they put the gifts with which they have been blessed to a right use.

Railways were not used for passengers at first. Five years after the Stockton line had been built, a passenger railway was opened between Manchester and Liverpool. Then people woke to the fact that they had gained a new power. A great stride was taken by building a line from London to Birmingham. It had to overcome the determined opposition of landowners, who resented the new system of traveling by "tea-kettles," much as ignorant laborers resented labor-saving machines. Landowners are now glad to have railways running near, for they raise the value of land wherever they run.

The advantages of railway traveling were quickly seen. Stephenson's genius was as much at home in constructing railways as locomotives. He was an industrial Napoleon, who knew not the meaning of the word impossible. The Stockton and Darlington Railway, the first in existence, was of Stephenson's construction, and was the first railroad on which were used engines of six coupled wheels.

The force of steam was soon applied to vessels to ply on the rivers, and then, in a few years, steamships were built to cross the ocean. These new and swift means of carrying goods, it was thought, would render canals, ships, and horses useless. No great invention really lessens the area of industry.

The ease with which goods were carried by railroad and steamer, and the saving of time in the transit, gave such an impulse to productive skill, that more goods were made than before. Though canals suffered for a while, their use soon revived,



Railroad Trains — American and English.

and the number of inland boats, as well as draught horses, carriers' carts, and sea-going sailing vessels, increased.

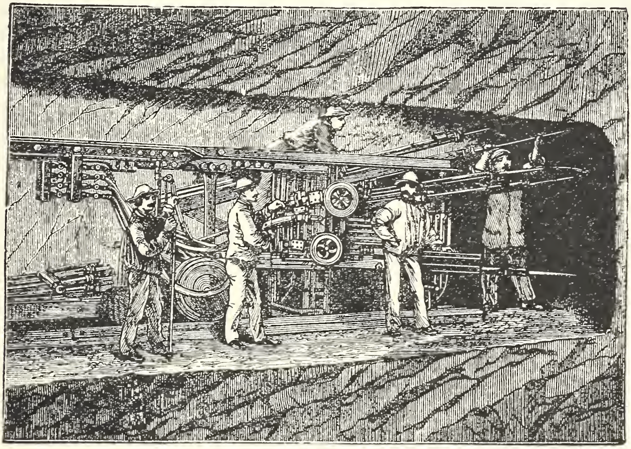
Steam transit has changed the methods of industry and commerce. Villages have grown into great cities, and new towns have sprung up by reason of the demand for labor. The desire for our textile fabrics and hardware has taught the negro kings of Western Africa that it is better to gather gold-dust and palm-oil for us than to capture and sell slaves. China feels the influence of our industrial life, and grows tea for us, in order to get our goods in exchange.

Friction in railway traveling is now so greatly diminished that for even a heavy train it is represented by a force of only a few pounds' weight, and is easily overcome at starting.

The speed of railway traveling depends largely upon the atmosphere. The resistance of the air increases the faster the engine travels. Thus, George Stephenson's first locomotive, Puffing Billy, went at the rate of six miles an hour; but, when he made an engine to go twenty-four miles an hour, that is, four times as fast, he found that the steam force he needed was not merely four times greater than at first, but sixteen times greater.

The engines that draw easily our present trains at the rate of forty-eight miles an hour, or eight times as fast as Puffing Billy, are not only eight times, but sixty-four times, stronger than that old engine. The air can act with terrific force, as the effects of a hurricane often show us; but whether an object offers resistance to moving air, or still air offers resistance to a moving object, the result is the same.

Without this resistance, railway speed could be increased almost without limit ; but with it, a point is soon reached beyond which no strength of



*Tunnel Boring.*

materials can bear the strain and wear of such an opposing force. Nevertheless, the trains on the main lines do reach a speed of sixty, and have at times exceeded seventy miles an hour.

When steam-engines were first run on rails, some opponents to railroads declared that trains never could be made to run at the rate of a mile a minute, for the resistance, of the air would tear them to pieces ; but, in this instance, the philosophers were wrong : the strength of materials was greater than the strength of their reasoning. Our engineers have proved again and again, that "impossibilities" are but difficulties to be surmounted. With genius the problem is not "Can it be done?" but "How can it be done?"

Nature yields to human genius. If the air resists with the square of the speed, our motive power shall increase with the cube. If an arm of the sea says, "No farther shalt thou come," we span it with a bridge, which laughs at winds and storms.

If a granite mountain is in our way, we bore a tunnel through it. The successors of Puffing Billy have learnt to deride the desert and the frozen swamps of the north, and a network of railways brings into industrial intercourse the whole family of man.

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## Lesson XIV.

### A Government Task.

In cities letters are gathered by carriers from letter-boxes fastened to lamp-posts or to walls, and are taken to the office. If a post-office is large enough to require a number of clerks, one is detailed for the work of getting the outgoing mail ready, and is called the mailing-clerk.

The table at which he works is termed the mailing-table, and is raised so high from the floor that he can work comfortably at it while standing. The top inclines toward the person at work, and into the table is set a large piece of rubber an inch or more in thickness.

The government requires that the canceling-stamp be of metal, and the ink black and indelible; but this rule is sometimes broken in small country offices by the use of rubber stamps and colored inks. The government furnishes all necessary stamps and ink, and the only excuse for not following the rule is that to a postmaster who handles but few letters the rubber stamp may be more convenient.

The penalty for removing the cancellation mark from a postage stamp and using the stamp again is imprisonment or a fine.

The mailing-clerk, placing a pile of letters on the table in front of him, cancels them rapidly, sliding each piece, before he strikes it, upon the rubber in the table, thus securing a good impression of the stamp, and a slight rebound to aid the next stroke.

It has become a custom which thoughtful persons observe, to place the stamp on the upper right-hand corner of the envelope; but few people have ever stopped to think what is the reason for this choice of position. The canceling-stamp and the postmarking-stamp are fastened side by side upon the same handle, and if the stamp is correctly placed, one blow makes the two required marks.

If, however, the stamp is on the lower right-hand corner, the postmark may fall on the address, while, if the stamp is on the left-hand side, the postmark, which is always at the left of the canceler, does not strike the envelope at all, and a second blow is necessary. So, if the stamp is anywhere except on the upper right-hand corner, it makes just twice as much work for the clerk; and this labor, when he is stamping many thousand pieces every day, is no small matter.

There has been in use for some time in the post-office in Boston a number of canceling-machines, into which the letters, all faced upward, are fed. These machines, if the stamps are correctly placed, do the work quite well, leaving on the envelopes the black lines which we all have noticed on Boston letters.

The Boston post-office has also, quite recently, put in operation a most ingenious machine for canceling and postmarking postal cards. Two hundred cards are placed in it at once, a crank is turned, and click, click! they fall into a basket all stamped.

The mailing-case looks like an immense wardrobe fitted up with pigeon-holes. It is set up before the mailing-clerk, each opening being labelled "Boston," "Providence," "New York," "Boston and Albany," and names of other cities or railroads. Into the first orifice are put all the letters for Boston, into the second all those for Providence, while into the one marked "Boston and Albany" go all the letters for the offices on the railroad connecting these two places, unless there may be among them cities so large as to need a separate box for each one.

Of course, the larger the office is, the more letters there will be, and consequently the need for more boxes. Boston, for instance, sends mail pouches directly to many hundreds of the larger towns all over New England, and consequently there is, in the mailing-case of the Boston office, a box for every one of those towns.

It seems to be the impression of many people that mail is gathered carelessly together, thrown into a mail-bag, locked up, and despatched. This belief is wholly wrong; for even in the smallest offices the letters and cards are all gathered face upward, and are tied into a neat package.

The government furnishes the twine to do this work; and some idea of the immensity of the postal service can be formed from the fact that in one year the cost to the government of the twine for this purpose (which, though strong, is of the cheapest quality) was nearly $72,000.

All over this great country, from Maine to California, and from St. Paul to New Orleans, every mail-lock is the exact counterpart of every other one of the many hundreds of thousands of locks; and every one of these the mail-key in any post-office in the country will lock or unlock.

Each key is numbered; and though the numbers run high into the thousands, record of every key is kept by the government, and its whereabouts can be told at any time. Once in six or seven years, as a measure of safety, all the locks and keys are changed. New ones of an entirely different pattern are sent out, and the old ones are called in and destroyed.

The story of the growth and prosperity of the postal service of the United States is a wonderful one. In 1790 there were only seventy-five post-offices in the country, and our entire postal revenue was only $25,000. Now we have 63,000 post-offices, and our postal receipts are five or six times as much every day as they were in 1790 for a whole year.

In 1833 a New York newspaper complained because news by mail from Washington was a week old when it should have gotten through in four days. The Post-office Department has a contract, dated about that year, for transporting the mails between Philadelphia and Pittsburg in four-horse post-coaches. The contractors were to run two

*Old-time Mail Coaches.*

lines a day, one to go through in a little more than two days, and the other in three and a half days. The first was the through letter line, and was the "fast mail" of that day. The slower was called the "way mail," carrying newspapers and letters for the small offices.

It was considered a great stride forward when a contract was made for an express mail between New York and Philadelphia in six hours. At that time an express did not mean a railway train, but a fast horseback service. The distance between those cities is ninety miles, and a speed of fifteen miles an hour was required. This rate was attained by running the horses at full speed, and changing them every five miles.

It took two horses each way to carry the mail, and there were eighteen changes or relays, so that seventy-two horses were necessary, and reserve animals to supply the places of horses that might be disabled. The amount paid for this extraordinary service was a dollar for each mile run by each horse.

A great portion of the way was over what was called a corduroy road, which was made by throwing trunks of trees into a marsh and leaving them to settle there.

A report explaining delay in the transmission of the mails between New York and Philadelphia states that the post coaches were "drawn for miles upon the axle-trees, so deep was the mud in the roads."

Between 1833 and 1840 a few short railroads were built, and immediate advantage was taken of them to expedite the mail service. It was many years before there was a line of any considerable length. In 1835 a Washington newspaper hazarded the prediction that the day was not far distant when travelers leaving Washington in the morning would dine in Philadelphia, and arrive in New York the evening of the same day.

The distance between New York and Washington is now run by trains in five hours. It is bewildering to think of the progress that has been made in the postal service during the last fifty years. The mails are now carried upon 160,000 miles of railroad in the United States. Postal clerks are employed on 133,000 miles.

By the old way of mail distribution all the mails were carried in closed pouches to fixed points designated as distributing-offices. At each of these the letters and packages were assorted, and the mails made up for the offices within its district. You can readily see that this plan was days slower than distribution by postal clerks between stations on swiftly flying trains.

Congress ventured in 1862 to authorize a trial of a railroad postal service, and the system was successful from the very outset. Its advantages in quickening mail communication were so apparent that the system was rapidly extended. Its growth has been marvelous. By 1867 eighteen railway postal routes had been established, with 160 clerks.

In 1890 more than 6,000 postal clerks were employed. Last year, in the discharge of their duties, they traveled an aggregate of 126,000,000 miles. The number of pieces of mail matter handled by them during that time was above 7,000,000,000!

Do not the clerks make a good many mistakes in distribution?

Not nearly so many as might be expected.

The men become by practice wonderfully expert. They do their work at all hours of the day and night, while whirling along at from thirty to fifty miles an hour. Rapidity and correctness are essential. The clerks must distribute the mails as they are picked up on the way, and must make up those which are to be dropped off.

Every mistake is recorded and charged up to the man who makes it. Last year the errors were only one to every 3,895 pieces handled.

Do not the clerks have trouble with defective and illegible addresses?

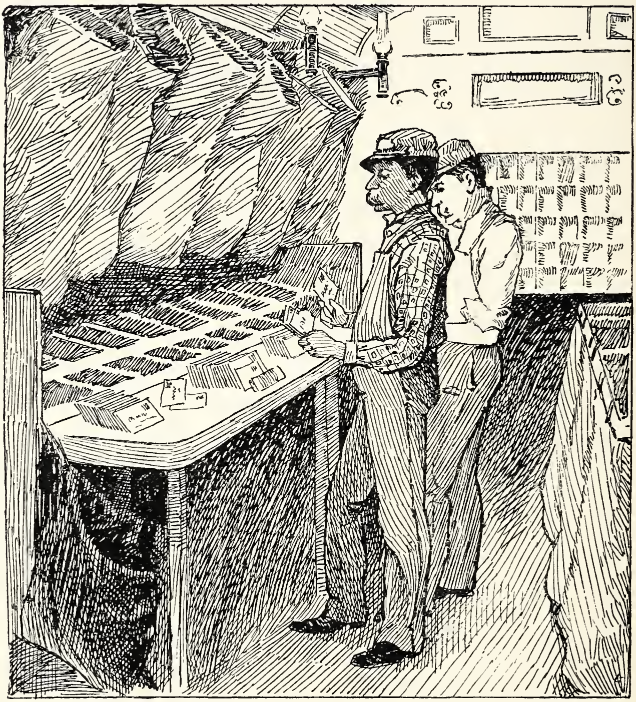
A postal clerk on a railway train cannot spend much time in deciphering an illegible superscription. If he cannot read it at a glance, he sets it aside. Letters illegibly addressed are sent to certain designated offices, where people who have more time try their skill upon them. There are experts at these offices, who succeed in making the proper disposition of about half of them. The other half they send to the Dead Letter Office in Washington.

Nearly every railroad in the United States carries, at least once a day, two or more men in the railway mail service. They receive, sort, and deliver the mail gathered at the towns along or near that road.

If there is but little work to be done, one man works alone in a small room built in a part of the baggage-car or smoking-car. As the business increases, two or more men work together, having a whole car for their accommodation. This car is drawn directly behind the engine, so that there shall be no occasion for any person to pass through Uncle Sam's traveling post-office.

With still more business two or more cars are run. Between New York and Chicago a whole train is run exclusively for the mail service. This train is made up of five cars, and carries twenty railway postmen. A line of railroad between two cities, used in this way for sorting the mail, is called an "R. P. O.;" that is, a "railway post-office," and there is an immense number of such railroad lines in the country. They take their names from the chief offices on each line.

The "New York and Chicago" is divided into three sections. On this R. P. O. run the twenty men who start out from New York, are relieved by as many more at Syracuse, and these workers in turn are relieved at Cleveland by another com-



*Interior of Postal Car.*

pany, who take the train into Chicago. Generally, however, a run is planned to be about the distance which can be covered in a day.

On all the more important lines there are two sets of men, one set for day and one for night service. If the run is a short one, with but little mail, one man does the work alone, running every day, and usually having several hours to rest at the end of his trip.

Where the run is so long that the trip takes all day, there are four sets of men. One set starts at one end of the run, and covers the entire line, meeting another set somewhere on the route, and returning the next day.

When these men have worked a week, they go home to rest a week, and the other two sets take their places. Such is the arduous nature of the work, the strain to mind and body, and particularly to the eyesight, from working all day long in a jolting car, that few men would be able to retain their positions were it not for these periods of rest.

The railway mail service of the whole country is divided for convenience into eleven divisions, all under the charge of a general superintendent at Washington. Each separate division has a superintendent of its own.

All the railway mail clerks have to go through a civil service examination. They are, however, examined with special reference to their fitness for the business. The clerks must understand the geography of this country, and be able to read poor writing quickly. These two qualifications count much more in the examination than any others. If a man is seriously deficient in them, he is not likely to make a good postal clerk.

But a certificate that he has passed a creditable examination does not give a man a position. It simply means that he is qualified to learn to hold one. He is taken on probation for six months. At the end of that time, if he has acquitted himself well, he gets a permanent appointment. If he is not quite up to the mark, but gives promise of success, his trial term may be extended three months.

From time to time, as the law provides, the permanent clerks are examined for promotion to higher grades. Those who pass have their pay increased. There is, therefore, a constant incentive to reach the highest possible proficiency. The examinations consist chiefly of the actual distribution, as if they were letters, of a large number of cards, which bear the names of post-offices. Celerity and correctness in doing this work are the talents that count. The clerks are started at $800 a year. At present the maximum pay is $1,400.

Unquestionably the railway mail service will continue to grow, keeping pace with the development of the country. In promoting speedy communication, it has conferred upon the people a benefit that cannot be measured. It is a fact that the towns and villages get relatively more advantage from the service than do the large cities.

Between the cities the mails go through direct; the greatest benefit comes from the quick distribution of the mails that are picked up along each route. The railway mail system costs something, but the government makes no expenditure that pays better.

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## Lesson XV.

### Tracing up our Letters.

When one has learned how enormous is the amount of mail pieces passing through the New York post-office every day, he is inclined to believe that it must be impossible to keep track of all the letters. Yet the system of stamping is so good, that more is known about an individual piece than might be supposed.

In the first place, letters placed in street-boxes, and letters mailed in the post-office or any one of the branch stations, are stamped differently. The casual observer would not detect this difference; but oftentimes the fact that it can be shown that a letter was or was not placed in a street-box is of great importance.

Again, letters for New York from out of town, are "back-stamped" differently from those of local origin. The mark beside the stamp shows whether or not the piece of mail was posted in the city.

Of course it is necessary that every stamp should be absolutely truthful, but many persons seem to have the idea that post-office officials do not object to making the marks on a letter tell a lie. Requests to put a false stamp on a letter are therefore not infrequent. It is needless to say that all such requests are refused.

No reliance could be placed on a stamp, if it were easy to have false postmarks put on letters. In the next place, if the false stamping were done, the post-office would have to explain why there was delay in delivering the letter.

Its own stamps would convict the office of gross negligence, which no amount of talk could explain away. Naturally, the officials do not want to get into trouble merely to do a stranger a service.

There is also a moral objection, but self-interest is a sufficient ground of action in such cases.

Sometimes the mark on a letter is important legal evidence, and a postal clerk has then to appear in court to swear that stamps are never imprinted except in the ordinary course of business. Sometimes postmarks are forged, but such imitations are generally poor pieces of work and easy of detection.

An additional safeguard against an attempt at this kind of fraud is the impression sheets on which a record of each kind of stamp in use on each day is kept. Whenever a stamp is changed, an impression of it is made on one of these sheets, and they are kept on file for two years.

By means of the impression sheets, therefore, the genuineness of a postmark made in New York can be tested with almost perfect accuracy.

The hour of the stamps in use is changed every thirty minutes of the day and night, so that the time when a letter is mailed at the post-office, or was brought there by a carrier, can be easily told. The stamps are changed on the minute, or as near it as possible.

To avoid the delay of changing figures, two sets of stamps are used, one marking the hour, the other the half-hour. At the hour one set is distributed, and thirty minutes later the other. In this way there is abundant time to shift the figures without interrupting the work of the clerks.

The stamp put on every foreign piece of mail received here by ship shows at once on what vessel it came. Mail on the first ship to get in on a certain day is marked A, that on the next ship, B, and so on. A record is kept of these letters, and the vessels to which they correspond, so that it is always easy to prove by what steamer the envelope was brought.

To avoid doubt, the same letter is not used twice in one week for steamers of the same line, even if two of the line's vessels should get in first, second, third, or fourth on different days. The date of the postmark is not always clearly printed, and this alphabetic arrangement prevents the chance of confusion.

Letters which come in the large railway mails are stamped with the number of the arrival; that is, the number by which the train is known in the post-office books.

The postmaster of every large city receives many letters inclosed in envelopes, accompanied with requests to mail the letters in his own post-office. The writer perhaps explains that he has just left the city, and came away without remembering to mail the inclosed letter.

The postmaster always obliges such correspondents, but has the envelope stamped "Received from —— under cover," and the blank is filled up with the name of the place in which the letter was first put in the mail.

Not only is the object of the sender thwarted, but his attempt at lying is revealed to the very person whom he wished to deceive. This outcome may seem cruel, but the Post-office Department cannot share in a fraud. The writer may not be a swindler, but the government will not aid him in telling a lie.

Another item about post-office methods which many persons may not know is that every piece of mail matter is counted. This counting seems an enormous task, when you learn that nearly 700,000 letters are received at the New York post-office *daily*.

The work is divided, however, so that it is really no great burden. Every stamping clerk must keep an accurate account of the number of pieces he handles, and must make a daily report of the amount of work he has done.

He must not only give the total number of letters he has stamped, but he must tell also how many reached the office by carrier, by wagon, by train, or by steamer, and how many were mailed in the post-office itself. A general watch is kept on the reports of the men, to see that reasonable accuracy is maintained.

The heads of departments can tell about how many letters a certain number of sacks usually contain, and can, therefore, readily find out when a clerk does not keep a proper count.

There is no branch of the Postal Department more interesting than the dead-letter office. People in general have only a vague idea of its importance, and of the amount of work it does.

More than 6,000,000 letters drifted into that office of buried hopes in 1891, and over 1,000,000 magazines, papers, and packages. The daily supply of "dead letters" is about 18,000. All those containing money are sent to one clerk, who keeps a record of the amount received each day.

By the end of the year the lost money sometimes reaches the snug little sum of thirty-five or forty thousand dollars — a fact proving that there are people who have faith in the postal arrangements of our country. And their confidence is not usually misplaced, as most of the money is restored to the owners. However, when there is no clew, the United States Treasury is the gainer. In 1891 over $8,000 was thus added to the government's wealth.

No doubt postmasters are sometimes at fault; but sins of omission on the part of the senders are more often the cause of loss and delay — thousands of letters are not stamped, while others have no address. Of course, no one will believe there are many of the latter class; nevertheless, in 1891 there were 27,000 blank envelopes sent to the dead-letter office.

Then, again, people are careless as well as absent-minded, and often misdirect, or only partially address letters. These of course never reach their destination, unless the clerks in the dead-letter office can supply the missing links. In 365 days over 400,000 such epistles were received.

So it would seem that a thorough knowledge of cities and towns, as well as patience, practice, and considerable shrewdness, is necessary to correct the blunders of the writing public. Who but a dead-letter office clerk would imagine that "Bill Town," Kansas, was intended for Williamstown in that enterprising State?

In the foreign department letters are not opened. The clerks look them over; and, if they have any information that furnishes a clew, try again to find the owners, otherwise the letters are returned unopened to the postal administration of the country from which they came.

Foreigners have a way of ignoring the States, that causes dire confusion. "St Duskin, America," was easily located at Sandusky, O., but some letters become "all tattered and torn" in going to and fro throughout the States seeking an owner.

A letter addressed to "Santa Claus, Paris, France," from Cleveland, O., read, "Please, Santa Claus, bring me a sled, a village, a doll's playhouse, and a shade for my lamp." It was returned to the dead-letter office, marked "Address incomplete."

Another from Charleston, S. C., was addressed to "Kris Kringle, Hartz Mountains, Germany," asking for various Christmas gifts. It was returned with indorsements by seventeen letter-carriers, saying that the "person could not be discovered."

What becomes of all the dead-mail pieces? The thousands of magazines, illustrated papers, picture cards, and valentines that cannot be returned to their owners are distributed, by order of the postmaster-general, among the inmates of the various hospitals, asylums, and other charitable institutions of the District of Columbia. So those "dead" posted articles serve a good cause, carrying brightness into many weary lives, and happiness to little waifs without a home.

Although every effort is made to find owners for the various things that drift into the dead-letter office, so many packages remain unclaimed, that an auction is held at the end of each year. It is a sort of departmental house-cleaning. No other sale in our capital city draws such a crowd as Uncle Sam's annual sale of dead-mail articles. The packages are sold unopened.

The museum of the dead-letter office always interests visitors. There they see what extraordinary things people try to send through the mails. There are two big axes on exhibition, which look formidable enough, and cause practical sightseers to wonder whose purse was long enough to pay postage on such weighty articles.

A hitching-post, a loaded revolver, and a belt of sleigh-bells form a trio of curiosities most unexpected among mail pieces. An Indian scalp and a skull are very appropriate relics for Uncle Sam's cemetery, but they must be uncanny objects to find in a mail pouch. Among the odd things which attract general attention is a letter from the far Northwest — a curious epistle, for it is written on a large shingle.

Snakes are but a few among the many specimens of the animal kingdom that reach the Department in "dead-letter" packages. Live centipedes and tarantulas, horned toads, and Gila monsters, contribute to this lost freight. Small alligators from Florida not infrequently make their appearance.

A mail-bag slit with a knife bears an interesting history. In 1885 a mail-carrier named F. M. Peterson was attacked by Apache Indians while on his regular route from Lochiel, Arizona, to Crittenden in the same Territory. The savages, after shooting him, and cutting him in pieces, slit open the leather sacks he carried, and tore all the letters to bits in search of money, finally leaving behind them the bag in question, which even now shows dark stains made by the victim's blood.

Another curiosity which was lost in the mail is a glass box that was postmarked "Vicksburg," and bore on the outside of its brown-paper wrapper simply the words, "Vicksburg is taken."

No brief list could summarize the innumerable strange things that have fallen into the hands of the dead-letter office clerks. There are bottled specimens of minerals thrown up by the Charleston earthquake, boxes of cartridges, percussion caps, quantities of fire-crackers and torpedoes, false teeth, corn-husking gloves, kitchen utensils, carpenter's tools, horns, tambourines, banjos, harmonicas, and gold-headed canes.

Many of the objects accumulated come under the "unmailable" head, being made of glass, or being "pointed instruments," which might damage the mails. Bottles or surgical tools are not carried by Uncle Sam, unless they are inclosed in wood or tin. One hundred dollars' worth of gold-dust in a box came in a short while ago. A damaged silk hat, which had no address, and a grotesque doll about the size of a child, are among the dead-letter office's curiosities. There are some gloves from the steamship Oregon, which were one hundred and fourteen days under water, though they seem to be in fair condition even now. Some wedding-cake fifty years old is exhibited.

In the new postal museum we may see the official costumes of foreign letter-carriers, specimen letter-boxes, miniature mail vehicles, superb photographs of foreign post-offices, statuettes representing people engaged in transporting mail after various fashions, and many other interesting sights. There is a set of figures in *papier-mâché* from India. One of them shows a postal runner in British India, carrying a bag of letters, and holding in his left hand a long spear, from which little bells dangle.

The weapon is for his defense against the wild animals that infest the jungles through which he is obliged to pass, — though one would think it a poor tool for coping with a tiger,— while the bells are intended to frighten cobras, kraits, and other venomous serpents. Another statuette presents the same runner in the act of paddling across a stream on a raft made simply of four big corked jars of earthenware fastened together. Other mail-carriers are seen riding on camels, which travel eighty miles a day, or are seated in light carts drawn by Indian buffaloes over rough roads on which horses would be useless.

There is to be seen a model of the negro postal runner of South Africa, who bears a letter in a split stick, which he plants upright in the ground when he pauses to rest. He consumes little food, but his endurance is wonderful. He carries the letter in the manner described so that it will not get greasy. While swimming with one hand across a stream, he holds the missive out of the water with the other. The architect of the Post-office Department building once said that he regretted not having placed a statue of this primitive mail-carrier above the main entrance to the edifice.

Another type of postman shown is the messenger of Scriptural times, frequently referred to in the Bible, who conveyed royal messages by word of mouth. It is wonderful to read how swiftly information or orders were transmitted in this way across the country, every man being obliged by law to run to tell the next person along the line of communication.

The Bedouins practice this method of conveying intelligence at the present day. If there is news for an individual, each one who hears it communicates it to his neighbors, and they spread it in every direction, until finally the man is found for whom it is meant. Japan has now as good a postal system as that of the United States; but fifty years ago a letter addressed to anybody in Japan usually bore only the name, with no address whatever. The missive reached the intended recipient from hand to hand, either directly or by a method similar to that just described.

Other models in the new museum represent the wonderful postal couriers who carry royal messages in China. They are the most rapid riders in the world, and have been known to make the entire distance of 3,000 miles from L'hasa, the capital of Thibet, to Pekin in twenty-five days. They have a right to seize by imperial order any horses on their routes, no matter to whom the animals belong.

One hundred miles a day is about their average rate of travel. They eat and sleep but little. Before leaving his point of departure, each courier has his dispatches placed in the lining of his robe, which is sealed upon his person so that he cannot open the garment during his journey.

The work of these Chinese couriers reminds one somewhat of the famous pony-express that used to make the distance of 2,000 miles in ten days, from St. Joseph, Mo., to San Francisco, over the roughest sort of country. Daring riders, each traversing his allotted distance, simply transferred the mail-bags from saddle to saddle, so that the entire journey was one long gallop. There was always great danger from bandits and wild Indians.

It is rather interesting to note the photographic illustrations of the primitive manner in which mails are carried even nowadays in northern Michigan, where the transport of the United States post is the work of dogs. In teams of six, they draw sledges carrying letter sacks over wintry snows.

Other interesting methods for conveying the mails are illustrated by the miniature reindeer sledges such as the Russians use on routes in Siberia, and by dog-teams, sleds, snowshoes, and skates, all of which are employed in Norway and Sweden.

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## Lesson XVI.

### Used in School.

From the slate-quarry to the school-room is a straight road, for Nature has done all she can to make the work of the quarryman, and the men who prepare writing-slates and blackboards, as easy as possible. Nature must have had the future misery of school-children in view when she began to make slate.

This is the manner in which she set to work. She deposited on the floor of the ocean, beds of fine mud into which iron was introduced to color it blue, green, purple, gray, or black, as the case might be. Then, there being a rocky deposit below, another was placed above. The upper bed, in quarryman's parlance, is "ribbon."

Then came another rock formation, another deposit of fine mud, then another "ribbon," and so on until it was thought sufficient slate had been deposited to supply the school-children of the world with writing-slates, and the teachers with blackboards till Doom's-Day. The next step was to make the slate accessible. Earthquakes were brought into requisition. Up popped the slate deposits from the bottom of the sea.

It was during this upheaval that Nature produced what is called slate-cleavage. Without cleavage slate would be useless for cheap educational or roofing purposes. The cleavage planes, along which the rock splits, are quite distinct from the planes of original mud deposits, though sometimes parallel to them; but, as a rule, the planes of cleavage are inclined at angles of from fifteen to forty-five degrees to the planes of original deposit. This cleavage must have occurred after the beds were deposited at the bottom of the ocean, and it is held by the most eminent geologists that it is the result of pressure during the uplift.

But at the same time and through the same causes the quarryman was supplied with other allies to assist him in his zealous work for education; namely, the joints. The joints are fissures forming division planes. They afford the quarrymen the greatest assistance in getting out blocks of slate.

But nature did more than supply slates on which hard problems in arithmetic could be struggled through by young hopefuls. She supplied them as well with slate-pencils. The edge of a piece of slate drawn across a slab of the same rock will produce that gray powder which has so often displayed our knowledge, or betrayed our youthful ignorance. And to make the manufacture of slate-pencils all the easier, there are districts where cross-cleavage has occurred in the slate strata, and there the pencils are made from the natural production.

But man has learned to make slate-pencils also from the compression of various materials ground together, and some children have learned the bad habit of biting them. The Greeks and Romans, although they used to import tin from Cornwall, evidently knew nothing of the great deposits of slate in Britain, or they would not have written their letters on waxed tablets.

Tradition has it that slate was used for roofing some of the Welsh castles built in the ninth century, but who discovered the writing-slate and blackboard neither tradition nor history relates. In the fifteenth century some of the Welsh quarries had, however, become famous for roofing-slates. It speaks well for American enterprise, that England, which has enormous slate quarries, and exports $6,250,000 worth of roofing-slate to Europe every year, imports for her own use similar slate from the United States.

Like their first cousins, the miners, quarrymen get so accustomed to the use of explosives that they become careless in handling them. It is a common item of news in a mining or quarry camp to hear of experienced workmen putting cartridges of giant powder into an oven to dry, or throwing dynamite cartridges about their cabins. It is not often that they have a chance to repeat either proceeding.

Yet we notice that yonder quarryman puts the stick of giant powder into the bore in the slate rock, and begins tamping away with an iron rod. The giant powder having been driven home, he inserts a dynamite cap with a copper wire attached to it, and the bore is filled up with blasting-powder, which is also tamped. The reason that ordinary blasting-powder is used, as well as giant powder, which is the same as dynamite, is that the former explosive drives upwards, while the later works destruction in a downward course.

The wire fixed to the dynamite cap protrudes a few inches from the bore, and is attached to the ends of two other copper wires which connect with a battery. In cases of small blasts, quarry-men use a fuse. Now the driller climbs up the side of the quarry, and seeks a place of safety above the battery. The electric circuit is completed, and the explosion takes place.

Out of the mass thrown by the blast, which has fallen down the quarry's steep side, men carefully select and sort out all the good blocks weighing from five hundred pounds to three tons a piece. Iron chains are attached to these blocks, which are drawn up out of the quarry by a carriage running along a cable to the top of a derrick. Then they are taken in a car to the slate shanties, there to be shaped, split, and trimmed.

The block-maker, with the aid of a steel chisel and hammer, shapes the block, and reduces it to the size required. To do this he cuts a nick on each side of the block in the shape of a V. He then splits the block in almost a straight line.

The blocks are now handed over to the "splitter," care being taken to keep them wet; that is, to keep in them the quarry water, otherwise it would be impossible to split them. The "splitter" sets the block on end, the left side resting against his knee.

He takes a thin chisel about two inches wide at the base, and twelve inches long, tapering to a point. This he sets on the upper edge of the block, and, tapping the top of the handle gently two or three times with the mallet, wedges the chisel into one of the slaty cleavages, and splits the slate through as evenly as if it had been sawed. For roofing-slates, about five of these splits are made to the inch.

The "dresser" then takes the slates, yet irregular in shape, in hand. He first places them on the edge of a block of wood, and roughly dresses them by the blows of a sort of chopping-knife, called a sax. On the back of this tool is a sharp, tapering steel point, with which the workman when preparing slates for roofing makes two holes into the slate near to the head, or upper edge, for the nails which are to hold it to the roof.

He then cuts the slate through with a long, sharp knife, which is attached to a machine worked by a treadle. The slate is cut as easily as if it were mere cardboard.

Blackboards and school slates are split in the same way as roofing-slate. They are then put on a horizontal circular rubbing-bed of cast-iron, which revolves at the rate of thirty-five times a minute, and cleanly washed river sand having been applied, the slates are rubbed down to an ordinary polish.

After this treatment they are rubbed by hand with grit, and later with pumice-stone. To make an especially smooth surface, a secret process is employed. The refuse at most of these slate quarries is ground into powder, molded and burned, and makes very good bricks of a dull red color.

Meanwhile our quarryman has been blasting away while we have been watching the processes by which man finishes off a useful material that nature has provided. The whistle at the engine-house, where a boy is attending to the running of the machinery, proclaims the hour to be six in the evening, and the quarry is soon deserted.

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## Lesson XVII.

### From Paper-Mill To Treasury.

The paper used in the manufacture of greenbacks is made in an old mill in Dalton, Mass. There are placed in the greenback paper those bits of blue and red silken threads that excite wonder in the curious. After the paper has been cut into sheets, and piled in bundles of 1,000 sheets each, it is sent to the Treasury Department, Washington. The process of the manufacture of the paper is a secret.

The secretary of the Treasury doles out the paper to the Bureau of Engraving and Printing, so many sheets at a time, which have to be rigidly accounted for. It is dampened, for it is well known that upon dampened paper only can you print well.

The printing is done in a curious fashion. The paper first is laced between wet canvas cloths, twelve sheets of it in each cloth. After a few hours the paper is shifted; the middle sheets of the twelve are placed on the outside, and those that were on the outside are placed on the inside. The eye of a Government inspector is watching this performance, and, in fact, Government inspectors watch everything that is done in the Bureau of Engraving and Printing. The paper is next sent to the printer.

But it is necessary to have engraved plates before the printing can take place. The engraving is done by a force of engravers who work steadily. In the engraving-room is the geometrical lathe, which makes on the greenbacks' plates the fine lines that run round and round and into one another, delicate tracery which it is difficult to follow even when the eyesight is aided by a reading-glass. This lathe is an expensive instrument. It resembles a heavy-framed scroll saw, with a revolving bed and numerous little cogs.

The design finished, the block is sent to the custodian; and should the portrait, vignette, scroll-pieces, and other work for a note be drawn correctly, the different blocks are trimmed and fitted together in their proper positions, and are sent to the transfer division on the other side of the room, in order that a plate may be made. Here and there are nine brightly polished transfer presses, looking something like medium-size trip-hammers, a number of operators, or pressmen, working at benches or desks, with two watchmen guarding both men and machines, and the whole section is inclosed by a stout wire partition.

This is the most closely watched and carefully guarded working division in the whole bureau. Each press is locked and sealed, and its key is kept in a vault. When the custodian receives an order for a new bank-note plate, the order is copied in a register, and is then sent out to a transfer pressman, with instructions to do the work required.

The pressman makes a requisition on a workman in an adjoining room for a blank plate, a piece of steel about fourteen inches long, ten inches wide, and one-half an inch thick, and gives the original order to one of the watchmen, whose duty it is to unlock the press, and to stand guard while the work is being done.

The dies must be made; that is, each engraved block, after being tempered or hardened, is placed on the transfer press, and a roller run over it several times under powerful pressure. The soft steel, of course, receives an impression of every line of the engraving on the harder metal beneath, and when the impression of every block has been taken, each on a separate roller, the dies are ready to be taken into the hardening-room. There, by means of furnace heat and certain chemicals, the dies are made extremely hard.

Then the plate of soft steel is placed on the bed of the press, and the tempered dies are passed over the plate several times, each time leaving an exact facsimile of the engraving in the original block. Now the plate is tempered, and after polishing, it is ready for the printer; or, if it is not to be used immediately, the face of it is coated with a clear wax to protect it from dampness, and it is then placed in a vault for safe keeping.

It is in a room foul with gas and the odor of printing-ink that the work of printing greenbacks is carried on. The printing-machines are cast-iron frames, each holding a small sliding bed with a cylinder not more than five inches in diameter. After each impression the printer picks up his plate, turns it around, and sets it down on a little gas stove, jerks up an ink-roller, and daubs it with ink until the whole surface of the plate is thickly coated.

By the time he has laid down the roller, the gas-jets have heated the plates until the ink has run into and filled even the finest engraved line. The surplus ink is partly wiped off with a rag, more is removed with the palms of the hands, and finally the printer rubs his inky palms on a ball of chalk, and then polishes the plate until it is brighter than when it was first made.

While he is doing all this work, his assistant removes the printed sheet from the cylinder, places it between paper to prevent the ink from blurring, and prepares another sheet by rubbing a wet sponge across it several times. When the plate goes back upon the press, everything is ready for another impression. Thus the work goes on.

The largest denomination of greenbacks ever printed is the $10,000 note. The next highest is the $5,000; then come the $1,000, $500, $100, $50, $20, $10, $5, $2, and $1, bills. In national bank currency there is no note worth more than $1,000.

The time required for the making of a bank-note, or a greenback, is twenty-two days, and during that period it passes through the hands of fifty-two persons; yet, should you at any time come into the bureau with a note of old, or recent date, it would be possible, within a short space of time, to give you the name of every employee through whose hands it had passed while being printed; for everything is recorded, as well as guarded, in this building.

Sixty-two young women work the numbering-machines. In the numbering-room the legal tenders receive the register's and treasurer's numbers; and national bank currency is stamped with the charter number of the bank and the number of the note—those figures in red ink, with a capital letter, denoting the series, and a curious character following.

No series, no number of any series, is ever duplicated; and there are curious combinations (known only to the register, treasurer, and comptroller) by means of which a complete record of all the money printed is kept. In each note there is a fine blue or red silk thread extending across the face or back, and it is the intention always to have the numbers of a note fall upon this thread.

In a little cage-like division in this room the sheets of money, now complete, are counted for about the fiftieth time, and, if legal tenders, the notes are separated by a cutting machine, but, if currency, the sheets are sent out whole; for the national banker must scissor as well as sign his bills.

The last count and examination are the most careful of all, and only old and trusted employees are promoted to this counting-division. One woman has been counting money in this room for seventeen years, and has the reputation of never having made a mistake or a false count during all that time.

After the final count the money is done up in little bundles of 4,000 notes each, bound with a strip of yellow paper, on which is printed the initials of the counter, and the numbers of the first and of the last bill in the package. Late in the day these little bundles are placed in iron safes, which have combination locks, and are taken to the stock vault to await transfer to the Treasury on the succeeding morning.

The men who make the beautiful designs for bank-bills are called engravers. They not only do that particular kind of work, but it is also part of their business to make designs for bonds, stock certificates, postage and revenue stamps, checks, drafts, bills of exchange, tickets for railways, bridges, and ferry companies; in fact, they do all kinds of fine engraving.

A bank-bill is never engraved by one man, but by a number of men. Each engraver is skilled in his own particular branch of the work ; one man may be expert in engraving portraits, another in making the old English and other fancy letters you see on the bill, another in the script phrases, "Will pay the bearer," or "Payable to the bearer on demand."

To become a successful engraver, a boy must have good ideas of perspective, and must be painstaking, patient, and clever in both drawing and writing. At first he is only an assistant to the regular workman. After a time he will be allowed to make small drawings. The pay of engravers ranges from $25 to $100 a week, sometimes more. But the man who receives $100 a week or more must be an exceptionally skillful person. The best qualified workmen are those who can execute portraits.

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## Lesson XVIII.

### Genius To-day.

The intellectual activity of man's nature assumes different forms in different eras ; and if in some departments of human endeavor one age is less active than the age preceding, its achievements may be looked for in other lines of work.

Our time is producing no Shakspeares, Miltons, or Raphaels ; but the genius of this generation is immortalizing the names of scientists and inventors. It is difficult to ascertain the real cause of to-day's inventive activity, but that it is a continual wonder to all, may be attributed to the fact that invention is an entirely new field.

In literature and art the ancients achieved such noble results that the works of our writers and artists seem little better than imitations.

It is otherwise in the realm of invention. Everything is new and fresh here, and no comparison can be made with the past. The achievements of early scientists cannot take away any of the glory due to modern men of science. As there is no imitation possible, no rules to be guided by, it is not unreasonable to claim that applied science or invention is a characteristic of the highest civilization.

It is possible only when there is a great accumulation of knowledge; and our present inventive age is indebted to the past for its fine equipment and preparation. The original mind is the highest type of intellect, and inventions come nearer to absolutely original works than any other products of mental labor.

The inventions in electricity alone have been sufficient to make a complete transformation of many mercantile interests. Electricity touches modern life at nearly every point; and it is gradually annihilating the two conditions which philosophers of all time have instanced as distinguishing the material from the immaterial, — space and time.

But inventions have not halted in any of the departments of industry, nor with the use of any of the powerful agents in the earth, air, and water. In all of the industrial arts the impulse given to them by mechanical and chemical inventions and discoveries is so great that no one can keep acquainted with the numerous rapidly expanding enterprises. In the textile industries new products are manufactured almost as rapidly as machines can prepare them for human use. In the realm of mining, strides have been made that would alone create an epoch in any other period of the world's history.

It is in machinery, however, that the greatest inventions have manifested themselves. The machinery age began about 1760, and its development has been rapid and wonderful; but perhaps it has not yet grown out of its infancy. Crude muscular power will gradually be displaced by skillful machinery as man's servant. This change will be the highest triumph of mind over muscle.

In the world of machinery the inventions of past ages are mere toys compared with those of to-day; and no less toy-like seem our present achievements when compared with the inventions promised for the future. Machinery is, no doubt, only the forerunner of great undiscovered applications of new forces, a truth that should constantly remind us that the golden age is in the future and not in the past.

Very few inventions that have reaped fortunes have been the result of happy accident, and not of hard, studious work. Some of the professional inventors have accumulated enormous fortunes, but the majority have not received more than a comfortable income. A vast number of useful, practical inventions have come from men whose inventive talent was limited to one idea.

Happening to strike upon a single good idea, an inventor has been stimulated to put it into useful form by the hope of pecuniary reward, and the natural love for embodying ideas in visible things. The peculiar mental activity of the American people makes them tired of plodding learning, but ever ready for a useful novelty.

The inventive activity of our age has results of a far-reaching character. This fact was premised years ago when laborers openly and secretly opposed any innovations in their work. The results were supposed to be detrimental to their interests; but in this country, where inventions have had the widest and freest sway, the contrary effect has been found to follow

Many of the great inventions have vastly increased the number of new employments, and hundreds of thousands of people have been given work in new lines of labor that would never have existed if inventions were not permited. Books, pictures, and art products are not only placed before the poor at cheaper rates, but the reduction in the hours of labor enables the toiling classes to have more time to read and to improve their minds.

The workman's nature is certainly elevated as he begins to get glimpses of the marvelous power in the machinery which he controls. He soon learns that from a rude instrument of toil he has developed unconsciously into an intelligent guider of hidden forces, which obey his slightest will more readily than the humblest slave of ancient days obeyed his human master.

It is impossible to guide and to control complicated machinery without inquiring into its construction and methods of running, and thus becoming familiar with fundamental laws of science. The man who was himself only a rude, muscular machine, becomes a student of object-lessons. He passes through a mental evolution, until he begins to gain dignity in the thought that he is an important factor in the work, and that his intellect rules and guides it.

## Lesson XIX.

### Making Money.

One can see millions of dollars in cash exhibited any day at the Treasury Department in Washington, but to see the money in process of manufacture is much more interesting.

At the Treasury you can behold thousands of bags full of silver and gold. All you see, however, are the bags of coins. In the mint, on the contrary, — supposing that you are a favored visitor, — you may view the actual precious metal, walls of gold bricks, and pure silver.

You will see a little bookcase behind a sort of cage, in which is stored about $17,000,000 worth of gold bricks. It is astonishing to note how little room so enormous an amount of wealth takes up. One gets a notion, from the sight, how it is that all the gold that has ever been dug out of the earth would not more than fill a room seventy-five feet cube.

A gold brick of the shape of an ordinary brick for building purposes, and of about the same size, is worth $8,000. The weight of one such gold brick is astonishing.

A part of the mint's business is to manufacture what are called "merchants' bars," for sale to jewelers, dentists, and others, including gold-leaf makers, who need for their trade pure metal. Such bars, whether of gold or silver, are made 999 fine; that is to say, 999 parts pure out of 1,000.

How fine this quality is may be judged from the fact that our gold and silver pieces are only 900 fine, the remaining 100-1000 being copper. What is called "coin silver" is, therefore, only 9-10 pure.

The mint derives its supplies of gold and silver mainly from mines. Such precious metals as it gets in this way come direct from the mines through the United States assay offices. Upon its receipt at the mint, the silver or the gold is separated, refined, melted, and molded into bricks.

A good deal of gold and silver is all the time coming in from private sources, jewelers, pawnbrokers, and others selling their stock of such sort in this way, the rule being that not less than $100 worth will be purchased. Three days after deposits of this sort have been made, payment is returned to the depositors.

All of the $100,000,000 in gold and silver bricks at the mint have gone through most surprising changes. To begin with, the silver, dissolved with nitric acid, appeared in an enormous tank that was stirred about with a huge ladle. Precipitated from this mixture, the silver was put into a great trough, looking like so much plaster of paris.

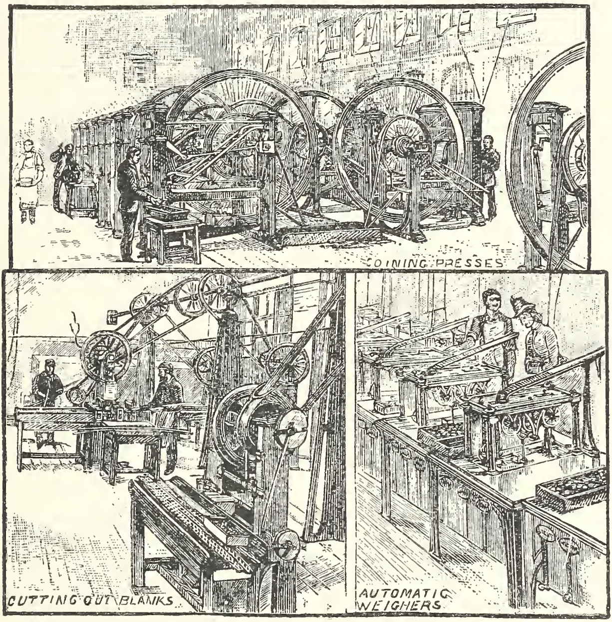
This was shoveled into another trough filled with a zinc solution, and the silver, thus exposed to the action of a baser metal, became like so much earthy gravel in appearance. From this last trough it was taken and pressed under a hydraulic squeezer into thick round disks. Then the metal was ready to go down to another department to be melted.

As for the gold, it had all the appearance, in the crude state, of so much fine red gravel. If you had seen a pile of it by the roadside, you would not have been disposed to pick up a handful of it. Yet a small amount in a brass box on wheels, an official in charge tells us, is worth $220,000.

The silver and gold thus made ready in the "separating-room" went down-stairs to be melted in crucibles of black lead banked in among the reddest of hot coals. Workers at $3.50 a day reduced the metals to a molten state in the crucibles, from which the precious fluid was dipped out by ladlefuls and poured into iron molds.

Incidentally to the melting, however, ten per cent of copper was mixed with the gold or silver, such being the proportion of that baser metal in United States coins.

As soon as the gold and the silver bricks have had time to get cold and solid, they are taken out of the molds, and are sliced into thick strips. Each silver brick, for example, is cut into half a dozen strips of its own length and thickness.




Mint Machines.

These strips are passed under a powerful roller, which squeezes them out so as to make them about twice as long and half as thick.

At the same time it compresses the substance of the metal so much that it becomes almost as hard and dense as steel. Next, the strips are annealed, or softened, by putting them into a red-hot oven, the heat of which is 1,600 degrees. Finally, they are taken out of the oven, passed three times beneath another roller, and are then ready to have the disks, which are to be coins, punched out of them.

This punching is performed with much simplicity by passing the strips beneath punches that work rapidly up and down, the disks as they are punched out falling into boxes below. In this way each punch cuts out 100 silver dollars or 200 dimes every minute. The blanks thus made are washed, and then milled.

This latter process is simply to give each coin its raised edge, and it is performed with great rapidity by machines that compress the edges of the coins toward their centers. At this point the blank pieces are ready for another process of annealing, to soften them, in order that they may receive properly the impress of the die. They are put into an oven, and are heated red-hot.

Then they are stirred about with scoops in a chemical bath to make them bright again, the annealing having turned them black, and upon being taken out of the bath they are poured into a revolving cylinder full of bass-wood sawdust. When they come out of the bath they look white, but after being turned about in the cylinder with the sawdust they are bright and shiny.

Now the blanks are at last ready to be stamped with Uncle Sam's designs. The dies strike off 80 coins a minute, printing both sides at once, and at the same time corrugating the edges prettily.

Women with deft fingers feed the blanks to the machines, which strike them off and automatically dispose of one blank while they receive another, dropping the complete dollars or halves or quarters or dimes into boxes beneath. All that remains to be done is the counting of the coins, which is performed, with a celerity simply marvelous by a girl who thinks nothing of counting $1,500 in thirty seconds.

Gold coins are turned out in pretty much the same way. The eyes of the average visitor to the mint are attracted, in the room where the counting is done, by great boxes filled with beautiful shiny yellow disks as yet unstamped. Usually the visitors say something to the effect that they wish they could only be permitted to carry off their pockets full, and so be rich for life.

Were the permission given them, they would not be able to live very long on the amount taken away, inasmuch as the disks are in reality only bright copper pennies, or rather blanks for pennies. These blanks are made by contract, a firm in Connecticut supplying the Government with them at a trifle less than one-tenth of a cent apiece. They come to the mint and are stamped there with the Indian's head and the obverse inscription.

Blanks for five-cent pieces are turned out in like manner by contract, and it costs Uncle Sam only a cent and a half to produce a nickel.

The first making of money in the United States began in 1786; but instead of the faces of representative statesmen, the coins minted bore only the figure of Liberty. Some few coins were stamped with the face of Washington, and are highly valued by collectors. The first coins struck by the United States mint were some half-dimes in 1792; the first dimes were struck in France from old silver family plate furnished by Washington, the coins being known as Martha Washington dimes.

The United States mint in San Francisco is the largest mint in the world. The process of dime-making there may not be without interest. The silver bullion is melted and run into two-pound bars. These in turn are run through immense rollers, and flattened out to the thickness of the coin. The strips are then passed through a machine, which cuts them into the proper size for the presses, the strips first having been treated with a kind of tallow to prevent them from being scratched in their passage through the cutters.

The silver pieces are then put into the feeder of the printing-presses, and are fed to the die by automatic machinery at the rate of 100 per minute, 48,000 dimes being turned out in a regular working-day of twelve hours.

As the smooth pieces are pressed between the printing-dies, they receive the lettered and figured impression; at the same time each piece is expanded in a slight degree, and the small corrugations are cut in its rim. The machine drops the completed coin into a box receiver, and it is ready for the counter's hands.

The first silver dollar was coined under the Act of Feb. 12, 1792, and had a fineness of 892.4, which standard was continued for many years. The first coins struck for America, however, are supposed to have been the Sommer Island shillings; the date of coinage, place, and circumstances under which they were issued are unknown. The Sommer or Summer Islands are the present Bermudas. The shilling was called a "Hoggs-Penny," composed of copper; weight 177 grains.

The silver dollar, since the first introduction of the coin, has undergone many changes, all of which have had effect in establishing a value among collectors of rare coins. The dollar of 1804 bears the palm in scarceness, and has won for itself the name of "The King of American Rarities." Only eight of the 1804 dollars are known to be in existence.

One "legend" of the cause of the scarcity is that a vessel bound for China had on board almost the entire coinage, $19,570, and was lost at sea. Another theory concerning this mysterious coin runs as follows: That the entire issue was shipped to pay the Yankee tars who fought in the war with Tripoli. The sailors drifted around after the war closed, and many of them went to Africa, where they spent their money.

The native kings collected all the coins and buried them as trophies.

The national motto, "*E pluribus unum*," on different United States coins, was never authorized by law to be so placed. Although the mint was established in 1792, the use of the motto on any of the gold, silver, or copper coins was not authorized or directed by any of the provisions of the act establishing it. None of the coins since 1837 bore the motto until the standard silver dollars were coined.

It remained on the early gold and silver coins until 1834, when it was omitted from the gold coins. From the double eagle in 1866 it was also omitted. In 1836 it was dropped from the 25-cent piece, and the following year from all silver coins, the trade dollar only reviving its use. The motto was first used on a half-penny or cent struck in New Jersey in 1786.

The motto "In God We Trust" has a curious history. Until 1864 no religious motto appeared on American coins. In November, 1861, a clergyman addressed a letter to Mr. Chase, the secretary of the Treasury, suggesting a recognition of the Deity on the coins. This letter was referred to James Pollock, director of the mint at the time, but it was found that the mottoes could not be changed without authority of law.

In December, 1866, the director submitted plans for a new three-cent, two-cent, and one-cent piece, on which it was proposed that one of the following mottoes be inserted : "Our Country, Our God," "God, Our Trust," Mr. Chase suggested in lieu of these mottoes the one "In God We Trust." It was upon the two-cent piece that the motto of Secretary Chase first appeared.

Regarding the dollar mark, writers are not agreed as to the derivation of this sign to represent the word dollar or dollars. Some contend that it comes from the letters U and S, which, after the adoption of the federal constitution, were prefixed to the currency of the new United

States, and which afterward, in the hurry of writing, were run into each other, the U being made first and the S over it.

Others say that the contraction is from the Spanish *pesos*, dollars; others still believe it to be derived from the Spanish word *fuertes*, meaning hard, so called to designate silver and gold from paper or soft money. A more reasonable explanation of the puzzle is this: That the symbol is a modification of the figure 8, and that the character, as we mark it, denotes that we are speaking, or writing, of a sum of money equal to eight reals; or, as the dollar was formerly called, a piece of eight.

In the early history of the dollar, when everybody knew it as a piece of eight, writers who had occasion to mention it in their articles did so by making this character, $\frac{(8)}{(8)}$

The two eights and the double hyphen gradually changed until the sign came out as $.

When all the silver had been paid out of the Treasury of the United States early in 1862, Gen. Spinner, then the treasurer of the United States, procured from the Post-office Department quantities of postage stamps for the purpose of making change.

He had stamps to the value of 25 cents or of

50 cents pasted on slips of paper. Mr. Montgomery Blair, then postmaster-general, agreed that he would redeem them in that condition in postage stamps. It was soon found that this mode of procedure was impracticable.

Gen. Spinner then persuaded the postmaster-general to procure the engraving and printing of facsimiles of the postal compound postage stamp. These the treasurer bought from the postmaster-general under an agreement that the Post-office Department would redeem them. This currency was what was called "postal currency."

The postmaster-general soon became tired of the additional responsibility and labor that the issuing and redemption of this currency threw upon his office, and he procured the passage of a law by Congress for the printing of paper money that would represent fractions of a dollar.

The little bills were engraved and printed in denominations of 3, 5, 10, 15, 25, and 50 cent notes, and in contradistinction to the postal currency were called fractional currency.

When Mr. J. N. Huston took charge of the United States Treasury, he gave a receipt for the money which the treasury vaults contained, and this receipt was the largest ever given in the history of the world. A facsimile of it is framed and hung up in the treasurer's office. The amount for which the receipt was given was $771,432,-329.45.

Gold coin is shipped abroad in five-gallon, iron-bound oaken kegs. Each keg holds ten bags, and each bag contains $5,000, so that the value of a keg is $50,000.

Over 90 per cent of the silver produced in the country passes through the hands of a few banks and firms in New York and San Francisco. In fact, three or four houses monopolize the greater part of the trade, and to them silver is consigned for sale by the mining and smelting companies.

A number of bars go to the United States assay office to be converted into assay bars, which are thin bricks of silver weighing 200 ounces each, and bearing an official stamp of their weight and fineness. These bars are in demand by silver-smiths on account of the guarantee of the stamp.

The silver bullion shipped to Europe is in the form of bars, which are carted to the steamer and placed, unpacked, in the treasure-room.

What becomes of all the pennies?

It seems to be with them very much as it is with pins—nobody knows where and how they disappear. Yet they vanish in some fashion. In 1891 the Philadelphia mint coined 94,000,000 cents. It would take a good-sized room to hold so many, yet they did not supply the demand.

Bronze cents are subject to more accidents than happen to any other United States coins. It is said that a penny changes hands in trade ten times for once that a dime passes from one pocket to another. Being of small value, these little pieces are not taken much care of. There are a thousand ways in which they get out of circulation, and thus the minting of them has to be kept up continually.

One may get a notion of the number of pennies lost, from the history of the old half-cents. Of these, 800,000 were issued some decades ago. Where are those money tokens now? A few are in the cabinets of coin collectors. A few have been returned to the mint for recoinage; not one is held by the Treasury. Nobody sees them in circulation. All of them, except some hundreds saved by curio-hunters, have disappeared. Of the old copper pennies 119,000,000 still remain unaccounted for, save that once in a long while one sees a specimen.

Let us now pay a short visit to the richest bank in the world, the Bank of England. It is located in London. Here we are — in front of us is the building.

As we enter the courtyard two beadles greet us with military salutes.

The doorway opens into the bullion office, where all the gold and silver that enters or leaves the bank passes through to be checked. On the right is the gold; on the left the silver.

We are introduced first to the scales, or, as it is termed, the "grand balance."

This marvelous instrument is a ponderous and peculiarly built weighing machine, standing about seven feet high. It is under a huge glass case. The scale is worked by hydraulic power, and is the most sensitive weighing machine in existence. The foundation, which is of solid concrete, is sunk to a depth of sixteen feet, so that not a jar can affect the balance.

The man in charge sets the hydraulic power in motion by means of a small wheel, and then touches an ivory button at the side. Immediately the entire scale, weighing hundreds of pounds, sinks seven inches, and is ready for weighing.

"We will weigh first a postage stamp," observes the suave attendant. On each side the scales are fitted with weights amounting to 400 ounces.

The stamp being added to the 400-ounce weights, another ivory button is touched, and the index jumps a distance of six inches. Think of it, six inches on the index for a postage stamp!

"Supposing a bar contains more than a scale is made to weigh," says the manager; "any other scale would go to its limit and give no sign. Not this one, however." To prove this statement, he adds one-quarter of an ounce more than the maximum weight, when, instead of the index moving, there is a pause of some few seconds, and then an electric bell commences ringing. There is something almost human about this machine which declines to execute a task of which it is incapable. This is the only balance of its kind in the world.

The maker has never constructed a duplicate. This triumph of the mechanical art cost exactly £2,000 sterling. The silver scale is, of course, not so finely balanced, and the two are respectively christened, "The Lord Chief Justice" and "The Lord High Chancellor."

The manager then moves away from the scale, and, turning a handle in the wall, suddenly illuminates a long vault, which would otherwise pass unnoticed. We walk in, followed by one of the bank's guards.

On small barrows with strong wheels are 400-ounce bars of gold. Each barrow contains 40,000 ounces, or about £170,000 worth of metal. On shelves ranged along the walls are heaps upon heaps of bags containing coins, each bag weighing 500 ounces. The coins are of the India, French, German, Dutch, and American currencies.

We arrive at a door which admits us to an inclosure almost entirely of glass, in which ordinary visitors stand and gaze upon the wonders within.

However, the guard throws open the door, and stepping up to the chief, whispers a word in his ear. He approaches us with a warm welcome, and bids us walk up to one of the gold-weighing machines, of which there are thirty here. This is the room where sovereigns and half sovereigns are weighed when sent in by bankers and others. Here, again, hydraulic power is used.

A machine consisting apparently of counter weights is completely inclosed in glass. A long feeder, like a tube cut in half down its length, and made of brass, is set at an angle of 45° and is filled with sovereigns. These turn as they slip down onto a circular, movable plate, slightly larger than a sovereign.

Our guide moves a small lever, and the coin at the end of the tube drops onto the weighing-plate.

For a moment the plate seems to be deciding upon the merits of that particular coin. Then, as if it has made up its mind conclusively, it deftly turns the coin to the right, and lets it slip down a metal tube into a till below.

If a coin proves to be lighter than the standard weight, the delicate machine turns it to the left, and condemns it to the guillotine. One is impressed with the idea of a hand weighing the sovereigns. One can almost fancy that a hidden person is feeling the weight. There is more than a mere mechanical look about the momentary indecision of the scale-plate: it suggests the hesitation of an intelligent animal.

These machines weigh coins at the rate of twenty-six per minute, and a day's weighing amounts to about £100,000 sterling. The light coins are taken to the guillotine and dropped down a long tube. As they slip through, a sharp knife clips the coin neatly down the center, and allows it to fall out at the slot at the side, and, to carry out the guillotine notion, the coins fall into a small basket.

They are not cut in halves, but the cut is more than half-way through; and this disfigurement prevents the banker who has paid them in from again circulating them, although he can take them away after they are clipped. He never does ask for his condemned coins, but takes the weight value of the gold.

The guard now shows some animation. Producing a hand lantern from some mysterious recess, he turns and bids us follow. We walk through narrow alleys formed of piles of boxes, where not a ray of light penetrates, and find ourselves making a rapid descent, with the lantern ahead, like some guardian light. We descend a steeper incline, when a chill air striking us proves that we are underground.

Then the figure in front turns, and announces to us in a tone calculated to strike terror into nervous persons, "We are now in the labyrinth."

We begin to entertain fears that he is leading us to some dungeon fastness, when he turns again, and solemnly remarks, with a wave of his hand, "All bank-notes." Some idea can be gained of the quantity of them, when it is learned that they are 77,745,000 in number, and that they fill 13,400 boxes, which, if placed side by side, would reach two and a half miles.

If the notes were placed in a pile, they would reach a height of five and a half miles; or, if joined end to end, would form a ribbon 12,455 miles long. Their original value was over £1,750,000,000, and their weight is over 90½ tons.

Thence, after being shown the books of the bank, — the first one dated 1620, — we enter the bank-note printing department. More glass cases, more whispered words, and the mystic phrase pronounced which admits us inside.

Six huge printing-presses are at work.

Each sheet of paper has to be accounted for. The workmen handle the bank-note paper with as much unconcern as though they were printing handbills. They only feed the machine. The double printed notes drop out into a little frame.

A dial indicates not only the number of notes turned out, but the number of revolutions in each of the six processes in printing. A superintendent is at each machine.

Along another passage we enter a large room — really a vault —which is surrounded from floor to ceiling by iron doors of safes, which are five feet high by five feet wide. One of these is opened, and shows rows upon rows of bags having, in gold coin, £2000 sterling each.

Another door is opened, and we observe a stack of bank-notes. I remark that I have seen a lot already. For answer the manager takes out a parcel of 1000 £1000 sterling notes, and says, —

"Take hold." I do so, and am told I am holding £1,000,000 sterling.

"This small safe contains £8,000,000 sterling," continues the polite manager, as he puts back the parcel, "and you are in the richest vault of the Bank of England. This little room at present holds £80,000,000 sterling."

By this time our appetite for wealth is nearly gone, and we hail with delight the merry splashing fountain in the courtyard. Here are the quarters of the thirty-four guardsmen who nightly patrol the establishment. Sentries are posted at each gate, and as they load their rifles with ball cartridges the bank is not a safe place for burglars to try to rob.

## Lesson XX.

### A Strange Animal Home.

Perhaps few of the multitude of people who use sponges are aware that those handy articles are found in large quantities on our own seashore. A very large proportion of the sponges in daily use comes from the Florida coast.

Prior to 1850 all of the sponges sold in the United States came from either the Mediterranean Sea or the Bahama Islands; but about that time attention was first called to the abundant sponge-growths occurring on the reefs of South Florida.

The people of Key West had utilized for years sponges from their own islet's shore, but considered them of little or no commercial value, and did not discriminate between the different varieties. In 1852 specimens of the most durable variety of Florida sponges, the so-called "sheep's-wool," were secured and prepared for market, and were found to compare very favorably with many of the Mediterranean grades.

At first the business was but little understood; and, from want of capital, of the proper vessels, and of working gear, it advanced but slowly. As foreign sponges became more costly, however, the demand for Florida sponges rapidly increased; and the profits became so tempting as to induce Key West merchants to engage in the business much more extensively than before.

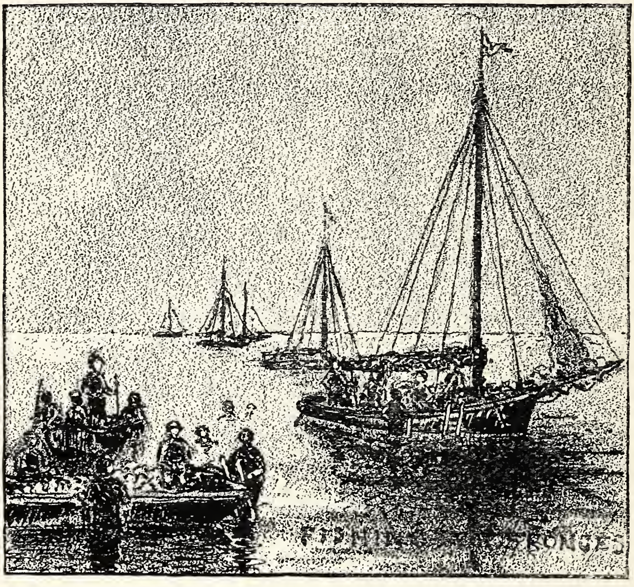
Key West was nearer the sponge-grounds than any other city of the Gulf Coast; and, moreover, its people were, as a class, accustomed to a sea-faring life.

It was natural, therefore, that the islet's citizens should take the lead in the Florida sponge-fishery; and year after year Key West's sponge-gatherers have added to their fleet of vessels, and to the number of their packing-houses, until now their business has assumed large proportions, and has become a source of great profit to their enterprising little city. More than 75 per cent in value of all the Florida sponges marketed are of the finest of sheep's-wool variety.

The sponging-vessels of Key West are the pride of the place, and with good reason, as they are trim crafts and fast sailers. There are about a hundred of them now in the trade, ranging in size from five to forty-five tons. They carry each a crew of from five to eleven men, mostly Americans. There is, however, a large percentage of negroes, many of whom are Bahamians, or "Conches" as they are called.

The Florida sponge-fishery may be carried on throughout the year, providing the weather permits. The principal season for work is from May to September, for during that period the water is generally smoother and clearer than at other times.

The process of gathering the sponges is very interesting. When the vessel has arrived on the



*Florida Sponge-Fishing.*

sponging-ground, the spongers pair off to man the small boats, while the cook remains on board to keep the vessel under way, and to prepare the meals. Of the two men who occupy each boat, one is called the "sculler," and the other the "hooker." The former worker stands in the stern of the boat, and sculls it slowly and steadily forward, being prepared to stop and hold it exactly in place at a moment's notice from the hooker, who kneels down amidships, or at the bow, with his head in a water-glass, through which he scans the rocks below. The "water-glass" is a wooden bucket with a glass bottom.

Through this odd telescope very small objects can be seen on the bed of the sea, even though the water be of considerable depth. As soon as a sponge of sufficient value comes into view, the hooker fastens to it by means of a long hook, and brings it to the surface.

The marketable sponges taken by fishermen are the sheep's-wool, yellow, and grass sponges, and the worthless ones are termed "logger-head" and "finger sponge."

Collecting the sponges goes on at all times when the water is smooth and clear, conditions not always met with. Some of the Key West spongers have partly removed the inconvenience of rough water by the use of oil. A cup of oil will produce a smooth surface for as long a time as the hands in a small boat care to fish in one spot. Shark-oil is considered the best for the purpose.

During the day the boats work steadily along the reefs, picking up sponges here and there, until dinner-time or night arrives. As soon as the sponges are brought on board, they are carefully spread over the deck of the vessel in their natural upright position, so as to allow the slimy matter, called "gurry," to run off easily.

They are not like the clean, delicate, light-colored sponges which we see in shop-windows. When first taken from the water, sponges look and feel more like pieces of raw flabby meat than anything else. They are slimy, ugly, and have a most offensive odor. Their color is generally a sort of brown.

Most people have read that the sponge is an animal; and many persons when they visit Key West expect to see sponges swimming about the harbor, if, indeed, they do not surprise some of the more athletic ones making little excursions over the island, or climbing the trees. But visitors soon learn that the animal portion disappears long before the sponge reaches a market; and that the part we use for mopping up fluids is only the many-roomed house in which the creature sheltered itself at the bottom of the sea, a regular marine tenement house, built with great skill.

Sponges kept on deck generally die, and lose the greater part of their jelly-like matter in one day. They are then put into "crawls" (inclosures of stakes eight or ten feet square, situated in water two or three feet deep), where they remain for about a week, when the outside skin or covering falls off. Then the sponges are beaten with a short, heavy stick, called a "bruiser," and are squeezed as dry as possible, and are strung on rope yarns six feet long. The bunches are hung up to allow the sponges to bleach.

They are then put through a process called "liming;" that is, they are dipped in a weak solution of lime and sea-water. Then they are again dried in the sun. After this process is completed, the sponges are trimmed, sorted, and packed. Preparatory to being trimmed, boys beat them once more with mallets to remove all particles of stone, shells, or other hard substances.

The trimming is done with sheep-shears, and all the uneven parts and ragged edges are cut off. After this operation is completed, an experienced man sorts out each variety and quality, weighing them in crates in lots of 100 or 120 pounds each. These lots are then placed under a hydraulic press, and are formed into compact bales, measuring, each, about 30 inches long, 18 inches wide, and 18 inches thick. Lastly, the bales are covered with bagging, and are corded securely. In this form they are shipped to New York.

The "sheep's-wool" sponge is the best quality. Its texture is fine, soft, and very strong; and it sells for from $1.25 to $3.00 per pound in the Key West market.

The "yellow" sponge is of finer texture, but is neither so soft nor so durable as the variety just named. It sells for 25 or 40 cents a pound. The "grass" sponge is very fine and firm, but is not durable, and is usually so irregular in shape that it is torn easily, and the few sponges of this grade that come to market are sold by the lot for 8 or 12 cents per pound. The average annual sales of sponges at Key West amount to about £200,000 a year.

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## Lesson XXI.

### A Modern Science.

In those nations of antiquity which occupy proud positions in the history of the world, instructors sat apart from their pupils or disciples, or, at most, allowed only a chosen few to have seats near them. The famous Greek philosophers, Plato, Zeno, and Aristotle, gathered around themselves a few favored disciples, and sought to elevate their minds; but for the improvement of the great body of the people those great teachers felt no concern. If in the observations of the astrologist any new fact in astronomy was discovered, it was not thought worth recording.

If in the experiments of the alchemists any great truth in chemistry revealed itself, it was looked upon as a matter of no interest. Men searching for the philosopher's stone, and the universal solvent, and the elixir of life, cared little for scientific principles which could help the common people in their daily life. In our own time, the reverse of this state of affairs is true.

There is no subject about which people have fewer accurate notions than the value of scientific truth. How many persons even dreamed that there was even the slightest connection between Malu's discovery of the polarization of light, and the remunerative manufacture of beet-sugar?

Who ever associates in thought Priestley's decomposition of the oxide of mercury with the success of the gold-miner? or Scheele's hydrochloric-acid experiments with the immense production of the paper mill? or Eli Whitney's invention with the cheapness of the cotton fabrics which clothe the world? or the simple pile of Volta in his laboratory at Pavia with the electric wires which now stretch in every direction across continents and under seas?

We often refer with pride to the fact that we live in an age of progress, and point with admiration to the rapid strides which science has made in the last half-century.

If we should ask the scientist to what *one* science, more than another, are we indebted for our continually increasing wealth, his answer would be, "*Chemistry.*"

In the thirteenth century people knew nothing of foreign food or fruits, nothing of watches, clocks, steel pens, bank-notes, checks, money-orders, the postal-system, police, telegraphs, paved streets, macadamized roads, stage-coaches, cabs, omnibuses, street or steam railroads, canals, steam-ships, steam-engines, gas, gas-lighting, electric lighting, photography, bicycles, sewing-machines, pianos, silk, alpaca, the working of textile fabrics by machinery, soap, coal-tar dyes, phosphorous matches, petroleum lamps, articles of gutta-percha and india-rubber, the phonograph, telephone, and electric railway, and many other conveniences which are fast taking their places as valuable servants.

In looking over this list, any one will be convinced that these comforts and conveniences of daily life are indebted to the laboratory of the chemist for much of their success. Surely, a branch of science that can prove itself to be so necessary to the perfect working of a large number of industrial pursuits can need no plea to establish the fact that it is of great practical use.

Some one has said that whoever would make two ears of corn grow upon a spot of ground where only one ear grew before would do essential service to his country. There can be no doubt that the chemist is a public benefactor. Guided by his teachings, the agriculturist is becoming the master of the vegetable kingdom, and is learning how to feed his crops as wisely as he has learned how to feed his stock.

Agriculture being the oldest industry on the earth, it seems fitting that the labors of the chemist should be often applied to the land, since hundreds of millions of persons are tillers of the soil.

Chemistry enables the farmer to look into the earth, and to gather, from the wonderful experiments which nature is ever performing in her dark laboratory, some hints about the relation which exists between the growth of plants and the elements of soils.

To how great an extent are we all indebted to the chemists! We have received from them the wonderful aniline colors; we can now make velvet out of cotton, and seal-skin out of silk. We can obtain perfumes surpassing the distilled refinements of the spices of Araby the Blest. We can make artificial feathers, or whole birds if necessary.

Many substances formerly wasted are now rendered useful. Our dwellings are illuminated with chemically made gas, and this is lighted with matches which chemistry has given us in place of the old flint and steel.

Our clothing is bleached and dyed by chemical means; metals are extracted from their ores by chemical processes; soap, glass, porcelain, paints, varnishes, have all become better and cheaper than before the chemist studied them; wood is preserved from decay by chemical applications; many infectious diseases are checked by chemical disinfectants, and a multitude of chemical preparations aid the physician in alleviating pain.

Three-fourths of the working male population of the United States are engaged in agriculture and mechanical labor. We look to the chemistry of the future for aid in bringing these men up to the highest efficiency, by making these men of action, men of thought; muscle must not be separated from mind. For in every department of human labor, he succeeds best who brings to his work, not the greatest physical strength, but the keenest intellect.

## Lesson XXII.

### The Bank of the Banks.

How many boys in this school know just what is meant by the phrases "clearing-house," and "clearing-house certificates"? These phrases are used in connection with the national banking business, and should be understood by every boy who is seeking a thorough business education.

We will attempt to explain the clearing-house system, as it is employed in connection with the national banks of Boston. The "clearing-house" system is nothing more nor less than a system by which national banks, like individuals, may square their accounts with one another every day, and this system is the same in all our great commercial cities.

If you should enter a certain large building on State Street, Boston, and should pass down the long hallway and through the doors at the end, you would find yourself in a room, the most striking feature of which is a great counter, shaped like a horseshoe. This counter occupies most of the space in the room, and is divided into little compartments by wire lattice-work. Each compartment is numbered, the last one being No. 56. In the high and vaulted ceiling a skylight helps the windows to light the apartment.

We will suppose that the hour is ten o'clock, A. M. Business at the clearing house is beginning to grow brisk. At each of the little divisions of the long counter two men, one on each side, are seated upon high stools.

These men are the settling-clerks — one clerk from each bank represented at the clearing-house. Opposite each clerk is the messenger who comes with him, bringing the checks on the other banks that have been received by his own bank. All checks belonging to each bank are tied up together, and the total amount is marked on the paper in which they are wrapped.

At the hour for opening business at the clearing-house, a bell is struck, and the line of messengers from the different banks begin to move from clerk to clerk. As the messengers go around, they leave the checks for each bank with its clerk, so that when they have finished the circuit of the counter, they have no checks left. Each of the settling-clerks has a large sheet of paper, on which is printed the name of each bank, with its clearing-house number, the name and number of his own institution across the top; there are also debit and credit columns on the same page.

Every clerk puts down under the credit heading the amount of the checks held against his bank by each of the other banks. He has already in the debit column the sums called for by the checks he holds against his brother clerks. The total of the latter account is handed to the clearing-house cashier on a slip like the following form, the blanks being filled up of course:—

| CREDIT TICKET. | No. 816. Boston Clearing House.<br>. . . . . . . . . . . . . . . . . 1892.<br>Credit.<br>Tenth National Bank. $ . . . . . . . . . . . . .<br>. . . . . . . . . . . . . . . . . . . . . . Settling Clerk. |
|---|---|

When the clerk has footed up the columns on his sheet, and has struck a balance, he knows whether he is in debt or not, and he makes out another slip like the form below, which tells to the clearing-house cashier the story of the clerk's account:—

| BALANCE TICKET. | No. 96. Boston Clearing House.<br>. . . . . . . . . . . . . . . . . 1892.<br>Dr. American National Bank. Am't rec'd $ . . . . .<br>Cr. " " " Am't bro't $ . . . . .<br>Balance $ . . . . due Clearing House,<br>Balance due the American National Bank, $ . . . . .<br>. . . . . . .<br>. . . . . . . . . . . . . . . . . . . . . . Settling Clerk. |
|---|---|

The checks are then taken by each clerk to his own bank.

The clearing-house does not concern itself with checks which prove to be spurious. The banks arrange the loss between themselves. The total amount "cleared" or "settled" at the Boston clearing-house averages from $15,000,000 to $20,-000,000 a day; but the balances foot up only about $2,000,000.

The balances are paid in the following manner: The banks are given until 12.15 P. M. to pay what they owe; about 1 o'clock the clearing-house begins to pay what is due the banks that have gained.

Sometimes a bank finds a balance against it, and has not the spare cash to pay. It goes to one of its neighbors to borrow the money. Perhaps the latter bank has a large amount coming to it from the clearing-house, so instead of loaning cash and then sending and getting what was due it from the clearing-house, it gives an order on the latter institution like the following: —

BOSTON CLEARING HOUSE.

$................ BOSTON ..........1892.

Transfer to the credit of the ................ or order,
..................................Thousand Dollars.
And charge the same in settlement of the balance due to

The ...........................................

To ALBERT GALLATIN, Manager.

.......................... Cashier.

This order is received by the clearing-house as cash, and is paid out as such to the bank that gave it. In this way the handling of money is often avoided. The receipts at the clearing-house are all paid out again, so that it begins with nothing and ends with nothing every day.

Now permit me to explain the phrase, "clearing-house certificates."

During financial crises it is often hard for the banks to get cash; that is, actual money. A bank may be perfectly sound: it may be worth much more than the claims against it; but it can not turn its securities into cash without a very great sacrifice. The question then arises, "How can these securities, or rather, the values represented by them, be used in squaring accounts?"

It is not feasible to pass the securities from hand to hand; but if something standing for money, and accepted as such by the banks, because based upon good collateral, could be put out, the crisis would be safely met. So a committee of bankers is appointed to issue certificates on satisfactory collateral up to 75 per cent of its value. The clearing-house agrees to accept these certificates as money, and the banks make a similar agreement.

When a bank needs money, its cashier or president takes stocks or bonds to the committee, and makes application for certificates to the desired amount. If his collateral is good, the certificates are given him, the committee keeping the collateral, — the stocks and bonds. The bank is charged interest at the rate of $7^{3}$ per cent per annum, this figure being chosen because it is just $1.00 on $5,000 a day.

The bank has now something it can use. If it holds a $5,000 certificate for four days without presenting it at the clearing-house, it is then accepted for $5,004, and can be paid out for that amount. When the bank redeems its obligation, it pays interest to the holder. As the latter bank accepted the certificate for its face value, plus the interest then due, interest is paid for only the actual time the certificate has been held, each receiver in turn having obtained his share of the interest from the one to whom he gave the certificate.

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## Lesson XXIII.

### Aids to Eyes.

The spectacle business in the United States is an industry that has had its growth almost wholly within the past thirty years, and its short history is one of continuous prosperity. Prior to our Civil War, nearly all our large supply of optical goods was imported. To-day a single spectacle factory in Massachusetts employs nearly 800 persons, and produces 1,600,000 pairs of spectacles and eye-glasses annually, besides thousands of lenses in addition to those used in its own products.

It is the largest optical goods manufactory in the world; and its immense business has been built up since 1865. In that year the firm employed only eleven hands.

This phenomenal growth is conclusive evidence that in the years of its existence the use of spectacles has greatly increased; and it also indicates that the foreign spectacle, once so largely imported, has been almost wholly superseded by the American product. The importation of the foreign-made article has steadily decreased since 1866, until the present time finds it but little called for by American customers; because the domestic article is as cheap for the same grade of goods, and is superior to the foreign one in finish and general workmanship.

The making of a pair of spectacles is an operation that involves a far greater amount of labor, and calls into play more skill, experience, and ingenuity than one would suppose from a casual inspection of those eye-helpers. The number of pieces which are used to form a pair of spectacles varies according to the style, but the average number is seventeen. To make any one of these different parts is a trade in itself, and there are numerous other branches of labor incident to the work. To what an extent division of labor is carried in these manufacturing days!

The improvements in the making of spectacles and eyeglasses have been so great and manifold during this century, and particularly during the past twenty-five years, that these invaluable aids to eyesight are substantially a modern invention; for the spectacles of to-day are quite different articles from those of even thirty years ago. With the introduction of steel came the first decided change in the method of making the frames of spectacles, and eventually English manufacturers placed on the markets of the world steel spectacles which, with their lenses, weighed but one-quarter of an ounce a pair.

So popular did steel spectacles frames become, that they for a time almost supplanted frames made of other materials, such as gold, silver, and tortoise-shell. This popularity was secured solely because the steel spectacle was lighter, and hence more convenient. In recent years, however, new and improved methods of working gold have become known, and the question of lightness is now rather in favor of those made of this metal.

A marked advancement has been made also in lenses; not only in the quality of their material, but also in their adaptation to defects of vision.

An instance of this last gain is had in the treatment of the optical error or defect known as astigmatism, in which the rays converge or become twisted. An eye with this defect is called an astigmatic eye, and the extent of this error is easily measured by a trial lens, when the patient looks at a chart consisting of a series of letters made of alternate black and white, horizontal and perpendicular letters. To his vision some of these letters are clear and distinct, while the appearance of others is decidedly hazy.

It is asserted by some opticians that astigmatism is a far more common optical defect than is ordinarily supposed.

Down to so recent a time as twenty years ago, spectacles and eyeglasses were made almost wholly by hand, and consequently their cost was high; but now the different parts are made by machines, some of which are extremely intricate and almost human in their workings. As competition in trade increased, the necessity of furnishing a better article at a lower price was promptly and repeatedly met by the invention of labor-saving machinery.

In fact, the history of the optical business for the past two decades affords a striking illustration of the changing of business methods that they may the better conform to the changed conditions of industrial life. The call for a light yet serviceable pair of spectacles has been answered in the production of steel ones, which weigh less than two penny-weights, and of gold eyeglasses still less in weight. Formerly spectacles were made in only three or four designs, but now gold spectacles and eyeglasses alone are produced in 150 styles!

The making of a pair of gold spectacles begins with the melting of the bars of bullion. Each bar weighs twenty-five ounces, costs $500, and bears the Government stamp of its purity, which is in all of them .999 pure. The melting is done in crucibles made of graphite, and during this operation the bullion is made of coin value by adding the copper alloy. When melted to the proper consistency, the liquid metal is poured into molds of different shapes, flat ones for temples, and square ones for eye-frames.

The strips of gold as they come from the molds are each from one-half inch to an inch in width, and one foot in length. Those designed for temples are rolled into sheets, tapering to an end, and from these the temples are stamped out, conforming to the desired style. The strips from which the eye-frames are wrought are drawn into wire, oftentimes to a fineness of .008 of an inch.

In the formation of the frames for the lenses the wire is wound upon "formers" of the desired shape and size.

The making of the end pieces requires delicate machinery. The little pieces are milled, countersunk, tapped, doweled, supplied with a joint for the temples, and fastened together with a screw so small that its thread is hardly visible to the naked eye. The nose-guard of a pair of gold spectacles is nearly all made on a machine, the only hand-work required being the making of the incline to conform to the shape of the nose.

The soldering of a pair of gold spectacles is an operation that calls for skill and care on the part of the workman. The solder used is usually silver, but sometimes gold is employed. After the solder particle has been placed in position, the operator puts a tube in his mouth, and turns a gasoline flame upon the solder, all the while exercising the utmost care not to overheat the frame or temple, as gold is extremely sensitive to heat.

The making of the temples in their different styles, known as flat, riding, and half-riding, does not require the same number of processes as the formation of the frames. The flat temples extend to the ear, the half-riding temples quarter-circle the ear, and the riding half-circle that organ.

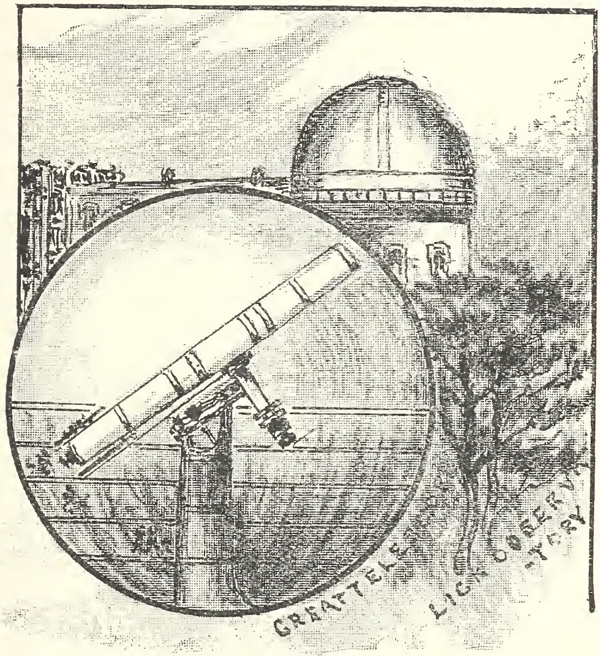
The temples are evened by gentle hammering, which has the additional advantage of imparting a spring to them. Then they are polished with gold rouge on wet wheels covered with felt. The lenses are burled out on grindstones, and are then fitted to the frames. The making of a pair of gold eye-glasses differs in detail from that of spectacles, but the main principles are the same.

The making of steel spectacles, while calling into operation processes not used in the fashioning of gold spectacles, is carried on by means of similar methods. The blue or bronze cast is given to the frames by quickly moving them in pans of common sand heated to a high point. The bronze color appears first, and the blue is obtained by simply leaving them in the sand a little longer.

The grinding of lenses is accomplished by placing them on oval forms embedded in a cement-like substance, which, as the operation proceeds, hardens, and thus holds each lens in position.

Over each form is placed a bowl, and this moves upon the lens in a manner closely resembling that produced by moving the palm of one hand in that of the other. The material used in grinding is vermilion. The glass for the lenses is imported chiefly from Germany and France, and colorless crystal glass makes the best lens, better than Brazilian pebble or rock crystal. As the practical value of a pair of spectacles lies in their lenses, self-interest enjoins every buyer to look carefully to the qualities of these.

The process which *telescope* lenses have to go through is long and slow. After a lens has been



On Mt. Hamilton, Cal.

received in its rough state, it is placed on a revolving circular frame, and is rotated at a slow and uniform rate of speed. Sharp steel instruments cut out the surplus glass of the surfaces, and a smoothing-machine, moving in a constantly changing curve, is for months and months kept passing over each surface before the lens can be used.

During this period it is tested perhaps hundreds of times by the aid of a silver mirror, till its proper focal power is established.

Getting the correct focal power of a lens is one of the most interesting of the many processes of lens manufacturing. A ray of light is made to pass through the lens set before the mirror, and is reflected back through the lens from the mirror. Until all the inequalities of density in the glass are removed, the lens goes from the grinding-machine to the testing apparatus, until the ray of light comes through the glass as perfect as when it left the little lamp that sent it forth.

The grinding-machine is a most ingenious affair. It is worked by two cranks, one of which revolves seventeen times to one time that its fellow moves around. This arrangement makes the lens present a constantly changing surface to the tool which is polishing it. Red oxide of iron is used in the grinding, and beeswax brings out the polish. But even after the machines have done all their work, human fingers must complete the polishing process.

## Lesson XXIV.

### An Honorable Service.

In these modern days progress is the watchword. In no other way has improvement been more strikingly shown than in the fire service of our American cities. Great fires, caused by the inflammable nature of wooden buildings, were the necessity which spurred invention with us; and we have made advances so noteworthy in fighting fires, that when London and Paris remodel their fire departments, they come to America in order to get the most practical ideas.

Every aged man can recollect when volunteer firemen worked the brakes on the old hand-engines, after drawing them for perhaps miles, guided to the fire by the sound of the bell which first announced it. The methods of the old volunteer firemen are gone; but the spirit which animated those noble men still lives, tempered by discipline, in their successors, the paid firemen of to-day.

Modern invention has produced the water-tower, which is a tube shut into a square tube, like a telescope, and mounted on wheels. By hydraulic pressure it is raised perpendicularly; the inner tube is then shot upward by gearing until it reaches, in nine seconds, a height of 55 feet. Inside the tubing is a length of hose three and one-half inches in diameter, connected at the bottom with six lines of hose, and at the top with a pipe, which is at right angles with the perpendicular tube.

This arm can be worked up and down and to the right and left by a man standing on the ground, and through it can be thrown a stream of 150 gallons of water a minute, representing the united forces of three engines, and powerful enough to tear down a brick wall.

The advantage of a water-tower lies in the fact that a vast volume of water can be directed so as to reach almost any portion of the interior of a building. The same quantity of water played from the street would strike the ceiling of the story into which it was directed, and would fall on the floor only a few feet from the window, and, therefore, would not reach the fire beyond. Again, the men operate the tower from the ground, and there is not that danger to them from falling walls which there would be if ladders were used to support hose and men.

Experience proves that the power which a tower has to deliver so large a quantity of water in the upper part of a building prevents the confined air from becoming superheated, and thus stops hot-air explosions, which are extremely dangerous, as they frequently throw down the walls of a burning building, killing men and spreading the fire.

The appliances which are used in a great city's fire department are numerous, — door-openers for opening a door without damaging it, axes, shut-off nozzles, spanners for coupling and uncoupling hose, and various other helps unknown a few years ago.

In fighting fires time is everything; quickness in getting an alarm, and celerity in responding are of the greatest consequence. All appliances must be ready at all times for service, at any hour of the day or night. When, through accident or otherwise, any article becomes unfit for service, the department repair-shop stands ready at a moment's notice to repair or to replace it, thus preventing delay, which might, in case the apparatus was needed, be disastrous.

The fire department of every large city has also a school of telegraphy, where members are educated in writing with the Morse key, and in receiving messages by sound. They are detailed at fires to send messages and commands by telegraph to control the rest of the force. They are to the fire department what the signal corps is to the army.

The Pompier ladder is a strip of wood from twelve to eighteen feet long, iron bound, with small cross-pieces to rest the foot on ; at the end of the ladder is a hook, a belt with a swivel snap-hook attached, which enables the wearer to snap onto any convenient hold, and to support the body while the arms are free. The user of the ladder carries a coil of rope thrown over the shoulder. The fireman climbs by the small cross-pieces to the first window, by catching the hook onto a window-sill.

Then sitting or standing on the sill, he raises the ladder perpendicularly, and fastens the hook on the sill above. Then he climbs up to that sill, and so on, until he reaches the person in danger, whom he lowers down to his comrades by means of the rope.

Two members of the fire department in a large Eastern city, with the aid of a Pompier ladder, scaled a building ninety feet high in fifty seconds. Rescue climbing is only one of many uses to which the Pompier ladder can be put. It is a most useful fire appliance, and it has supplied, to a great extent, the deficiencies of modern fire-ladder service.

In case ladders cannot be used, the life-gun comes into play. This curious gun shoots a light line up to the person in danger, and this line enables him to pull up a heavier one, down which, when he has fastened it, he slides, or by its aid a fireman climbs up, and lowers him from danger.

In case all other means fail, and the flames force one as a last resort to drop to the pavement to save his life, he is caught in a circular jumping-net made of strong tarred rope, and held taut by the firemen. While this method is not absolutely safe for the one jumping, it is far preferable to death from flames, or to being dashed to death on the pavement.

The fire department has its skirmishers, which are called chemical-engines. They are mainly, each, two 60-gallon tanks, hung on four wheels. On account of their lightness, these engines can be drawn with great rapidity to a fire. The tanks are filled with water, and in a second can be charged with vitriol and soda, which, combining, evolve gas, and cause pressure enough to force water through a hose in pretty much the same way as soda-water comes from a fountain. When one tank is empty, turning a valve connects the hose with the second tank, and while that is playing, the first is being filled for use after the second is exhausted.

Many people think that it is the chemicals which put out the fire. There is very little ground for this supposition. The utility of the chemical-engine lies in the fact that a pail of water, properly directed, is far more useful at the start of a fire than hundreds of gallons later when it gets under strong headway.

The chemical, because of its lightness and ability to go quickly, is one of the most useful agents that we have for fighting fires. If a chemical-engine is unable to cope with a fire, then the steam-engine comes into play.

Stripped of its elaborate detail, it is a boiler, with cylinders and pumps attached, which by means of steam, forces water, drawn from a hydrant, through a hose. A popular fallacy is that the engine weighing the most in pounds is the most powerful. Such is not the case. It is the engine having the largest pumps, with sufficient steam capacity, that can do the greatest amount of work.

A perfect engine is one that can pump the largest quantity of water onto a fire, and be so light in weight as to be drawn to the burning building in the shortest time.

If the fire threatens to spread, then larger streams become necessary. It seems to be a well-settled fact that a small quantity of water poured on a large fire only adds to the intensity of the flames, owing to chemical action, and the larger the flame the more the necessity of increasing the volume of water thrown on the fire.

The hose-wagons, which follow the steamers when in service, and carry the hose for their use, are fitted with small hand chemical extinguishers capable of putting out small fires. These wagons also carry Pompier ladders, the men, and nearly all the tools which are needed at fires.

The ladder trucks are a very essential arm of the service. They carry the ladders. These range from the baby Bangor ladder to the extension, 92 feet high, which with a tip can be made still higher. To man them requires strong men. To be a ladderman, you must weigh at least 160 pounds, and stand 5 feet, 9 inches in height. A 65-foot ladder weighs about 500 pounds, and to place it in position requires strength, activity, and judgment.

When ladders 85 to 92 feet in height are to be raised, then turn-table trucks are brought into service. These raise the ladders by means of machinery worked by hand.

Let us imagine ourselves visiting, after sunset, an engine-house in the business district of one of our great cities. As we enter, we see a fireman in full uniform on floor patrol like a sentinel. On the wall above his head are a small gong and a large one, a telephone, an instrument that electricians call a pen register, and an apparatus showing the last alarm. On the floor are two engines. Each engine is attached by a pipe from its boiler to a small heater, which keeps a steam pressure on the boiler of 10 pounds or more. By this means the engines are ready for immediate service in case of a fire close at hand.

Behind each steamer we find a hose-wagon with Pompier ladders.

In the center of the floor stand the wagons of the chief of the department and the district chief; the former vehicle lit by electric lights. If a first alarm of fire comes in, the smaller engine answers with twelve men, and the larger one stays behind with nine to respond in case an alarm should come in from another box in the same district. If a second alarm comes from the box at which the first alarm was rung in, the larger engine responds, and a second alarm means a fire of some size.

In front of the engines, and suspended about six feet from the floor by cords drawn through pulleys attached to the ceiling, are harnesses for the horses, and coming down through openings in the ceiling are several brass poles, called sliding-poles. At the rear we see a series of doors with small square glass windows. Behind these doors are the horses. Up-stairs in the dormitories the men are fast asleep.

You can hear the scratching of the pen with which the man on patrol is writing down in the record-book the happenings of the last hour.

A quiet, almost deathly in its stillness, prevails. Now, suppose that a man passing along a street sees smoke coming from some building within the district served by the company quartered in this engine-house. He rushes to the nearest fire-alarm box, turns the handle of the keyless door to the right, then opens the door and pulls down the hook inside once. Then he lets go.

That simple act is almost magical in its effects upon the fire department. Every man and piece of apparatus is instantly on the alert.

The letting go of the hook has notified the fire-alarm operator at the City Hall, and the men in every fire station in the city, that there is a fire near the box. The man's finger has hardly left the hook, when the small gong at the patrol's side rings three quick blows, pauses, and then rings six more quick blows. This ringing it repeats four times, the pen register registering the number of blows on a strip of paper.

At the first blow of the gong, the patrol presses an electric button; the doors in the back of the engine-room fly open, the house is lit with a flood of electric light, the horses rush out, and stand under the harnesses, the men in boots, trousers, and jackets come down the brass sliding-poles, the drivers take their seats, men snap the collars on the horses' necks, and by that simple action and the pulling of a cord, the animals are harnessed.

The patrol announces the number of the box, the engineman lights the fire under the boiler, the captain gives the word "Go!" and jumps on the engine with the engineman and assistant engineman, while the rest of the company follow on the hose-wagon.

Probably in ten seconds from the first blow on the gong, the engine, hose-wagon, and twelve men, are out and away to the fire, while the chief's wagon is driven away to pick him up and to carry him to the scene of danger.

We hear the rolling of the apparatus on the pavements, as it flies down the street, drawn by powerful horses, the music of the bugle, shrill and clear, sending ahead a warning.

Gradually all sounds die away in the distance, except a faint murmur of the bugle; then there is silence, occasionally broken by the restless pawing of the three magnificent horses hitched, Russian fashion, to the larger engine, which, with hose-wagon and men, stands waiting for further developments.

Meanwhile the fire-operator in the City Hall repeats, with the electric machinery in his care, on the second and larger gong, the alarm which has been received. If the small gong had failed to work, the apparatus would have waited for the notice from the operator on the second gong, and in case both gongs had failed, the telephone of the department system would have been used.

Thus three ways for sending alarms are open.

In the mean time the chief of the department and several of the district chiefs will have arrived at the fire, and the driver of the wagon of the district chief in whose district the fire is will have hurried to the alarm-box, will have adjusted his portable telephone, and, with the Morse telegraph key in the box, will have notified the fire-alarm headquarters that he is there. In this way the officer in command at the fire has communication with the rest of the department.

In three minutes the engines are connected with the hydrants, the hose is laid, and the water is playing, the laddermen having meanwhile thrown their 40, 65, and 85 foot ladders up against the building to allow the hosemen to get at the fire.

If the fire threatens to get beyond control, the officer in command orders a second alarm, and the fireman on duty at the box pulls the hook. The small gongs in every station in the department strike the same number as before, and the operator in the City Hall verifies it by striking on the big gongs a certain number of blows, followed by the box number.

In the engine station, hardly has the second alarm done striking on the small gong when the command "Go!" finds the men on their way with the larger engine. The three horses hitched abreast drawing the engine, weighing almost five tons, speed along. Sparks fly from her smoke-stack. It is a spectacle exciting and beautiful.

Should the fire still threaten to increase, a third alarm is rung in the same way as the second, except that the fire-alarm operator verifies it by striking on the big gongs ten blows twice, followed by the box number. The designated engines, as provided in the department running-card, rush to the fire, and others come in, and cover the territory thus left vacant.

The fourth alarm, and the general, followed by the box number, come next, if the magnitude of the fire warrants both signals.

The system of covering in is still used in these alarms. Even the general alarm, which means a conflagration, and is struck on an average only once in ten years, and calls almost the whole department into service, leaves apparatus scattered over the city sufficient to cope with any ordinary fires that may occur.

When the fire is out, the fact is telegraphed to the fire-alarm operator, who strikes a certain number of blows, followed by the box number, on the small gong. All the engines return to their proper stations, and if another alarm comes from the same section, the department knows that the proper apparatus is ready to reply, and there is no need of the covering apparatus to respond.

At second and third alarms the department veterinary surgeon comes to look after the horses, the superintendent of repairs to attend to repairs and the coaling of the engines, and experts come to supervise the running of the engines, and to assist if anything mechanical needs looking after.

The method of having telegraphic and telephonic connection with the rest of the force, by means of the fireman stationed at the box near where the fire is, enables the chief or officer in command to call what help he needs immediately; and he can, if there is a fire elsewhere, send apparatus from the first to the second fire, if it is necessary, and he has an engine to spare.

Always in one's thoughts in connection with a fire department are the powerful, spirited horses bounding along with the apparatus in response to an alarm. Historians have written, poets have sung of the war-horse, his strength and his glory. The fire horse has yet to find a place in literature.

In his way he is as worthy of fame as his more celebrated brother. Sound in wind, intelligent, with great strength, weight, and swiftness — only horses possessing these qualities are fit to enter the fire service.

At six years of age the department horse enlists, is given his number, and, after years of hard work down town, is transferred to the outer sections of the city, where his labors will be lighter. Much might be said of the fire horse's intelligence. He learns his duties quickly, and in many cases shows feelings almost human. He becomes a pet and companion, and often a whole company mourn when death suddenly takes away a horse — an old favorite in the service.

In war the officer often points out to the private soldier the way to glory and perhaps death; in fire fighting the officer must lead and the men follow.

As the soldier is animated by the noblest sentiment in the heart of man, love of country, it is not to be wondered at that he is brave in giving battle to his hated foe. The fireman fights an enemy of the common good; and although he has not the same incentives as the soldier, yet it is all the more to the fireman's credit that in fulfilling his duty he often exhibits a bravery unsurpassed in the annals of war.

## Lesson XXV.

### Fine Feathers, Fine Birds.

The ostrich plume has been prized from time immemorial as a head ornament. At the battle of Crécy, in 1346, the English leader, the Black Prince, having slain the king of Bohemia, plucked the ostrich plume from the vanquished king's helmet, and, placing it in his own, assumed it as the "crest of the Prince of Wales," as which it has ever since been recognized.

The ostrich is a native of Africa, and has been found from Algeria to the Cape of Good Hope Peninsula. Though there are evidences in quaint etchings on Egyptian monuments, and in the writings of some of the old authors, that the ostrich was a domesticated bird, it would be difficult to prove that the ancients knew much about this remarkable feathered biped. And for all practical purposes the taming of the ostrich, the transforming of it from one of the wildest and most timid creatures of the desert to a tractable species of farm stock, may be said to be due to the Boer farmers of South Africa. The beginning of the taming of the bird dates back to 1865.

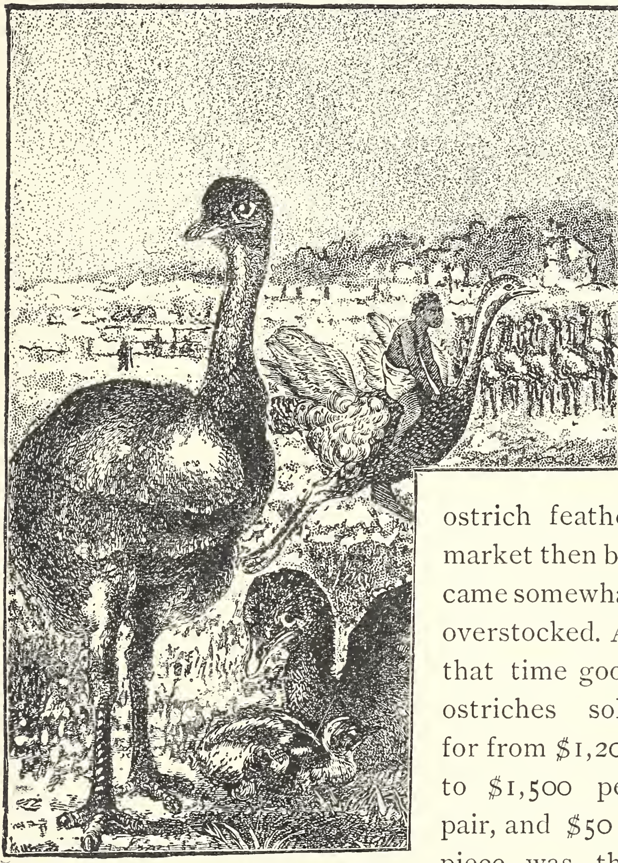
Prior to that year the entire supply of ostrich feathers for the markets of the world was obtained by killing the ostriches, from which the feathers were pulled. The demands of fashion for these dainty ornaments made them high-priced; and to obtain them, so relentless was the warfare waged upon the ostrich by both white and black hunters, that its utter extinction at one time seemed imminent.

The first effort at domesticating the ostrich in South America was made by a Boer farmer. He captured some young ostrich chicks, and tamed them, a proceeding found not difficult. But old hunters and travelers from the interior all declared that any attempt to keep the birds in a tame state would be useless.

It was the prevailing belief, that so shy was the hen ostrich, that if her nest of eggs was once viewed by human eyes she would never more return to it.

It is needless to say that this theory was soon exploded; and it was proved that in a domesticated state the ostrich would multiply far more rapidly than in its wild or native condition, principally, no doubt, because it was better protected from the dangers from hunters and wild beasts.

From the beginning made with only a few tame ostriches in 1865, the increase became so rapid, that in 1882 the number of the birds amounted to nearly 200,000, and the value of the export of their feathers reached the enormous sum of $5,500,000. That year was the zenith of the industry, and the ostrich feather market then became somewhat overstocked. At that time good ostriches sold for from $1,200 to $1,500 per pair, and $50 a piece was the ruling price for chicks only a few weeks old. The enormous profits which up to this period had been realized



Ostrich Farming in South Africa

in the industry had induced many people to abandon other pursuits to engage in it; and the over-production, and the consequent fall in prices which ensued, created a financial panic throughout Cape Colony. Many a misguided ostrich-raiser was made to realize the wisdom of the old saw: "Every cobbler to his own last." The business has since settled down to a basis of regular demand and supply, and on that safe foundation continues to be a profitable pursuit for a large number of persons.

Ostriches have been exported from South Africa to Australia and the Argentine Republic. They seem to have done well in those countries. In 1884 twenty-four fine full-grown ostriches were shipped from Cape Town, South Africa, to Southern California. There they have greatly increased in numbers, and have proved a source of profit to their owners.

The climate of Southern California is dry and mild, like that of Cape Colony, Africa, and on that account will be congenial to the ostrich. For the same reason, New Mexico, Arizona, and Western Texas should be suitable for ostrich farming.

The ostrich is of a timid, shy nature, and in the wild state is generally to be found in flocks, — a fact that proves his sociable disposition. He possesses a voracious appetite, and while his fancy runs to grasses, clover, cactus leaves, sweet fruits, and like tid-bits, he does not disdain to eat insects, scorpions, lizards, snakes, frogs, scraps of meat, and even bones. This indifference in the choice of food has given rise to the assertion that he is omnivorous. A well-nourished five-year-old male ostrich will weigh about 300 pounds, and without using much effort can look over a wall ten feet high.

The stupidity of the ostrich is proverbial: he will lie down whenever and wherever the inclination takes him, whether in the mud or on the sand, and under sudden fright starts off at breakneck speed, and is oblivious to any obstacle which may lie in his course. In this way his legs are often broken, and not infrequently he is killed outright.

An ostrich nest is a circular hole in the sand about nine inches deep, four feet long, and three feet wide. To dig this hollow, the male bird seats himself upon the ground, and scratches away the sand with his powerful claws. When the nest is finished, the hen ostrich begins the serious part of her work by laying one egg every alternate day.

About forty eggs is the annual yield. When the laying season is ended, the eggs are at first sat upon for a few hours each day by the male bird; but finally the pair take alternate watches, —

the male *always* being on duty at night. In about forty-five days the chicklings chip through the eggs, and come forth at first limp and weak, but, being soon revived by the warmth of the parent body, they begin to run about, and within twenty-four hours develop a voracious appetite for insects, small pebbles, and almost anything else coming within their reach. The parent birds look on admiringly, but do not assist their little ones in their search for food.

For several years past the steam-heated incubator has superseded the natural hatching of ostriches in South Africa.

There are few scenes calculated to inspire the traveler from the city with more interest than a visit to a well-conducted ostrich farm. Considering the high prices of ostrich feathers, it is strange that there are not to be seen in the southern and south-western portions of the United States many ostrich farms.

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## Lesson XXVI.

### A Useful Mineral.

One of the most curious of volcanic products is sulphur — a mineral known from the earliest times. In later days it has become of great importance, as it is used in many industrial arts.

The United States contains numerous deposits of sulphur. Attempts have been made to utilize a few of them.

The mine yielding the largest amount of the mineral in this country is situated in Northern Utah. But the most extensive deposit of pure sulphur to be found in any part of the world is within the crater of one of the world's highest mountains — Popocatapetl, Mexico.

The former inhabitants of Mexico, the Aztec Indians, knew of the existence of the yellow mineral in its strange hiding-place in the top of the mountain, more than three miles above their beautiful capital. Over 370 years ago the Spaniards, under Cortez, invaded the country, and by means of their firearms — weapons utterly unknown to the Aztecs — succeeded in defeating the natives in several hard-fought battles.

Suddenly the white men found that their supply of gunpowder, their sole means of safety from swift destruction at the hands of the Indians, had run very low. The discovery struck terror into their hearts. What was to be done? "We will make some gunpowder," said their intrepid captain.

Charcoal in superabundance was to be had from the square miles of forest around them; a bed of saltpeter had been passed, they knew, on their march inland, but sulphur — where could that indispensable substance be obtained? An Aztec traitor told them of the enormous deposits of that mineral to be seen in the immense hollow on the top of the lofty "Smoking Mountain" (Popocatapetl).

A dozen Spaniards, headed by Francisco Montano, a lieutenant of Cortez, volunteered to ascend the terrible volcano. After a toilsome two days' journey, they reached the summit, and, faint and worn, gazed into the awful chasm below. Sulphurous vapor filled the air. They heard the constant rumbling produced by the appalling energy of volcanic action, and they felt the ground tremble under their feet.

It was decided to draw lots to decide who should go down into the frightful, clouded depths. The lot fell on Montano himself! Equipped with several baskets, he was let down by ropes. He succeeded in filling the baskets with sulphur, and was drawn up with them in safety.

The descent of the volcano was soon made, as joy lent wings to the feet of the bearers of the yellow treasure — a treasure then and there infinitely more valuable than gold. We may be sure that the Spaniards felt grateful to the lofty "Smoking Mountain."

The sulphur of this volcano is said to be the purest in the world, and it has been more or less used since the days of Cortez. The top of the mountain is crowned with perpetual snow. You can see it shining in the sunlight from Mexico City. Opposite Popocatapetl stands the other grand volcano, known as the White Woman (Iztaccihuatl). These two mountains tower over the Mexican capital like ghostly sentinels watching its safety. The Mexicans are proud of them, and the Indians have many traditions concerning their origin.

You can ride to the foot of Popocatapetl on a railroad, and, continuing your journey on foot, by nightfall you are at a little frame hut, where you sleep, and start onward at about 4 o'clock in the morning. Leaving here, you first strike a strip of pine forest, out of which you go into an inclined plane of loose black sand. This extends to the snow-line. You are away up in the clouds above the rest of the world of Mexico.

If the day is clear, you have magnificent views of the great Mexican valley, a big basin surrounded by mountains. You see the White Woman below you, and all around are the great hills, which form the most striking feature of the great Mexican plateau. If the day be slightly cloudy, you will see the clouds above and below you at the same time.

You can watch them crawling up to your feet, chasing one another from mountain to mountain, and feel them envelop you, and then pass onward and upward until they are lost in the crater.

As you go up, the snow, which is wet at the bottom of the snow-line, becomes harder. The air grows colder and rarer, and if your lungs and heart are weak you will grow faint. Near the top there are pillars of ice, and your hands are torn with pulling yourself up, step by step. Your eyes grow sore with the glare of the Mexican sun on the white snow; but you stand at last on the edge of the crater, at one of the topmost points on the American continent.

This crater is about half a mile wide. In some places it is 1,000 feet deep, and from it comes a volume of sulphurous smoke. At the top the walls slope out and downwards gradually, so that you can crawl down for about a hundred feet, and peep over.

The Indian workmen gathering the sulphur can be seen, like ants, below you, and you feel the ground quake under you as you look. Working in the mine is by no means safe. One is liable to be overcome by the fumes of the sulphur; or an avalanche of snow from the western part of the mountain may roll down, and overwhelm all the workers below. Rocks in the wall of the crater at times become loosened by the shaking and rumbling, and fall down, crushing all in their path.

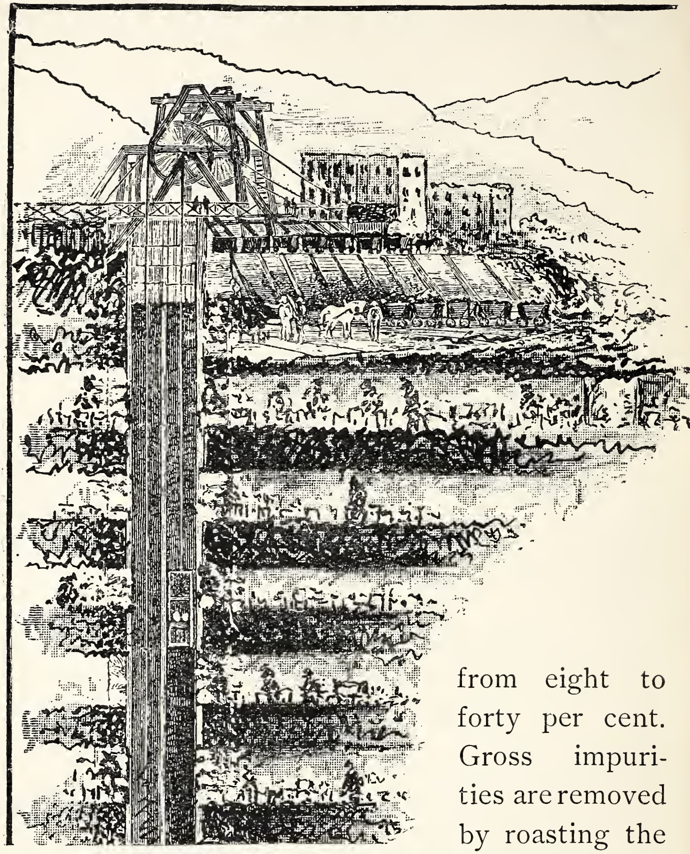
The action of the sulphur on the clothes and health of the workmen is very injurious. It rots the clothes, and the teeth of the men finally become loosened, and drop out. The result is that high wages have to be paid, and the men contract to go up on the mountain and to work in the crater for a month at a time, not returning to the bottom of the volcano before the month is completed.

The transportation of the sulphur down the mountain is an easy matter. A sort of chute has been made, and the sulphur wrapped up in mats is placed upon this, and both men and sulphur slide down.

The largest portion of the world's supply of sulphur comes from Sicily. There it is mined — dug out of the ground, just as coal or rock-salt is obtained.

Sicilian sulphur in its natural state is not pure, but is mixed with clayey or chalky earth. The mode of mining is to sink a large deep shaft, and to excavate, on each side of it, horizontal tunnels. A central pillar is left to support the roof of each chamber hollowed out. Not unfrequently the whole mine falls in.

The proportion of sulphur in the soil varies



Sulphur-Mine.

from eight to forty per cent. Gross impurities are removed by roasting the mineral in pits lined with stones. The sulphur thus obtained is exported to various countries, where it is refined by distilling it in large iron stills.

Sulphur-mining in Sicily is carried on mostly by handwork. The atmosphere of a sulphur-mine is very baneful, and nearly all the workers are afflicted with disease brought on by their employment.

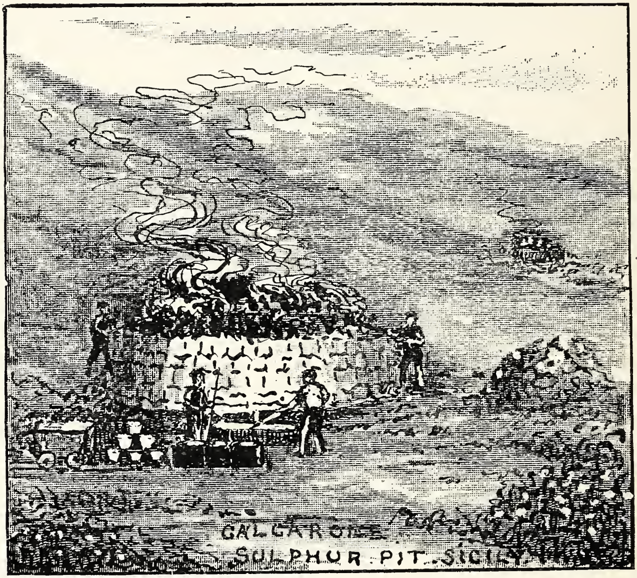
Americans are shocked at the sight of the large numbers of children forced to drudge twelve hours a day in the noxious depths of Sicily's numerous sulphur-pits.

Let us stand, at the close of the working-day, near the mouth of a shaft of an extensive mine in the central part of the island, and take note of the workers as they swarm out.

Notice the first batch of children. Their ages range from six years to ten. Next comes a throng of lads from twelve to seventeen years of age probably. Lastly, the men make their appearance. Thousands of these laborers walk six miles a day to and from their work, preferring this additional fatigue to sleeping in the deadly air of their places of daily toil.

When a proprietor of the soil possesses, or believes that he possesses, a sulphur-mine, he is bound to inform the authorities, and to pay a small sum (about $25) for the right of working the mine. Then his duties end, and his rights begin.

Few proprietors work their mines. All the expenses of exploration, sinking pits, constructing galleries, are assumed by the contractor, who pays the proprietor so many loaves of sulphur, which his agent selects and carries off. The proprietor keeps a staff of agents to look after his interests ; to see that so many galleries, arches, and columns are constructed and kept in due repair, so that, at the




*Roasting Sulphur.*

expiration of the lease, the proprietor may find all in due order, and be able to make better terms with the next contractor.

The depth of the mines varies from mine to mine, and in the same mine from plane to plane. Maybe the first gallery is 150 yards below the mouth of the pit ; 50 feet lower, perhaps, is another gallery; and the lowest one is down 300 yards often. The heat is so intense that only those used to it can stand it.

Each miner has a certain number of helpers of different ages, — boys of twelve, men up to sixty, — who transport the material either to the cars or to boxes on wheels, or to the mouth of the pit. The cars run on inclined planes, but "lifts" have been introduced into some of the large mines, and only where there are such contrivances can a stranger descend.

Where slides, or lifts, are used, you may, if you do not descend, leave the mines with the conviction that the mining is carried on by this rough sort of machinery; but you would be in error. The boxes go down only a third of the depth of the mine; and from the bottom up to the level where the cars land, the children or men bring up the sulphur in sacks or baskets, in loads of from 20 to 200 pounds on each journey.

Up the steep, slimy steps or paths they go, scarcely daring to rest a second, every third burden-bearer carrying an oil-lamp on his head, and sweating, panting, moaning, till he reaches the "magazine," or depot. There he throws down his load, turns, and with lightning speed dashes down again — some of the little ones actually singing and leaping with the sheer joy of their momentary relief from pain. Ten journeys these "bearers" make per day, and, if the distances are short, twenty, and in some mines even thirty trips.

The worst feature of the case is that the little boys are farmed out by their own fathers to the miners; hence the life-long slavery of each boy begins when he is about ten years of age.

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## Lesson XXVII.

### About Railroads.

Towards the end of last century, tramways formed by laying down narrow plates of iron were in use in mines in several parts of England. The plates had usually a projection or flange on the inner edge, in order to keep the wagons on the track, for the wheels themselves had no flanges, but were of the kind used on ordinary roads.

These flat tramways were found liable to become covered with gravel, so that the benefit which would have been obtained from their smoothness was in a great measure lost. *Edge rails* were, therefore, substituted, and the wheels were kept on the rails by having a flange cast on the inner edge of each wheel-rim. The rails were then always made of cast-iron; for, although they were very liable to break, the great cost of making them of wrought-iron prevented that material from being used until 1820, when the method of forming rails of malleable iron by rolling came into use.

The first time a tramway was used for the conveyance of passengers was in England in 1825, when the Stockton and Darlington Railway was opened. It appears that the cars were at first drawn by horses, although locomotives were used on this and other colliery lines for dragging, at a slow rate, trains of mineral wagons.

Before that time engineers were exercising ingenuity in overcoming a difficulty which never existed, by devising plans for giving tractive power to the locomotive through the aid of toothed rails. It never occurred to any of the engineers to try first whether the adhesion of the smooth wheel to the smooth rail was not sufficient for the purpose.

During the first quarter of the present century the greater part of the freight carrying, and much of the passenger traffic, was done by the canals. It is quoted, as a proof of the careless manner in which this service was performed, that the transport of bales of cotton from Liverpool to Manchester sometimes occupied twice the length of time taken for their voyage across the Atlantic.

The first railroad was to be used only for the conveyance of goods, especially cotton and cotton manufactures, and the wagons were to be drawn by horses. When the line was nearly finished, the idea of employing horses was abandoned in favor of steam power. The directors were divided in opinion as to whether the carriage should be pulled along by ropes wound on large drums by stationary engines, or whether locomotives should be employed. Finally, the latter plan was adopted, and it was also suggested that passengers might be carried.

The directors offered a prize for the best locomotive, and the result has been already mentioned in Lesson XIII.

In the light of our experience since that time, it is curious to read of the doubts then entertained by skillful engineers about the success of the locomotive. In a serious treatise on the subject, one eminent authority hoped "that he might not be confounded with those hot-brained enthusiasts who maintained the possibility of carriages being driven by a steam-engine on a railway at such a speed as twelve miles an hour."

When the "Rocket" attained a velocity of twenty-nine miles an hour, and the railway was opened for passengers as well as for freight, the thirty stage-coaches daily plying between Liverpool and Manchester found their occupation gone, and all ceased to run except one, which had to depend on the roadside towns only, while the daily number of passengers between the two cities rose at once from 500 to 1,600.

In later days George Stephenson liked to tell how the promoters of the scheme struggled against "vested interests;" how the canal proprietors, confident at first of a secure enjoyment of their monopoly, ridiculed the proposed railway, and continued their exorbitant charges and tardy conveyance, pocketing in profits the prime cost of their canal about every three years; how the land-owners offered every resistance to the railroad surveyors; how the Duke of Bridgewater's farmers would not allow them to enter their fields, and the Duke's gamekeepers had orders to shoot them; how newspaper writers declared that the locomotives would kill the birds, prevent cows from grazing, and hens from laying, and would burn houses, and cause the extinction of the race of horses.

All the civil engineers scouted the idea of a locomotive railway, and Stephenson was held up to derision as an ignoramus and a maniac by the professional engineers of the time.

An article appeared in the *Quarterly Review*, remarking in reference to a proposed line between London and Woolwich, "What can be more palpably absurd and ridiculous than the prospect held out of locomotives traveling *twice as fast as stage-coaches!* We should as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's rockets as trust themselves to the mercy of a machine going at such a rate. We will back old Father Thames against the Woolwich Railway.

"We trust that Parliament will, in all railways it may sanction, limit the speed to *eight or nine miles an hour*, which is as great as can be ventured on with safety."

When it has been decided to construct a railroad between two places, the laying out of the line is a subject requiring great consideration and the highest engineering skill; for the matter is, on account of the great cost, much more important than the setting out of a common road. The idea of a perfect railroad is that of a straight and level line from one terminus to another; but there are many circumstances which prevent such an idea from being carried into practice.

First, it is desirable that the line should pass through important towns situated near the route; and then the cost of making the roadway straight and level, in spite of natural obstacles, would be often so great, that to avoid it, detours and inclines must be submitted to, the inconvenience and the increased length of road being balanced by the saving in the cost of construction. It is the business of the engineer who lays out the line to take all these circumstances into consideration, after he has made a careful survey of the country through which the line is to pass.

The cost of making railroads varies, of course, very much according to the number and extent of the tunnels, cuttings, embankments, or other works required. The road itself when the rails are laid down is called *the permanent track*, perhaps originally in distinction to the temporary tracks laid down by the contractors during the progress of the works.

The permanent road-bed is formed first of *ballast*, which is a layer of gravel, stone, or other carefully chosen material, about two feet deep, spread over the roadway. Upon the ballast, and partly embedded in it, are placed the *sleepers*, which is the name given to the pieces of timber on which the rails rest. These timbers are placed across the direction of the rails.

It may easily be seen on looking at a line of rails that these are not laid with the ends touching one another, or, at least, they are not usually in contact. The reason of the separation is that space must be allowed for the expansion which takes place when a rise in the temperature occurs. If the rails are laid down in the hottest weather that they are ever to experience, they may then be placed in actual contact; but in cold weather spaces will be left by their contraction.

For this reason it is usual when rails are laid to allow a certain interval between their ends; thus rails 20 feet long, laid when the temperature is 70°, are placed with their ends $\frac{1}{20}$th of an inch apart, at 30°, $\frac{1}{10}$th of an inch apart, and so on. The neglect of this precaution has sometimes led to serious accidents.

The distance between the rails in the United States is 4 feet 8½ inches, that width having been adopted by George Stephenson in the construction of the earlier lines in England. Brunel, the engineer of the Great Western Railway in England, adopted, however, in the construction of that railway, a gauge of 7 feet, with a view of obtaining greater speed and power in the engines, steadiness in the cars, and increased size of freight-cars for bulky goods.

The wheels of railroad cars and engines differ from those of ordinary carriages, in being fastened in pairs upon the axles, with which they revolve. The tire of the wheel is conical, the slope being about one in twenty; that is, in a wheel-tire five inches wide, the diameter of the outer edge is $\frac{1}{4}$ inch less than the diameter of the inner; and the rails are placed sloping a little inwards.

The effect of this conical figure is to counteract any tendency to roll off the rails; for if a pair of wheels were shifted a little to one side, the parts of the tires rolling upon the rails being then of unequal circumferences, would cause the wheels to roll towards the other side.

The conical shape produces this kind of adjustment so well that the flanges do not in general touch the rails. They act, however, as safeguards in passing over curves and junctions. In curves the outer line of rails is laid higher than the inner, so that in passing over them the train leans slightly inward, in order to counteract what is called the centrifugal force, — a force to which any body moving rapidly in a curve is subject.

It is obvious that the amount of centrifugal force, and therefore of inward slope, will increase with the speed and sharpness of the curve, and on railroads the rails are so placed that the slope counteracts the centrifugal force when the train travels at about the rate of twenty miles per hour.

A very important part of the mechanism of a railway is the mode of passing trains from one line of rails to another. Engines and single cars are sometimes transferred by means of *turn-tables*, but the more general mode is by *switches*. These are movable rails, and are worked by means of levers attached to rods, each lever being placed either near the rails, or in a *signal-box*, where a man is stationed, whose sole duty it is to attend to the switches and to the signals.

The telegraph is now an important agent in railroad signaling, and in a signal-box we may see the bells and instruments which inform the signal-man whether a certain section of the line is "blocked" or "clear." The signals now generally used are made by the semaphore, which is simply a post from which an arm can be made to project.

When the engineer of a train sees the arm projecting from the left-hand side of the post, it is an intimation to him that he must stop his train; when the arm is dropped half-way, so as to project at 45° from the post, it is meant he must proceed cautiously; when the arm is down, the line is clear. These signals, of course, are not capable of being seen at night. Then their place is supplied by lamps provided with colored glasses, red and green, and also with uncolored glass.

Each lamp may have the different glasses on three different sides, and be turned round so as to present the required color; or it may be made to do so without turning, if provided with a frame having red and green glasses, which can be moved like spectacles in front of it.

The meanings of the various colored lights, and the corresponding semaphore signals, are these:—

| | | | |
|---|---|---|---|
| \| | White | *All right* | Go on. |
| /\| | Green | *Caution* | Proceed slowly. |
| ˥ | Red | *Danger* | Stop. |

We may remark that the signaling instruments on all the well-equipped lines at the present day address themselves both to the ear and to the eye, for they consist of, first, bells, on which one, two, or more blows are struck, each series of blows having its own particular meaning; and, second, of a kind of miniature signal-post, with arms capable of being moved by electric currents into positions similar to those of the arm of an actual signal-post, so that the position of the arms is made always to indicate the state of the line. One arm of the little signal-post, the left, is red, and it has reference to *receding* trains; the other, viz., the right arm, is white, and relates to *approaching* trains.

The interior of a large signal-box exhibits a very animated scene, in which there are but two actors, a man and a boy, both as busy as bees, but with no hurry or noise. The ruling genius of the place is the strong, active, intelligent signalman, standing at one end of the apartment, the monarch for the time being of all he surveys.

Immediately before him in one long line, extending from side to side, is a goodly array of levers, bright and clean from constant use and careful tending, each one labeled for its respective duty. Before him, to the right and left, are the various electro-magnetic semaphores, each one in full view, and adjusted in position to the pair of tracks to which it is appropriated, and all furnished with porcelain labels.

Directly in front of him is a screen, along which are arranged the various semaphore keys ; and on brackets are the bells and gongs, the twin companions each of its own semaphore. Before the screen are the writing-desk and books. Here stands the youngster, the ministering spirit, all on the alert to take or to send electric signals, and to record them, his time and attention being devoted alternately to his semaphore keys and to his books, and he himself being immediately under the eye and control of the signalman.

This no place for visitors, and the scenes enacted here have little chance of meeting the public gaze ; indeed, the officers whose duties occasionally take them hither are only too glad to look on, and to say as little as may be, and not to interrupt the active pair, between whom there is evidently a good understanding in the discharge of duties, upon the accurate performance of which so much depends.

Looking on, the man will be seen in command of his rank and file: signals come, are heard and seen by both man and boy; levers are drawn and withdrawn, one, two, three, or more; the arms and the lamps on the masts outside, of which there are three, well laden, are displayed as required; distant signals are removed, switches are shifted, and tracks made ready; telegraph signals are acknowledged; and on looking out, trains are seen moving in accordance with the signals made; and on the signal-posts, right and left, arms are seen up and down in sympathy with those on the spot, and with the telegraph signals that have been interchanged.

There is no cessation to this labor, and there is no confusion in it: one head directs the whole work so that there are no misunderstandings; all is done in perfect tranquillity, and the great secret is that one thing is done at a time. All this work, which is so simple to the expert, is to the visitor intricate and vague; and though he cannot at first even follow the description of the several processes, so rapidly are they begun and ended, yet, as his ideas become clearer, he can not fail to be filled with admiration at the great results that are brought about by means so simple.

The parlor cars on American railroads are luxurious hotels upon wheels. Each car accommodates about forty persons, having a kitchen, hot and cold water, china and linen closets, and more than a hundred different articles of food.

Then there are the palace and the sleeping cars, in which the traveler who is on a long journey makes himself at home for days; as, for instance, while he is being carried across the continent from ocean to ocean at the easy rate of thirty miles an hour on the Pacific Railroad and other connecting lines.

His housekeeping is done, and admirably done, by alert and experienced servants; his dinner is sure to be abundant, very well cooked, and not hurried; and the country through which his train is speeding is strange, and abounds in curious and interesting sights. He may write comfortably at a table in a little room called a "drawing-room," entirely closed off from the remainder of the car.

Books and photographs lie on tables in the car. Children play on the floor, or watch at the windows for the comical prairie-dogs sitting near their burrows, and turning laughable somersaults as the car sweeps by.

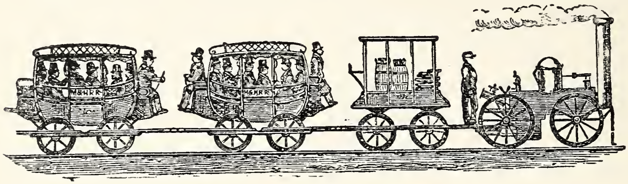
An important general truth may find a familiar illustration in the subject of railroads. The truth in question may be expressed by saying that, in all human affairs, as well as in the operations of nature, the state of things at any one time is the result, by a sort of growth, of a preceding state of things.

It is certainly true of inventions that they never make their appearance suddenly, in a complete and finished state; but their history rather resembles the slow and progressive process by which ordinary mortals attain to their full stature.

We have already seen that railroads had their origin in the tramways of collieries; and, in like manner, the palace car grew out of the stage-coach; for, when railroad cars to convey passengers were first made, it did not occur to the designers that anything better could be done than to place coach bodies on the frames of the trucks; and accordingly the early cars were formed by mounting the body of a stage-coach, or two or three such bodies, on timber framework supported by flanged wheels.

The cut on page 242 is from a painting in the possession of the Connecticut Historical Society, and it represents the first train in America on its trial trip (1831), in which sixteen persons took part. They were then thought to be extremely reckless individuals! We see that the cars were stage-coaches, and the same was the case in England.

But it is very significant that to this day the stage-coach bodies are traceable in many of the carriages now running on English lines, especially



*First Railroad Train in America.*

in the first-class carriages, where, in the curves of the moldings which are supposed to ornament the outside, one may easily recognize the forms of the curved bodies of the stage-coaches, although there is nothing whatever in the framing of the cars which has the most distant relation to these curves. Then, again, almost universally on English lines the old stage-coach door-handles are still retained on the first-class carriages, or cars as we call them.

The cut proves that we Americans set out with the same style of carriages; but North America, as compared with the Old World, is pre-eminently the country of rapid developments, and here carriages, or cars, have for a long time been made with numerous improvements, and in forms more in harmony with the railroad system.

The perfection of comfort in traveling appears to be attained in our famous Pullman cars, of which we have long enjoyed the benefit; while in the birthplace of railways no attempt has been made to effect any material improvements in the general plan of the carriages.

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## Lesson XXVIII.

### A Great Work.

The remarkable development of railroads which has taken place in the United States has its most striking illustration in the grand system of lines by which the whole continent can be traversed from shore to shore. The distance by rail from New York to San Francisco is 3,215 miles, and the journey occupies about a week, the trains traveling night and day. The traveler proceeding from the Eastern States to the far West has the choice of many routes, but these all converge to Omaha.

From this point the Pacific Railroad will convey him towards the land of the setting sun. This railroad traverses broader plains and crosses higher mountains than any other railroad in the world. Engineering skill of the most admirable kind has been displayed in the laying out and in the construction of the line, with its innumerable cuttings, bridges, tunnels, and snow-sheds.

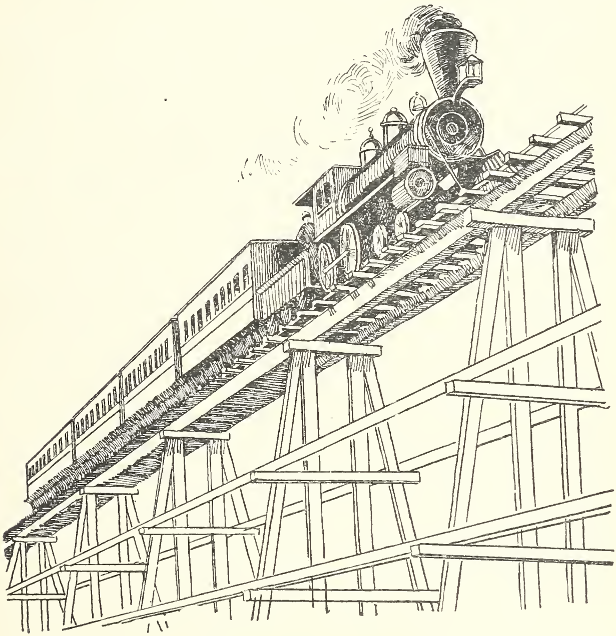
A little distance from Omaha the line approaches the Platte River. This portion of the line, passing through a district where leagues upon leagues of fertile soil await the hand of the tiller, has opened up vast tracts of land, — green fields, capable of supporting millions of human inhabitants.

Seven miles beyond Cheyenne the line begins to ascend the Black Hills. At Granite Cañon the rise in five miles is 574 feet, or about 121 feet per mile. A little beyond this point the road is in many places protected by snow-sheds, fences of timber, and rude stonework.

At Sherman the line attains the summit of its track over the Black Hills, and the highest point on any railway in the world, this town being 8,242 feet above the level of the sea. Wild and desolate scenery characterizes the district round Sherman, and the hills, in places covered with a dense growth of wood, will furnish an immense supply of timber for years to come.

The timber-sheds over the line and the fences beside it have been constructed not so much on account of the depth of snow that falls, as to prevent the snow from blocking the line by being drifted into the cuts by the high wind. A few miles beyond Dale Creek at Sherman is the largest bridge on the line. It is a trestle bridge, 650 feet long and 126 feet high.

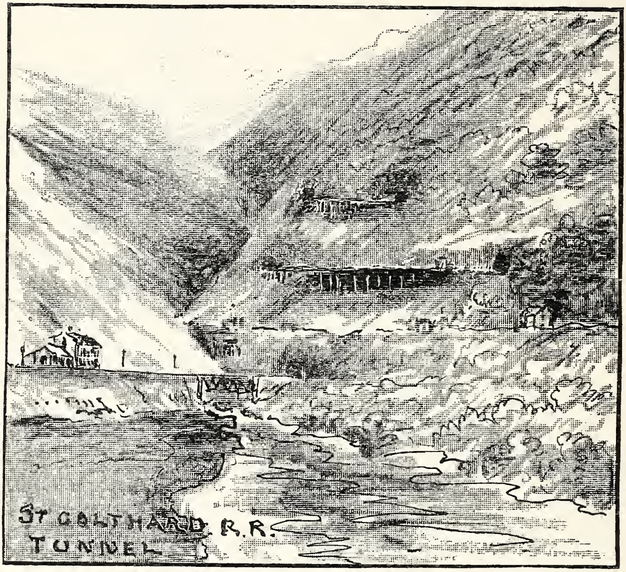
At Percy is a station named after Colonel Percy, who, when surveying for the line, was killed here



*Railroad Trestle Bridge.*

by the Indians. He was surprised by a party of the red-men, and retreated to a cabin, where he withstood the attack of his assailants for three days, killing several of them; but at length they set fire to the cabin, and the unfortunate Colonel, rushing out, fell a victim to their ferocity. Near

Creston, 737 miles from Omaha, is the water-shed of the continent; for all streams rising to the east of the ridge here flow ultimately into the Atlantic, while rivers having their sources in the west




*Railroad Tunnels.*

fall into the Pacific. Where the road could not be carried round or over the spurs of the mountains, it passes through tunnels, often cut through solid stone.

We have now arrived at Ogden, where the western division of the great railroad line connecting the two oceans unites with the Union Pacific.

This western section is known as the Central Pacific Railroad, and it stretches from Ogden to San Francisco, a distance of 882 miles.

The portion of the line which unites Sacramento to Ogden was commenced in 1863 and finished in 1869. About 50 miles west of Ogden, the remarkable engineering feat of laying 10 miles of railroad in one day was performed. It was accomplished thus: when the wagon loaded with the rails arrived at the end of the track, the two outer rails were seized, hauled forward off the car, and laid upon the sleepers by four men, who attended to this duty only.

The wagon was pushed forward over these unfastened rails, and the process of putting down rails was repeated, while behind the wagon trooped a little army of men, who drove in the spikes, and lastly, came a large number of Chinese laborers, with pickaxes and spades, who ballasted the line. The average rate at which these operations proceeded was about 240 feet of track in 77 seconds, and in those 10 miles of railroad there were 2,585,000 cross-ties, 3,520 iron rails, and 55,000 spikes!

Four thousand men, and hundreds of wagons were required; but in the ten miles all the rails were laid by the same eight men, each of whom is said to have that day walked ten miles and lifted

1,000 tons of iron rails. Nothing but the practice acquired during the four previous years and the most excellent arrangement and discipline could have made possible the performance of such a feat as the laying of eight miles of the track in six hours, which was the victory achieved before dinner by those stalwart workmen.

The more exposed mountain portions of the road are covered with snow-sheds, solidly constructed of pine-wood posts, 20 inches across: the total length of snow-sheds on the Sierra Nevada may equal 50 miles. These sheds sometimes take fire; but the company have a locomotive at Summit Station, ready to start at a moment's notice with cars carrying tanks of water.

The snow falls there sometimes to a depth of 20 feet in one winter; and in spring, when it rolls down into the valleys in avalanches, sweeping down the mountain-sides, it passes harmlessly over the sloping roofs of the snow-sheds. Where the line runs along the steep flank of a mountain, the roofs of these snow-sheds abut against the mountain-side, so that the masses of snow, gliding down from the heights, continue their slide without injury to line, or sheds, or trains. Where, however, the line lies on level ground, the snow-sheds are built with strong roofs of double slope, in order to throw off the snow.

About 36 miles from Summit, the great American Cañon, one of the wildest gorges in the Sierra Nevada range, is passed. Here the American River is confined for a length of two miles between walls of rock, 2,000 feet in height, and so steep that no human foot has ever yet followed the stream through this tremendous gorge.

A few miles beyond this cañon the line is carried, by a daring feat of engineering, along the side of a mountain, overhanging a stream 2,500 ft. below. This mountain is known as "Cape Horn," and is a place to try the nerves of timid people. When this portion of the line was commenced, the workmen were lowered and held by ropes, until they had hewed out a standing-place on the shelving sides of the precipice, along whose dizzy height, where even the agile Indian was unable to plant his foot, the science of the white man thus made for his iron horse a secure road.

These lines of railroad, connecting Omaha with Sacramento, are remarkable evidences of the energy and spirit which characterize the American people. The men who conceived the design of the Central Pacific Railroad, and actually carried it into effect, were not persons experienced in railway construction; but five middle-aged merchants of Sacramento. Believing that such a railway should be made, and finding no one ready to undertake it, they projected the railway, and got it completed.

The project was at first ridiculed, and pronounced impracticable by engineers of high repute. It was opposed by capitalists. An eminent banker, who personally regarded the scheme with hopefulness, would not venture, however, to take any stock, lest the credit of his bank should be shaken, were he known to be connected with so wild a scheme. And, indeed, the difficulties appeared great.

Except wood, all the materials required, the iron rails, the pickaxes and spades, the wagons, the locomotives, and the machinery had to be sent by sea from New York, round Cape Horn, a long and perilous voyage, and had to be transshipped at San Francisco for another journey of 120 miles before they could reach Sacramento.

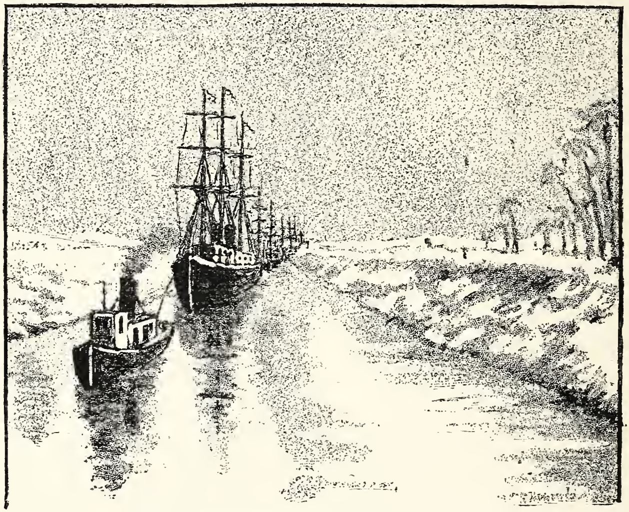
Subscriptions came in very slowly; and before 30 miles of the line had been constructed, the price of iron rose in a very short time to nearly three times its former figures. At this critical juncture, the five merchants decided to defray, out of their own private fortunes, the cost of keeping 800 men at work on the line for a whole year.

We cannot but admire the unswerving confidence in their enterprise displayed by these five traders, unskilled in railroad making, unaided by public support, and even discouraged in their project by their own friends. The financial and legal obstacles they successfully surmounted were not the only difficulties to be overcome. They had the engineering difficulties of carrying their line over the steep Sierras, a work of four years. Long tunnels had to be bored. One spring, snow 60 feet in depth covered the track, and had to be removed by the shovel for seven miles along the road; saw-mills had to be erected in the mountains to prepare the sleepers and other timber-work; wood and water had to be carried 40 miles across alkali plains, and locomotives and rails had to be dragged over the mountains by teams of oxen.

The requirements of the traffic necessitate not only solidly constructed iron-covered snow-sheds, but massive snow-plows to throw off the track the deep snow which could in no other way be prevented from interrupting the working of the line. These snow-plows sometimes require the united power of eight heavy locomotives.

The cutting apparatus varies in arrangement; some forms being designed to push the snow off on one side, some to fling it down the precipices, and others are intended merely to throw it off the track.

At San Francisco, or rather at Oakland, 3,212 miles from New York, is the western terminus of the great system of lines linking together the opposite shores of our vast continent. San Francisco is connected with Oakland by ferry; but the railroad company have constructed a pier, which



*Ship Canal across the Isthmus of Suez.*

carries the trains out into the bay for two and a quarter miles. This pier is strongly built, and is provided with a double set of rails. Ships trading to China, Japan, and Australia, can load and unload directly into the trains, which may pass without change from the Pacific to the Atlantic Ocean.

The description we have given of one of our great Pacific railroads may suffice to show that the modern engineer is deterred by no obstacles, but boldly drives his line through places apparently impassable. He shrinks from no operations however difficult, nor hesitates to undertake works the mere magnitude of which would have made our forefathers stand aghast.

Not in America alone, but in every other part of the world, have railroads extended with wonderful rapidity; the continent of Europe is embraced by a network of lines; distant Australia and New Zealand have thousands of miles of lines laid down, and many more in progress. The map of India now shows that peninsula traversed in all directions by the iron roads; and in the far distant East we hear of Japan having several lines in successful operation, and the design of laying down more.

In answer to the demands of commerce, ship canals have been cut in connection with such works. At home and abroad many navigable rivers have been bridged, and not seldom has an arm of the sea itself been spanned; hundreds of miles of embankments and viaducts have been raised; hills have been pierced with innumerable cuttings and tunnels, — and all these great works have been accomplished within the experience of a single generation of men.

## Lesson XXIX.

### Modes of Lighting.

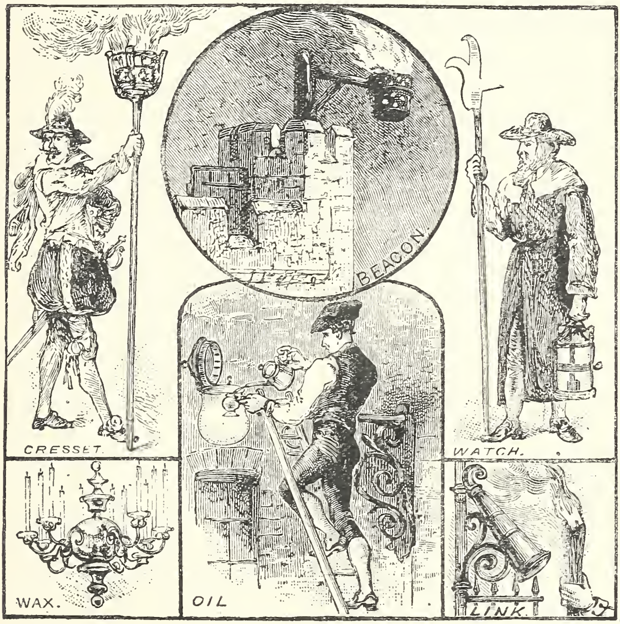
Of all the natural world's gifts that add to man's happiness and comfort, there is none of more value than light. Our own century may truly be called the age of light.

We are so well accustomed to the intense brightness of the electric light, that we are amazed when we learn how long the human race lived without finding out any good means of illuminating their homes after the powerful king of day had faded out of view in the western heavens.

From the creation of "the sun to rule by day," till the tallow candle was invented, more than fifty centuries rolled down into the crypt of Time. During all that long period men had no brighter artificial light than the light of a burning pine torch.

A round basket formed of iron bars and filled with blazing pine-knots made the beacon of the Middle Ages,—a light that usually was a danger-signal. The cresset was the original of the torches which we have all seen by the thousand, carried by men marching in processions during Presidential campaigns. Burning wood was the basis of the cresset's light.

Lamps were invented at an early date, but they differed widely from the ornate glass or metal-worker's light-giver of to-day. At first they were mere clay saucers holding oil on which floated burn-



Ancient Modes of Lighting.

ing strips of pith. The ancient Egyptians, Hindus, and Assyrians were well supplied with lamps. Some of these were gorgeous products of the skill of artist workers in metal.

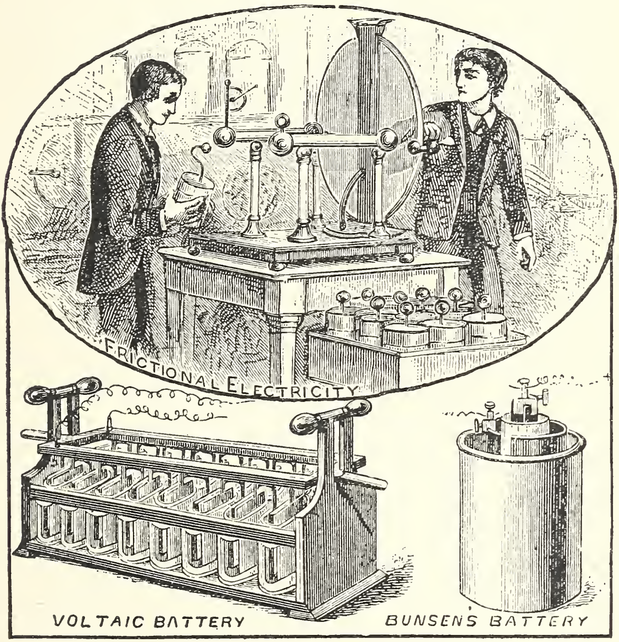
The great lawgiver of the Jews, Moses, was commanded to make a candlestick (lamp) of pure gold for the Tabernacle. This lamp was five feet high, and had seven branches, with a cup in each one to hold the oil. The gold in this marvelous candlestick was of the value of $25,000. Olive-oil was burned. The wicks were strings of flax. In Solomon's Temple there were ten golden candlesticks, each as beautiful as the one fashioned by Moses.

Until the beginning of the present century, improvements in lighting came slowly. Our forefathers dwelled in darkness a large part of their time; yet we often miscall bygone centuries "the good old times."

The wax candle is occasionally to be seen in our homes even nowadays. We all are aware how little darkness it can dispel, yet it was the best light-producer known a hundred years ago in the wealthiest homes in America.

Some oil-lamps, swung from ropes, flickered in the streets of London and Paris in the beginning of the eighteenth century, and were then great novelties. Small hand torches continued to be carried in European cities down to the first decade of this century. Gas slowly forced its way into general use, and now we have the still more brilliant light produced by that strange force—electricity. It is hard for us to realize how new, how modern, is this mysterious power.

About sixty years ago a popular book was published, having for its theme the advantages which would flow from the general diffusion of scientific knowledge. Great prominence was, of course,




*Apparatus for generating Electricity.*

given to the utility of science in its application to useful arts, and many scientific inventions were duly enumerated. Under the head of electricity, however, the writer of that book mentioned but few cases in which this agent aided in the accomplishment of any useful end.

At the present day the applications of electricity are so numerous and important that even a brief account of them would fill a volume. Electricity is the moving power of the most remarkable and distinguishing invention of the age—the telegraph. It is the energy employed for firing mines and torpedoes; it is the handmaid of art in electroplating and in the reproduction of engraved plates, blocks, and letterpress; it is the familiar spirit invoked by the chemist to effect marvelous transformations, combinations, and decompositions; it is an agent of the greatest value in the hands of the skillful physician.

Such an extension of the practical application of electricity as we have indicated implies a corresponding development of the science itself; and, indeed, the history of electricity during the present century is a continuous record of brilliant discoveries made by men of rare and commanding genius; such as Henry, Ampère, Thompson, Volta, Ohm, Edison, Faraday, and Oersted.

The science of electricity presents some features which mark it with special characters as distinguished from other branches of knowledge. No theory has yet been advanced which satisfactorily explains electrical action, or gives us a mental picture of any pulsations, rotations, or other motions of particles. Incapable as we are of framing a distinct idea of the real nature of electricity, there are few other natural agents with whose ways we are so well acquainted as with those of electricity. The *laws* of its action are as well known as the laws of gravitation.

Definite as are the laws of electricity, there is no branch of science on which the ideas of people in general are so vague. Spectators of the effects of this wonderful energy, — as seen violently in the thunderstorm, and silently in the Aurora, — knowing something of its powers in traversing the densest materials, in giving convulsive shocks, and in affecting substances of all kinds — the common people regard electricity with a certain awe, and often are inclined to attribute to its agency any effect which appears mysterious.

The popular ignorance on this subject is taken advantage of by impostors of every kind. Electric and magnetic nostrums of every form, electric elixirs, galvanic hair-washes, magnetized flannels, polarized tooth-brushes, and voltaic shoes appear to find a ready sale — a fact that speaks unmistakably of the very slight knowledge which is possessed by the public concerning even the elements of electrical science.

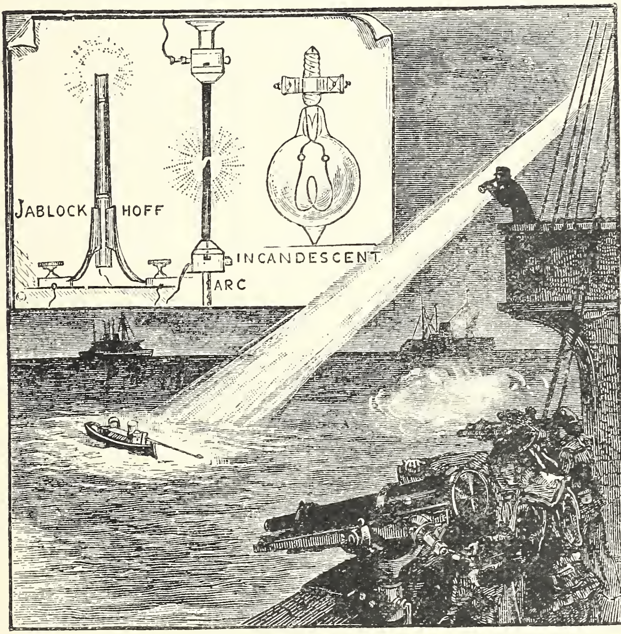
Electricity has also a special position with regard to its intimate connection with almost every other form of natural energy. Evolved by mechanical action, by heat, by movements of magnets, and by chemical action, electricity is capable in its turn of reproducing any of these forces. It plays an important, but as yet an undefined part in the nervous system of the human body, and is, in fact, all-pervading in its influence over all matter. Possibly electricity is present in all the operations of nature.

The arc electric light has not been brought to its present position without the expenditure of much care and ingenuity in the preparation of the carbons used in its production. When Davy first produced the voltaic arc, he used sticks of charcoal. These were very quickly consumed, and a more durable form of carbon was sought for.

This was found by Foucault, who made use of rods sawed out of the residue left in the retorts in the process of making coal-gas. This substance was, however, by no means sufficiently pure, and the light obtained was unsteady. Many experiments were made in preparing special carbons. Pounded coke and charcoal were mixed with tar into a paste, which was molded and compressed, and then the sticks were kept in covered vessels at a high temperature for many hours.

At the present time electric-light carbons are made of a mixture of powdered coke, calcined lamp-black, and a sirup made of sugar and gum.

The whole mass is well mixed, water being added from time to time to make up for loss by evaporation, and to give the paste the proper degree of consistence.




*Different Electric Lights.*

The paste is then subjected to compression, by which it is forced through draw-holes, and the carbons, having been piled up in covered crucibles, are exposed for a certain time to a high temperature.

As a practical illuminant for lighthouses, the arc electric light came into use in 1862.

This change took place when the generator of the current was the costly magneto-electro machine; but now, when this generator has developed into the modern dynamo, the cost of the electric supply has been enormously reduced, so that, power for power, electric lights may be produced at half the former cost, and with greater convenience and certainty.

Light for light, electrical illumination is cheaper than gas. Again, the arc electric light has properties which have caused it to be employed, not only in every important lighthouse in England, France, Russia, America, and elsewhere, but most ships of war are provided with means of projecting a beam of electric light in any direction, in order that the presence of torpedo boats may be discovered at night, or harbors entered and signals made under circumstances when such operations would otherwise be impossible.

It was by the use of the electric light that, in 1886, a steamer passed safely through the Suez Canal at night; and the experiment was so satisfactory, that the canal authorities placed beacons and light-buoys to guide such vessels as, being provided with electric apparatus, were enabled to hold the proper course between its banks.

The use of projected beams for watching the movements of enemies, and for signaling to great distances in times of war, has been recognized by all the great military powers. The advantage of the electrical light in some mines and submarine operations, and generally in work that has to be carried on at night by large bodies of men, is constantly finding illustration.

The arc lamps are used in series; that is, where there is a certain number of lamps to be supplied, the same electric current circulates through the whole of them, and this current, of course, must have force enough to overcome the resistance of the whole circuit. Thus, at each lamp the intensity of the illumination must necessarily be very great.

A solution was long sought to the problem of so dividing the current energy that it might be made to produce lights of moderate intensity at a greater number of points. When Mr. Edison, shortly after having invented the phonograph, announced that he had solved the problem of electric-light division, there was a great panic among the holders of shares in gas companies, and a heavy fall in gas-stock immediately occurred.

As it turned out, the alarm was unnecessary, for gas was not to be superseded, immediately and definitely, by electricity. Nevertheless, it is by virtue of the principle that was contained in Edison's invention that electric lighting has assumed the wide-spread importance it has at the present day, and that it is now actually ousting gas as an illuminant in our large towns, and in halls, art museums, libraries, and other public buildings.

It appears, however, that as early as 1841 a platinum wire, made incandescent by means of an electric current, was proposed as a source of light, and in 1845 carbon was used in the form of slender rods by King, and also by J. W. Starr, in the United States. Both inventors inclosed their carbons in glass tubes, from which the air was exhausted, so that the carbon might not burn away.

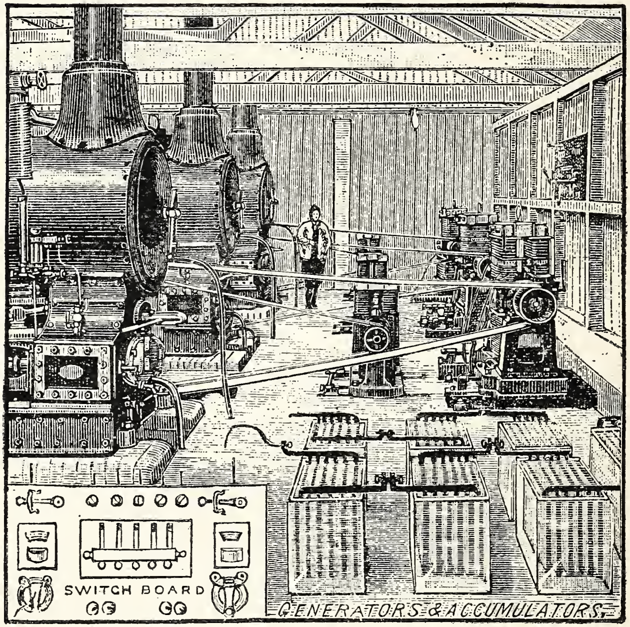
The Edison incandescent lamp was a reversion to the plan of an incandescent metallic wire. This wire was made of an alloy of platinum and iridium, which was adopted by Edison on account of the very high temperature required for its fusion. But the advantages presented by carbon over metallic conductors led him to attempt the formation of filaments by charring first slips of paper, afterwards slips of bamboo.

The arrangement of the lamp is extremely simple: the filament of carbon bent into a horseshoe form, or so turned as to form a loop, is inclosed in a glass bulb of egg shape. The extremities of the filament are connected in an ingenious manner to two platinum wires that pass outward through the glass into which they are fused, and terminate either in binding screws or in two small loops.

The bulb is exhausted first by an ordinary air-pump, and then by a mercurial pump, the current of electricity being sent through the filament during the last stages of the process, and finally the bulb is sealed. The light yielded by these lamps is mild and steady, and its intensity depends on the electric current sent through them; but this current may be carried high enough to make the light of one lamp equal to that of twenty candles. Each horse-power of force expended on the dynamo suffices to maintain ten of these lamps.

In all ocean-going passenger steamers, electric lighting of the saloons and cabins is now the rule.

No other illuminant so readily adapts itself to the production of artistic and decorative effects as the glow lamp; for the covering glass may be tinted of any required shade, and the light may be placed in any position. Small glow lamps are occasionally used as personal adornments. When such lamps are placed in, for instance, a lady's head-dress, amid diamonds, a novel effect of great brilliancy is produced. It need hardly be said that the wearer is not required to carry a dynamo about with her, for the electricity is supplied in a




*Producing Electricity by Steam-Power.*

manner much more convenient for this purpose by an accumulator,—a tiny lead-lined box charged with electricity.

For several years incandescent reading-lamps, supplied by accumulators, have been in use every night in the trains running between London and Brighton, England. The lamps are placed at the backs of the seats, just above the heads of the passengers.

When any one wishes to make use of one of these lamps, he places a penny in a slot, and then, on pressing a knob, the light appears, and at the end of half an hour it is extinguished; but, of course, it can again be made to appear by another penny dropped in the slot, and so on every half-hour as long as may be required.

To maintain the electric light (whether arc or incandescent) quite steady, the greatest uniformity in the speed of the dynamo is essential; and if the prime mover by which it is worked, whether steam-engine, gas-engine, water-wheel, or turbine, is not perfectly regular in its action, the lights will fluctuate in brightness, and thus produce an effect which is very unpleasant.

A very light electric railway has been designed, in which the cars run along rails attached to posts at such a height above the ground as may be required to make the line level, or with only slight gradients. The rails also serve as conductors. This is known as the telepherage system, and it is found to be well adapted for light loads in an undulating country.

Another plan which makes use of accumulators commends itself for application to ordinary street-cars, because no wires are required along the line, and each car can move independently. The chief objections are the great weight of the accumulators and the space they occupy. The accumulator system would no doubt be extensively applied as motive power for ordinary street omnibuses, but for the difficulty of controlling the vehicles. The same objection lies against the use of the accumulators and motors for propelling tricycles.

But there is one mode of using electric propulsion that is free from objection, and, indeed, offers great advantages. In 1887 the first electric boat on the Thames was tried experimentally between Richmond and Henley, and the result was entirely in favor of the electric over the steam launch. The so-called "storage cells" are arranged beneath the floor of the boat, and the electro-motor is directly coupled with the screw-shaft.

The electric launch has these advantages, — perfect safety, freedom from dirt and smoke, no thumping or vibrating, no noise of steam discharge, or smell of hot oil, no engineer is required, and much larger space is available for passengers. Electric launches, not going full speed, can travel sixty miles without having the accumulators recharged.

Numbers of these launches are already in use, and many more are in course of construction. They are made of various sizes, from the boat which can accommodate only one person, to the vessel which will carry a large company.

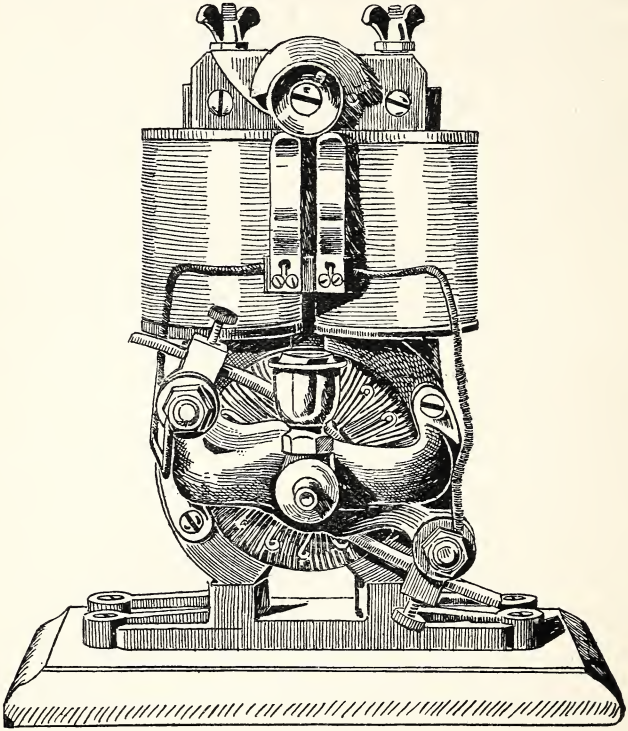
Some electricians believe that for even large vessels electricity, as a motive power, will yet be able to compete with steam in special cases.

The modes of using electric propulsion that we have just noticed furnish a very interesting chain of conversions of one form of force into another.

Let us begin with the carbonic acid gas that existed in the atmosphere of the distant Carboniferous period. The sun's rays were absorbed, and used by the leaves of plants to separate the two elements of the gas, — carbon and oxygen, the plants retaining the carbon, and returning the oxygen to the air. The plants became coal; and ages afterwards the particles of the two separated elements are ready to reunite and to give out in the form of heat all the energy that was absorbed by their separation.

This heat is in the steam-engine converted into the energy of mechanical power. This mechanical power is in the dynamo expended in moving copper wires through a magnetic field.

Every schoolboy who has played with a common steel magnet — and what boy has not? — knows that the space immediately round the magnet is the seat of strange attractive and repulsive forces; for he has felt their pulls and pushes on pieces of



*An Electro-Motor.*

iron or steel. This mysterious space is the magnetic field.

The mechanical power is absorbed in the dynamo, because the movement induces an electric current that would of itself produce in the machine motion in the opposite direction. The electricity induced by magnetism and motion is made to pass through the Faure cell or accumulator, and does chemical work by separating oxide of lead from sulphuric acid, leaving these substances in a position to unite again instantly. This uniting produces a current of electricity, if there is a metal circuit. The coils of the electro-motor form this circuit; the electricity induces magnetism, and the magnetism gives rise to motion and mechanical power.

A pair of copper wires connecting a dynamo with an electro-motor becomes a very convenient means of *carrying power* from one place to another. There are situations in which shafts, belts, or any other mechanical expedients, are troublesome or impossible to use for this purpose.

For instance, a dynamo working at the mouth of a tunnel or a coal-pit may be made to drive any machinery within, with nothing between but the motionless wires. Or a single dynamo will supply moderate power to a number of small workshops, provided each has an electro-motor, with no other connection than a pair of copper wires. This arrangement is found very advantageous for light work, and where power is required only occasionally, as in watch-making.

A dynamo may be driven by a gas-engine, and may work into a set of accumulators. It seems not a little remarkable that if the gas were burnt in the ordinary way, instead of being used in the gas-engine, it would give only a fraction of the amount of the light it causes to be given out by the electric lamps.

But at the present time in Europe, houses and business premises are supplied with electricity by companies who carry electric mains through the streets. In England these electric mains, which are thick insulated copper wires, are inclosed in iron pipes, and are laid beneath the pavement, like the gas mains. In the United States, where electric illumination is much used, the conductors are usually carried overhead like telegraph wires.

The electric-supply companies have central stations in suitable positions, where very large and powerful dynamos are regularly driven by steam-power. These stations are provided with appliances for measuring the currents, and for duly controlling the energy sent out.

What will appear very extraordinary, when we remember that electricity is in itself unknown, is that the quantity of it supplied to each house or establishment can actually be measured, and is paid for by meter, as in the case of gas. Electricity can, however, be measured by its effects, and it is the chemical effect which it is found convenient to use for measuring purposes.

The plan of measurement is simply this: two plates of zinc dip into a solution of sulphate of zinc, and from one plate to the other there is sent through the solution one-thousandth part of the current to be measured. While the current passes, zinc is deposited on the plate towards which the current goes in the solution; and if this plate is periodically weighed, it furnishes the measure of the total current.

The electric light is another example of the fact of which we have had so many examples, that new arts which seem at first to injure old arts, do not really do so, but doubly benefit us, — first by the service they render as fresh gifts, and then by the stimulus to improvement they give to the old arts. The brightness of the electric light threatened gas-light with extinction. Gas remains, and takes the place of coal in our cooking-stoves; and its range of usefulness has become so widened, that the demand for gas increases, even while its employment for lighting purposes is dying out.

## Lesson XXX.

### The Wonderful Wire.

In October, 1832, among the passengers on board the steamship Sully, bound from France to the United States, was a talented American artist, named Morse, who had gained some reputation in his profession. A casual conversation with some fellow-passengers on electricity, and the plan by which Franklin drew it from the clouds along a slender wire, suggested to the artist the possibility of thus communicating news by signals at a distance.

He explained his belief to a fellow-passenger, Dr. Jackson, an American professor, who had devoted some attention to electrical science; and this gentleman suggested several ways in which the project might, he thought, be accomplished. None of these suggestions, however, indicated the direction in which the idea afterwards took practical form in Morse's hands.

From the time of this chance conversation with Dr. Jackson, Morse devoted his mind entirely to the subject of telegraphic communication. Although then more than forty years of age, he abandoned the profession in which he had already gained some distinction, and with the energy and power of adaptability which characterize the American mind, he gave himself up to this new pursuit to such good purpose that a few years afterwards saw his telegraph system completely established in the United States, where the lines now exceed 160,000 miles in length.

It was in 1836 that Morse first brought his notions into practical form, but his apparatus has since received many improvements. The transmitting key invented by Morse has proved a valuable piece of apparatus, and its simplicity has contributed much to the telegraph's success. Telegraphs were erected in America in 1837, and the Morse apparatus is now extensively used in every civilized country.

The dot and the dash are the elementary signs of the Morse code of signals, and these are producible according to the time the contact key is held down. By employing various combinations of these two signs, the letters of the alphabet, numerals, and punctuation marks are indicated. In selecting the combinations Professor Morse had regard to the frequency with which the different letters recur in the English language.

Thus, for E, which is more frequently used than any other letter, the symbol chosen was a dot; and for T, which is the letter next most frequently employed, the dash was plainly the most appropriate; then the four only possible combinations of the signs in pairs fell to the next most generally used letters, and so on. The following table gives the Morse alphabetic code :—

| Letter. | Sign. | Letter. | Sign. | Letter. | Sign. |
|---|---|---|---|---|---|
| A | - — | J | - — — | S | - - - |
| B | — - - - | K | — - — | T | — |
| C | — - — - | L | - — - - | U | - - — |
| D | — - - | M | — — | V | - - - — |
| E | - | N | — - | W | - — — |
| F | - - — - | O | — — — | X | — - - — |
| G | — — - | P | - — — - | Y | — - — — |
| H | - - - - | Q | — — - — | Z | — — - - |
| I | - - | R | - — - | Ch | — — — — |

The most striking achievements in connection with telegraphy are the great submarine lines which unite the Old and New Worlds. Morse and Wheatstone about the same time (1843) independently experimented with wires under water, and their success gave rise to numerous projects for submarine lines.

In 1855 the practicability of an Atlantic cable was no longer doubted. A cable was manufactured weighing 10 tons to the mile; and in August, 1857, 338 miles of it had been successfully paid out by the ships when the cable parted.

Better paying-out apparatus was now devised — self-releasing brakes were constructed, so that the cable should not be exposed to a very great strain;

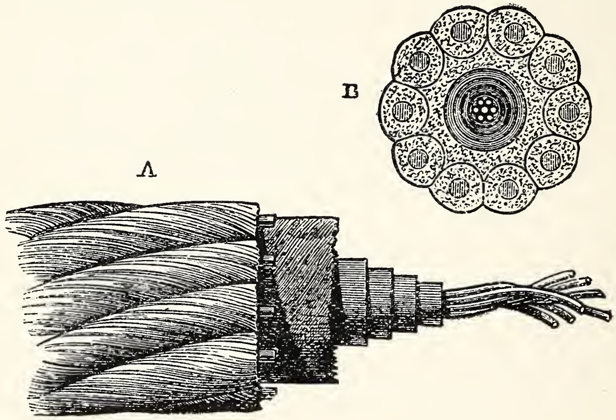
and in 1858 another cable was manufactured, and the laying of it commenced in mid-ocean — the Mægera and Agamemnon going in opposite directions, and paying out as they proceeded. Twice the cable was severed, twice the ships met and repaired the injury; but the third time, when they were 200 miles apart, the cable again broke.

But again the attempt to lay it was repeated, and this time success crowned the effort; for on the 5th of August, 1858, the two continents were telegraphically connected. Unfortunately the electric continuity failed after the cable had been a month in use.

Seven years elapsed before another endeavor was made; but the experience gained in the unsuccessful attempt was not lost; and in 1865 another cable was constructed, and the Great Eastern was employed in laying it. This cable was 2,600 miles long, and contained 25,000 miles of copper wire, 35,000 miles of iron wire, and 400,000 miles of hempen strands, or more than sufficient to go twenty-four times round the world.

It was formed into lengths of 800 miles, and shipped on board the Great Eastern in enormous iron tanks, which weighed, with their contents, more than 5,800 tons. The great ship sailed from Valentia, Ireland, on the 23d of July, 1865, and the paying-out commenced. Constant communication was kept up with the shore, and signals were exchanged with the instrument-room at Valentia.

When the vessel was about half-way over to Newfoundland, the cable broke, the grappling apparatus was unable to pull it up, and after the spot of the breaking had been marked by buoys, the




*Section of an Ocean Cable*

Great Eastern steamed home to announce the failure of the great enterprise.

But this disaster did not crush the hopes of the promoters of the gigantic project, and in the folowing year the Great Eastern again sailed with a new cable, the construction of which is shown on this page. In this cable there is a strand of seven twisted copper wires, forming the electric conductor; round this strand are four coatings of gutta-percha; and surrounding these is a layer of jute, which is protected by ten iron wires twisted spirally about the cable; and each wire is enveloped in strands of hemp.

The Great Eastern sailed on the 13th of July, and on the 28th the American end of the cable was spliced to the shore section in Newfoundland, and the two continents were again electrically connected. The cable of 1865 was eventually fished up, and its electrical condition was found to be improved rather than injured by its sojourn at the bottom of the Atlantic.

It was spliced to a new length of cable, which was successfully laid by the Great Eastern, and was soon joined to a Newfoundland shore cable.

At the present time upwards of 90,000 miles of submerged wires are in constant use in various parts of the world.

It must not be supposed that ocean cables break often. They do not. Still, they break often enough to keep the repairing vessels busy. Eight ocean cables are now owned by the Western Union, Anglo-American, and Commercial Cable companies.

Two of these cables are kept ready to use in case of breaks in the others, and so even when one of the great wires does part, business is not interrupted while the break is being repaired. The cables may become broken from a variety of causes.

Off the banks of Newfoundland, cables are often torn in two by coming into contact with the dragging anchors of fishing-boats. Then the icebergs that float down from the north at certain seasons extend deep under the water, and not seldom damage the wires badly.

The wear and tear of use is another cause of breakages. The bottom of the ocean is not flat like the top of a table, but has mountains and valleys. So the cable that stretches from Newfoundland to the coast of Ireland has to span rough country.

Some credulous people used to believe that whales and swordfish, and other monsters of the deep, once in a while bit or cut a cable in two when it got in their way. But practical cablemen say that this belief is nonsense, and that no such incident ever happens.

It costs a large sum of money to repair an ocean cable. The owners have to maintain a fully equipped steamer, with expert navigators and electricians on board, whose business it is to devote their trained knowledge to this single matter for, say, two weeks or a month. There have been breaks in the cables that have cost each as much as $100,000 to mend.

The first step that the experts have to take, when it is found that there is a break somewhere in the wire, is to locate that break, and this task is not altogether an easy one. Still the electricians can figure with great accuracy as to where any break may be.

They have now an instrument by which they can determine with much nicety how far an electric current, started on a given line, travels before it is interrupted. A calculation is made on this side of the Atlantic by means of this instrument, and a similar calculation on the European side, and the location of the point of interruption is thus ascertained.

The captain or navigator is informed as to its distance from land, and is shown by the chart of the route of the wires that the company has on hand just where he has to go. So accurate is the system, that he can steam to the very spot where the cable parted.

The grappling irons are long and heavy, with great hooks on the end. They are attached to huge ropes, and are operated from the deck by means of machinery. The repairers aim to grapple the cable about ten miles from where the break took place. It would not do to grapple the line too near the broken part, for the cable would then slip off the hooks before it could be brought to the steamer's deck.

When the cable is grappled, the men on the steamer by the strain know that they have caught their fish.

Sometimes when the cable comes to the surface, it is found that it has not been broken at all, but that the electric current has been interrupted by some defect in the insulation. In such a case the matter is easily remedied.

When the cable is found to be broken, the men set to work to splice it together again.

First, however, communication is established with both the land stations, to make sure that, aside from this break, communication is uninterrupted. Then the work of splicing goes on, and this work must be done very carefully. The repairers set to work to cut away every part that is at all damaged, and a piece of new cable is spliced in.

Ordinarily the repairing of the cable may be done on the deck of the steamer without much interruption. It is otherwise in stormy weather. Work then is frequently interrupted. But such interruption the repairers now go prepared for. They have immense buoys, known as "cable buoys."

They are carried especially for use in rough weather. When a storm comes up, and the waves commence to run high, and to toss the steamer about from place to place, it is obviously impossible to keep the broken ends of the cable safe on the steamer.

The ends are attached to the buoys, and they are dropped into the ocean. When the storm has gone down, the buoys are pulled up easily, and the work of repair goes on.

Messages sent through a cable are not read by sound, as land telegraph messages are taken by the receiving operator. The cable apparatus for receiving signals requires the use of the eye. A very small magnet attached to the back of a tiny circular mirror, a lens, and a lighted lamp comprise the main parts of the apparatus.

The operator is seated in a darkened room, and, instead of dots and dashes, he watches for streaks of light from the little mirror. The flashes vary in length, and in the direction in which they fall. This apparatus is called the *mirror galvanometer*.

Another receiving instrument of great delicacy is termed the *siphon recorder*. The electricity flowing through the cable moves an ink-filled glass tube which is almost as fine as a hair. Out of this tube the ink is, by the electric currents, thrown onto a band of paper that is drawn along by clockwork while the message is being received.

Very interesting forms of telegraph are those in which a dispatch is not merely written or printed, but actually transcribed as a facsimile of the writing in the original; and in this way it is possible for a design to be drawn telegraphically at the distance of hundreds of miles. The instruments which produce these apparently marvelous results are scientifically successful; yet there appears to be no public demand for these copying telegraphs.

One of the best known is Bonelli's, which dispatches its messages automatically, when they have been set up in raised metal types. In Bonelli's

**BONELLI'S CHEMICAL TELEGRAPH**

*Bonelli's System.*

telegraph the impressions are produced by chemical decompositions — effected at the receiving station on the paper prepared to receive the message.

By Bonelli's instrument it is said that when the type has been set up, messages can be sent at the extraordinary rate of 1,200 words in one minute of time! The action of this system is such that it is possible to reproduce in a few seconds the very characters of a page of type the moment before set up in a distant place.

By furnishing the means of almost instantaneous communication between distant places, the electric telegraph has enabled feats to be performed which appear strangely paradoxical when expressed in ordinary language. When it is mentioned as a fact that intelligence of an event may actually reach a place before the time of its occurrence, a very extraordinary and startling statement appears to be made, on account of the ambiguous sense of the word *time*.

Thus it appears very marvelous that details of events which may happen in England in 1893, can be known in America in 1892, but the statement is certainly true ; for, on account of the difference of longitude between, say, London and New York, the hour of the day at the latter place is about six hours behind the time at the former. It might, therefore, well happen that an event occurring in London on the morning of the 1st of January, 1893, might be discussed in New York on the night of the 31st of December, 1892.

When the telegraph came into use, and it was found possible to use it for communication of intelligence to great distances, it is not surprising that the further problem of transmitting by electricity, not signals merely, but audible speech, should be suggested. Perhaps the first scientific person who avowed a belief in the possibility of doing this work, and even indicated the direction in which the solution of the problem was to be sought, was Bourseul, a French scientist.

In 1854 he pointed out that sounds are caused by vibrations, and reach the ear by like vibrations of the intervening medium. He suggested that a man might speak near a flexible disk, which the vibrations of his voice would throw into movements, and that, at a distance, electric currents might be arranged to produce like vibrations in another disk.

One cannot help thinking that if M. Bourseul had but pursued his experiments a little longer, he would not improbably have achieved the invention of the speaking telephone, for which the world had to wait twenty years longer. As it is, we cannot but admire his scientific foresight, and his confidence in the ultimate realization of his idea.

But before this event came to pass, an intermediate stage was reached in the apparatus contrived by M. Reiss, a schoolmaster of Friedrichsdorf, Austria, who, in 1860, solved the problem of electrically transmitting musical tones. So far as concerned the reproduction of the sounds, his telephone was founded upon a discovery, made in 1837, by an American physicist, named Page.

Worthy of remark is the very humble nature of the materials of which Reiss made his first experimental apparatus. The receptacle for the voice was simply a large bung hollowed out into a conical cavity, and the membrane was supplied by the skin of a sausage, while the clicking-bar of the receiver was a stout knitting-needle, surrounded by a coil of covered copper wire and thrust into the bridge of a violin, which, by acting as a sounding-board, made the clicks produced in the needle distinctly audible.

Reiss tried to use his arrangement for transmitting speech, but without success, although occasionally a syllable could be very indistinctly heard.

The Bell speaking-telephone was publicly exhibited for the first time at Philadelphia in 1876, and was shown the same year to the British Association by Sir William Thompson, who pronounced it the wonder of wonders.

The telephone is used by speaking distinctly before the mouth-piece of the transmitter, while the listener at the other end of the line applies the mouth-piece of his instrument to his ear, and one wire is sufficient with good earth connections, although sometimes a second wire is employed to complete the circuit. It is also found advantageous to have two instruments in the circuit at each end, so that one may be held to the ear while the operator is speaking through the other.

In this way, a rapid conversation can be carried on with the greatest ease, or again, an instrument may be held at each ear, by which arrangement the words are more distinctly heard. It is not necessary to shout—shouting has no effect, but one should speak with clear intonation, and some voices are found to suit better than others.

The vowel sounds are best transmitted, except *e*. The letters *g*, *j*, *k*, and *q*, are always imperfectly transmitted. A song is very distinctly heard, both words and air, and the voice of the person singing is readily recognized.

Several instruments may be included in one circuit at different stations, so that half a dozen persons may take part in a conversation, and questions and answers may be understood even when crossing one another. If two distinct telephone circuits have their wires laid for a certain distance (two miles) near each other, say a foot or more apart, and without any connection whatever, listeners at the end of the one line will hear the conversation exchanged through the other line.

Other forms of the instruments have been arranged, by which a large audience may hear sounds produced at a distance. For instance, a cornet was played into a telephone receiver in a concert room in Worcester, Mass., and was heard by thousands of people assembled in a hall in Boston, forty-four miles away,—the hall being, of course, the other end of the telephone circuit.

## Lesson XXXI.

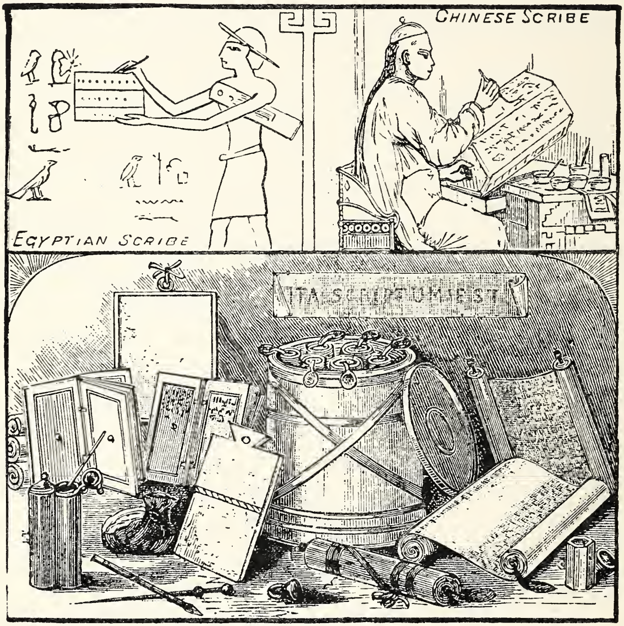
### Paper.

Without cheap paper the invention of printing could have benefited the world but little. The newspapers and magazines, read by everybody, and aiding the growth of intelligence, are enabled to exist chiefly because paper is very cheap. Our low-priced, attractive school-books — books essential to education — could never have been published had not the art of paper-making reached its present degree of perfection.

Our advance in pictorial art has been largely dependent on our progress in the manufacture of paper. Photography owes much to a new kind of specially prepared paper, which brings out a wealth of detail formerly lost in the texture of the paper used. Wall-paper has helped to make the homes of the people more attractive.

The numerous industrial arts are beginning to rely greatly on the paper-maker. *Papier-maché* is already in very extensive use. The present speed and safety of railroad travel are due in no slight degree to the invention of the paper car-wheel. This wheel's material is much more elastic and durable than iron.

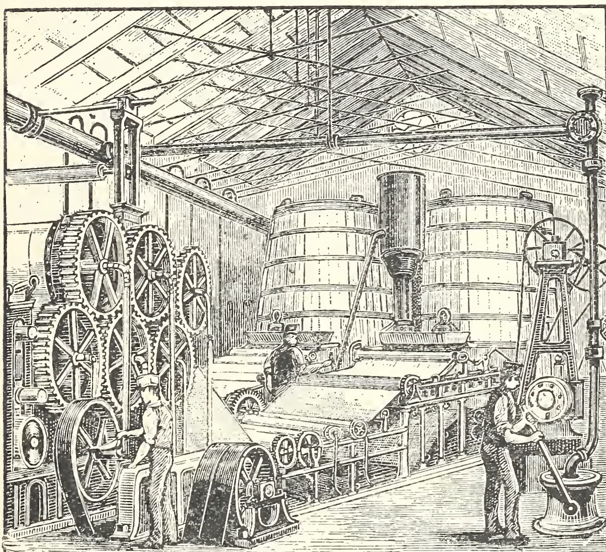
Building trades use large quantities of paper, and retail commerce consumes thousands of tons of it yearly. Paper manufacturing is now fifth in the list of United States industries, having risen from the tenth place since 1880.




*Ancient Book-making and Books.*

When books were merely written rolls of parchment, as were the books of the ancients, paper was, of course, unknown. Even after the pen-work of the patient scribes had given way to printing from blocks and engraved plates, the demand for paper was but slight, although the secret of paper-making had long before been revealed to Europe by the Arabs.

It was the invention of the printing-press that



Paper-Making.

made paper a necessity, and rendered its manufacture a profitable industry. In 1891 the United States used more than 3,000,000 pounds of wrapping-paper, and over 4,000,000 million pounds of paper for books and newspapers.

Who was the first paper-maker? That unlovable insect, the hornet! Hornets and certain species of wasps make their paper entirely of wood. Men finally grew wise enough to imitate these little creatures, and to-day wood is the source from which most of our paper is manufactured. Spruce, poplar, and pine are the chief kinds of wood used.

For hundreds of years the art of making paper remained in so crude a condition that only the very best fiber-producing material, linen rags, could be utilized in the work. Even nowadays the best paper is manufactured out of clippings of new linen cloth.

Rags reach here in bales bound with hoop-iron and scented with sassafras. They come chiefly from China, Egypt, Asia Minor, and Hindustan. In those countries most of the clothing worn is made of cotton or of linen; and labor in those densely peopled regions is so cheap that it pays to collect rags that, in the United States, would not be worth gathering from the streets.

In the paper-mill, rags are first cleaned by machinery, and are then assorted by women. Any valuables found in the rags belong to the finders. All woolen scraps are carefully removed, for wool is useless in making paper.

Then the rags are cut into smaller bits, bleached, made into a pulp with water, and passed into a machine that forms this pulp into sheets and rolls. The pulp then goes over a wire screen containing 1,600 meshes to the square inch. How does this screen compare in fineness of weaving with the cloth of your handkerchief?

The wet paper film is led off this screen onto a circular belt of woolen cloth, and is pressed between iron rolls, thus rendering the paper material dense and firm. Next, after being dried, it goes between other rolls, and around large cylinders filled with steam. These dry the paper thoroughly. Then it is finished by passing it between the so-called "calender" rolls. Lastly, it is cut into sheets, and wrapped up for the stores.

Since the use of wood pulp has become so extensive, but few rags are employed in the manufacture of the paper on which newspapers are printed. Pulp from wood goes through processes similar to those by which rag pulp is turned into paper.

Straw, jute, saw-dust, cotton-plant stalks, and esparto grass — this grass being a North African product — are also utilized by the paper manufacturers.

Inventive minds are constantly at work striving to discover new uses for paper: the makers of it are straining every nerve to improve the quality, and constructers of paper-making machinery are ever seeking to perfect their product. It would seem that the industry is still in its infancy as compared with the power it will, in the future, wield over the mental growth and advancement of the human race.

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## Lesson XXXII.

### The Art Preservative.

Block-printing was the earliest mode of taking ink impressions on paper. A design cut in wood was evenly covered with ink, and then the printer transferred it by hand-pressure onto a sheet of paper. This process was a great step in advance of the slow plan of copying books with the pen, and was introduced about the middle of the 15th century as a new discovery, though the Chinese had printed for ages by this method.

Examples of their block-printing are furnished in the paper which covers every chest of their tea. Almost at the same time a German of the name of Guttenberg cut metal letters or types by hand, and between the years 1440 and 1460, printed the Mazarin Bible, the first edition of the Holy Scriptures in movable type.

Cutting types by hand did not satisfy the printers, the process being tedious and costly. Before Guttenberg's Bible was completed, Schoeffer invented molds to cast type, and the art of letterpress printing thus arose.

Block-printing was not abolished by letterpress, but was turned into other paths of usefulness.

Caxton at Work.

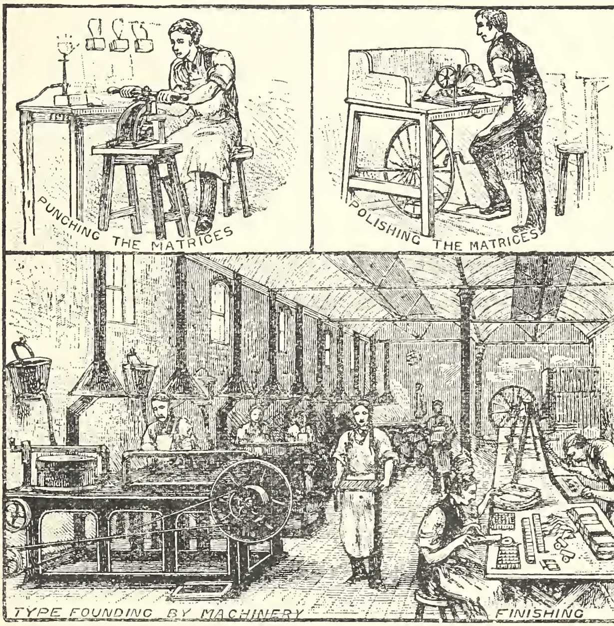
The wood engravings which adorn our books and newspapers, often works of great skill, now represent the old block-printing.

Caxton has the credit of being the first letterpress printer in England. He set up his press in one of the chapels of Westminster Abbey; hence arose the curious custom among compositors, as the workmen who set up types are termed, of giving the name of *chapel* to a lodge of their trade union. Caxton's earliest success was "The Game and Play of Chesse. *Translated out of the Frenche and emprynted by me, William Caxton. Fynyshed the last day of March, the yer of our Lord God a thousand four hundred and lxxiiij.*"

The types up to this date, and to the close of the century, were all in Gothic style, or **Black-Letter.** Roman letters were first used in 1500. Some of our chief typefounders cast fonts of type in every kind of alphabet, both ancient and modern.

With the advancement of the art of printing, division of labor soon became necessary. Printers no longer cut or cast their own types and put together their own presses, but gave their whole attention to the printing. Typefounders, in like manner, limiting their labors to the casting of the letters, soon made improvements both in the casting and in the compound metal which they employed for the types.

Types are composed of an alloy of lead and antimony. These two metals melted together make a mixed metal, harder than either one separate. A full assortment of all the letters is called a "font." Fresh from the founder, types glisten with silvery brightness, but soon tarnish, and grow dark. The vowels most used are cast in the largest numbers. The letter *e* in a font of

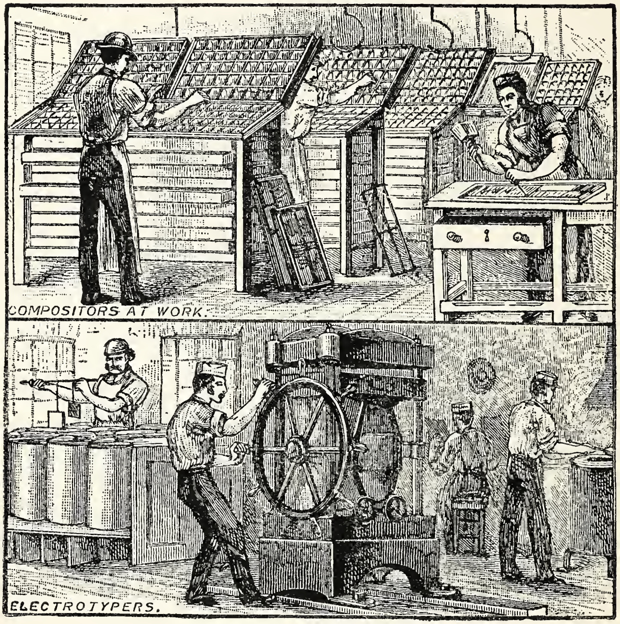



*Making Type*

500 pounds weight, takes 12,000 types, and *a*, *i*, *o*, call for about 8,000 each. The only consonants that rival the vowels in number are *t*, *s*, and *n*.

Types are arranged in two cases, or trays, divided into shallow compartments, large or small, according to the letters. The capitals, small capitals, accents, note-signs, and fractions are in the upper case, and the ordinary small letters and the figures in the lower case.

The letters are not placed in the order of the




*Type-setting. Electrotyping.*

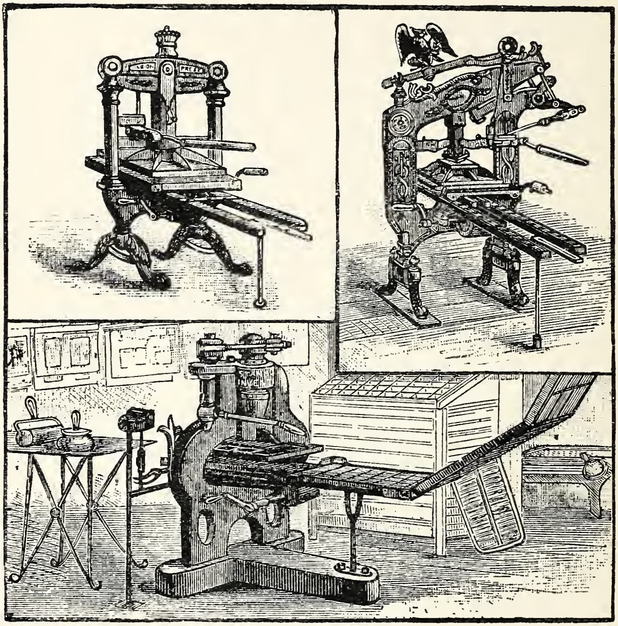
alphabet, but are arranged for ease in picking up, those most used being closest to hand. The compositor's touch is very sensitive; and with the help of a little notch or nick in the side of each metal letter, he seldom fails, while setting types as fast as his hand can move, to place the right end of every type in its proper position.

Printer's ink was formerly always laid upon large round pads of leather, stuffed with wool. When these pads, which were each, perhaps, about 12 inches in diameter, had received a charge of ink, an apprentice dabbed one against the other, working them with a twisting motion, and after having obtained, with many dexterous flourishes, a uniform distribution of ink on their surfaces, he applied them to the face of the types with both hands, until all the letters were completely and evenly charged.

The operation was very troublesome, and much practice was required before the necessary skill was obtained, while it was always a most difficult matter to keep the pads in good working condition.

The first important step toward a printing-machine was made when for these inking-balls was substituted a roller, mounted on handles. The body of the roller is of wood; but it is thickly coated with a composition that unites the qualities of elasticity, softness, and readiness to take up the ink and to distribute it evenly over the types.

The materials used for this composition are chiefly glue and molasses, and sometimes also tar, isinglass, or other substances. The composition is not unlike india-rubber in appearance. The roller is applied to the type in hand-presses by being moved backward and forward over a smooth table upon which the ink has been spread.



*Printing-Presses of the 18th Century*

From the time of the first appearance of printing-presses in Europe, down to almost the beginning of the present century, a period of 350 years, no improvement in the construction appears to have been attempted. They were simply wooden presses with screws, on exactly the same plan as the cheese-presses of the period.

Earl Stanhope first, in 1798, made a press entirely of iron; and he provided it with an excellent combination of levers, so that the "platen," or flat plate which overlies the paper and receives the pressure, is forced down with great power just when the paper comes in contact with the types.

Stanhope's press was not of a kind to meet the desire for rapid production, to which the increasing importance of newspapers gave rise. The first practical success in this direction was achieved by König, who, in 1814, set up for Mr. Walter, the proprietor of the London *Times*, two machines, by which that newspaper was printed at the rate of 1,100 impressions per hour, the machinery being driven by steam-power.

The *Times* of the 28th November, 1814, in the following words made its readers acquainted with the fact that they had in their hands for the first time a newspaper printed by steam-power:—

"Our journal of this day presents to the public the practical result of the greatest improvement connected with printing since the discovery of the art itself. The reader of this paragraph now holds in his hand one of many thousand impressions of The *Times* newspaper which were taken off by a mechanical apparatus.

"A system of machinery has been devised and arranged, which, while it relieves the human frame of its most laborious efforts in printing, far exceeds all human powers in rapidity and dispatch. That the magnitude of the invention may be justly appreciated by its effects, we shall inform the public that after the letters are placed by the compositors, and inclosed in what is called the 'form,' little more remains for man to do than to attend this unconscious agent in its operations.

"The machine is merely supplied with paper, itself places the form, inks it, adjusts the paper to the form newly inked, stamps the sheet, and gives it forth to the hands of the attendant, at the same time withdrawing the form for a fresh coat of ink, which itself again distributes, to meet the sheet advancing for impression; and these acts are performed with such velocity that no fewer than 1,100 sheets are impressed in one hour."

American inventive genius soon took König's steam printing-press in hand, and began to improve it rapidly. Up to about 1840 the fastest press known was what was called the Napier. It was a clumsy machine, requiring five persons, — one pressman, two feeders, and two boys to run it, and its utmost capacity was about 2,500 copies an hour.

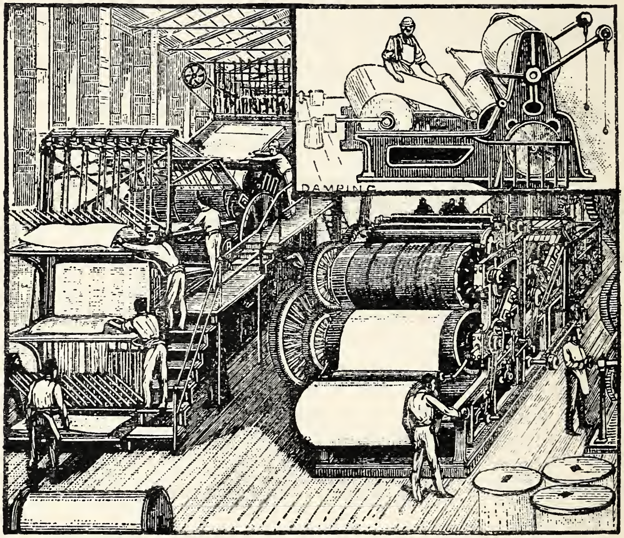
About 1840, however, Col. Richard M. Hoe hit upon the "rotary" press. In this machine the papers ran on cylinders, and were pressed against the flat form of type, which lay horizontal. People thought that a faster press never would be needed, and its 4,000 single impressions an hour were declared enough.

This press printed upon one side of the sheet only. In 1863 William Bullock of Pittsburg took out a patent for a press that would print on both sides and deliver the sheets flat. In 1869 he produced a press which cut the paper after printing, and was, in principle, the press of to-day.

But the time was now ripe for Hoe & Co's master stroke, — a web-perfecting press, with a collecting cylinder. All presses up to that time had a flat delivery. This press collected the papers over a cylinder, and rolled them out at the rate of 15,000 an hour — more than double the speed of venerable rotaries. It printed two four-page papers at a revolution ; and as there were few eight-page papers then, this machine was felt to be equal to all demands that might be made upon it.

That was the single stereotype perfecting press. The fast-growing demands of our great modern newspapers have resulted in the construction of gigantic quadruple presses, that now make it possible to toss off 150,000 copies of an eight-page paper daily. Let us take a look at one of these monsters.

Here is one directly in front of us—a quadruple stereotype web-perfecting press. A "per-



*Printing a Newspaper To-day.*

fecting" press is so termed because it prints on both sides of the paper at the same time; and it is called a "web," not because of any inventor's name, but because it prints from a "web" of paper,—a roll miles in length.

A double press does twice the work of a single one, a quadruple press twice the work of a double. This immense machine will print 48,000 eight-page papers an hour, or 384,000 single impressions! Yet people believed that König's press, turning off 1,100 sheets in an hour, could never be surpassed.

But, you ask, how much does one of those rolls of paper weigh?

A single roll, such as is used in printing an eight-page paper, averages about 900 pounds, and is four and a half miles in length.

How long does it take to use it up?

About 20 minutes.

Suppose the quadruple is going at full speed, turning out eight-page papers — 800 a minute dropping out of it.

Forty miles of paper an hour, or two-thirds of a mile a minute, are then covered with print!

Although wood-pulp paper can be bought for less than three cents a pound, yet the United States has nine newspapers whose owners have, each, to expend over $200,000 a year for paper. These journals pay from $2,000 to $6,000 apiece in weekly wages to their compositors. Of course very much larger sums are required to pay all the other persons connected with each paper, — editors, reporters, correspondents, clerks in the business department, pressmen, engineers, porters, and janitors.

Stereotyping is a term applied to the process of obtaining the impression of a form of movable types, or of a woodcut, on a plate of metal which can be printed from. These plates, after the required number of copies have been printed, can be stored away; and they are ready for use whenever another issue of the work is required.

When the pages that are to be stereotyped have been set up in ordinary type, there are several methods by which the stereotype plates may be obtained from them; or rather, there are several materials used to form the matrix or mold in which the metal is cast. When plaster of paris is used, the form is first slightly oiled, to prevent adhesion of the plaster; a thin mixture of plaster and water is then poured upon the form, which is surrounded by a raised rim, to retain the plaster.

The plaster is carefully led into all the recesses of the type, and soon sets, and is then lifted off the type, and, after drying, is ready to receive the molten metal of which the stereotype plate is to be formed. The metal is an easily fusible alloy of lead, antimony, and other metals, which takes the form of the mold with great accuracy, and is, when cold, as hard as type.

Another mode of obtaining the mold is known as the *papier-maché* process. When several sheets of thin unsized paper, pasted together and still quite moist, are forced down upon the form by powerful pressure, a sharp, even mold of the type is obtained, every projection in the types producing a corresponding depression in the *papier-maché* mold. When the paper mold is dry, it may be used for forming a *cast* by pouring over it some fusible metallic alloy, having the properties of becoming liquid at a temperature which will not injure the mold, and of taking the impressions sharply, and of being sufficiently hard to bear printing from.

This process is largely used for newspaper presses, and sometimes for bookwork, as it forms an invaluable means of obtaining rapidly a number of stereotype plates from the movable types. This production of a number of similar forms makes it possible to strike off a very large number of copies in a short time, for many presses can be employed simultaneously.

A fourth method of producing plates for the same purpose as the stereotype plates already described is *electrotyping*. This method is almost universally applied to bookwork and woodcut illustrations.

Many of our illustrated periodicals have so large a circulation that the engraved wooden blocks would necessarily be spoiled by being used in steam presses long before they had yielded the required number of impressions. The method has also the great advantage of securing the original engraving from the danger of accidental damage. Hence, woodcut illustrations are now always printed from electrotype copies of the engraved blocks, whether the work itself be printed from movable types or not.

But the electrotype or stereotype process is always resorted to in the case of a work, whether illustrated or not, when it is foreseen that a re-issue will be demanded. These processes are also of great advantage to the practical printer, because when the pages set up in type have received their final corrections, he can take the casts, and then the type may be distributed; that is, returned to the cases, ready for the compositors to use for other work.

For woodcuts, the artist makes the drawing on a block of finely grained boxwood, in which the fibers of the wood are perpendicular to the surface. The engraver hollows out all the parts which in the impression remain white, while all the parts which are to receive the ink and to produce the black parts of the impression must be left at the original level.

The wooden blocks thus engraved would serve to produce a certain number of impressions, which could be taken off by careful hand-printing without perceptible damage to the block. But the pressure necessary for printing inevitably crushes the projecting parts of the block, and the impressions soon lose their sharpness.

This is especially the case in machine printing ; but not only does the electrotype cast present a surface capable of bearing hard usage much better than the surface of the hardest wood, but even if the number of impressions required should wear out the metal plate, it can easily be replaced by another cast from the original block.

The mold which serves to give the electrotype cast may be made either of gutta-percha, softened by a gentle heat and applied to the wood, or of wax. In either case pressure is applied, in order to force the yielding substance to take the forms of the engraved block or of the metal type.

Wax is now generally preferred. The yellow wax used for this purpose is melted, and poured into a shallow pan ; when it has become solid, it is sprinkled over with finely powdered pure blacklead, which is brushed over the surface, and then the excess is removed by blowing with bellows made for the purpose. Thus prepared, the wax is pressed down on the type-form or the wooden block by a powerful press.

The impression, of course, has hollows corresponding to the projections of the wooden block, or to those of the type-form. The face of the wax mold is now very carefully and completely black-leaded. It is then placed in a solution of sulphate of copper, and the blacklead receives in about forty or fifty hours a firm, compact copper deposit about as thick as the finger-nail. It covers the black-leaded surface, forming a perfect reproduction of even the most minute details of the engraved block or letterpress form.

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## Lesson XXXIII.

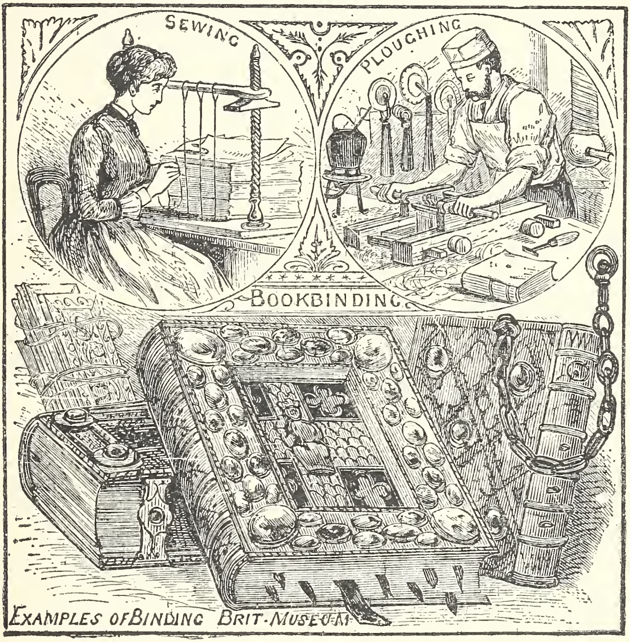
### Books and Newspapers.

After a book has been printed, it has still some stages to pass through before it comes into the hands of a reader. From the printing-office it goes to the bookbinder, who folds the sheets, collates or properly places the pages, stitches the back, and covers the work in bindings of cloth or of leather.

The bookbinder's craft is very ancient. When books were written by hand, they were great treasures on account of their scarcity. Their covers were often ornamented with gems and the precious metals.

Books have their edges plain, gilded, marbled, or colored; and their covers are lettered, tooled, or embossed with graceful designs. The manufacture of the cloth for binding is an art employing hundreds of work-people.

To publish or bring out a book is a work of much risk and cost. The publisher's business is




*Bookbinding.*

to undertake this work, and to make the book known by advertising. He is animated by the desire of commercial profit; and when a writer is willing to take upon himself the cost, the publisher is ready to arrange for any book that will not discredit his house.

Most authors, however, are not prepared to take the whole risk; and then the publisher, if he sees a sale for the book, buys it outright, or bargains with the writer to share the risk and the profit — the author's profit coming to him in the shape of a royalty, or certain sum upon every copy sold, or a percentage upon the profit gained from year to year.

Printing is an art in which labor-saving machines are in very extensive use in every one of its numerous branches. Have workmen gained or lost thereby?

The whole world benefits from the productive power of machinery; even the laborers who are displaced share in the benefit. It is utterly absurd to fear that wood and iron, the creations of man's hand and intellect, will ever take man's place. To be forever drudges cannot be our lot while there are untiring forces in nature to obey our bidding, and to relieve us from the burden of toil, as fast as we learn the laws by which those forces are governed.

Movable types were cut, so that they might be used over and over again. Cast type took the place of cut letters, and made printing a hundredfold cheaper. Was the number of printers lessened? Certainly not; for every year the number grew larger.

Did typefounding abolish block-printing? There are more block-printers now than ever before; though they are now called paper-stainers, calico-printers, wood, copper, steel, and zinc engravers or lithographers. Besides, typefounding is a new branch of labor, and gives wages to skilled workmen—a gain to all and a loss to none.

Stereotyping came in to save the movable types. Is there a smaller quantity of type founded? Are there fewer typefounders? Typefounding flourishes, and scarcely any other division of industry seeks more eagerly for skilled workmen, or pays them better wages. Typefounding is now done by machinery. As a consequence, ten times the weight of type is cast, type can be had at a much lower cost, and more hands are employed, at higher rates of wages.

In antiquity the method employed to disseminate news among the general public was a herald or crier. The news given out by the herald related only to official announcements.

The history of newspapers, like that of the art of printing, begins in Germany. The earliest periodical collection of "the news of the day" was *The Frankfurter Journal*, a weekly publication started in 1615.

First, we have the written news-letter furnished to the wealthy aristocracy; then, as the craving for information spread, the ballad of news sung or recited; then the news pamphlet, and lastly, the newspaper.

The first regular newspaper printed in the English language, *The Certain Newes of This Present Week*, published in London in 1622, contained no advertisements; but in 1662 advertisements appeared, in something like their present form, in the *Mercurius Politicus*. Books were the articles earliest advertised. The great plague in London brought forth the first medical advertisements. In 1700 Addison, a famous author, reviewing the advertisements of his time, speaks of their "cuts and figures."

The first American daily journal, the *Independent Gazette of New York*, 1787, in its second year contained thirty-four advertisements. The papers founded since 1833 have greatly popularized advertising.

Not until the reign of Queen Anne, 1702–1714, did the newspaper first become really eminent for its intellectual power and talent. It then began to assume the influence and appearance of a newspaper in the modern sense of the word. Anterior to this time it presented very few of the features which characterize the journal of to-day.

The increasing power and popularity of the newspapers became so distasteful to the British government that stringent measures were employed to dishearten the enterprising publishers. Prosecutions were multiplied, but with small success; and, notwithstanding editors met with temporary setbacks, the power of the press, even in those days, could by no means be overcome.

About two hundred years ago the first American newspaper was issued, from the office of Benjamin Harris, at the London Coffee House, Boston. The name of this pioneer sheet was *Publick Occurrences.* The issue of September 25, 1690, was marked "Numb. 1;" "Numb. 2" never saw the light. Mr. Harris was editor, publisher, and reporter, combining, in fact, in his own person the entire staff.

To the public of Boston and vicinity he announced: —

"It is designed that the Countrey shall be furnished once a moneth (or if any Glut of Occurrences happen oftener) with an account of such considerable things as have arrived unto our Notice."

The second number of *Publick Occurrences* failed to appear, the Legislature of the Colony having declared its publication to be contrary to law. Massachusetts was then a colony under the rule of Great Britain, and a free newspaper might be dangerous to the petty tyrants sent over from England as colonial governors.

*Publick Occurrences* consisted of three printed pages of a small, folded sheet, one page being left blank. From such an inconsiderable beginning the newspaper press of the United States has experienced a growth unsurpassed in any other country. At the present time the annual aggregate circulation of all American newspapers and periodicals reaches the enormous figure of 1,500,-000,000 copies.

In the two centuries since its birthday here, journalism has become one of the chief professions of the land. The happenings of a day in any quarter of the globe are read the next morning in the public prints. The pulse of public feeling is felt continually: its condition is portrayed, and its throbbings are noted by the editorial pen. Newspapers are read when no other printed matter is read.

Newspapers record the world's daily progress; that is, the world's steady increase in knowledge and experience. This world-wide record of life, thought, and action grows fuller and more accurate with time. There is but little news of public interest which the newspaper does not chronicle, from the debates in the Senate to the state of the weather, from the spots on the sun to the habits of ants.

From the newspaper we learn the condition of foreign nations, as well as of our own country. When there falls on the world some calamity that brings our human brotherhood home to all, we feel that the newspaper has grown into our lives, and the electric wires seem to be human nerves, along which have shot, to every corner of the earth, the self-same thrill of pain.

It is hardly possible to over-estimate the benefits which newspapers confer upon society. They are the poor man's library, providing him with his daily mental food. They have called into being a race of able and graphic writers.

For a long time after newspapers were started rulers disliked them, as tending to make people discontented with their lot. Heavy taxes were laid upon the paper, both before and after printing. Wiser statesmen removed those taxes upon knowledge.

It was at last seen that to be discontented with bad political conditions is the first step towards a better state, and that to interest the people in the affairs of the nation, leads them to improve and cherish, not destroy, the fabric they have reared. We have now a free press, freedom of meeting, and freedom of discussion; and the well-being of the country has been promoted thereby.

Newspapers have, within the last half-century, given a beneficial impulse to art. The illustrated papers show admirably the progressive stages of wood-engraving, from its humble beginnings to its present excellence. Indeed, our modern periodicals may be said to have almost created the art of


Picture-Making.

color-printing. Many of the engravings are choice works of art, and cost much money, skill, and time to produce.

Large designs are cut up into squares, and the engraved blocks are neatly bolted together into one. As many as two or three dozen artists may be engaged on these blocks. A finishing artist gives a final touch, so that the joins shall not be seen. An electrotype is now taken, put in the form of type, and sent away to the printing-machine. Improved methods enable the publishers to do all this high-class work in two days, whereby more pictures are published than in former years.

A colored picture goes through many processes. The picture is photographed onto boxwood, and is then engraved. This is called the key, or black block. Each color plate has to be made in metal. The shading is produced by the action of acid on copper plates, the acid biting or eating away the lighter parts, leaving the dark ones in relief.

In some colored pictures there are as many as twenty separate printings. An impression of each plate is then taken by means of a press. Hardly a plate is perfect at first, however. One has, perhaps, to be thrown away, another to be redone, a third to be toned down, and a fourth to be strengthened. Finally the plates are ready, but duplicates or copies must be made by electrotyping.

Engravings, either black or colored, cannot be rattled off, like newspapers, many thousands an hour. The printer has to watch each sheet with the eye of an artist, and to throw out any faulty impression. No machine has yet been contrived that can give more than 2,000 good, clear impressions an hour.

The influence of the press has been the most important factor in the progress of mankind during the past two centuries. This influence has been exerted in the molding of public opinion, in the discovery of new countries, in the exploration of unknown lands, in sending geographical expeditions to countries difficult of access, in the mitigation of human sufferings, in the succor of famine-stricken lands, in the advancement of science, trade, and art, and, in general, for the amelioration of the great mass of mankind.

These gains are but some of its fruits, and of its first fruits. For the press is a mighty engine which never rests, which is never perfect. A point which was yesterday invisible is its goal to-day, and will be its starting-post to-morrow.

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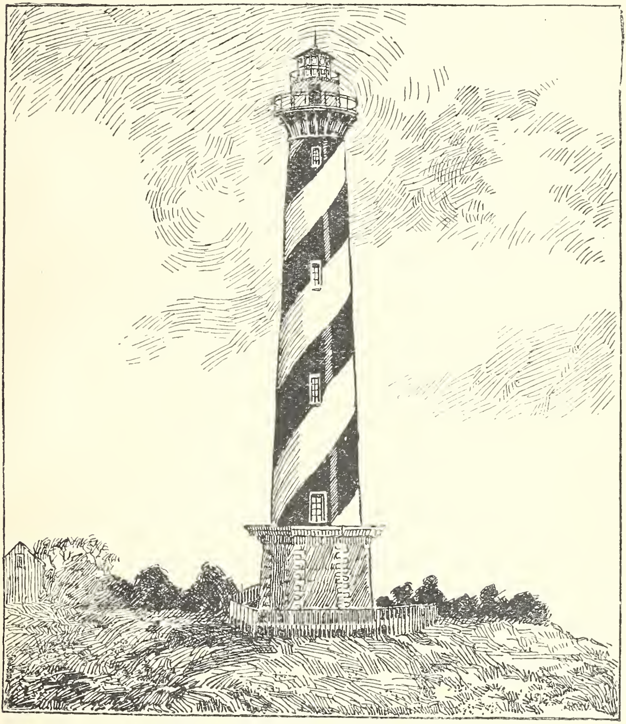
## Lesson XXXIV.

### Modern Advances.

Who does not regard with interest the lighthouses which at night throw their friendly beams across the sea to warn the sailor away from sunken rocks or treacherous shoals? The modern lighthouse, its strong electric light, and its wonderful optical apparatus for concentrating that light and making it a thousandfold more intense, are due entirely to the applied science of our age.



*Lighthouse.*

The lofty structures erected near certain ancient harbors had no better signal lights than fires of wood. The famous first lighthouse on the

Eddystone rock, which is near the south-west coast of England, gave its warning simply by means of a hoop of lighted candles.

Several recently built lighthouses can condense their electric lights into beams, each as powerful as the light from 6,000,000 burning candles! Such a beam can be seen many miles out at sea, and vessels are warned off the dangerous shore, and life and property are thus often saved. This beneficent result is due to science, and to science alone.

It was the touch of science that roused the human mind from its long trance, which historians call the Middle Ages. Civilization then entered on a career of wider range. The labors of the great astronomers, Kepler, Galileo, and Newton, aided by the telescope, showed that the earth is round, and demonstrated the absolute truth of the Copernican theory that the earth revolves around the sun.

Enterprise went hand in hand with knowledge; for to know, spurred men on to dare. Harvey proved the circulation of the blood. Magellan sailed around the globe. Commerce began to rise into national importance.

The stream of emigration which commenced to flow into the New World about the opening of the seventeenth century steadily increased in volume.

Mediterranean cities no longer held the most important sites of trade. The Atlantic became the chief scene of commercial activity. London and New York arose in the place of Genoa and Venice. Most important of all, so far as regards industry, came the invention of the steam-engine.

Since man has learned how to utilize steam, wonderful machinery driven by that motive power has, to a large extent, superseded manual labor; and goods are made with a rapidity, accuracy, and finish beyond the power of hand-work.

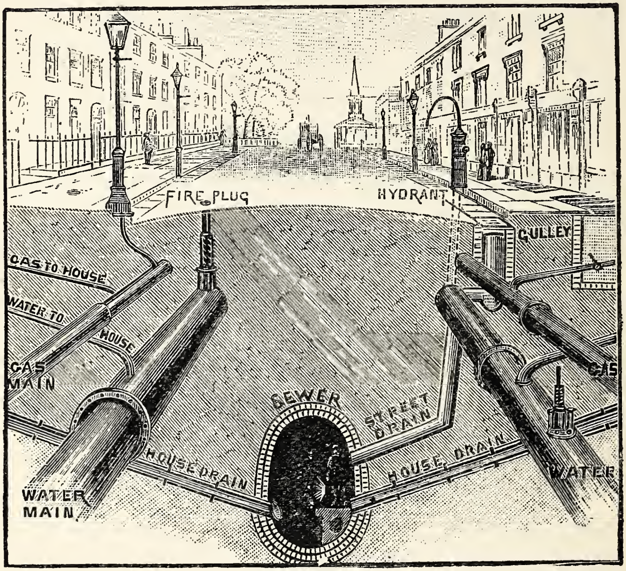
The increased demand for manufactured products has had the effect of stimulating the production of raw materials.

Europe alone consumes every year, 600,000,000 pounds of wool and 300,000,000 pounds of flax. France exports annually $80,000,000 worth of silks. The United States sends abroad every twelve months, breadstuffs to the value of $1,000,000,000. The manufactures of England — a country less than half the size of Montana — amount yearly to the enormous sum of $1,500,000,000.

The results of this extraordinary intellectual and industrial activity are visible not only in cities, but also in the country. Land, wild a few years ago, is now a scene of rural labor — of orchards, of vegetable gardens, or of thriving farms.

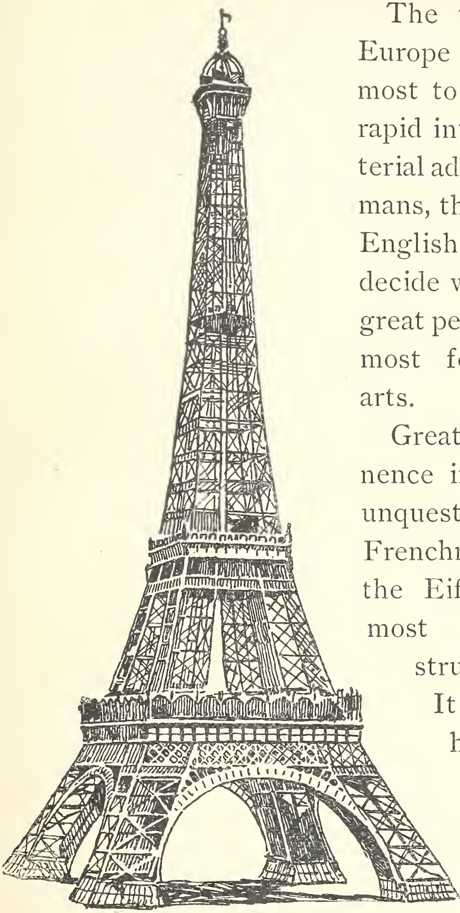
Instead of corduroy tracks we have good roads and railways.

The progress of scientific medicine has taught us that the frightful plagues which so often deso-




*Street Pipes.*

lated the cities of Europe were caused by the dirt and filth heaped up in the narrow, unpaved lanes of the times. Sewers, and wide, clean-swept streets free us from fear of similar scourges to-day. Gas-mains and water-pipes supply even the humblest city tenement with comforts that no royal palace had a century ago.



*The Eiffel Tower.*

The three nations of Europe which have done most to bring about this rapid intellectual and material advance are the Germans, the French, and the English. It is difficult to decide which one of these great peoples has done the most for the industrial arts.

Great Britain's pre-eminence in iron-working is unquestioned, yet it is a Frenchman that designed the Eiffel Tower — the most remarkable iron structure ever erected. It is 1,000 feet in height, and weighs 7,500 tons. The top is provided with a powerful electric light, which may be seen from Orléans — a city distant about seventy miles.

But no country can compare with our own in the number of brilliant inventions, in the colossal nature of our public works, or in material resources. Europe itself is likely to be left behind by the United States. Our natural advantages promise a future of prosperity to which it is impossible to point out the limits.

"Westward the course of empire takes its way."

Why? What causes brought about the removal of learning, wealth, and commerce from the Euphrates and the Nile to the Thames and the Hudson? Do not the seasons return to Egypt and Asia Minor now as regularly as they returned to those lands 3,000 years ago? Is not nature the same now that it was then?

Yes; nature is just as bountiful to-day as ever, but the man of Syria and of the Nile valley has changed. He has suffered his race to decay. When those lands were peopled with men that were wise, prudent, brave, and industrious, their fields bore heavy harvests, and their cities were magnificent.

But Babylon and Memphis became ruins when their citizens lost the high qualities of mind and soul that had distinguished their ancestors. The scepter of power passed from the East to Greece, to Italy, to Spain, to England.

The rising greatness of this country indicates that at no distant day we shall be the ruling nation of the world. Already we are the richest and most powerful people on the globe.

To fulfill our high destiny, and to avoid the evils that brought the ancient nations to the dust, our people must be educated. Not only then does one's ability as a wage-earner depend on knowledge, but one's usefulness as a citizen of this great country may also, in great part, spring from the education received at school. Should we not, therefore, use our time well now?

Only by knowledge of nature's laws can man use nature's materials for his own purposes. The whole history of arts and inventions is a continued comment on this statement. Since the needed knowledge can be obtained only by observation of nature, it follows that science, which is the exact and orderly summing-up of the results of such observation, must powerfully contribute to the well-being and progress of mankind.

Science has lengthened life; it has extinguished diseases; it has increased the fertility of the soil; it has furnished new arms to the warrior; it has spanned great rivers with bridges of form unknown to our fathers; it has guided the thunderbolt harmlessly from heaven to earth; it has lighted up the night with the splendor of the day; it has extended the range of the human vision; it has multiplied the power of the human muscles; it has annihilated distance; it has enabled man to descend into the depths of the sea, to soar into the air, to penetrate into the recesses of the earth, to whirl across the land in steam-drawn cars, to cross the ocean in ships that run twenty knots an hour.

Every new invention, every triumph of engineering skill, is the embodiment of some scientific idea. Experience has proved that discoveries in science, however remote from the interests of every-day life they may at first appear, ultimately confer incalculable benefits on mankind.

While no advance is ever made in any branch of science which does not sooner or later give rise to a corresponding improvement in some industrial art, on the other hand, every advance made in any industrial art furnishes a striking illustration of some scientific principle.

The enormous material advantages which this age possesses, the cheapness of production that has placed comforts and refinements unknown to our fathers within the reach of the humblest person, are traceable in a high degree to the arrangement called the division of labor.

It is found more advantageous for each man to devote himself to one kind of work only — to the steam-engine and its numerous applications; to the metals and the methods of extracting them from their ores; to the use of powerful and accurate tools; or to the modern plan of manufacturing articles by copying, instead of fashioning them anew by manual labor.

A century ago wares were slowly and imperfectly made by the tedious toil of the workman's hand; but now marvelously perfect products of ingenious manufacture are in every-day use. Their very commonness prevents us from viewing them with the attention and admiration which they deserve. Machinery now performs with ease and certainty work that was formerly the drudgery of millions of laborers.

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