The Project Gutenberg eBook of Appletons' Popular Science Monthly, April 1900, by Various and William Jay Youmans

Title: Appletons' Popular Science Monthly, April 1900

Author: Various
Editor: William Jay Youmans

Release date: October 23, 2014 [EBook #47183]

Language: English

Credits: Produced by Greg Bergquist, Charlie Howard, and the Online
Distributed Proofreading Team at http://www.pgdp.net (This
file was produced from images generously made available
by The Internet Archive)

Transcriber's note: Table of Contents added by Transcriber.

CONTENTS

Recent Years of Egyptian Exploration	625
The Gold Sands of Cape Nome	633
A State Official on Excessive Taxation	645
Latest Developments With the X Rays	659
A Hundred Years of Chemistry	673
The Science of Art Form	685
Steam Turbines and High-speed Vessels	696
A Survival of Mediæval Credulity	706
Genuine Starch Factories	716
Trade Corporations in China	722
Editor's Table	728
Fragments of Science	731
Minor Paragraphs	737
Publications Received	639
Index	741

Established by Edward L. Youmans

APPLETONS'
POPULAR SCIENCE
MONTHLY

EDITED BY
WILLIAM JAY YOUMANS

VOL. LVI
NOVEMBER, 1899, TO APRIL, 1900

NEW YORK
D. APPLETON AND COMPANY
1900

625

APPLETONS'
POPULAR SCIENCE
MONTHLY.

April, 1900.

RECENT YEARS OF EGYPTIAN EXPLORATION.

By W. M. FLINDERS PETRIE,
PROFESSOR OF EGYPTOLOGY, UNIVERSITY COLLEGE, LONDON.

Familiar as we are with the methods of science—exact observation and record, comparison, and the strict weeding out of hypotheses—yet such methods have only gradually been applied to various branches of learning.

Geometry became a science long ago, zoölogy much later, medicine only a generation or two ago, and the history of man is but just being developed into a science. What was done for other sciences by the pioneers of the past is now being done in the present day for archæology. We now have to devise methods, to form a notation for recording facts, and to begin to lay out our groundwork of knowledge. With very few exceptions, it may be said of Egypt that there is no publication of monuments before this century that is of the least use, no record or dating of objects before 1860, and no comparison or study of the history of classes of products before 1890. Thus, the work of recent years in Egyptology is really the history of the formation of a science.

The great stride that has been made in the last six years is the opening up of prehistoric Egypt, leading us back some two thousand years before the time of the pyramid builders. Till recently, nothing was known before the age of the finest art and the greatest buildings, and it was a familiar puzzle how such a grand civilization could have left no traces of its rise. This was only a case of blindness on the part of explorers. Upper Egypt teems with prehistoric remains, but, as most of what appears is dug up by plunderers for the market, until there is a demand for a class of objects, very little is seen of them. Now that the prehistoric has become fashionable, it [626]
is everywhere to be seen. The earlier diggers were dazzled by the polished colossi, the massive buildings, the brilliant sculptures of the well-known historic times, and they had no eyes for small graves, containing only a few jars or, at best, a flint knife.

The present position of the prehistory of Egypt is that we can now distinguish two separate cultures before the beginning of the Egyptian dynasties, and we can clearly trace a sequence of manufactures and art throughout long ages before the pyramid builders, or from say 6000 B. C., giving a continuous history of eight thousand years for man in Egypt. Continuous I say advisedly, for some of the prehistoric ways are those kept up to the present time.

In the earliest stage of this prehistoric culture metal was already used and pottery made. Why no ruder stages are found is perhaps explained by the fact that the alluvial deposits of the Nile do not seem to be much older than eight thousand years. The rate of deposit is well known—very closely one metre in a thousand years—and borings show only eight metres thick of Nile mud in the valley. Before that the country had enough rain to keep up the volume of the river, and it did not drop its mud. It must have run as a rapid stream through a barren land of sand and stones, which could not support any population except paleolithic hunters. With the further drying of the climate, the river lost so much velocity that its mud was deposited, and the fertile mud flats made cultivation and a higher civilization possible. At this point a people already using copper came into the country. Their bodies were buried in shallow, circular pit-graves, covered with goat skins, which were fastened rarely by a copper pin; before the face was placed a simple bowl of red and black pottery, and some of the valued malachite was placed in the hands. The body was sharply contracted, often with the knees almost touching the face, and the hands were usually in front of the face.

Very soon they developed their pottery into varied and graceful forms, and decorated it with patterns in white clay applied to the dark-red surface, but it continued to be entirely hand-made, without the use of the potter's wheel. The patterns, usually copied from basketwork, show the source of the forms of the cups and vases. The modern Kabyle, in the highlands of Algeria, has kept up the same patterns on hand-made pottery, and the same use of white clay on a red base. It is probably to a Libyan people that this civilization is first due, and the skulls of these prehistoric Egyptians are identical with those of the prehistoric Algerians from the dolmens and the modern Algerians. This first growth of the civilization not only developed pottery, but also the carving of stone vases entirely by hand. The principal type of these is the cylinder, with many small variations. [627]
Figures were carved in alabaster and bone, and modeled in clay and paste; these are rude, but show that the type of the race was fine, with a high forehead and pointed beard. The use of marks denoting property was common, and such marks seem to be the earliest stages of the system of signs which developed later into the alphabet. This civilization had apparently passed its best time, decoration had ceased on the pottery, when a change came over all classes of work.

The second prehistoric civilization seems to have belonged to a people kindred to that of the first age, as much of the pottery continued unchanged, and only gradually faded away. But a new style arose of a hard, buff pottery, painted with patterns and subjects in red outline. Ships are represented with cabins on them, and rowed by a long bank of oars. The use of copper became more general, and gold and silver appear also. Spoons of ivory, and rarely of precious metals, were made, but hair combs, which were common before, ceased to be worn. Stone vases were commonly carved in a variety of hard and ornamental stones, but always of the barrel outline and not the early cylinder shapes. Flint-working reached the highest stage ever known in any country, the most perfect mastery of the material having been acquired. Though this civilization was in many respects higher than that which preceded it, yet it was lower artistically, the figures being ruder and always flat, instead of in the round. Also the use of signs was driven out, and disappeared in the later stage of this second period. The separation of these two different ages has been entirely reached by the classification of many hundreds of tombs, the original order of which could be traced by the relation of their contents. In this way a scale of sequence has been formed, which enables the range of any form of pottery or other object to be exactly stated, and every fact of connection discovered can be at once reduced to a numerical scale as definite as a scale of years. For the first time a regular system of notation has been devised for prehistoric remains, and future research in each country will be able to deal with such ages in as definite a manner as with historic times. The material for this study has come entirely from excavations of my own party at Nagada (1895), Abadiyeh, and Hu (1899); but great numbers of tombs of these same ages have been opened without record by M. de Morgan

(1896–’97), and by French and Arab speculators in antiquities.

The connection between these prehistoric ages and the early historic times of the dynastic kings of Egypt is yet obscure. The cemeteries which would have cleared this have unhappily been looted in the last few years 628
without any record, and it is only the chance of some new discoveries that can be looked to for filling up the history. We can at least say that the pottery of the early kings is clearly derived from the later prehistoric types, and that much of the civilization was in common. But it is clear that the second prehistoric civilization was degrading and losing its artistic taste for fine work before the new wave of the dynastic or historic Egyptians came in upon it.

These early historic people are mainly known by the remains of the tombs of the early kings, found by M. Amelineau at Abydos (1896–’99), and probably the first stage of the same race is seen in the rude colossi of the god Min, which I found at Koptos (1894). Unhappily, the work at Abydos was not recorded, and it is not known now out of which of many kings’ tombs, nor even out of which cemeteries, the objects have come. Hence scientific results are impossible, unless enough material has escaped the careless and ignorant workmen to reward more accurate reworking of the same ground. We can at present only glean a general picture of the early royal civilization from Abydos, supplemented by some splendid carvings of two reigns found at Hierakonpolis (1897–’98) by Mr. Quibell.

The burials continued to be in tombs of the same form—rectangular pits lined with brickwork and roofed over with beams and brushwood. But they were made larger, and, in the case of the royal tombs, great halls were formed about fifty by thirty-five feet, roofed with beams eighteen or twenty feet long. In these royal tombs were placed a profusion of vases of hard and beautiful stones, bowls of slate, and immense jars of alabaster; these contained the more valuable offerings of precious ointments and other funereal treasures. Besides these, there were hundreds of great jars of pottery, containing provision of bread, meats, dried fruits, water, beer, and wine. Doubtless there were many vases of metals, but these have been almost always robbed from the tomb anciently. Around the tomb were the small graves of the retainers of the king, each with a lesser store like that of their master. The royal tomb was denoted by a great tablet bearing the king’s spiritual name by which he would be known in the future world. The private tombs had small tablets, about a foot and a half high, with the names of their occupants. As all these tablets show considerable weathering, it seems that they were placed visible above the tomb. Tombs of the subsequent kings were elaborated with small chambers around the great one, to contain the offerings, and even a long passage was formed with dozens of chambers along each side of it, each chamber containing a separate kind of offering.

Turning now to some of the remains of these kings during their life, we learn that they were occupied with 629
frequent wars—the gradual consolidation of the kingdom of Egypt. One king will record the myriads of slain enemies, another gives a picture of a captive king brought before him with over a million living captives, the regular Egyptian notation for such large numbers being already complete. Another king shows his triumphal entry to the temple, with the slain enemies laid out before him. On other sculptures are shown the peaceful triumphs of canalization and reclamation of land, which are alluded to in the traditions of the early dynasties preserved by Greek historians. All these scenes are given us on the slate carvings and great mace heads covered with sculpture from Hierakonpolis.

Thus in these great discoveries of the last few years we can trace at least three successive peoples, and see the gradual rise of the arts, from the man who was buried in his goat skins, with one plain cup by him, up to the king who built great monuments and was surrounded by most sumptuous handiwork. We see the rise of the art of exquisite flint flaking, and the decline of that as copper came more commonly into use. We see at first the use of signs, later on disused by a second race, and then superseded by the elaborate hieroglyph system of the dynastic race.

The mixture of various races was surmised long ago from the varied portraiture of the early times. It is now shown more plainly than ever on these early monuments. We see represented the king of the dynastic type, a scribe with long, wavy hair, a chief of the dynastic shaven-headed type, another with long, lank hair, and another with a beard, while the enemies are shown with curly hair and narrow beards like Bedouin. Four different peoples are here in union against a fifth. And this diversity of peoples lasts on long into the historic times. After several centuries of a united Egypt, under the pyramid builders, we find that some people buried in the old contracted position, others cut up the body and wrapped every bone separately in cloth, while others embalmed the body whole. Thus great diversity of belief and custom still prevailed for perhaps a thousand years after the unification of Egypt. So useless is it to think of “the ancient Egyptians” as an unmixed race gradually rising into “a consciousness of nationality.”

The excavations at Deshasheh in 1897, which first showed me the diversity of burials, also showed that the type of the race had already become unified by intermixture, and that, strange to say, four thousand years later, after untold crossings with many invaders, the type was unchanged. Later work at Dendereh and elsewhere has pointed to the conclusion that a mixture of a new race is subdued to the type of the country by the effect of 630
climate and surroundings within a few centuries.

Turning now to the purely classical Egyptian work, the principal discoveries of the last few years have given us new leading examples in every line. The great copper statue of King Pepy, with his son, dates from before 3000 B. C. It is over life size, and entirely wrought in hammered copper, showing a complete mastery in metal work of the highest artistic power. Probably of the same age is a head of a figure of the sacred hawk, wrought hollow in a single mass of hammered gold, weighing over a pound; this again shows work of noble dignity and power. Both of these were found at Hierakonpolis in 1898, and are now in the Cairo Museum.

Some centuries later was made the exquisite jewelry found at Dahshur in the graves of three princesses. This is a revelation of the delicacy possible in goldsmith’s work. The soldering of the minute parts of the gold is absolutely invisible. The figures of hawks are made up of dozens of microscopic pieces of colored stone—lazuli, turquoise, carnelian—every one cut to the forms of the feathers, and every piece having a tiny cell of soldered gold strip to hold it in place, yet the whole bird only about half an inch high. The finest colored enameling ever made would be child’s play compared with a piece of this early jewelry. The exquisite grace of form, harmony of coloring, and sense of perfection leave the mind richer by a fresh emotion, after seeing such a new world of skill. Coming down to about 1500 B. C., a large work has been done in the last six years in clearing the temple of Queen Hatshepsut at Deir el Bahri, on the western side of Thebes. That great ruler had there commemorated the events of her reign, particularly the expedition to the south of the Red Sea to obtain the plants of the sacred incense and other valued products. The attention shown to exact figuring of plants and animals makes this valuable as a record of natural history. This clearance has been made by Dr. Naville for the English fund. Meanwhile, Franco-Egyptian officials have been clearing out the Temple of Karnak, on the opposite bank, but with disastrous effect. The huge columns, built poorly of small blocks by Rameses II, stand now below the level of the inundation, and, after removing the earth accumulated around them, the Nile water has free circulation. This has dissolved the mortar so much that nine of these Titanic columns of the Great Hall fell last year, and three more threaten to follow them.

The Valley of the Tombs of the Kings has been prohibited ground to foreign explorers for over forty years, although the official department never did any work there. The native plunderers, however, turned up many years ago the beautiful chair of Queen Hatshepsut, and lately they found the entry to still unopened royal 631 tombs. The secret passed—for a consideration—to the Department of Antiquities, and two royal tombs were opened. These contained the bodies of several kings of the eighteenth and nineteenth dynasties—one undisturbed, the others moved from elsewhere. With these was a crowd of objects of funereal furniture. Unhappily, nothing is published in detail of any official discoveries; with the exception of the first find of the Dahshur jewelry, there has never been any full account issued of the great discoveries in the most important sites, which are reserved to the Government. The great group of kings found at Deir el Bahri, the great necropolis of the priests of Amen, the second find of Dahshur jewelry, the second group of royal mummies, of all these we know nothing but what has appeared in newspapers, or some partial account of one branch of the subject. Hardly any publication has ever appeared, such as the English societies issue every year about the produce of their excavations.

Many of the royal temples of the nineteenth dynasty at Thebes were explored by the English in 1896. The Ramesseum was completely examined, through all the maze of stone chambers around it. But the most important result was the magnificent tablet of black granite, about ten feet high and five wide, covered on one side with an inscription of Amen Hotep III, and on the other side with an inscription of Merenptah. The latter account, of about 1200 B. C., mentions the war with the "People of Israel"; this is the only naming of Israel on Egyptian records, and is several centuries earlier than any Assyrian record of the Hebrews. It has, of course, given rise to much discussion, which is too lengthy to state here.

One of the most important results of historical Egyptian times is the light thrown on prehistoric Greek ages. The pottery known as "Mykenæan" since the discoveries of Schliemann in the Peloponnesus was first dated in Egypt at Gurob in 1889; next were found hundreds of vase fragments at Tell el Amarna in 1892; and since then several Egyptian kings' names have been found on objects in Greece, along with such pottery. The whole of this evidence shows that the grand age of prehistoric Greece, which can well compare with the art of classical Greece, began about 1600 B. C., was at its highest point about 1400 B. C., and became decadent about 1200 B. C., before its overthrow by the Dorian invasion.

Besides this dating, Greece is indebted to Egypt for the preservation of the oldest texts of its classics. Fragments of Plato almost contemporary with his lifetime, pages of Thucydides, whole books of the Iliad, and the celebrated recent publications of Bacchylides and Herondas, all are due to Egypt. Moreover, of Christian 632 times we have a leaf of an early collection of Sayings of Jesus, a leaf of gospel about two centuries older than any other biblical manuscript, and a host of documents bearing on early Christianity, such as the Gospel of Peter and other apocryphal writings which were later banned by the Church.

Now it may be asked how all these discoveries are made—indeed, many people take for granted that some government kindly pays for it all. On the contrary, the only official influences are a severe check on such scientific work. While a native Egyptian can plunder tombs with but little hindrance, any one desiring to preserve objects and promote knowledge must (after obtaining the permission of the Egyptian Government for the exact place he wants to work) be officially inspected at his own expense (a matter of twenty or thirty pounds a season), and then, after all, give up to the Government half of all he finds, without any recompense. The English Government long ago gave up all claim for British subjects to occupy any post in the Cairo Museum, thus putting a decisive bar on the hopes of would-be students and hindering the object very effectually.

In face of all these disadvantages, work has yet been carried on by the Egypt Exploration Fund and by the Egyptian Research Account; both rely on English and American support, and the latter body is intended expressly to help students in training. Besides these, private work has been carried on during several years by two or three other explorers, partly at their own cost, partly helped by friends. The two societies above named have kept to the principles that everything shall be published as soon as possible, and that all the antiquities removed from Egypt shall be divided among public museums as gifts in return for the support from various places, nothing ever being sold publicly or privately. In this way several centers in America send large annual contributions, have representatives on the London Committee of the Exploration Fund, and receive their share for museums every year.

Besides this organizing of ways and means, there is quite as important organization needed in the excavations. At present most of the above-named work is done by a corps of men who have been engaged at it for many years. They leave their homes and assemble as soon as the winter begins; any dealing in antiquities or misconduct since the last season excludes them from rejoining. They each know their work, what to preserve, how to leave everything intact in the ground where found, and how best to manage different kinds of excavating. With such men it is always possible to screw more information out of a site, however much it may 633 have been already wrecked in ancient or modern times. And it is far safer to leave such men unwatched, with the certainty that they will receive a fair value for all they find, than it is to drive a gang under the lash, on bare wages, without rewards to keep them from pilfering. The English system means mutual confidence and good faith; the native and French system of force means the destruction of both information and antiquities.

And yet besides this there is the essential business of observing and recording. Every hole dug must have a meaning and be understood, as to the date of the ground at different levels and the nature of the place. Everything must be spelled out as the work advances; any difficulties that can not be explained must be tried with all possible hypotheses; each detail must either fall into place as agreeing with what is known, or be built in as a new piece of knowledge.

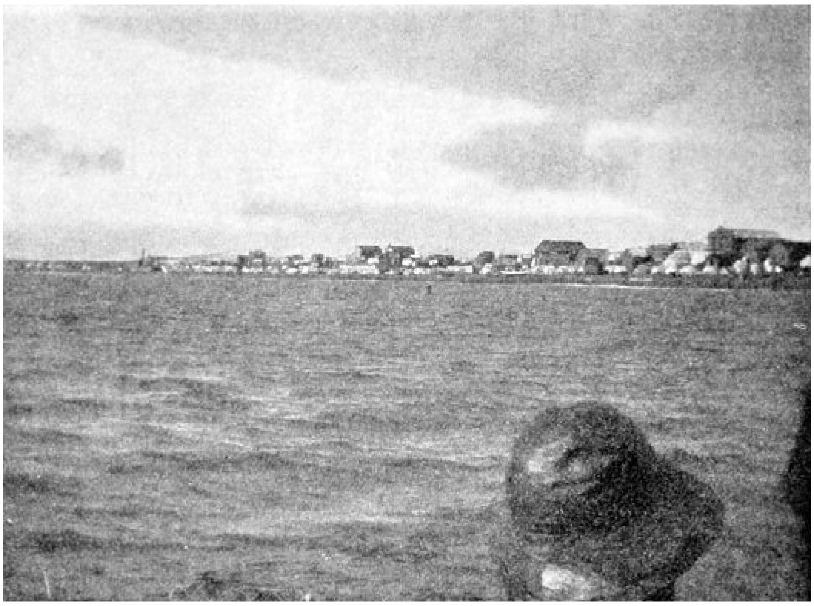
Twenty years ago nothing was known of the date of any Egyptian manufactures, not even of pottery or beads, which are the commonest. Now, at present it is seldom that anything is found which can not be dated tolerably near by, and in some classes of remains the century or even the reign can be stated at once, without a single word to show it. The science of Egyptian archæology is now in being.

In this, therefore, as in many other matters, the Anglo-Saxon taste for private enterprise is the ruling power, and in spite of political obstacles and of taxation, which are happily unknown in other sciences, the private work of individuals has quietly traced out the foundations of one of the earliest civilizations of mankind.

THE GOLD SANDS OF CAPE NOME.

By Prof. ANGELO HEILPRIN,
LATE PRESIDENT OF THE PHILADELPHIA GEOGRAPHICAL SOCIETY.

One of the most interesting contributions to the history of gold and gold mining has undoubtedly been discovered in the region of Cape Nome, Alaska, during the past summer. Vague reports have from time to time, for a period of a year or more, been sent out from the bleak and inhospitable shores of Bering Sea of the discovery there of rich deposits of placer gold, and of almost fabulous wealth acquired by a few fortunate prospectors—a new Klondike on American soil—but these gained little credence beyond the portals of transportation companies and the organizers of "boom" enterprises. A few of the more credulous and those unmindful of adventure and hardship took practical action on the receipt of the reports, and prepared to buffet 634 the still ice-bound waters of the Pacific to gain early access to the new land of promise. In a brief period the fame of Golovnin Bay had been spread broadcast, only to be again dimmed by the later announcements that the earlier reports of finds were only "fakes." Making and unmaking are a part of all new mining centers, and in an incredibly short time all manner of conclusions are arrived at regarding the possibilities of a location.



An Off-Shore View of Nome.

New reports of finds made along the coast of Bering Sea, about fifty miles west of Golovnin Bay, called renewed attention to the region, and those who in the early summer of the past year (1899) timidly ventured their fortunes to share in a possible discovery, found, on their arrival at the tundra-bound shores about Cape Nome, that miles of territory had already been located as claim sites, that sluice-boxes were in full operation, and that sackfuls of gold dust and nuggets had been carefully laid to one side, representing "outputs" of tens of thousands of dollars. At this time many of the journals of civilization in the East, repeating the warnings that they persistently threw out following the discovery of gold in the Klondike, jealously guarded the secrets of the earth by doubting, or even denying, the claims to discovery, but, withal, wisely counseling against that haphazard and purseless rush which is one of the invariable accompaniments of gold announcements. A new mining district had suddenly sprung into existence, and before two months had passed—i. e., by the early days of September—a full front of tents and frame houses took possession of what continues to remain a dreary and 635 desolate expanse of ocean beach—sufficiently pleasant in the quiet, balmy days of summer and autumn, but wofully exposed to the hurricane blasts of the arctic winter—and gave shelter to from three to four thousand adventurers, where formerly a few Indians and Eskimos from the still farther northwest and King's Island constituted a straggling and accidental population. This, in brief, is the initial history of the Nome or Anvil City mining region, which will almost certainly call to it in the coming spring fifteen to twenty thousand additional inhabitants.

A Street in Nome.

Far more interesting to the one who has not been properly rewarded in his search for placer claims than the placer deposits themselves are the gold-bearing beach sands, whose productivity will mainly be responsible for the influx of population to the new region. From them, by crude and simple methods, has been taken, in barely more than two months, gold to the value of more than a million dollars, and what the possibilities for the future may be no one is wise enough to tell. So clearly exaggerated did the accounts of the free-sand rocking appear, even those coming from reputable miners who were personally known to me, that I could hardly bring myself to take them at their full value, but, being accidentally drifted in the course of a summer's wanderings to St. Michael, above the mouth of the Yukon River, I had easy opportunity to verify for myself the accuracy of the statements that had been sent out, and to cast a geological glance at the situation. My examination of the region was confined to a few of the later days of September and to early October. 636

The geographical position of the Nome region is the southern face of the peninsular projection of Alaska which separates Kotzebue Sound on the north from Bering Sea on the south, and terminates westward in Cape Prince of Wales the extent of the North American continent. In a direct line of navigation, it lies about twenty-five hundred miles northwest of Seattle and one hundred and seventy miles southeast of Siberia. The nearest settlement of consequence to it prior to 1899 was St. Michael, a hundred miles to the southeast, the starting point of the steamers for the Yukon River; but during the year various aggregations of mining population had built themselves up in closer range, and reduced the isolation from the civilized world by some sixty miles. The Nome district as settled centers about the lower course of the Snake River, an exceedingly tortuous stream in its tundra course, which emerges from a badly degraded line of limestone, slaty, and schistose mountain spurs generally not over seven hundred to twelve hundred feet elevation, but backed by loftier granitic heights, and discharges into the sea at a position thirteen miles west of Cape Nome proper. Three miles east of this mouth is the discharge of Nome River. Both streams have a tidal course of several miles. Nome, or, as it was first called, Anvil City—named from a giant anvil-like protrusion of slate rock near to the summit of the first line of hills—occupies in greater part the tundra and ocean beach of the eastern or left bank of Snake River, but many habitations, mainly of a temporary character, have been placed on the bar beach which has been thrown up by the sea against the mouth of the stream, and deflected its course for some distance parallel with the ocean front. A number of river steamers (one even of considerable size) and dredges have found a suitable anchorage or "harbor" in the barrier-bound waters, and much driftwood passes into them at times of storms and higher waters, when the greatly constricted and shallow mouth is made passable. The entire region is treeless, and the nearest approach to woodland is in the timber tract of Golovnin Bay and its tributaries, about forty miles to the northeast. A fairly dense growth of scrub willow, three to five feet in height, with elms and alders, forms a fringe or delimiting line to parts of the courses of the streams in the tundra, which greatly undulates in the direction of the foothills and incloses tarnlike bodies of fresh and slightly brackish waters. It is covered merely with a low growth of flowering herbaceous plants, grass, and moss, with a somewhat scantier admixture of the 637
dwarf birch, arctic willow, and crowberry. The surface is pre-eminently swampy during the warmer periods of the year, and walking over it means either wading through the water or risking continuous jumps to and from the individual clumps of matted grass and moss—the so-called "nigger-heads." The greater part of the tundra seems to rest on gravel and sand—doubtless of both marine and fluviatile origin—and ordinarily the frozen stratum is already reached at a depth of two or three feet, sometimes less. In early October of the past year it was still too "open" to permit of easy walking over it, but in quite early hours of the morning the surface afforded fair lodgment to moderate weights. Fragmentary parts of the skeleton of the mammoth have been found here and there, even loose on the top grass, but where found in such situations it is by no means certain that they had not been redeposited by high tidal wash. A large fragment of thigh bone, with shoulder blade, which I found about an eighth of a mile inland and perhaps fifteen feet above the water, was associated with 638
one of the mandibular bones of the whale. I could obtain no information as to their having been possibly carried to their present position by man, but it may have been the case. A large skull, which I owe to the kindness of Mr. Inglestadt and to Mr. Louis Sloss, Jr., manager of the Alaska Commercial Company, was obtained, as nearly

as I could determine through inquiry on the spot, from about the same locality. Where it abuts upon the sea the tundra stands from eight to twenty feet above it, at places descending to even lower levels. The sea face is almost everywhere an abrupt one, showing undercutting by high water, and it is continued by a broad, rapidly sloping sand and shingle beach, which packs firmly, and almost immediately beneath the surface exhibits a distinctly stratified construction—the alternate layers of fine, flat gravel, coarse, clayey sand, and finer "ruby" (fragmented garnet) sand sloping like the surface, although generally with a milder pitch, to the sea.

A Native of the Land of Nome.

The open sea front, with inland tundra, is continued for a distance of about fourteen miles westward of Nome, where it is interrupted by the mountains, in a west-southwest course, reaching the sea; flat-topped Sledge Island, so much recalling in aspect some of the islands lying off Whale Sound, in the northwest of Greenland, is their oceanic continuation for some distance, with sharp breaks on both the oceanic and inner sides. It is probable that much of the *débris* that has resulted from the disruption of the mountain masses has been distributed littorally by the sea, with an eastward wash, to form the bars and shallows which for some distance stretch along the coast; nor is it impossible that some of the giant bowlders of limestone, marble, granite, and syenite which are found on the margin of the beach about four or five miles west of Nome, some of them measuring eight and twelve feet or more in diameter, and all of them smoothly rounded and evenly polished, represent a part of this destruction. At the same time, there is good reason to suspect that they may have been deposited by ice action, either as erratics of floe ice coming from the northwest, or of glacial distribution from the region of the mountains. Whatever may have been the final stage in the history of the amphitheater of Nome (the region included between Cape Nome and Sledge Island), which my limited observation did not permit me to determine to full satisfaction, it is almost certain, even in the absence of the ordinary glacial testimony, that the region is one of past glaciation, and that much of the gravel and bowlder material of the ocean front is of morainic origin, so modified and altered in position by readjustments of the land and water as to have lost its proper physiographic contours. The aspect of the hills and valleys is almost precisely that of some of the regions of Greenland which have only quite recently been vacated by the glaciers, 639
while the composition of the shingle—the inclusion over so long a front of bowlders from beyond the first line of mountain heights, many of them most markedly grooved and polished—is also highly suggestive of glacial deposition.

The Harbor of Snake River (Nome).

The gold sands, or sands that are worked for gold, are merely the ordinary materials of the beach, loose and incoherent like most seashore sands, and particularly defining horizons three to six feet below the surface. In regular stratified layers, with fine and moderately coarse gravel, they embrace four or five distinct layers of fragmented garnets (the components of the so-called "ruby sand"), and it is from these, and at this time almost exclusively from the bottom layer of three to five inches thickness, which is popularly described as lying on "bed rock"—in most places merely a hard-pan of arenaceous clay or argillaceous sand, with no true rock to define it—that most of the gold is obtained. Each ruby band nearer to the top seems to contain less and less gold, and there is no question that the different layers are merely reformations by the sea from those of earlier deposition, just as surface shingle deposits generally are in part reconstructions of underlying beds. That the ocean is to-day depositing the ruby sand is unmistakably shown by the great patches of this sand lying on the surface and its incoming in the path of nearly every storm. Even these surface sands are mildly gold-bearing, showing that the gold, despite its high specific gravity, may be buoyed up and wafted in by such a light medium 640
as water when it has been reduced to sufficiently minute particles or scalelike forms. It is little wonder that a general belief has gained currency with the more enthusiastic locators that the sand gold is a deposition or precipitate from the sea.

The gold itself occurs in an exceedingly fine state of subdivision, too fine in most cases to be caught without mercury or the best arrangement of "blanketings." Much of it is really in the condition of colors dissected nearly to their finest particles, and it is hardly surprising that it should have so long escaped detection. Occasionally pieces to the value of three to six cents are obtained in the pans, and I was witness to the finding of a scale with the value of perhaps nearly twenty cents. The usual magnetitic particles are associated with the gold, and their origin can clearly be traced to the magnetite which is so abundantly found in some of the schists (micaceous, chloritic, and talcose schists), which, judged by the fragments and bowlders that everywhere lie in the path of the streams of the tundra, must be closely similar to the series of schists of the Klondike region. The particles of fragmented garnet, which by their astonishing abundance give so distinctive a coloring to the layers which they compose or constitute, are of about the ordinary fineness of seashore sand, perhaps a trifle coarser, but occasionally much coarser particles or masses of particles are found; and in the placer deposits of Anvil Creek, as in the bunch of claims around "Discovery"—about five miles due north of Nome—fragments of the size of lentils are not uncommon. I have seen full garnets obtained from the wash here which were of the size of small peas. Nodules of manganese (manganite, pyrolusite) are at intervals found with them, and some stream-tin (cassiterite), as in the Klondike region, also appears to be present. Apart from the evidence that is brought down by the magnetite and garnet, it would naturally be assumed that the gold had its primal source in the mountains back of the coast. These, as has already been stated, have undergone exhaustive degradation, and the materials resulting from their destruction, in whatever way brought about, have been thrown into the sea, and there adjusted and readjusted—or, so far as the gold particles are concerned, one might say "concentrated." Latterly, and perhaps this is also true to-day, the land has undergone elevation, and exposed much that until recently properly belonged to the sea. The tundra is a part of this ocean floor, and it too doubtless contains much gold, perhaps even very much.

The length of the sea strip that was worked during the past summer, and so far in autumn as the clemency
of the weather permitted, covered a nearly continuous thirty or thirty-five miles, extending beyond Synrock on 641
the west and, with interruptions, to Nome River on the east. The full extent of the auriferous sands remains unknown, however, and report claims for them reappearances throughout the entire coast as far as Cape Prince of Wales. The season's work gave easy and lucrative employment to perhaps fifteen hundred, mostly needy, prospectors, who realized on an average certainly not less than fifteen dollars per day, and many as much as sixty, seventy, and eighty dollars. It is claimed, and I have little reason to doubt the truthfulness of the statement, that from a single rocker, although operated by two men, one hundred and fifty dollars had been taken out in the course of nine hours' work. It is also asserted that two men realized a fortune of thirteen thousand dollars as the result of their combined season's work, and two others are said to have rocked out forty-five hundred dollars in the period of a month. Women have, to an extent, shared with men the pleasures of "rocking gold from the sea," and their application in the toils of the sea plow, with booted forms, rolled-up sleeves, and sunbonnets, was certainly an interesting variation on the borders of the Arctic Circle from the

scenes one has grown accustomed to at Atlantic City or Newport.

Erecting a Steam Pump (Nome).

The placer deposits of the Nome district are in the form of shallow, largely or mostly unfrozen gravels, which occupy varying heights, partly in disrupted or overhanging benches, of the valleys and gulches which trench the slate and limestone mountains. Perhaps the most favored ones are those of Anvil and Glacier Creeks (with Snow 642
Gulch as an affluent of the latter), tributaries of Snake River, and Dexter Creek, a tributary of Nome River. My time and the conditions of weather permitted only of a visit to Anvil Creek, and an examination mainly of the properties about “Discovery.” The diggings here are all shallow, from four to seven feet, when bed-rock, a steeply pitching and highly fissile slate, is reached. As before remarked, the gravels are not frozen, and thereby present a marked contrast to the condition that prevails in the Klondike region, and one, it is hardly necessary to state, which is eminently to the favor of economy in mining. A layer of ice, about eight inches in thickness, covers one side of the layers in claim “No. 1 below,” but beneath this the matrix is again open. In all these claims the pay-streak was at first reported to be very broad, but it seems that the later work has narrowed down the probabilities of extension very measurably—at any rate, in the condition of a rich producer. Of the wealth contained in these claims there is no question, but it would probably be straining the truth to say that it is the equal of that of the best or even the better claims of the Klondike region. A two days’ clean-up from “No. 1 below” is reported to have yielded thirteen thousand dollars, while the entire product of that claim from July 26th, when the first wash was made, to September 21st, was placed at one hundred and twenty-five thousand dollars. Claim “No. 1 above” appears to be equally good, and “Discovery” falls perhaps not very far below either. A nugget of the value of three hundred and twelve dollars—a magnificent specimen, measuring upward 643
of four inches in length—was obtained from the tailings of “No. 1 below”; a larger one, of the value of four hundred and thirty-four dollars, is to the credit of “No. 1 above.” It is interesting to note that these rich claims are located at the very issuance of Anvil Creek from the mountains—i. e., at the contact with the upper rise of the tundra—and other good properties are found still lower down, a condition which makes it certain that the inner reaches of the tundra, whatever the whole tundra may be, must yield largely in gold.

“Digging” the Seashore Sands for Gold.

The city of Nome itself might properly be termed a model of production. Before the end of June, 1899, there was practically nothing on its present site; in early July it was still a place of tents, but by the middle of September it had blossomed out into a constructed town of three to four thousand inhabitants, more than one half of whom were properly housed in well-built cabins, the lumber for which was in part brought from a distance of two thousand miles, and none of it from less than one hundred miles. Numerous stores and saloons had arranged themselves on both sides of a well-defined street (which was here and there centrally interrupted by building transgressions), the familiar signs of dancing and boxing bouts were displayed in front of more than comfortably filled faro and roulette establishments, and in a general way the site wore the aspect of riding a boom swell. And indeed there was plenty of activity, for the final weeks of fine weather warned of the impending wintry snows and blasts, and much had to be done individually to shield one from these and other discomforts. There was at that time a threatening shortage in building material, and fears were expressed for those who seemingly would be obliged to spend the winter months—a dreary expanse of nearly one half the year, with hurricane blasts of icy wind blowing with a velocity of fifty to eighty miles an hour, and under the not very comfortable temperature of -40° to -60° F.—in the frail shelter of tents. How many, if any, remained in this condition can not now be known. Much driftwood and some coal had been secured by many of the more fortunate inhabitants, and it is possible that some provision has been made by which everybody of the two or three thousand wintering inhabitants will receive a proper measure of heating substance, without which the utmost discomfort must prevail. The last coal before my departure sold for seventy-five dollars per ton, but I suspect that later importations must have realized the better part of double this amount. In early October flour could still be purchased for seven to eight dollars per sack, and meat for a dollar a pound, but these prices were 644
run up very materially in the period of the next two weeks. Good meals were only a dollar, and fractions of meals could be had for twenty-five and fifty cents. Magnificent oranges were only a quarter apiece, and watermelons four and five dollars. All these prices were, at the least, doubled before the first week in November, when the locality was finally cut off from contact with the rest of the civilized world. The principal commercial houses doing trade in Alaska—as the Alaska Commercial Company, the North American Trading and Transportation Company, the Alaska Exploration Company, all of which, besides others, have their agencies in Dawson and at various stations on the Yukon River—have well-constructed, iron-sheathed warehouses, and carry large lines of goods. The energy which in so short a period has planted these interests here, and in so substantial a manner, is certainly astonishing. Who a year ago could have expected that the needs of a resident population situated close under the Arctic Circle, and along the inhospitable shores of Bering Sea, would have demanded depots of sale of the size of those that one finds in cities of importance in the civilized South?

Nome prints to-day three newspapers, the first issue of the first journal, the Nome News, appearing about the 10th of October. Its selling price was twenty-five cents. Up to the time of my leaving, there were no serious disturbances of any kind, but indications of trouble, resulting from the disputed rights of possession, whether in the form of squatter sovereignty or of purchase, were ominously in the air, and it was feared that should serious trouble of any kind arise, neither the military nor civil authorities would be in a position to properly cope with it. It was freely admitted that the community was not under the law that so strongly forces order in Dawson and the Klondike region. Much more to be feared than disturbance, for at least the first season, is the possibility of conflagration; closely packed as are the tents and shacks, with no available water supply for combating flames, a headway of fire can not but be a serious menace to the entire location, and one which is in no way lessened through the general indraught of hurricane winds. The experiences of Dawson should have furnished a lesson, but they have seemingly not done so, nor has apparently the average inhabitant profited in any effort to ward off the malignant influences arising from hard living, unnecessary exposure to the inclemencies of the weather, and a non-hygienic diet. Hence, typhoid or typho-malarial disease, even if not in a very pronounced form, has already sown its seeds of destruction, and warns of the dangers which here, as in Dawson, man brings to himself in his customary contempt for the working of Nature’s laws.

645

A STATE OFFICIAL ON EXCESSIVE TAXATION.

BY FRANKLIN SMITH.

It is not to government reports that a student of social science looks for warnings against the perils lurking in the enormous expenditures and the extraordinary enlargement of the duties of the state. Officials are usually so deeply impressed with the importance of their positions and so anxious to magnify the worth of their labors that they are prone to take the rosiest view of any part of the great clanking machine intrusted to their care. With the keenest pride they point to their achievements in furthering the work of human welfare. If modesty does not restrain them, they are certain to paint, with an artless faith in their own abilities, the still greater work that could be done with a slight increase of funds and a little more assistance. Not all officials, however, permit themselves to indulge in the natural vanity of bureaucrats. They refuse either to be blinded to the perpetual failure of state-made civilization, or to deceive the impoverished victims of the same costly system of modern magic. Of the very few of this class Mr. James H. Roberts, for five years Comptroller of the State of New York,[A] is perhaps the most conspicuous. Astray as he is on the question of a graded inheritance tax, and trustful as he is in the virtue of State supervision, he puts himself beyond criticism in his opposition to the policy of State socialism, now the rage at home and abroad. Indeed, no one could hold it up to graver reproach.

[A] He was in office from January 1, 1894, to January 1, 1899.

Whenever an observer of the signs of the times in the United States ventures to say that they offer little food for hope, he is branded as pessimistic or unpatriotic. He is told that if he had the confidence in democratic institutions of a man with a good digestion and a fair intelligence, he would know that they possess a vitality, a power of rejuvenation, that does not belong to an autocracy nor an aristocracy. If he is particularly despondent, and seeks to justify himself with fact and argument, he is denounced as a dangerous agitator, or, what is a shade more odious, as an absurd *doctrinaire*. But Mr. Roberts has not been consigned to any such depths of contempt. He is known as a "hard-headed business man," a title of honor that always frees the most ridiculous optimist from any suspicion of the theorist or sentimentalist. Yet, as the supervisor of the finances of a great State, he was brought in contact with a mass of phenomena that forced upon him the conviction that something is wrong, and that if it is not righted it will bring disaster. Indeed, I do not recall a pessimist, however 646
dyspeptic, nor a *doctrinaire*, however visionary, that has struck a more melancholy note than he. In all his reports much will be found that indicates anything but a belief that a democracy that plunders and enslaves a people is any better than any other despotism guilty of the same offense, or that the practice in the one case will be productive of greater prosperity and happiness than in the other.

It is, however, in the report for 1897 that Mr. Roberts gives the fullest expression to his apprehensions. "This country," he says in an elaborate argument for a graded inheritance tax, which he believed would bring some relief to the poor and discontented, "has just passed through the most threatening political campaign in its history. The portents in 1896 were vastly more dangerous than those of 1860, when peace and internecine war hung in the balance. Issues were advanced last year, and vigorously supported by a large element of the American electorate, which, if adopted, would have undermined the very foundations of American institutions. These issues were largely the outgrowth of discontent among the people. The farmer, as a class, the work people, and the small trade folk were in distress.... Hundreds of thousands of industrious people were out of employment, the best efforts of the farmer had been attended with poor results, and the small tradesman and business man were worse off than if they had been doing nothing." In the report for the following year he spoke again of the "public discontent and dissatisfaction with existing conditions in this State." Instead of joining the comfortable and contented in a denunciation of them as a delusion, born of envy or criminal instincts, he expressed the opinion that they had a very substantial basis. "My four years of close official study of the State finances," he says, "compels me to say there is serious ground for complaint." After giving an impressive summary in another place of the enormous increase of public expenditures within recent years he is moved to ask, "Whither are we drifting?"

The answer commonly given to this question is one quite flattering to American vanity. It is that we are drifting away from "parochial" things and taking our proper place as a great "world power." Having solved all the petty problems that have absorbed our thoughts and energies for a hundred years, we have gone forth to "take up the white man's burden," and to solve the greater problems that a discriminating Providence has so wisely confided to our ability and philanthropy. At the same time we are going to have our say as to how the affairs of the world outside of our narrow and cramping borders shall be managed. Mr. Roberts, however, does 647
not appear to take any such pleasant view of the future. He has none of the blood of Don Quixote flowing in his veins. The bestowal of the blessings of a Christian civilization with machine guns upon breech-clouted savages has no attractions for him. He sees that we have made such a disgraceful failure of the management of the contemptible things in which we have been so ignobly absorbed that we are threatened with national decadence! "While the contests against unjust and oppressive taxation," he says in his report for 1899, "have been the contests of freedom and civil and religious liberty in the world, it must not be forgotten that unjust and burdensome taxation has been in all ages the most prolific cause of national decadence as well. There are nations in Europe, once great and prosperous," he adds, thus recalling the warnings of Lord Salisbury's famous speech on the same subject, "which to-day seem dying of dry rot because, to meet their immense expenses and to pay interest on their great bonded debts, taxation has been increased beyond the safe limit, and the very sources of national prosperity have been taxed so that they run dry, or send down a rill where it should be a river. Few national diseases are more dangerous or harder to cure than burdensome taxation. Can any one charged with the responsibility of making tax laws," he asks, profoundly stirred by the startling facts that have come under his observation, "afford to ignore the undoubted lessons of history or the manifest tendency of the times in the matter of revenue raising and expending?"

Obvious as is the fitting answer to this question, it is one that few people stop to give. Both the lessons of history and the tendency of the times are willfully and incessantly ignored. Not only are they ignored by demagogues, who thrive most when public distress is greatest, and by misguided philanthropists, who seek to relieve it in ways that only intensify it. Even publicists, whose studies in history ought to make them more familiar with the signs of social decadence than a man of affairs with vision less extended, ignore them also. They seem to be as insensible to the real significance of what is going on before their eyes as the wooden totems of a burning tepee. But to minds more alert and penetrating, even if less congested with musty lore and fine intentions, the flight of the farming population to the cities is something besides "a great natural movement toward urban life that accompanies an advance in civilization"—it is a desperate but futile attempt to escape conditions that have become too hard to be borne. The swarms of impoverished and degraded humanity that crowd the slums to suffocation are not altogether the product of willful sloth and incapacity; they are due, in a measure, to the growing taxation that has wiped out the narrow margin that separates independence from 648
dependence—self-support and self-respect from destitution and pauperism. The hatred of the rich, the denunciation of capital, the contempt for the Church, the bloody insurrections of labor, the general feeling of rancor, accompanied by an increase of the tyranny of trades unions and government regulations, are not the inevitable manifestations of envy, ignorance, and criminal instincts; they are the inevitable fruits of the perpetual aggressions in a thousand forms that spring from politics and war. But instead of acting upon this natural interpretation of the signs of the times and seeking to solve the social problem in the only way that it can be solved, the "new" reformers tormenting the world are engaged in the invention of schemes that add to the public burdens and hasten the nation's decay.

The reckless expenditure of public money in the United States has not been confined to any particular political division nor to any particular geographical section. The national, State, and municipal governments have seemed to vie with one another in the plunder of the taxpayer. From the North, the South, the East, and the West have come the same complaints of excessive burdens.[B] But figures are needed to give these statements the vividness of reality. Beginning with national expenditures, Mr. Roberts says that during the decade from 1820 to 1830 they were $1.07 per capita; from 1851 to 1861, they were $2.06; and for the year 1894, $6.08. "In a word," he adds, "the per capita expense of the national Government in 1894 was nearly six times as great as it was in 1820, and nearly three times as great as it was in the decade before our great civil war." The per capita expenditures of the State of New York in 1830 were $1.30, thirty years later they were 649
$1.89, in 1890 they were $2.15, and "in 1897 the estimated per capita expenditure reached the alarming amount of $4.95." That is to say, the combined expenditures of the State and national governments gave a rate as high as that prevailing in France before the outbreak of the Revolution. "The tendency to increase," says Mr. Roberts, commenting on these figures, "is a persistent one. In 1881 the amount expended by the State was $9,878,214.59; in 1884, $10,479,517.31; in 1887, $14,301,102.48; in 1890, $13,076,881.86; in 1893, $17,367,335.98; and in 1896, $20,020,022.47." Coming to municipal expenditures, where the hand of the prodigal has been most lavish, Mr. Roberts says that "between 1860 and 1880 the municipal debts of our Union increased from $100,000,000 to $682,000,000, and in fifteen cities, believed to represent the average, the increase in taxation was 362.2 per cent, while the increase in taxable valuation was but 156.9 per cent, and of population but 70 per cent. In the year 1860 the direct taxes for State, county, town, and city purposes in New York were $4.90 per capita, in 1880 it was $8.20, and in 1896 it had reached $10.43, an increase in thirty-six years of 213 per cent." It should be added that the bonded debt—State, county, city, town, village, and school district—in the State is estimated by Mr. Roberts to be $450,000,000. Is it any wonder that people so mercilessly plundered feel that the times are out of joint? Is it any wonder, either, that in 1896 Mr. Roberts was moved to say that, without the discovery of new sources of revenue, "a low tax rate would never again be enjoyed in this State"? Is it any wonder, finally, that he declared again that if "we have not yet passed the danger limit of taxation," we have reached "a point where there is a deep feeling of unrest and dissatisfaction, and where a halt should be called or there will be danger"?

[B] From the mass of proofs of this statement in my possession I will select only one. In a call for a convention at Portland, Me., on the 10th of June last, of all persons "interested in the revision of the present system of State taxation and a more economical management of the State affairs," it is stated that "the expenses of the State have increased fifty per cent in ten years, while the wealth and population of the State have steadily declined." The object of the convention was "to protest against the course of extravagance that is rapidly bringing reproach upon the government of the State and reducing the farmers and taxpayers to automatons to grind out revenue to be absorbed by a rapacious and ever-multiplying horde of office-holders, who devour the people's substance as fast as they produce it." After showing how "once prosperous farming towns and townships have been reduced to but little better than a howling wilderness," the call says in conclusion: "These once prosperous farming communities were redeemed from the native wilderness by men who were no more temperate, industrious, or economical than the farmers of to-day, and the prices they received for their products were as low as, and in some instances lower than, to-day, but the fruits of their honest toil were not drawn from them as fast as acquired by national, State, county, and, in many instances, by municipal extravagance, as it is to-day." The plundered peasantry of Spain, Italy, or Russia, army ridden as they are, could not have made a more just complaint.

The stock explanation of this growth of expenditure is that with the advance of civilization the cost of government must increase in like degree; there must be more regulation and supervision of the activities becoming more numerous and complex. But this means, if it means anything, that the more enlightened and humane people are, the more difficult it is to maintain order and enforce justice, the more inclined are they to attack and plunder one another—in a word, the more barbarous they are. Preposterous as this theory of civilization is, it is precisely the one upon which the American people are acting with unparalleled energy. While we should naturally think them moving toward a point where they could get along without government, they are

moving toward a point where they will have nothing but government. Referring to the increase of expenditures already mentioned, Mr. Roberts says it “corresponds almost exactly with the increase of the number of 650
commissions and departments.... These departments and commissions,” he continues, “are largely for the purpose of extending social supervision and regulation over many things which, in the earlier days of our Commonwealth, were left to the localities or to self-regulation.” Again he says: “The amount of State inspection has become very great, reaching out constantly over new fields, and employing in the aggregate an army of inspectors.... The system of *laissez faire*, which was the rallying cry of democracy and free government at the beginning of the century, has yielded gradually to a system of supervision and control which monarchies never attempted.... What our State has done in this line can not probably be undone,” he says in a repetition of his warning, “but this tendency to expand and multiply and differentiate and segregate State supervision and regulation must cease, or the burden will soon become too grievous to be borne.”

But there is no warrant for the assumption that the more civilized we are—that is, the greater our self-control—the more are we in need of inspection and regulation. Such an explanation of the enormous increase in public expenditure is worthless. The true explanation lies in the greed of politicians and the delusion of social reformers. To both of these causes must be attributed the evils that Mr. Roberts deplores. “The truth of history,” he says, referring to the thirty-six new offices and commissions created since 1880, “compels the statement that it looks as if many of these creations were made not so much to satisfy a public want as to relieve a political situation.” That is to say, they were designed to provide spoils for the insatiable maw of politicians. One of the most flagrant examples of this popular method of forwarding the beneficent work of civilization and hastening the dawn of the millennium is the State Board of Mediation and Arbitration, created in 1886. Up to the present year it has cost the taxpayers $195,828.57. For this expenditure little can be shown but a shelf full of reports seldom read, and a pigeon hole of vouchers for salaries never earned. With one of the former members of this board, who served thirteen years and received $39,000 for his able services, I am personally acquainted. Of my own knowledge, I can say that for nearly three years at least his duties as commissioner never interfered perceptibly with his duties as editor. That most of the other offices and commissions are equally worthless there can be no doubt. Altogether they have cost the State the startling sum of $31,768,899.85, and are increasing the public burdens at the rate of more than $1,000,000 a year. But their true character as asylums for decayed politicians, or as stepping stones for ambitious young ones, and at all 651
times as centers of political intrigue and personal profit, is gradually dawning upon the public. Already several Governors have demanded, in their annual messages to the Legislature, that they be consolidated or abolished. As yet, however, it has been impossible to relax their grip on the taxpayer. Obedient to the instincts of their kind, they are inventing new arguments to establish their claims to the confidence and gratitude of the victims of their greed and incompetency.

But the creation of new and needless offices is not the only manifestation of what Mr. Roberts fitly calls “the vicious tendencies of legislation.” More demoralizing are the laws that actually encourage the robbery of one class of people for the benefit of another. A familiar example is the bounty law for the destruction of fishing nets. Almost as soon as passed it produced a new industry—namely, the manufacture of cheap nets, which were deposited in fishing waters, subsequently discovered and seized by a pre-arrangement, and made the basis of demands upon the public treasury out of proportion to their value. So great have been the frauds perpetrated under it that the cry for its repeal comes from every quarter. Another law even worse morally was passed to meet the clamor of the bicyclists and bicycle manufacturers. It provides that twenty-five per cent of the cost of so-called good roads to be built under it shall be paid by the State. As cities and villages are exempt from its provisions, this sum, which comes out of the pockets of all taxpayers, urban as well as rural, is, as Mr. Roberts says, simply “a gratuity to the towns for the benefit of country roads.” As a sign of the moral decadence of the times, I ought to add that one of the most powerful and effective arguments in favor of the law was this very discrimination. Still more shameless was one of the chief arguments in favor of the Raines liquor law. With a moral callousness truly astounding, its advocates framed tables of figures to show how great a percentage of taxation it would shift from the country to the city districts. In the heated political campaign that followed, these tables were made to do service again to save from defeat the party responsible for the enactment. To indicate, finally, how legislation may encourage vice, I must not omit to mention the provision that created the Raines hotel. Under it assignation houses have multiplied to a degree that Satan himself could not have foreseen nor have been more enchanted with.

But the greatest inroads on the pockets of the taxpayer have been made under the pretense of charity. I say “pretense” because it is a gross misuse of language to decorate with so fine a word the seizure of a man’s property under the forms of law and to devote it to the ostensible relief of want and suffering. It is the infliction 652
of an aggression that has no more warrant in a court of sound morals than the seizure of his property in disregard of the forms of law. Yet this evil has reached such vast proportions that Mr. Roberts was moved to protest against it. After speaking of “the tendency of the State in building up a gigantic system” that “will call for an enormous and ever-increasing annual expenditure for maintenance,” he expressed the belief in 1896 that “the time has come to call a halt before this burden of taxation becomes too heavy.” He then mentioned the significant fact that while the State spent $6,000,000 for charity, $4,800,000 for public schools, $800,000 for the militia, it spent only $500,000 for judges’ salaries! He pointed out also that the expenditures under the head of charity had increased from $1,468,471.58 in 1887 to $5,888,193.74 in 1897, or over four hundred per cent in ten years. He added the prophecy that it would be “a matter of a short time only when the annual expenditures for charity alone in this State will reach $10,000,000.” At that time five large State charitable institutions were in process of construction, and were soon to be thrown open to the public. In the following year he reverted to the subject in still stronger terms. “God forbid,” he says, “that I should put a straw in the way of charity rationally directed; but my four years’ experience as comptroller ... compels me to say that charity is dispensed in this State with an almost lavish hand, and in my judgment it is in many cases unwisely dispensed.” In his last report to the Legislature the aggregate cost of the fourteen great institutions in operation, with a population of 6,621, is put at $6,898,304.52.

That this enormous largess, wrested from the taxpayers without the slightest consideration for their own wants and sufferings, is unwisely dispensed in many cases Mr. Roberts furnishes the amplest proof. The charges that he brings against this form of State activity are most serious. They reveal the same odious traits that characterize the management of public affairs in no wise connected with the love of humanity. “Nearly every locality,” says Mr. Roberts, “having a State charitable institution deals with it as though it were established to afford that locality an avenue through which to reach the State treasury, and in most cases, where a majority of the managers live under or are dominated by local influence, the avenue has been profitably traveled. The result of such predominance is combination among local dealers, a division of the furnishing of the supplies among them at greatly advanced prices, the palming off upon the institution of inferior articles which would find no sale in the market, a row with the superintendent if he undertakes to expend money outside of the locality, 653 and, through friction and disturbance, the work of the institution is more or less demoralized.” He charges that “the only aim” of some institutions “seems to be the expenditure of their entire appropriation, irrespective of the number of inmates provided for or the results obtained.” Putting the same charge in another way, he says that “the cost of an institution is more frequently based upon the amount of the appropriation granted by the Legislature than upon its real or apparent necessities.” When it is remembered that the managers of the institutions against whom these astonishing charges are brought are picked people, representing much more than the average character and ability, the conclusion is not unnatural that ward heelers and caucus packers have no monopoly of the rotten ethics of politics.

If we look a little further into the management of the institutions, all the familiar footprints of the unscrupulous politician become visible. Money appropriated for specific purposes is diverted from them. Over fifty-five per cent of the amount expended in 1898 under special appropriations was used for the benefit of two institutions, leaving less than forty-five per cent for the remaining fourteen. Plans for new buildings or the improvement of old are so changed as to require an expenditure considerably in excess of the money appropriated for the purpose. Not infrequently the excess ranges from twenty-five to fifty per cent, and thus the way is paved for further appeals to the Legislature to meet the dishonest deficits. A more reprehensible use of public money is appropriations for new buildings and improvements of old ones belonging to private institutions. As examples, Mr. Roberts cites the expenditure of $77,473 upon the private property of the Malone Institute for Deaf-Mutes, and $457,556 upon that of the Randall’s Island Reformatory. “In my judgment,” he says, expressing an opinion that every fair-minded person will approve, “this is a mistaken public policy. If these institutions are to be steady recipients of State aid for permanent improvements, the title of the property should be transferred to the State.” Otherwise any philanthropist might found a charitable institution to provide himself with congenial employment, and, availing himself of the courtesy of the State to thrust his hands into the pockets of his neighbors, make additions to it and keep it in repair.

But these are by no means the only ways that money picked from the pockets of taxpayers is poured into the bottomless pit of State philanthropy. One of the most common and most expensive is the unjustifiable increase of salaries. In 1894 and 1895, when the country was still in the throes of the great panic of 1893 and when 654 hundreds of thousands of people were glad to get work at almost any pay, the salary list of nine charitable institutions was increased forty thousand dollars a year. Indefensible variations in the per capita cost of practically the same service discloses another mode of waste. Mr. Roberts gives elaborate tables in exposure of this evil. While the per capita cost of the inmates of the Western House of Refuge for Women at Albion is $254.27, that of the inmates of the House of Refuge for Women at Hudson is $217.63. Again, while the per capita cost of the inmates of the State Industrial School at Rochester is $219.49, that of the inmates of the Reformatory on Randall’s Island is $210.59. Still again, while the per capita cost of the inmates of the State School for the Blind at Batavia is $313.74, that of the inmates of the Northern New York Institute for Deaf-Mutes at Malone is $258.36. If it be remembered that the institutions on Randall’s Island and at Malone are under private management, the lower rate prevailing there, compared with the higher rate at the Batavia and Rochester institutions, suggest a fact of no slight significance. “Private institutions,” says Mr. Roberts, calling attention to it, “are only paid in some instances $110 per annum for the care and support of inmates, ... while the cost in State institutions is more than $200 per annum.” Yet, despite the possible indefinite multiplication of such facts, the “new” reformer pins his faith to the State as a fit agent for the regeneration of his fellows.

Before leaving these institutions I must call attention to another characteristic form of waste. I refer to the delicacies furnished to the officials and inmates. “It has not seemed exactly right,” says Mr. Roberts, setting forth the scandal in very moderate terms, “that the taxpayers of the State should be required to pay for Blue Points, lobster, terrapin, frogs’ legs, partridge, quail, venison, and most of the delicacies of the season to supply the tables of officials already well paid and well housed by the State.” But solicitude about table economies was never known to be a trait of bureaucratic parasites. They never trouble themselves to prolong their vision to the meager tables of the poor and suffering robbed of the necessaries of life to load theirs with luxuries. The same limited vision is exhibited on holidays in their generosity at other people’s expense. “Is it fair,” says Mr. Roberts, protesting against this touching display of human goodness, “that the average workingman should wear poor clothes and live on plain fare in order that he may bring up his family decently and honestly, while the inmates of State institutions are indulged with turkey at eighteen cents a pound, footballs at $4.83 each, oranges, candy, nuts, ice cream, and expensive luxuries?... It must not be forgotten,” he adds, mentioning a 655 truth commonly forgotten even by people that have reached a higher civilization than that of the average State official, “that the money spent for these inmates is not voluntary contribution, but is the product of enforced taxation.”[C]

[C] But I ought to add that this mismanagement of State charitable institutions is duplicated in the management of other State departments that came under Mr. Roberts’s observation. Although more than $24,000,000 have been spent on the new Capitol, it proves to be too small for the purposes it was designed to meet. Mr. Roberts recommends the conversion of the old State Hall into a finance building. The State Library has become so large that it will soon require a separate building. The racing tax law was so bunglingly framed that the collections under it in 1896 were attended with “more difficulty and expense than usual.” As the forest-preserve law stood in 1896, it permitted people purchasing State lands to strip them of lumber, and then, owing to certain irregularities connected with the sale,

> making it illegal, to recover the money originally paid with interest at six and seven per cent added. Because of the absence of any law covering the personal expenditures of members of legislative investigating committees, claims for seven and eight dollars a day are rendered, although four or five dollars a day are believed to be ample. Let me add that these investigations, which, during the period from 1879 to 1896 inclusive, cost $823,534.51, reveal another source of waste from State management. Still another source of waste is State printing. Pointing out the "growing expenses of State printing," Mr. Roberts shows that they have increased from $95,029.51 in 1887 to $315,585.81 in 1896. At one time the law was so defective that it was impossible to frame specifications for bids that would allow for printing of different kinds. For example, blanks varying from two to three inches square to two and three feet had to be classed in the same schedule and price. A needless quantity of reports is printed. Some of them are printed in the highest style of the art and richly embellished with expensive plates and engravings. One report for 1895 cost $42,000, and others cost as high as $20,000 and $30,000. "It does not seem logical," says Mr. Roberts, commenting on this extravagance, "to spend as much on the illustration of a report as it costs for clerk hire in many departments." Another evil is the failure of the Legislature to appropriate money enough to meet the printing bills each year, thus making it necessary either to borrow money to pay them or to compel the printer to wait for his pay at a loss of interest on the amount due him. In this connection attention must be called to the failure of the Legislature to provide money enough to cover expenditures during the period intervening before funds are available from taxation. Although Mr. Roberts recommended repeatedly legislation for the avoidance of this difficulty, which causes waste, no attention was paid to him. The management of court and trust funds by county treasurers has been particularly scandalous. In disregard of the express direction of the courts, thousands of dollars were retained by parties or their attorneys for their own personal benefit. Money has been paid out by county treasurers without certified orders of the courts merely upon the assurance of attorneys that the payments were proper. The rules framed by the comptroller in regard to this matter were constantly disregarded. Excessive allowances were made for costs of attorneys. In the case of one estate of $750, thus robbed, only $60 remained for the payment of the debts against it. By the defalcations of county treasurers, court and trust funds are often depleted, and the beneficiaries, often widows, orphans, and unfortunate litigants, are robbed. Mr. Roberts has recommended legislation on this subject, but no attention, as far as I know, has been paid to it. It is one of those "parochial" questions that the American people appear to have no taste for. But it would seem as if the protection of citizens, especially the poor and weak, was the first duty of the State.

Resistance to aggression is one of the fundamental instincts of the human race. It has been enforced during countless ages by the penalty of extermination. Only the people that refuse to be killed, or robbed and enslaved, [656] which are modified forms of the same crime, can respond to a scriptural injunction; they alone can be fruitful, multiply, and replenish the earth. All others must succumb to the pitiless law of the survival of the fittest. Efforts to escape taxation not sanctioned by justice, so common throughout the United States, are not, therefore, exhibitions of hopeless depravity; they are exhibitions of the natural desire for self-preservation that demands study and heed.

In New York State the efforts of taxpayers to escape this increasing aggression have had a deplorable effect. To still the voice of discontent and complaint, legislators have tried to lay on their burdens as lightly as possible. Acting upon a familiar definition of taxation, they have tried to pluck the goose so as to get the most feathers with the least squawk. But in their observance of the principles of humanity they have shown but slight regard for the principles of economics or justice. Mr. Roberts characterizes their enactments as "confused, illogical, and conflicting"; he adds that they are "nearly all legislative makeshifts, and many of them blunders." The moral effect of the aggression has, however, been more disastrous than either the economic or statutory. To escape it, the owners of every class of property, no matter what their intelligence, their religious professions, or their social standing, resort to every possible subterfuge. With the cries of the tortured fowl ringing in sympathetic ears, complaisant officials refuse to assess real estate, as required by law, at its full value. "The assessor," says Mr. Roberts, describing this form of evasion and its evil consequences, "undertakes, by reducing valuations on his own responsibility and in defiance of law, to protect his own county or town from paying more than its fair proportion of tax, and self-interest lulls the moral sense of the community into support of his action." The same law of assessment applies to the whole State, yet there are twenty-five rates of assessment in the sixty counties, and these rates range from fifty to ninety-two per cent of the value of the land. The owners of personal property avoid their obligations in a manner still more reprehensible. They either conceal it or lie about it. While its amount during the past forty years has reached the enormous total of $18,000,000,000, or more than four times the value of the real estate, its assessed value has not increased. It is Mr. Roberts's conviction, based upon "study and observation," that not "more than three per cent" of it is assessed. The result is that, although real estate pays a revenue of over $9,000,000 a year, personal property pays one of only about $1,000,000. As to the corporations, they are equally alert in avoiding their obligations. Before the enactment of a recent law they did [657] it by watering their stocks and issuing bonds, thus creating an indebtedness equal to their capital. They do it now by incorporating in other States and carrying on business in this State. They do it also by neglecting for a certain time to make the reports required by law, and then taking refuge behind the statute of limitations. If the burdens thrust upon them can not be shirked or borne, they fly to other States, where the aggressions of the tax collector are less ruinous.

To compel officials to do their duty, countless expedients have been invented from time immemorial. In the face of proof mountains high that no legislative or administrative device can uproot the selfishness imbedded in human nature or reshape the conduct molded to this immutable fact, social quacks still continue to spawn their schemes to work the miracle. Slight as is Mr. Roberts's sympathy with them, he is no exception. As a panacea for the dishonesty and incompetency of the county treasurers that mismanage court and trust funds, he recommends the substitution of State for local inspection. By a similar application of hocus-pocus, he would transmute the extravagance of the managers of charitable institutions into exemplary economy. Disgusted with the charlatans in charge of certain duties connected with these institutions requiring special skill and knowledge, he thinks “it would be well to provide a corps of enthusiastic scientists ... who have more than a pecuniary interest” in their work. But another recommendation of his is a direct assault on this simple faith in the honor and integrity of specialists. Already many of the departments of the State are in the hands of men supposed to have a special aptitude and liking for their duties. But Mr. Roberts finds that “leaving the department to expend the money as it deems best,” instead of appropriating it for a specific purpose, “is not in the interest of economy.” He says that “it absolutely deprives the Legislature of that judicial scrutiny of the necessity of appropriations” that “it should always exercise, and leaves to the judgment of one what could often be better decided if considered by several.” Could a deadlier blow be given to a common theory that under government management we have the same division of labor and the same perfect adjustment of means to ends that we have under private management? What legislative body, chosen by universal suffrage, the most perfect instrument ever invented for the selection of incompetents, would enable it to exercise the supervision over the thousand activities of life that Mr. Roberts recommends?

The same futile ingenuity exhibited in making officials do their duty is exhibited in making taxpayers do 658
theirs. One of the multitude of plans suggested is a single tax on land; but that does not seem promising, for it would not prevent the discriminations that assessors make—discriminations that Mr. Roberts himself believes to be beyond the reach of even State supervision. Another is a more rigid enforcement of the personal-property tax; but this is equally unpromising. “The fact is,” says Mr. Roberts, “that from the dawn of civilization the wit of man has failed to discover a plan by which intangible personal property could be made to pay its share of taxation, and it will never be made to pay on the ordinary assessment plan.” Besides the increase of taxes on corporations, the taxation of franchises, which has just been authorized, and a general revision and simplification of tax laws, it has been proposed that a graded inheritance tax be adopted. Mr. Roberts is particularly enamored of this idea. But his advocacy of it betrays the same disregard of the rights of others, and leads to the same appeals to specious facts and arguments that always accompany the commission of aggression in politics as well as in war. His reasoning is that since “special privileges conferred by government,” such as tariff laws, corporation laws, public franchises, etc., are “the foundation of most of the great fortunes of the country to-day”; since these fortunes are, to a considerable extent, “composed of personal property” that “very largely escapes taxation”; since the decedent has been “allowed the use and enjoyment of his fortune during life,” and the beneficiary simply pays “a fee for the privilege of receiving an estate in the creation of which he had little or no hand”; and, finally, since he can make no just complaint against the payment of such a fee, as his right to receive his fortune “comes from the State—is by the grace of the State”—the seizure at death of a certain percentage of all estates beyond a prescribed amount would be only justice to “the mass of small landowners and taxpayers who have from year to year borne more than their equitable share of the burden of taxation.” But, the fallacies of such an argument are easily exposed. The moral ownership of property does not lie in the State; it lies in the labor and skill of the man that accumulated the property. The moral title to a bequest does not lie in that fiction either; it lies in the right of the decedent to do whatever he pleases with his own. If great fortunes have been unjustly acquired in consequence of special privileges a great wrong has been committed, and it is not righted by the commission of another wrong. The only reparation that can be made is to abolish the privileges. So obvious a suggestion does not, however, appear to have occurred to Mr. Roberts.

But even if all the reforms in taxation that could be imagined were put in operation they would not meet the 659
situation; they would not deliver the American people from the great and alarming evil of over-legislation and excessive taxation. An increase of revenue, like an increase of supervision, is almost certain to increase the injustice that it was designed to abate. The first year’s operation of the Raines law contributed more than $3,500,000 to the State treasury, yet the addition to the public expenditures that accompanied its enactment made a high tax rate necessary. What the situation requires, therefore, is not more but less social regulation and taxation. We need also a gradual restriction of the duties of the State to the limits laid down by Mr. Spencer—to the preservation of order and the enforcement of justice. Although not apparently a disciple of that philosopher, Mr. Roberts himself virtually subscribes to this view. In his last report he demands “far greater economy and care in public expenditures, and no further excursions in the field of social supervision and regulation.”

LATEST DEVELOPMENTS WITH THE X RAYS.

By Prof. JOHN TROWBRIDGE,

DIRECTOR OF THE JEFFERSON PHYSICAL LABORATORY, HARVARD UNIVERSITY.

We have become accustomed to seeing photographs of the bones of our hands, and we no longer stop at shop windows to look at X-ray photographs. Indeed, they are rarely displayed, and the lecturer who once gazed on a sea of faces as he endeavored to explain the most marvelous electrical sensation of this century now addresses a mere handful of listeners. Such patient hearers continuing to the end may still hear of marvelous performances of this strange light of which the great public are even now ignorant, and in this paper I shall take my readers into a physical laboratory and endeavor to make the generally unknown manifestation of the new rays plain and free from technical language. I am sure that we shall all leave the laboratory with our imagination full of thoughts of unknown movements in the air about us—thoughts of possible telepathic waves through space, conceptions of new ranges of nerve excitations, hopes of new lights, conceptions of the vastness of the electrical whirls in that elevated region where the molecules of the air, in their endeavor to fly into the abyss of space, are controlled by the earth’s forces and are endowed with electrical energy by the sun.

In the first place, what is the present state of our knowledge of the X rays? Have we more efficient methods of producing them, and can we see farther into the recesses of the human body? In regard to the first question, 660
we can say that, although we may not be able to answer dogmatically that we know what these rays are, we have valuable hints in regard to their character, and our knowledge of their manifestations and their relation to light waves and magnetic waves has greatly increased during the four years which have elapsed since their discovery. They are now believed by the best authorities to be magnetic and electrical pulses, or waves of extremely short length. In the spectrum of sunlight formed by sending a beam through a prism of quartz the X-ray pulses or waves are to be found, according to this hypothesis, beyond the violet color of this spectrum—far into the dark region invisible to the eye, and only brought into view at present by the aid of photography. In this invisible region reside many singular manifestations of energy closely analogous to those of the X rays. The ultra-violet rays invisible to the eye have the property of refraction. They can be bent out of their course by prisms made of quartz. The X rays, however, can not be directed from a straight course. This is their greatest peculiarity, and many attempts, both mathematical and experimental, have been made to elucidate it. It is not a fatal objection to the X rays being classed with light waves, for, under certain conditions, even light waves can be made to lose the power of being bent aside.

Leaving for the present a further discussion of the question What are the X rays? let us examine what the actual condition of the art of using the rays is. Many attempts have been made to improve the Crooke’s tube, in which the rays are produced, but, like the hand telephone, its form has remained substantially unaltered since the first flush of discovery. Its present form consists of a bulb of thin glass, exhausted of air, containing a little concave mirror of aluminum, and opposite to this, separated by a gap of several inches, is an inclined sheet of thin platinum, called the focus plane, or anticathode. The electrical discharge passes between this plane and the mirror, and the X rays are thrown off from the inclined sheet of platinum. They are not reflected in the ordinary sense of the term, but the electric rays converge from the mirror to a spot on the platinum which glows with a red heat, and the X rays emanate from the heated spot as if it were their source. Thousands of investigators have endeavored to improve the form of tube, but, with several important minor appendages, it still maintains the principal features of an aluminum concave mirror and an inclined plane of platinum. Aluminum is found to be the best metal for the mirror from which the rays are generated, largely because its metallic particles are not torn off by the discharge, as would be the case if it were made of platinum. It is also light, and can be easily 661
fixed to a platinum wire. Among the important modifications of the tube are those which enable the operator to control the degree of vacuum in the tube. This is accomplished by sealing to the main tube an appendage containing certain chemicals which, on being heated, give off a small amount of vapor, and which take it up again on cooling. This modification is made necessary by the singular fact that after a Crooke’s tube is submitted to an electrical discharge for some time the vacuum becomes more and more complete, and a higher and higher electro-motive force or pressure is needed to produce the discharge in the tube. It prefers in time to jump over the surface. Thus, at the very beginning of our use of the X rays we meet with a mystery. Where do the remaining particles of air go? It is surmised that they disappear in the platinum terminals.

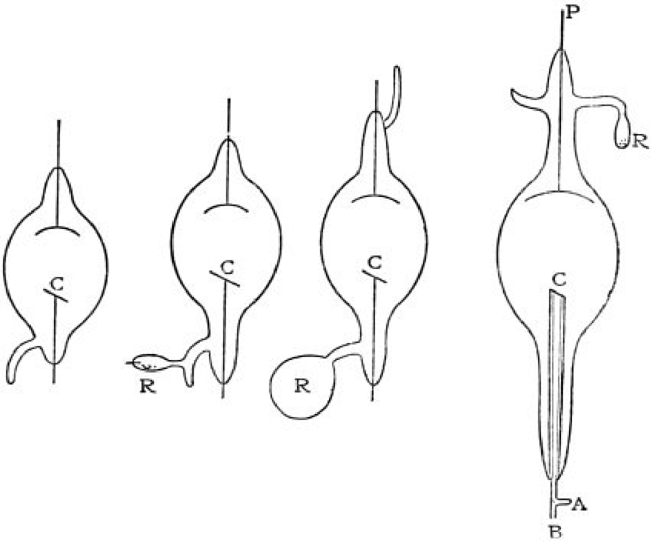


Fig. 1.—The evolution of the Crooke’s tube.

The manufacture of the X-ray tubes tests technical skill and the patience of the experimenter more highly, perhaps, than the preparation of any apparatus used in science. Glass working is a difficult art, and requires an absolute devotion to it. There is only one metal known which will enable an electrical discharge to pass into and out of a rarefied space inclosed by glass. This is platinum. A wire of this metal can be sealed into glass so that no air can leak into an exhausted space around the joints. All electric lamps, so commonly used in electric lighting, have little wires of platinum at their bases, by means of which the electric current enters and leaves the bulb. The Crooke’s tube is in principle an Edison lamp with the filament broken. The maker of Crooke’s tubes should complete the making of the tube at one sitting, for reheating of the tube is very apt to lead to a 662 disastrous cracking of the glass. He must take the utmost precautions against unequal heating and sudden cooling, and he must, above all, have phenomenal patience.

Fig. 1 shows the evolution of the Crooke’s tube which is used to produce the X rays. The first form of tube was barely larger than a goose’s egg. The size has been gradually increased, and at present it is three or four times larger than the original form. The interior arrangement has not been materially changed, and consists, as we have said, of a concave mirror, which constitutes the negative electrode, and an inclined sheet of platinum, from which the X rays seem to emanate.

The later forms of tube have accessory chambers, filled with certain chemicals, which, on being slightly heated, reduce the vacuum to the desired point. Certain forms of tubes have merely an additional chamber which, on being heated, reduces the vacuum in the main vessel. The latest form of tube, devised by Dr. William Rollins, of Boston, has a hollow anode tube (*B C*, Fig. 1), through which a current of water can circulate in order to save the tube from breaking. The end of this anode tube is small, in order to form a sharp radiant point of light. One of the platinum wires (*P*) inserted in the tube projects outside some distance. When the vacuum becomes too high in the tube, this platinum wire is slightly heated in a gas flame; then the flame is blown out and the hydrogen is allowed to flow against the heated wire. A sufficient amount of the gas is absorbed by the heated wire to reduce the vacuum in the tube. This tube stands very powerful electrical discharges, and is the most scientifically designed tube at the command of the experimenter.

There are three methods of generating the electrical discharge which produces the rays. The commonest method is that in which the Ruhmkorf coil is used. This coil is what is now known as a transformer, and consists of one coil of a few turns of coarse wire, which is connected to a battery or other source of electricity, and of another coil surrounding the first of a great number of turns of fine wire. Any sudden change of the battery current produces an electric pressure or electro-motive force at the ends of the fine coil of wire. By this simple arrangement of two coils we can thus exalt a current of low pressure to one of high electro-motive force. A battery current which can barely produce an electric spark of one hundredth of an inch at the ends of the coarse coil can cause a spark of eight inches or more at the terminals of a fine coil.

In the second method one uses an ordinary electrical machine in which the glass plates are supplanted by rubber ones, which are run at a high rate of speed. Both of these methods have their advocates. The use of the 663 Ruhmkorf coil is the most universal.

The third method consists in charging a number of Leyden jars by a storage battery and in discharging these one after another, so as to obtain a high electro-motive force. This method is a very flexible one. I can experiment with my apparatus over a range of electric pressure extending from twenty thousand units to three million. The electrical discharge produced by three million units or volts is over six feet in length.

The apparatus for discharging the Leyden jars or condensers in series is represented in Fig. 2.

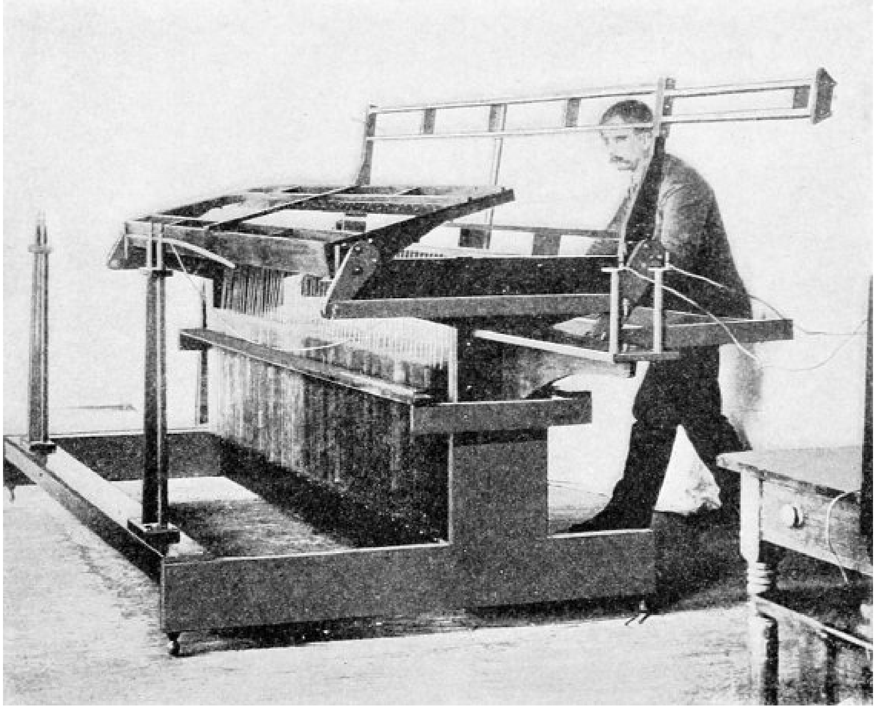


Fig. 2.—Apparatus for producing electrical sparks six feet in length.

A fourth method, first used by Professors Norton and Goodwin, of the Massachusetts Institute of Technology, consists in discharging a quantity of electricity through the coarse coil of a Ruhmkorf coil. This method obviates the necessity of a mechanical break to interrupt the battery current which is employed to excite the current in the coarse coil of this apparatus.

I have experimented with more powerful quantities of electricity than have been hitherto used. The accompanying photograph gives an idea of the magnitude of the quantity which I can use to excite the X rays.

It represents the discharge, burning a fine iron wire, and it makes a noise resembling the crack of a pistol. 664
Now, this discharge can be used in a variety of ways to excite various transformers in order to produce the best conditions for exciting the X rays. The method of using this powerful discharge to excite a transformer seems at present the most promising one in seeking the best conditions for obtaining rays of high penetrating power.

There is still another method of obtaining the rays yet in its infancy—the simplest method of all, for no apparatus is required.

It has been discovered that certain substances, like the salts of uranium, have the power of emitting rays which have all the properties of the X rays. The list of such substances is constantly increasing, and they are called radio-active substances. It is possible to take a shadow picture of the hand through a board by placing the hand on a covered sensitive plate, resting the board on the back of the hand, and strewing the board with one of these radio-active substances in the form of a powder. Can it be that all the skill and industry which has been employed to perfect X-ray apparatus is to be supplanted by a powder? The peculiar property shown by the radio-active substances leads investigators to surmise that we have evidence of new substances, and we have the waves radium and polonium.

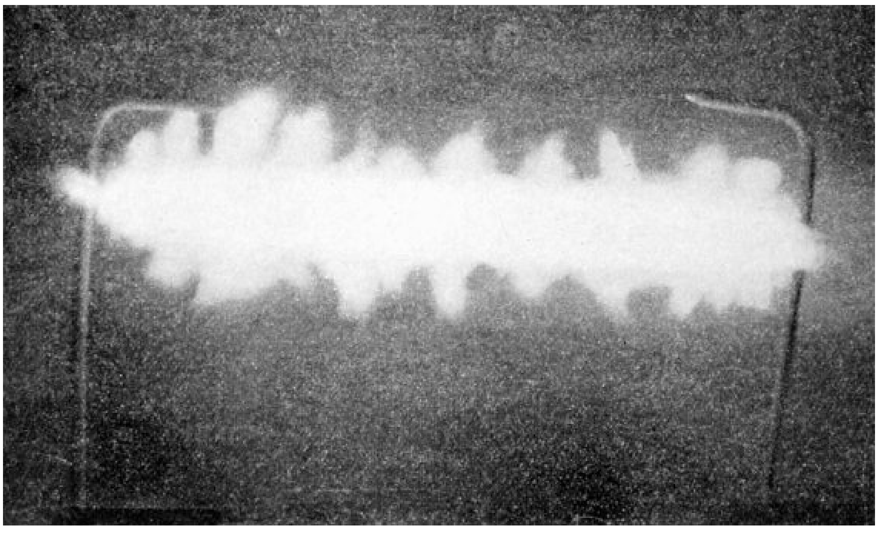


Fig. 3.—The burning of an iron wire by the most powerful electric discharge yet produced.

The methods by which the X rays are detected in practical employment in surgery have not been essentially changed. The ordinary photographic plate, shielded in a plate holder, is still used to receive the shadow cast by the bones, and salts of barium or of calcium strewn on pasteboard serve as fluorescent screens to receive on 665 their luminous surfaces these shadows and to make them evident to the eye. An interesting use of flexible sensitive films instead of glass plates has been made in dentistry. The films are put in the mouth, and the Crooke's tube placed outside in such a position that the rays can pass through the jaw. In this way the accompanying photographs were taken (Fig. 4).[D]

[D] Kindness of Dr. Dwight M. Clapp, Boston.

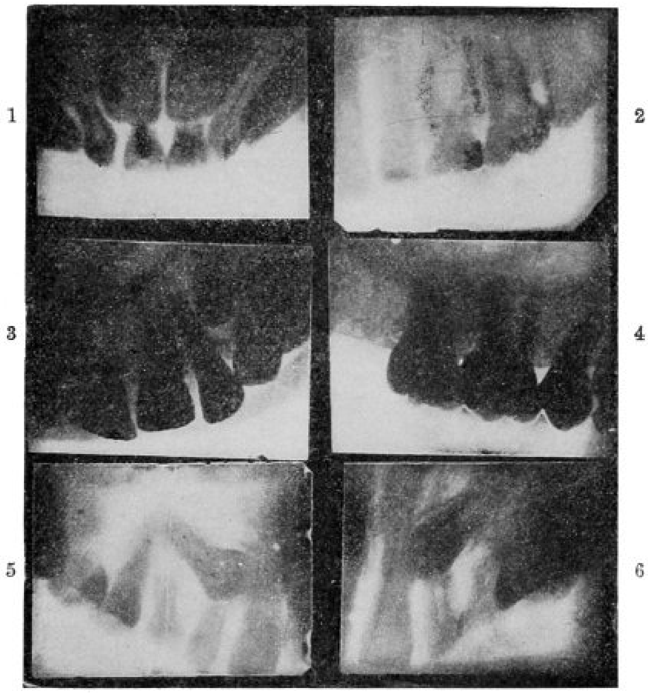


Fig. 4.—1. Male patient, aged ten years. Temporary incisors in position with the permanent incisors nearly ready to erupt. The roots of the temporary teeth nearly absorbed. Right temporary central cut incisor destroyed by a blow five years previous, showing gutta-percha filling put in at the time which, with the dead root, has been absorbed (same as the live root of the other central). It is taught in the text-books that teeth with dead nerves are not absorbed. 2. Temporary molars in position with no signs of the permanent bicuspid which should take its place. 3. Patient, aged ten years. Shows the open ends of the incisor roots. 4. Shows one bicuspid and two molar teeth. The roots of the teeth pass through the floor of and into the cavity of the antrum. The spongy character of the bone is shown. 5 and 6. Superior jaw, right and left sides, showing temporary cuspid teeth in place, with the permanent cuspids imbedded in the jaw entirely covered.

The use of photographic films in the application of the X rays in surgery will doubtless extend; we can easily imagine cases where the necessity of the use of the knife may be avoided by the information which a carefully placed film might afford. In general, X-ray photographs convey more information to the skilled eye of the specialist than to the untrained inspector of them. They should be studied from the negatives themselves, for the delicate details can not be reproduced in a print. It is remarkable that shadow pictures can show so much definition. Here is a photograph of an elbow joint which shows the texture of the bones (Fig. 5).[E] 666

[E] Taken by Professor Goodspeed, University of Pennsylvania.

The use of the fluorescent screen, too, has been greatly extended. Dr. Francis H. Williams, of Boston, has used it as a valuable instrument in medical diagnosis, especially in studying lung diseases. It has been used at the Harvard Medical School to follow the processes of digestion. To accomplish this, in one instance a goose was fed with food mixed with subnitrate of bismuth, a salt which absorbs X rays.

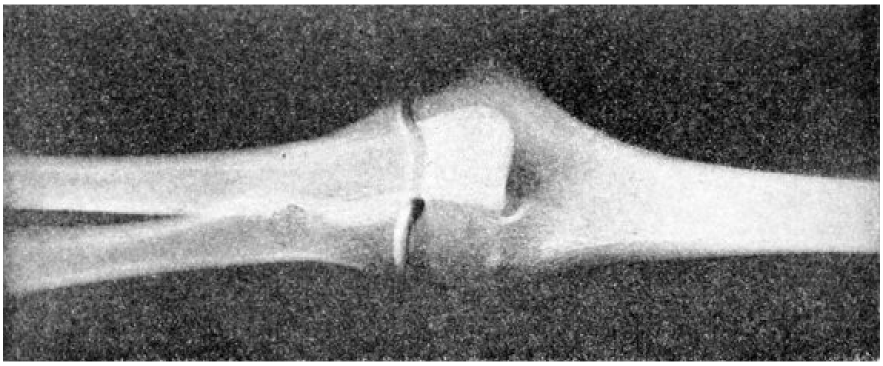


Fig. 5.—Photograph of an elbow joint, showing the texture of the bones.

The passage of the dark mass down the long neck of the bird could be traced on the fluorescent screen, and the peculiarities of its motion in the gullet could be studied. A cat was also fed with the same substance, and the movements of its stomach noted. These movements were analogous to those of the heart—in other words, were rhythmical when the processes of digestion were going on normally and uninterruptedly. When, however, the cat was irritated, it may be by the sight of a dog, these pulsations instantly ceased. As soon as the source of vexation was removed and the purring of the animal showed a contented frame of mind, the stomach resumed its rhythmical movements. The dependence of the digestive apparatus on the state of the nervous system was thus clearly shown. The female cat was much more tractable under these experiments than the male.

The use of the X rays is accompanied with some danger if the Crooke's tube is not properly used. A long exposure to the X rays is apt to produce bad burns which are like sunburns, and lead in certain cases to bad ulcerations. They are long in healing and are characterized by a peculiar red glow, especially on exposure to a cold wind. To prevent them one should place a sheet of thin aluminum between the Crooke's tube and the part of the body submitted to the rays. This sheet should be connected to the earth. This fact should be borne in 667
mind when we come to speak of the electrical region outside a Crooke's tube.

Many investigators, reflecting upon the singular fact that the rays pass so freely through thin aluminum and that, on the contrary, glass absorbs such a large percentage, concluded that Crooke's tubes provided with aluminum windows would be an improvement upon the thin incandescent lamplike bulbs now used. The glass of these bulbs is very thin, not more than one thousandth of an inch in thickness, where the rays emerge, not thicker than a sheet of ordinary note paper, and the absorption of such a sheet of glass is so small that it can not be detected by photography. Thus a sliver of glass of this thickness in the hand would not appear on the X-ray photograph of this member, and would not cast a shadow in the fluoroscope. There does not seem, therefore, any advantage in supplying a Crooke's tube with an aluminum window. The mechanical difficulties, too, in accomplishing this are very great. There is no way of joining the thin aluminum disk to the glass so that an air-tight joint can be made. In the process of exhausting the Crooke's tube, the tube must be heated to a comparatively high temperature in order to drive off the air which clings to the inside of the glass. The rise of temperature would soften or melt any current which might be used to make the aluminum adhere to the glass.

We can not expect, therefore, any improvement in the direction of aluminum windows. At one time, I suppose that the rays were highly absorbed in passing through atmospheric air, and that it would be an improvement in the application of the rays to surgery to interpose, so to speak, a vacuum chamber between the body and the source of the X rays. The experiment led to some interesting results, but not in the direction anticipated.

The vacuum chamber consisted of a glass cylinder three feet long and about eight inches in diameter. The two ends were closed by sheets of aluminum, and it could be exhausted through a side tube. The reader will immediately ask, in view of what has been said, How could the glass tube be hermetically closed with sheets of aluminum? This was indeed a difficult matter, but less difficult than in the case of the Crooke's tube, for the ends of the glass cylinder were provided with heavy brass flanges, which were perfectly flat, and the sheets of aluminum lying smoothly could be confined by many bolts between the flange and suitable brass heads. This cylinder, having been exhausted, was placed between the Crooke's tube and the arm, for instance, in the hope that a greater depth of human flesh and tissue might be penetrated by the rays. It was speedily seen that the 668
absorption of the layer of air three feet thick could not be detected either by photographs or the fluorescent screen. The glass cylinder was then filled with rarefied hydrogen, but no advantage was apparent. If the photographs of the human hand were taken, one through the rarefied cylinder and the other through an equivalent thickness of air, no difference in clearness or depth of definition could be perceived. The amount of absorption by a column of air three feet in length is less than ten per cent. This result interested me greatly, for it shows the remarkable difference between the X rays and the cathode rays, which had been investigated by Crooke, Hittorf, and Lenard; for the cathode rays are greatly absorbed by atmospheric air, being reduced in passing through five or six inches of air to one four-hundredth part of their value.

The small amount of absorption of the X rays lifts them into the realm of very short wave lengths of light, for their behavior in regard to the absorption by air is very analogous to that of ultra-violet rays. Although the vacuum chamber, by which I looked, showed no absorption of the X rays, it disclosed a beautiful phenomenon. In a dark room this large tube, three feet long and eight inches wide, was filled with a roseate light, which wavered like the northern lights when the Crooke's tube was emitting the X rays. If the finger was brought near the glass walls of the cylinder a stream of light apparently emanated from a point on the inside wall of the cylinder. The hand thus had ghostly streamers giving an image of it, although the hand itself was invisible. These banners of light could be diverted in any direction by the hand or by any conducting body brought near, and gave a vivid conception of how the streaming of the aurora can be brought about by this flitting of conducting clouds or the drifting of moisture-laden strata of air below the rarefied space in which the beams of the northern light dart back and forth. Both in the case of the Crooke’s tube and the aurora these streamers are produced by electrical discharges through rarefied air. The experiments show that outside the Crooke’s tube there is a strong electrical attraction and repulsion, which is only revealed in darkness and in a cold, lifeless, airless space, such as exists between us and the sun. Can we not extend our thoughts from the contemplation of this laboratory experiment to that of the immensely greater play of electrical forces between the earth and the sun across the immense vacant space ninety millions of miles in distance?

The mysterious effects of the X rays on the molecules in the air form a great subject of inquiry, and the
investigation of it promises to extend our knowledge of electricity and light and heat. When the Crooke’s tube is 669
excited we are conscious of a mysterious activity within it, for its glass walls glow with a phosphorescent light, and if certain crystals, like the diamond or the ruby, are placed in the tube, this phosphorescent light is vivid. Outside the tube, in free air, these luminescent effects are also present. The air is under an electrical strain, which is shown by the auroral streamers when this air is rarefied, and an electrical charge can not be maintained on a pith ball—it is dissipated in some strange manner. Still stranger, an electrical current is greatly aided by the X rays in its endeavor to pass through air—they make for the time being air a conductor. Furthermore, these rays separate the air into positively laden and negatively laden particles.

The electrical discharge in the Crooke’s tube is many-sided in its manifestations. Its energy seems all-pervading in the room where it occurs. Before the discharge passes through the rarefied space in the tube its energy manifests itself by a crackling spark, a miniature lightning discharge. This spark, five or six inches in length, can send out magnetic waves which extend far beyond the narrow limits of the room. They can be detected, by the methods of wireless telegraphy, fifty miles. When the same amount of energy is developed in a Crooke’s tube the magnetic waves hardly pass beyond the walls of the room, and the phenomenon of phosphorescence and fluorescence and the strange molecular effects outside the Crooke’s tube spring into prominence. The crackling spark outside the tube is far-reaching in its effect, yet it shows no signs of the X rays, its light can not penetrate the human body, it excites only a feeble phosphorescence at a distance of even two or three feet, while the same energy excited in the Crooke’s tube can cause luminescence at a distance of twenty feet. The crackling spark, however, can be seen much farther than the light of the Crooke’s tube, and it can also impress a photographic plate at much greater distance. The following experiments will illustrate the different manifestations of energy of which an electrical discharge is capable. I produced an electrical spark about six inches in length and exposed a photographic plate for six seconds, at a distance of two, ten, and twenty feet, to its light. A thin strip of tin, with a circular hole cut in it, served as a shutter. The sensitive plate was thus protected, except in front of this aperture. The images exhibit the decrease in light with the increase of distance. Another portion of the sensitive plate was exposed in the same manner during the same length of time to the light of a Crooke’s tube which was excited by this same spark. No image was obtained at a distance of ten
feet, and barely one at three feet. The spark in air, therefore, was far more energetic photographically than the 670
X rays, but it could not penetrate solid materials. This property was given to it by its passage through rarefied space. I then covered a screen with a phosphorescent substance, and exposed it to the spark in air. The phosphorescent light could barely be detected at a distance of three feet, while with a spark in rarefied air it could be seen at a distance of twenty feet.

When we consider these experiments we see that the X rays act toward phosphorescent matter much as the spark in air behaves toward the photographic plate. Now, these results, taken in connection with the strong electrical effects in the neighborhood of an excited Crooke’s tube, points to a certain connection between phosphorescence and electricity. Can it be that the strange light is excited by very short electrical waves sent out from the tube, which can not travel far but are very active in producing molecular effects? This activity, indeed, may prevent their extending to great distances. Wireless telegraphy evidently depends upon one set of waves sent out by a spark, and X-ray photographs upon another set developed only in rarefied air. Phosphorescence can not be produced with ease by the spark in air. On the contrary, it is developed to a remarkable degree and at comparatively great distances by the discharge in rarefied air. It has been shown by Mr. Burbank and myself that electrical force can develop phosphorescent light in certain crystals. The sunlight can do the same. Is sunlight an electrical phenomenon? That it is constitutes the greatest hypothesis in physics of this century. When we reflect, too, that the phosphorescence of the firefly is excited by some manifestation of a living organism—nerve force or some related force—shall we not include nerve force in the electrical category?

The X rays, therefore, bring into prominence strange lights which had heretofore been noticed chiefly by keen-eyed investigators, and which, with their names, phosphorescence and fluorescence, were unknown to the bulk of mankind. The fluorescent screen, by means of which surgeons observe the skeleton of the body, has now taken its place in medical practice with the stethoscope, by which the mechanism of the lungs is studied, and hopes have been excited that the blind may yet use the X rays in detecting objects and in regaining a sense of vision, even though this sense may be only partial. It is a curious fact that the retina of the eye is phosphorescent and fluorescent, and that one can see the shadow of certain objects in the dark when one stands so that the feeble X rays fall upon the eye. In other words, the retina acts as a fluorescent screen. The
eye at present recognizes only a limited number of the waves that are surging about us. We can see the colors 671
from red to violet, but the dark colors, so to speak, formed by waves longer than 1/40000 of an inch and shorter than 1/100000 of an inch make no recognizable impress upon our retina, unless, indeed, they constitute telepathic signals which apparently stir our consciousness and make us believe that friends are communicating from a distance. The electrical discharge has lifted, so to speak, a realm of short waves of energy out of the darkness and made them visible. Can the human brain be made conscious of other waves which fill space?

But we have not by any means exhausted the protean manifestations of the X rays. Besides the photographic, the phosphorescent, and fluorescent effects, there are still more singular properties of these rays. One of the most striking consists in their opening a path for a current of electricity. The electrical discharge, feeble in itself, not capable of lifting by means of a motor a pound weight a foot from the floor, is yet competent to open a path for a current which can set all the trolley cars of a great city in motion. To exhibit this mysterious effect we bring the ends of the electrical current which we wish to excite near each other, but not touching, in a glass tube with thin walls, from which the air has been exhausted. When the X rays fall on the gap between the wires the electrical current immediately jumps across the gap with a vivid light. We have here the mechanism of an electrical relay—the feeble energy of the electric discharge can call into play a giant energy. By what energy does it accomplish this? Is it by compelling molecules to put themselves in line, so that the electrical current can bridge the gap? Is it by breaking down this mysterious ether of space, as if we threw a stone at a turbid bull’s eye in a prison chamber and let in a flood of sunlight? How the imagination is stirred by this process, what seems dead and lifeless can, by a physical agency, be stirred to endless activity! The rays are like the touch of Ithuriel’s spear.

The electrical discharge can accomplish all this, but the story of its activity is not yet told. It can not be told, for each year adds information in regard to these activities, for there are thousands of investigators at work. Another far-reaching manifestation is this: the rays can separate the air or a gas into its constituent particles, much as a strong electrical current separates water into oxygen and hydrogen. They can communicate electrical charges to these particles—positive and negative charges. The charged air-particles, when forced through partitions of spun glass, does not give up their electricity as they do when they are charged by an electrical machine. This curious manifestation leads me to suspect that the electricity and magnetism of the earth may be 672
caused by an X-ray effect on our atmosphere. The sun and the earth are separated like the terminals of a Crooke’s tube—two conductors with a vacuum between. An electrical excitation from the sun may cause an electrical discharge between it and the earth. This discharge might consist of an X-ray effect which could separate the upper layers of the atmosphere into positive and negative charges. The velocity of the negatively charged particles is greater than that of the positively charged ones, and the revolution of the earth may cause such a movement of these electrified particles that electrical currents may be generated which in circulation around the earth could produce the observed magnetism of the north and south poles, together with the auroral lights characteristic of those regions. This, I am well aware, is an audacious theory. It is certainly a vast extension of the laboratory experiments I have described, but the electrical radiations developed in electrical discharges are as competent to produce powerful magnetic whirls as the heat radiations in our atmosphere to develop cyclones. In the lower regions of our atmosphere the air is an insulator like glass to the passage of an electrical current. A layer a foot thick can prevent the circulation of the most powerful current which is now used to generate horse power. When this air space is rarefied at a certain degree of rarefaction the electrical current passes, especially, as we have seen, if it is illuminated by the X rays. When, therefore, we ascend to a height of ten or twenty miles the rarefied air becomes an excellent conductor of electricity of high electro-motive force. To my mind the conditions exist for developing an electrical state in the earth’s covering of air, which is competent to explain the electrical manifestations of the air, the auroral gleam, and the mysterious effect on the magnetic needle which keeps it directed to the magnetic north. Can not we conclude that the study of the X rays bids fair to greatly extend our conceptions of the constitution of matter and of the action and interaction of Nature’s forces?

A Himalayan explorer reported, a few years ago, that he had seen, from one of the lofty summits of the Mount Everest district, a peak which, beheld in the same view with Mount Everest, was evidently higher than it. Nothing has been heard of the matter since then till the recent appearance of Major L. A. Waddell’s book, Among the Himalayas. This author, who has explored the same region, represents that the Tibetans there say there is another mountain, due north of Mount Everest, that exceeds that peak in height, thus confirming the story of the former Alpinist. It appears that Mount Everest is not called Gaurisankar or Deodunga, as some affirm, but that the Tibetan name of the culminating peak of the group is *Jomokang-kar*—“The Lady White Glacier.”

673

A HUNDRED YEARS OF CHEMISTRY.

By F. W. CLARKE,

CHIEF CHEMIST, UNITED STATES GEOLOGICAL SURVEY.

It is hardly an exaggeration to say that chemistry, as a science, is the creation of the nineteenth century. Chemical facts, indeed, were known even in remote antiquity; some principles were dimly anticipated long before the century began; Boyle had given the first rational definition of an element; the principal gases had been discovered; great foundations were laid, ready for the superstructure. But the making of bricks is not architecture, nor does the accumulation of details constitute a science. The scattered facts are needful preliminaries, but only with the discovery of laws and the development of broad generalizations does true science begin.

That truth can be born from error may seem paradoxical, but, nevertheless, the statement is exact. False hypotheses stimulate investigation, and so truth comes at last to light. In the history of chemistry this principle is clearly illustrated. During the eighteenth century the doctrine of phlogiston was generally accepted; this led to exhaustive researches upon combustion, and from these the science of chemistry received its present shape. Becher and Stahl had taught that every combustible substance contained a combustible principle—*phlogiston*—and that to the elimination of this principle the phenomena of combustion were due. According to this theory, a metal was regarded as a compound of its calx, or oxide, with phlogiston; hydrogen became a compound of water with phlogiston, and so the truth was curiously inverted. The doctrine was vigorously and ingeniously defended, and, although it was overthrown by Lavoisier, it had persistent supporters even after the present century began.

The weak point of the phlogistic theory was its practical disregard of the phenomena of weight. That the calx weighed more than the metal was well known, but quantitative considerations were subordinated to those of quality, and the form of matter was studied rather than its mass.

In 1770 the scientific career of Lavoisier began, and the balance became a chief instrument in chemical research. The constancy of weight during chemical change was experimentally established, and what had been a philosophical speculation—the increatability and indestructibility of matter—became a doctrine of science, a datum of knowledge instead of a hypothetical belief. In 1774 Priestley and Scheele independently discovered oxygen, and with the aid of the balance the phenomena of combustion were rendered intelligible. The 674
foundations of chemistry were laid, and upon them the nineteenth century has built. Lavoisier, the greatest of the founders, fell a victim to the guillotine; the judge who condemned him refused all appeals for mercy, saying “the republic has no need for *savants*,” but the necessity which judicial ignorance could not foresee presently made itself felt. France, at war with all Europe, her ports closed to supplies from without, fell back upon her own resources. Saltpeter was needed for her guns, alkali for her industries, and the chemist was called upon for help. The stress of continued warfare stimulated intellectual activity, and one result was the creation of chemical processes which revolutionized more than one industry. The dependence of modern civilization upon science then began to be recognized—a dependence which is, perhaps, the chief characteristic of the present century.

With the opening of the new century a period of great activity began. The constancy of matter was well established, and the fundamental distinction between elements and compounds was clearly recognized; two starting points for exact research had been gained. Only a small number of elements, however, had been identified as such; of some substances it was doubtful whether they were elementary or not, but the mine was open and a rich body of ore was in sight. Furthermore, the utility of research had become evident, so that intellectual curiosity received a new stimulus and a new direction. Theory and practice became partners, and have worked together to this day.

Between the years 1803 and 1808 one of the greatest advances, in scientific chemistry was made, when John Dalton announced and developed his famous atomic theory. In this we find a notable illustration of the difference between metaphysics and science. The conception of matter as made up of atoms, as discrete rather than continuous, was a commonplace of philosophical speculation. It had been taught by Democritus and Lucretius; it was the theme of wordy wrangles during centuries; Swedenborg, Higgins, and other writers had sought to apply it to the discussion of chemical phenomena; but it remained only a speculation, unfruitful for discovery. Up to the time of Dalton it had led to nothing but intellectual gymnastics.

A good scientific theory is never a product of the unaided imagination; it must serve some purpose in the correlation of phenomena which suggest it to the mind. This was the case with Dalton’s discovery, which grew out of his observations upon definite and multiple proportions. That every chemical compound has a fixed and definite composition was recognized by Lavoisier, and by other chemists before him; but the fact was disputed 675
by Berthollet, and its verity was not established until 1808. Dalton went a step further, and found that to every element a definite combining number could be assigned, and that when two elements united in more than one proportion even multiples of that number appeared. Thus, taking the hydrogen weight as unity, oxygen always combines with other elements in the proportion of eight parts or some simple multiple thereof, and so on through the entire list of elementary bodies. Each one has its own combining weight, and this was the law for which Dalton sought an adequate explanation. Fractions of the weights did not appear, fractional atoms could not exist; the two thoughts were connected by Dalton. Chemical union, to his mind, became a juxtaposition of atoms, whose relative weights were indicated by their combining numbers, and so the atomic conception for the first time was given quantitative expression. The facts were co-ordinated, the special laws were combined in one general theory, and the mere suppositions of other men were supplanted by a precise statement, which is a corner stone of chemistry to-day. The doctrine led at once to investigations, it rendered possible the discovery of new truth, chemical formulæ and chemical equations were developed from it; without its aid the growth of chemical science would probably have been slow. The nature of the atoms may be in doubt, they may be divisible or indivisible, but the value of the theory is independent of such considerations. It gives adequate expression to known laws, and it can only be set aside, if ever, by absorption into some wider and deeper

generalization.

The same year which saw the completion of Dalton's theory (1807) was also signalized by the remarkable discoveries of Sir Humphry Davy, who decomposed the alkalies and proved them to be compounds of metals. In 1810 chlorine, which was previously thought to be a compound, was proved to be elementary, and this fact was emphasized a year later by the discovery of iodine. These researches gave precision to the conception of an element, and prepared the way for later investigations upon many other oxides. All the so-called "earths"—lime, magnesia, alumina, and so on—were now seen to be oxy-compounds of metals, and an intelligent interpretation of all forms of inorganic matter became possible. The first step in the chain of research was the discovery of oxygen itself; from that, and from the teachings of Lavoisier, the later discoveries logically followed.

While the investigations of Dalton and of Davy were still incomplete, other chemists were actively studying the properties of gases and exploring the fertile border-land between chemistry and physics. In 1805 Gay- 676
Lussac and Humboldt determined the composition of water by *volume*; in 1808 Gay-Lussac extended these observations, and found that in all compound gases simple volumetric relations existed; and in 1811 the entire subject was generalized into Avogadro's law. Avogadro showed that equal volumes of gases, compared under equivalent conditions, must contain equal numbers of molecules, and although the force of his discovery was not fully appreciated until much later, it is now recognized as one of the fundamental propositions of both physics and chemistry. For the first time the distinction between atoms and molecules was clearly stated, and from the density of a gas the relative weight of its molecule could be calculated. Avogadro's law rounded out and completed the atomic theory, and to its application much of the advance in organic chemistry is due. Equally striking, but less far-reaching in its consequences, was the discovery announced by Dulong and Petit in 1819, when it was shown that the specific heat of an element was inversely proportional to its atomic weight. Otherwise stated, this law asserts that the atoms of all the elements have the same capacity for heat, and an important check upon determinations of atomic weight was thus provided.

The next twenty years in the history of chemistry were years of detail rather than of permanent generalizations. The multitudinous verification of known laws, the development of experimental methods, especially methods of analysis, the discovery of new elements, the preparation of numberless new compounds, occupied the attention of most workers. This period, which may be called the Berzelian period, was enormously fruitful in results, although but few of the theories then proposed have survived to the present day. During this period the name and influence of Berzelius overshadowed all others, and his marvelous researches, carried out in a laboratory which was hardly more than a kitchen, were of almost incredible variety. For the crude symbols of Dalton, Berzelius substituted a system of chemical formulæ which could be used in chemical equations; in 1818 and 1826 he published tables of atomic weights, determined with far greater exactness than ever before; he discovered five new elements and a multitude of compounds, devised methods of research, and proposed theories which, though later to be overthrown, for many years dominated chemical science. His electro-chemical experiments led him to his dualistic theory of compounds, which interpreted each compound as made up of two parts—one positive, the other negative. The electro-positive oxides were basic, the electro-negative groups were acid; chemical affinity was electrical attraction between the two opposites; chemical union implied
a neutralization of one by the other. These ideas were more than speculation, for they rested upon experiment 677
and led to further experimental research; but they went too far, and therefore could not last. The theory, however, contained much that was true, and the formulæ developed by it gave the first general suggestion of what is now known as chemical structure or constitution. The later study of organic compounds led up to the modern views.

Although Berzelius and many other chemists did some work upon organic compounds, their era was chiefly identified with inorganic researches. Mineral chemistry received a great deal of attention, the relatively simple acids, bases, and salts were studied, but the compounds of carbon were thought to be more complex and received less consideration. To-day, at the close of the century, nearly seventy thousand organic compounds are known, and of these comparatively few were discovered before the year 1830. Since then organic chemistry has been the dominant line of investigation.

Among the earlier chemists of the nineteenth century it was commonly supposed that organic and inorganic matter were radically different, and that the former could only be produced by the operation of a peculiar vital force. To this view there were some dissentients, Berzelius among them, but experimental proof for their contention was lacking. In 1827, however, Wöhler succeeded in transforming the inorganic ammonium cyanate into the organic urea, and the barrier was broken down. The era of synthetic chemistry had begun. Still earlier, in 1823, Liebig had found that silver cyanate and silver fulminate possessed the same percentage composition; in 1825 Faraday discovered an isomer of ethylene; and Wöhler's research now gave a third example of the same kind. Two different substances could contain the same elements in the same proportions, and to explain this fact Berzelius inferred different arrangements of atoms within the molecule, and suggested that their mode of union might be determined. A working theory, however, was still lacking, and without it progress was necessarily slow. The dualistic hypothesis explained the phenomena only in part, and as the known facts increased in number it had to be abandoned.

Two important investigations paved the way for an advance. In 1832 Liebig and Wöhler, studying benzoic acid, found that it and its derivatives contained in common a group of atoms, not isolable by itself, to which they gave the name of benzoyl. The conception of such a group, a compound radicle, already existed, but it lacked clearness, and now for the first time it became truly a scientific idea. The search for, and the identification of,
compound radicles began to occupy the attention of chemists, and a definite line of attack upon organic matter 678
was recognized.

Two years later the second great step was taken. Dumas, studying the action of chlorine upon acetic acid, showed that the chlorine could replace hydrogen atom for atom, or volume for volume, and that his observations explained other reactions which had been unintelligible hitherto. This research led him to the famous theory of substitutions, which at first was received with ridicule, but soon found general acceptance. Electro-chemical conceptions, the Berzelian doctrines, were then in vogue, and it seemed strange, even absurd, to suppose that electro-negative chlorine could be substituted for electro-positive hydrogen. But the facts were stronger than the preconceived ideas, and the latter soon gave way. In this discovery by Dumas the first germs of the modern theory of valence are to be found.

For the study of inorganic substances, however, the dualistic theory was long retained, with the result that inorganic chemistry degenerated to a great extent into analysis and compound making, without any general conceptions which could stimulate scientific advance. It became a science of details rather than of principles, and was soon overshadowed by the organic branch. In the latter, theory after theory sprang up, flourished, and died away, each one having partial truth, but none being exhaustive and final. Still, the intellectual activity led to discoveries, and the warfare between doctrines, unlike the warfare between men, was productive of good instead of destruction. From the conflict of ideas the truth gradually emerged, and a new system of chemical philosophy was developed. The theory of compound radicles, the nucleus theory, the theory of types, the conception of conjugated compounds, followed rapidly one after the other, until in the discovery of valence all discrepancies were reconciled, structural chemistry came into existence, and a single doctrine, applicable alike to organic and inorganic substances, had possession of the field.

The theory of valence was a logical outgrowth from its predecessors, whose valuable features it included in a wider generalization, but it was the work of no one master mind. Many chemists contributed to its up-building, Frankland and Kekulé being among the leaders; but its foundations are to be detected in the atomic theory itself, from which it is legitimately derived. To understand its full significance we must take a step backward in history, and trace the change in atomic weights from their first form to the modern system.

In the early days of the atomic theory, in the determinations by Wollaston, Berzelius, and others, attention was chiefly paid to the atomic weights in their aspect of combining numbers. They were primarily of use as 679
factors in chemical calculations, and chemists naturally sought for their simplest expressions, with little regard to theoretical considerations. The laws of Avogadro, of Dulong and Petit, had, indeed, been announced, but the adjustment of the atomic weights to meet their requirements was long neglected. The importance of the adjustment was not realized, for it was obscured by the prevailing dualistic theory, but without it the deeper general relations of the atoms could not appear. Accordingly, a system of chemical formulæ grew up which was based upon a deceptive apparent simplicity of ratios, and by which the theory of valence could not be even suggested. The old formula for water, HO, expressed only its composition by weight, ignoring its composition by volume; it failed, therefore, to accord with Avogadro's law or to give the slightest hint as to the relations which are now covered by the conception of chemical structure. A part of the existing knowledge was accurately symbolized, but the larger part was ignored, a state of affairs which could not last, although the change came about but slowly.

The incentive to reform came from two sources. Physics, in the kinetic theory of gases, gave a new demonstration of the truth of Avogadro's law, and led chemists to realize more clearly than before the distinction between atoms and molecules. Soon it was seen that the molecule was the smallest particle of matter which could exist as such, while the atom was the smallest particle which could take part in any chemical change. The metaphysical atom was really the modern molecule; the chemical atom was a new conception, due to the discoveries of chemistry alone. This distinction was found to hold good even for elementary bodies, and it became evident that free hydrogen or oxygen must contain two atoms to the molecule, while phosphorus and arsenic contained four. With mercury the atom and the molecule are identical, but in most cases the greater complexity exists, and the elements as we see them are compounds of like atoms with each other. That hydrogen can unite with hydrogen, oxygen with oxygen, carbon with carbon, is a conception to which the early chemists never attained, but which is a necessary consequence of Avogadro's law in its application to observed phenomena.

The second impulse toward change originated in the study of organic compounds, and gained its force from the struggle between contending theories. The advocates of each theory sought for evidence in its favor, and so innumerable discoveries were made, compound radicles were recognized in great numbers, and the mass of data became so overwhelming that for a while chaos reigned. Classification of compounds became imperatively 680
necessary, and to that all speculation was subordinated. In 1842 Schiel found that the alcohols formed a regular series, with progressive variation in their properties; Dumas observed a similar relation among the fatty acids, and so something like order began to appear.

In 1843 Charles Gerhardt proposed to use the law of Avogadro as a basis for the determination of atomic weights. This involved the doubling of many existing values, especially the atomic weights assigned to oxygen, carbon, and sulphur. At first the proposition was violently opposed, and even ridiculed, but by slow degrees it managed to make its way, although it was not until after 1858 that it began to find anything like general acceptance. In that year Cannizzaro put forth his revision of the atomic weights, adjusted to accord with physical laws, and a new era in chemistry began. The modern theories of chemistry became possible, and the many researches in which they had been foreshadowed received a clearer meaning. Cannizzaro did not stand alone; his work was but the capstone of a structure which had long been growing; Liebig, Dumas, Laurent, Gerhardt, Wurtz, Graham, Williamson, and Frankland were among the builders. But at last chemical and physical evidence were brought into full convergence, and each gave emphasis to the other.

During the formative period of the new doctrines, between 1840 and 1858, many discoveries were made which helped toward the final consummation. Even earlier than this the researches of Graham upon the phosphoric acids had familiarized chemists with the idea that different substances might have very different combining powers, and other polybasic acids were found to exist among organic compounds. The discovery by Wurtz, in 1849, that the hydrogen of ammonia was replaceable by organic radicles, forming the compound ammonias or amines, was a logical extension of the theory of substitutions; and the recognition at about the same time, by Hofmann, of ammonia as a distinct type upon which many other substances could be modeled, was another long step forward. In 1851 Williamson argued that nearly all inorganic and many organic molecules could be represented as analogous in structure to water, and a year later, as a result of his researches upon the organo-metallic bodies—zinc ethyl, tin ethyl, etc.—Frankland expressed the belief that every elementary atom has a definite combining power which limits the number of other atoms capable of direct union with it. This was the theory of valence in its first and simplest form, undeveloped to its consequences, but unmistakably clear. To carbon compounds in general it was yet to be applied.

In 1858 the work of Cannizzaro appeared, and a general revision of chemical formulæ became necessary. 681
The advanced views which a few chemists had held began to find a more general acceptance, and the significance of the change was gradually realized. In the same year Kekulé showed that the atom of carbon had a combining capacity of four, and furthermore that in many organic compounds the carbon atoms were in part united with each other, and even linked, as it were, into chains. Still later, studying benzene, he found that its six carbon atoms were best regarded as joined together in the form of a closed ring, and with this conception the idea of chemical structure received at last a definite form. These linkages of atoms, these rings and their derivatives, could all be represented graphically to the eye, in accordance with the combining power of the several elements, and so the structural formulæ of modern chemistry came into vogue. Types, substitutions, compound radicles, were all covered by and included in the new generalization, and each of the older theories was seen to be but an expression of special cases, rather than of any general law. No truth was set aside, but all were co-ordinated.

To the non-chemical reader the foregoing passages may seem vague and abstruse, but in an essay of this scope greater elaboration is inadmissible. It is clear, however, that each forward step has been a logical development of the atomic theory, which, as we shall see later, does not end even here.

Thus, then, the chemical formulæ and atomic weights of Berzelius grew by slow degrees into the modern system, with its representations of structure and atomic linking. The internal architecture of the molecule was now revealed not to the imagination only, but to the eye of reason, and, speculative as the new conceptions may seem at first, they have led to astonishing practical consequences. The new formulæ at once indicated lines of research, and with their aid synthetic chemistry was greatly stimulated. True, many syntheses of organic compounds had already been made, but progress became more rapid and the work of discovery was systematized to a wonderful degree. In 1856 Perkin discovered the first of the coal-tar dyes, creating a new industry which has been assisted beyond measure by the structural symbols that came into use only a few years later. In 1868 alizarin, the coloring principle of madder, was made artificially from the hydrocarbon anthracene; a host of other colors, a veritable chemical rainbow, have been discovered; the synthesis of indigo has been effected; and within twenty years we have seen medicine enriched by a great variety of drugs, all prepared by purely chemical processes from the former waste material—coal tar. To most of this work, at least since 1865, 682
Kekulé's conception of the benzene ring has been the guiding clew, and it is certain that without the theory the practice would have advanced much more slowly. Out of research for its own sake has come an enrichment of the world, which in any previous age would have been inconceivable.

The atomic theory, while replacing speculation in one sense, stimulated it in another. The human mind is always striving to get back of the known, to see what lies beyond the limits of visibility, and the conception of an element with its atomic weight opened up a field for the exercise of the imagination. What is an element ultimately? was an early question to ask. Are the elements really diverse, or do they manifest but one fundamental kind of matter? To such queries the atomic weights offered a promising line for investigation, and more than one mind began traveling along it. In 1815 Prout put forth the supposition that all atomic weights were even multiples of that assigned to hydrogen, and over this hypothesis a long warfare has raged. To-day it is practically abandoned by chemists, but the controversy which it provoked led to some of the most accurate investigations in the history of science, and so served to give precision to our knowledge. Without the instigation of Prout's hypothesis, which hinted at hydrogen as the ultimate form of matter, we might have been content with inferior determinations of atomic weight, and chemistry, as an exact science, would have suffered.

In due time, however, it was perceived that the elements could be arranged in groups, the members of each group having similar properties and forming similar compounds. Serial relations, analogous to those discovered among organic compounds, became manifest, and much thought was expended in seeking to trace out their meaning. The classification of the elements was more and more seen to be important, and regularities came to light which at first were unsuspected. Still, no general law, no one guiding principle, could be found so long as the old system of weights and formulæ was retained in common usage.

The adoption of Cannizzaro's atomic weights and the establishment of the theory of valence made possible a new attack upon the problem of classification. In 1864 Newlands arranged the elements in the order of their atomic weights, and showed that at regular intervals there was a periodic recurrence of certain characteristics. This observation, which foreshadowed the periodic law, was received with indifference and, to some extent, with ridicule, but the path had been found which soon led to a great discovery. In 1869 Mendelejeff published his celebrated memoir, and the periodic law took its place as a distinct addition to science. Almost 683
simultaneously Lothar Meyer announced similar views, but independently, and controversy soon arose as to the relative merits of the two philosophers. With that controversy we have nothing to do, but the law itself deserves our fuller attention.

According to the periodic law, all the properties of the elements are periodic functions of their atomic weights, varying from substance to substance in a perfectly regular manner. The elements thus fall into periods, or octaves, as Newlands called them, of a very striking character. If, for example, we start with univalent lithium, the next higher element has a valence of two, the next of three, and then comes carbon, whose atom is quadrivalent. Following carbon, the combining power of successive elements decreases until we reach sodium, in which something like the properties of lithium recur. Above sodium the same rise goes on to the fourth element higher, silicon, which resembles carbon, and then follows the regular step-by-step falling away, to end with chlorine, the last member of the second period. This periodic rising and falling is characteristic of all the elements, and they were so tabulated by Mendelejeff as to be perfectly clear, with a clearness which is not to be given by words. In Mendelejeff's table certain gaps appeared, which he ascribed to the existence of undiscovered metals. For three of these he predicted the properties, starting out from the properties of their neighbors. This was a rash thing to do, but the venture has been fully vindicated. In 1875 Lecoq de Boisbandram discovered gallium, which filled one of the gaps; scandium and germanium filled the other two later. The predictions of Mendelejeff were fulfilled; atomic weight, specific gravity, fusibility, the character of the compounds to be formed, were all foreseen for each of the three new elements; and, so far as experiment has yet gone, his anticipations have been perfectly realized. Every good theory is prophetic; but few generalizations have been so strikingly verified in this respect as has the periodic law. In spite of some outstanding difficulties, yet to be explained, the law has served to great advantage in the classification of the elements, and it has had much to do with the late revival of inorganic chemistry. The latter branch of science, long comparatively neglected, has now gained new interest, and for it, in the near future, a great growth can be prophesied.

The immediate effect of the periodic law was to prove that the elements are connected with one another by general relations, and so to stimulate the belief in their possibly common origin. This view has many upholders, although it is also strongly opposed, but the weight of argument seems to be in its favor. On philosophic grounds it is at least more probable than the opposite opinion, which can not account in any way for the 684
regularities which have been observed. From another source, partly physical and partly chemical, the theory of the unity of matter has received strong support, and this statement brings us to another of the greatest discoveries made during the nineteenth century—that of the spectroscope and spectrum analysis.

It was in 1860 that Kirchhoff and Bunsen added this new weapon to the arsenal of scientific research. The spectroscope itself, as an instrument, was an invention in the department of optics, but its applications to chemistry were among the most obvious and the most startling of its achievements. With its aid new elements were discovered—rubidium, cæsium, thallium, indium, and gallium; in many lines of investigation it found immediate use; but, more than all, it made possible the analysis of the heavenly bodies, and proved that the same kinds of matter exist throughout the visible universe. Before the day of the spectroscope all speculation upon the chemistry of the stars was in vain; with its advent the material unity of planets, suns, and nebulæ was made clear. To the astronomer, a new eye was given; to the chemist, a new laboratory. Three sciences were brought to a single focus, and each one gained in power thereby.

In its application to what may be called chemical astronomy, one achievement of the spectroscope was particularly notable—namely, the rehabilitation of the nebular hypothesis. When the gigantic telescope of Lord Rosse had resolved some nebulæ into clusters of stars, it was thought that all other nebulæ might be of the same character; the visible basis of the hypothesis was gone. But the spectroscope soon found among these celestial objects some which were truly clouds of incandescent gas, and so the nebular hypothesis received a new standing, becoming stronger than ever before. One point, however, was strange: these gaseous clouds were of the simplest composition; hydrogen and nitrogen were their chief constituents; how, then, could a world like ours originate from them?

Further investigation, to which Huggins and Secchi were the chief contributors, showed, however, that from nebula to planet there is a regular, progressive order of chemical complexity. The nebulæ are simple; in the hotter stars a few more elements appear; more still can be detected in colored stars and the sun; but the planets, represented by our earth, are most complex of all. So far the facts; the scientific imagination now comes into play. If suns and planets were derived by a process of condensation from such nebulæ as exist to-day, perhaps the process of evolution was attended by an evolution of the chemical elements themselves. Upon 685
that supposition the facts become intelligible; without it the evidence is not easily co-ordinated. This hint, together with the suggestions offered by the periodic law, has made chemists more ready to consider the probable unity of matter, even though actual proof for or against the conception has not yet been attained. That the chemical elements are absolute and final few thinkers of to-day believe; the drift of opinion is mainly in one direction, but no element has yet been decomposed or transmuted into another. Some mathematical relations have been found connecting the atomic weights of certain elements with the wave lengths of their spectral lines, and this field of investigation is a promising one for the future. That the atomic weights are connected hardly admits of doubt; to the mass of the atom its rate of vibration must be related; to that vibration the lines in the spectrum are due. The clews are obvious, and it will be strange if they do not lead to important discoveries ere long.

[*To be concluded.*]

THE SCIENCE OF ART FORM.

By D. CADY EATON.

Taste is so free and so subjective, so largely a matter of personal feeling, that any selection or limitation of attractive objects would be met by plausible objection. Every honest and unprejudiced investigator must, however, admit nowadays that his individual taste may be informed and purified, and that he is under obligations to be ever ready to explain and to justify it. The day for the mere proclaiming of preference has passed. The proclamation must be accompanied by explanations which will satisfy others, if they do not convince them, and which will be clear to one's own understanding. The authoritative explanation, "I like this, I dislike that," will no more pass current nor carry weight. Science has sufficiently studied the sentiments and emotions to know that they, too, are subject to laws which must be acknowledged and obeyed. Excitations for which there is no reasonable accounting, no justifiable source, must be relegated to the domain of folly. The reason for everything that appertains to thought and emotion, if not apparent, must be exposed and presented. Artists must explain their works to vulgar understanding. Writers must make their criticisms plain to the humble intellect. The age in which we live takes nothing for granted, accepts no man's *ipse dixit*, hates shams, is intolerant of secrecy, hypocrisy, and fraud.

I propose in this article, by contrasting good and bad examples, to put before readers a few of the simplest 686
elements of decoration. You can hardly fail to note the differences, and when once the eye has acquired the habit of discriminating there is no reason why there should not follow a growth in perception which will result in delightful and augmenting artistic enjoyment. No attempt is to be made to develop a system, nor, of course, to cover the whole ground of the subject. The object is simply to start perceptions in the right direction.

Almost all the ideas and the illustrations of this article are taken from a little work by Henri Mayeux, called *La Composition Décorative*. Henri Mayeux is Professor of Decorative Art in the École des Beaux-Arts in Paris. His work is one of the series of the *Bibliothèque de l'Enseignement des Beaux-Arts*, a series which should be among the very first works to be found in the library of every student of art.

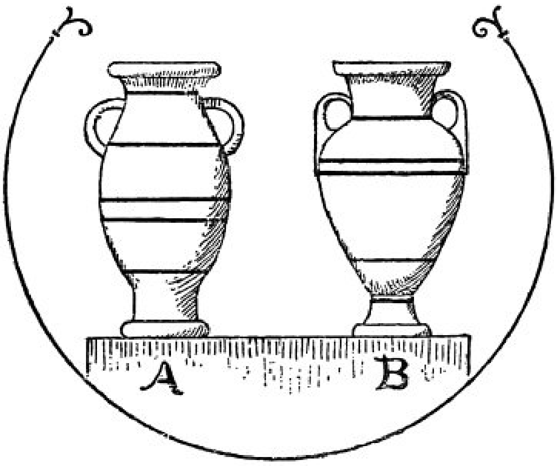


Fig. 1.

The very first of Mayeux's illustrations (Fig. 1) introduces the style of the teaching of the volume and of this article. Let me translate his accompanying description: "Here are two recipients of the same height, made of the same material, and with about equal care. Each has two handles and is decorated by the same number of fillets. The one marked *A* is the work of an ordinary potter, without artistic instinct or education. The other, *B*, is a Greek vase of fine and delicate taste. No one can fail to appreciate the superiority of *B* to *A*. The purity of its profile, the graceful manner in which the handles are attached, the calculated division of the fillets, establish at once a considerable difference of artistic value between the two objects." If Mayeux were addressing beginners he might add that one reason why all jugs and vases are round is that the shape is the easiest to make. The potter's wheel must have been one of the very earliest inventions of semi-civilized races. Besides, as a drop of water is globular, it seems appropriate that liquids should be contained in round receptacles. A square jug would not only seem inappropriate, but it would be ugly and perhaps difficult to handle. Notice in *B* how much better the different parts are distinguished: the neck from the body of the vessel, and the body of the vessel 687
from the foot. Two fillets are also very appropriately put where the vessel is largest, and where they seem to convey a sense of increased strength exactly where the pressure is greatest. You will find all the way through the study of ornament that utility, or use, is a fundamental principle which can not be violated without impairing beauty.

Before presenting objects for comparison it may be well to pass in review the elements which compose all objects. Decoration is the application of ornament to form. It therefore presupposes knowledge of both form and ornament, for form must be understood by itself, and ornament by itself, before the proper ornament may be selected for the given form. The elements of form are length, breadth, and thickness. A mathematical point is conceived to have no dimensions, a mathematical line but one, and a mathematical plane but two. But in actuality there is no tangible object without the third dimension—thickness. Still, where two dimensions are very much more prominent than the third—as, for instance, in a plaque, in the side of a room, in a single elevation of a building, or whenever merely the surface of an object is viewed—the third dimension may be left out of consideration. Lines and the surfaces they bound—that is, length and breadth—are the two elements of form which play the chief part in decoration.

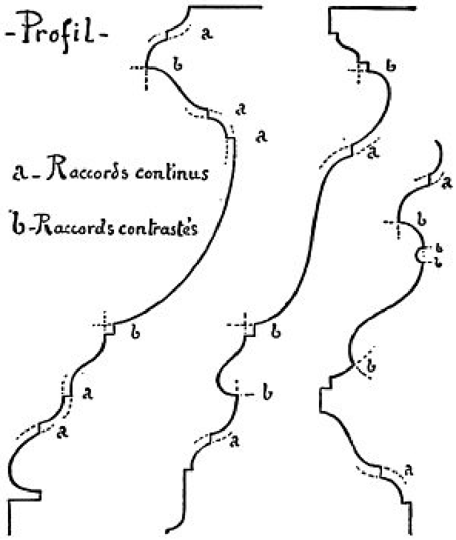


Fig. 2.

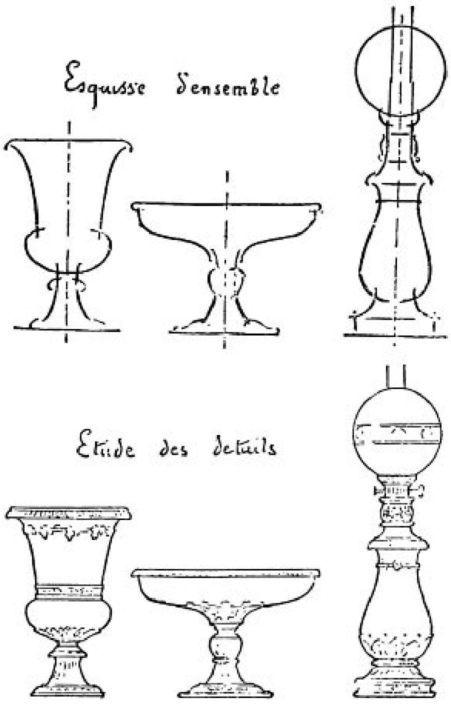


Fig. 3.

If the two vases which are represented in the view by vertical and horizontal, straight and curved lines, were actually before us you would have difficulty in finding any vertical lines, and the horizontal lines would turn out to be circles. The lines in the view mark the apparent terminations of the surfaces. For purposes of study, however, you must regard objects of three dimensions as bounded by lines, just as they appear in photographs, drawings, or other flat representations, geometric or perspective. In regarding objects from the point of view of decoration there is still another element to be considered; that is, the element of material, the substance of which objects consist, for it is evident that the ornament which would be appropriate to wood, for instance, might not be appropriate to metal or to stone. The element of material is of great importance in practical decoration, but of less importance in theoretical decoration. Lines and surfaces are therefore the two chief elements of decoration to be considered at present. Color, being an element of an entirely independent nature, will not be considered at all. 688

First, lines. The lines down one side of an object may be called the profile of the object, while the lines surrounding the object may be called the contour or outline of the object.

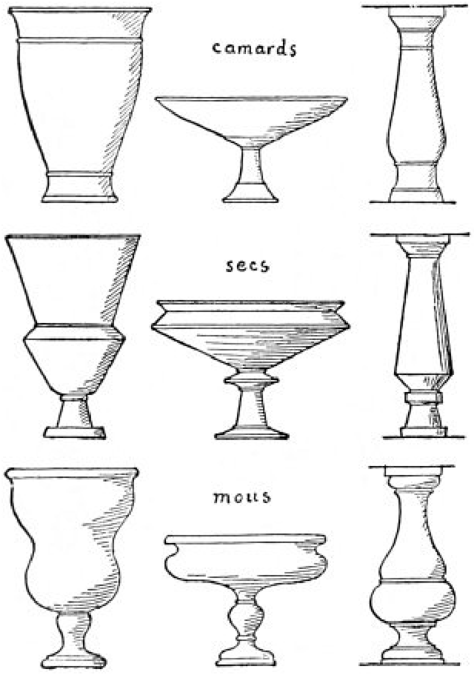


Fig. 4.

Profiles and outlines are made up of any number of straight and curved lines connected at any and every variety of angle. The view (Fig. 2) shows a few possibilities of combination of lines into profiles. The particular thing to be observed in these profiles is that individual curves are preceded or followed by curves which curve in the same direction or in the opposite direction—that is, regarding the curves as concave or convex from a given side of the profile, sometimes a concave curve meets a concave curve, sometimes it meets a convex curve. In these particular profiles the straight lines which unite the curves are so small and so insignificant that they appear as mere connections. Where the adjoining curves are homogeneous the connection is called continuous —*raccords continus*, as Mayeux puts it. When the adjoining curves are different, the connection is called 689
contrasted—*raccords contrastés*. In the view all continuous connections are marked *a*; all contrasted connections are marked *b*. Now follow these lines up and down slowly and deliberately—not once or twice, but a number of times. See exactly where the connections occur, and where the connections are continuous, and where they are contrasted. In these profiles are shown forth and made evident two of the most important and general laws not only of ornament, but of all artistic composition: First, that connected curves of the same kind must run substantially in the same direction; and, second, that for purposes of strong contrast curves of different kinds must be joined—that is to say, that where contrasted connection is desired, the difference in 690
direction must be abruptly and sharply indicated. In the profiles in the view the various curves have been continued in dotted lines beyond the profiles, so as to bring out and make clear these two laws. You see that wherever there is a *b.* the dotted lines cross at, or nearly at, right angles, and that wherever there is an *a.* there is no crossing at all of the dotted lines. The essence of these two laws is of such importance in all artistic and decorative composition that beginners might well be put to drawing profiles until the principles involved have been absorbed and made a part of artistic apprehension. The profiles in the view are all pleasing, because the laws are observed. Try your hand at drawing profiles in which the laws are not observed, and you will quickly perceive the difference. The most beautiful of pure profiles are those presented by Greek entablatures. The most beautiful of Greek outlines are those presented by Greek vases. The beauties of Greek sculpture and of renaissance design belong so strictly to the domain of pure art that they may not be used for comparison in an article on ornament.

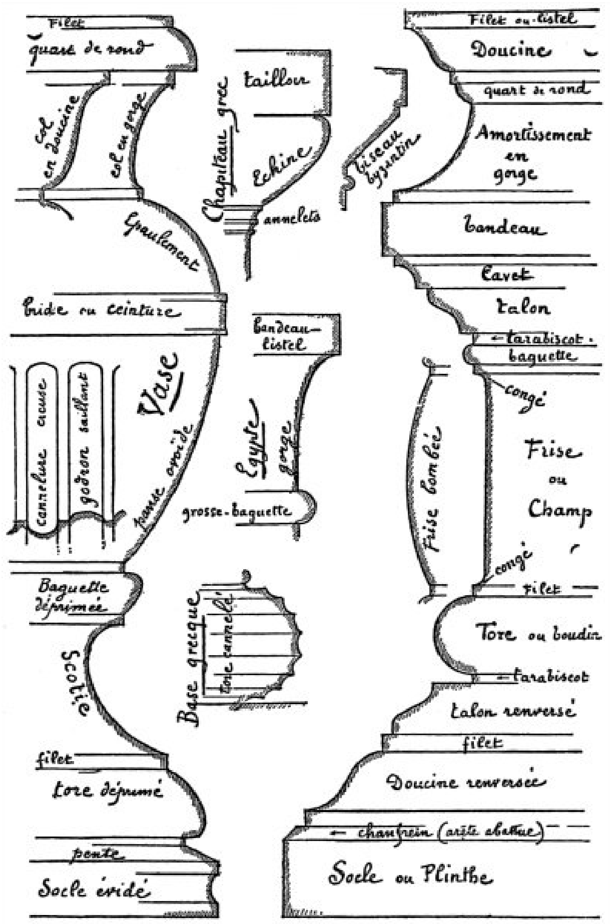


Fig. 5.

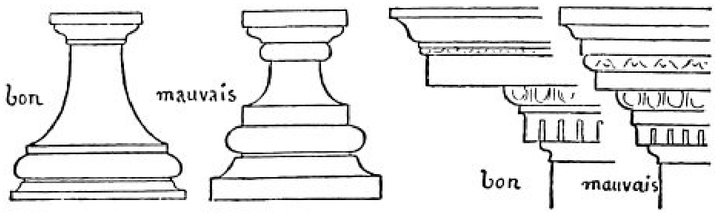


Fig. 6.

As outlines are composed of profiles, the same laws govern. That the curved line is the line of beauty stands out most evidently in the study of antique designs. Vertical lines and horizontal lines are the lines of support and strength, and must always have proper consideration; but in pure ornament the office of straight lines seems to be confined to connecting curves and to emphasizing their contrasts.

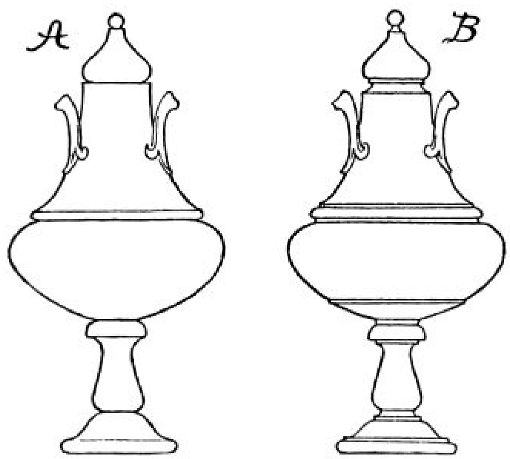


Fig. 7.

The next view (Fig. 3) is to illustrate the progress already made. On the upper line are the three rough outline sketches for modern articles, of which the final use and destination are shown on the lower line. In the sketch to the left the fine effect is produced by a few curves, of which the connections are boldly and finely contrasted. In the second sketch an equally pleasing effect is produced by curves, of which the principal ones are continuously connected, while in the third sketch there is a pleasing exhibition of both kinds of connections. The lower line gives you your first notion of the use of ornament in marking and embellishing the lines of form.

Contours bátards et indécis

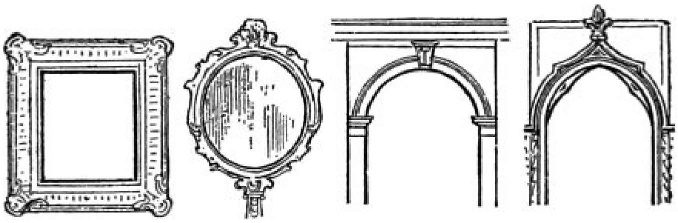


Fig. 8.

The next view (Fig. 4) exposes forms in which the above laws are violated, and by whose ugliness you can not fail to be impressed. On the top line are objects of which the curves are so weak and undecided that it would be difficult to state whether the connections are continuous or contrasted. In the second line is shown how ugly is the effect when straight lines are substituted for curved lines, and in the third line is shown how ugly effects may be produced even by curved lines when not used in obedience to some accepted and apprehended principle.

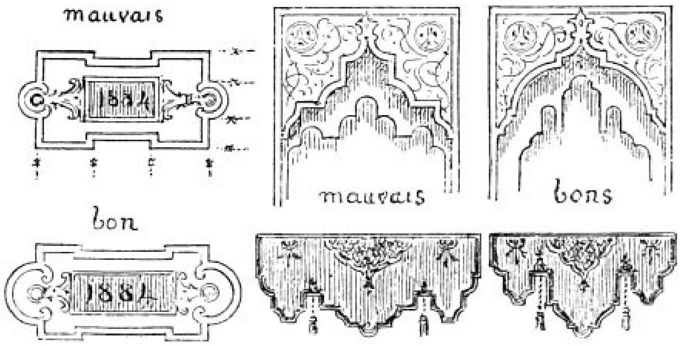


Fig. 9.

There is another presentation of form which is in reality but a modification of profile, but which, because it looks as if it had been separately applied, and also because it is separately treated in books, must be considered by itself. The term “molding” has been given to variations in surfaces which have both useful and ornamental 692
uses. Moldings are as old as architecture, and vary with schools of architecture.

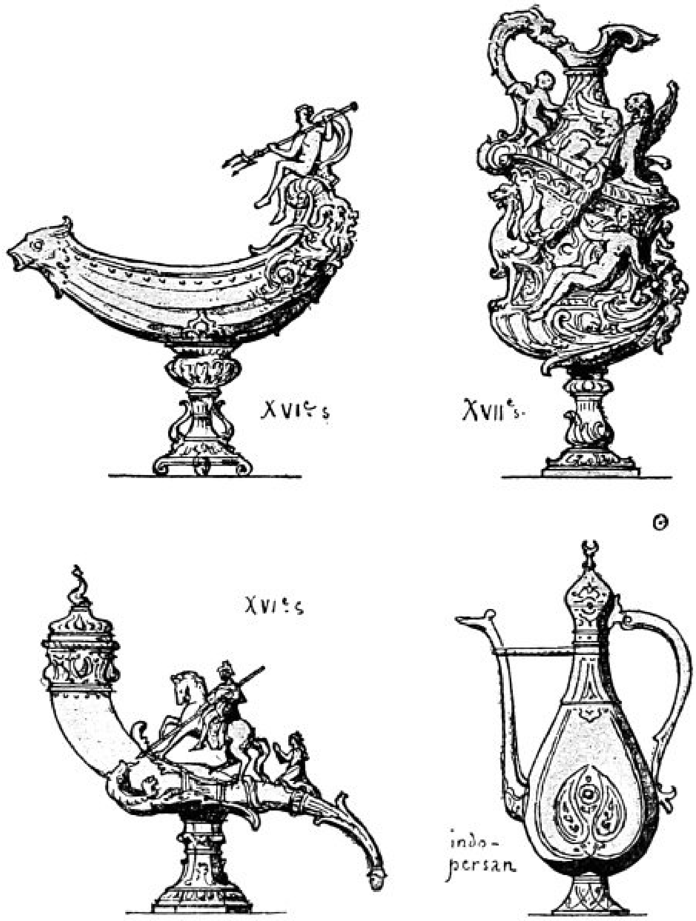


Fig. 10.

In the next view (Fig. 5), taken from Mayeux's work, are given the most ordinary Greek moldings with their French names. However necessary it must be for the architect, and however admirable it may be for the art student, to know the names of all moldings by heart and to be able to describe each one accurately, such proficiency is not required at present and is not necessary for the understanding of the present theme. Some moldings have square edges, some round. The curved edges of some are simple, of others complex. Each has its name, and of some the name is descriptive. The term molding would seem to indicate that moldings were made apart and subsequently applied to the main object. Whatever be the origin of moldings, the same rules apply to them which apply to other profiles, with the additional rule that moldings must always be kept subordinate to the principal object. For instance, in the view (Fig. 6) the pedestal marked *bon* is good, because the body of the 693
pedestal is the principal object and it is clearly seen that the moldings at the base and at the top are subordinate and merely ornamental, while the pedestal marked *mauvais* is decidedly bad, because more vertical space is given to the moldings than to the shaft, confusing outline, weakening the shaft, and destroying the sense of strong and steady support.

Readers may at once make use of the information already acquired by seeing how these rules apply to their own lamps, candlesticks, pieces of furniture, etc.

The next view (Fig. 7) shows incidentally how much better it is under all circumstances to mark with fillets and lines the changes from one curve to another, for you certainly see how much more substantial character and beauty has *B* than *A*.

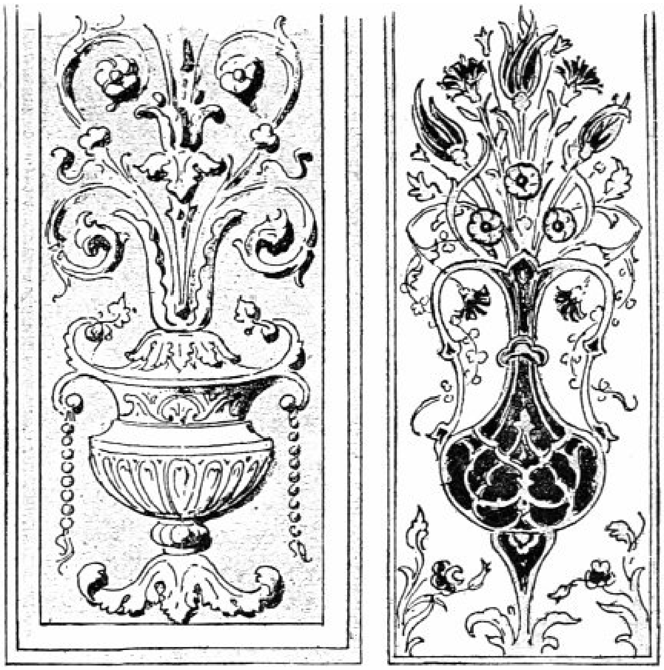


Fig. 11.

Finally, let it be said, and said emphatically, that though there are profiles which require the use of the compass to draw them, and though all architectural details must be worked out with mathematical accuracy, those profiles and outlines are the most beautiful where it is evident that artistic skill governing a free hand has controlled and where mechanical assistance is so subordinate as to be overlooked.

There is very little to be said about surfaces or forms of two dimensions. The principal requirement is that outlines should be agreeable and must be well defined. In fact, the two qualities are inseparable, for a well-defined outline is agreeable and a badly defined one is sure to be disagreeable. By well-defined is meant that its particular shape should easily appear and be clearly distinguishable. For instance, a square should appear with sides distinctly equal; a circle should have but one center. In an architectural opening either arch or entablature should prevail, and the character of the arch should be evident. In the examples presented (Fig. 8) in the view these principles are violated. The first figure is so clearly a square that at first, and before you have examined it closely, you think it is a square. It leaves an indefinite and consequently disagreeable impression. The same criticism applies to the second object, apparently a mirror. The glass is round, but the frame is so irregular that the impress of the circle is destroyed, and there is left an undecided and therefore uncomfortable sensation. In the third example the arch is so poorly defined and so weak, while the entablature above it is so strong and so prominent, that the result is a composition that fails to give pleasure, because no distinct idea is conveyed. In the last example the outlines of the arch are so indefinite that its character is indistinguishable. You can not see which prevails, the round arch or the pointed arch. 694

Fig. 12.

The same principles apply to smaller objects and to details, as seen in the next view (Fig. 9). To the left the date plate on top is bad in comparison with the one beneath it, because its direction is not so well marked and its corner projections are too large. In the lambrequins on the right, those are good in which the general direction is properly marked, and in which subdivisions are kept properly subordinated. Lambrequins have so entirely gone out of use nowadays that it is difficult to recall the time when they were regarded as indispensable parts of furniture.

There is one other point to which your attention should be called—that is, stability. If an object be intended to stand, its center of gravity should be so well within its base that there will be no danger of its being upset by 695 the ordinary uses to which it is exposed. Pots and pans, pitchers, lamps, and candlesticks, of general and daily household use, should have bases so broad and weight so low that the accidental bump of the inexperienced "help" will not be inevitably fatal.

When utensils are made more for show than for use, as those in Fig. 10, and are to occupy places of comparative security, beauty more than utility may be considered in the proportions of their supports. Where utility has disappeared altogether and the suggested outline of a vase, for instance, is used for purely ornamental purpose, supports may be done away with altogether, as appears in these drawings of Italian tapestries of the seventeenth century (Fig. 11).

The stability of pendant objects must also be considered. It is evident that the perpendicular line of suspension must be the line of equilibrium, and that these two must correspond with the design (Fig. 12). Whether any objects should under any circumstances be exposed to the real and apparent danger of falling is a question. We have got so into the habit of hanging pictures, engravings, and other works of art in our houses, and of seeing them hung in galleries, that we have lost sight of the incongruity of the custom. Pictures should be impaneled, and be permanent parts of the walls on which they appear. But, then, how could they be moved when owners tire of them, or tire of their houses, or how could they be gathered together in museums for purposes of study and public enjoyment? Picture frames are of comparatively modern invention. The idea of buying a picture for the purpose of selling it again was not entertained before the fifteenth century. Pictures were as substantial parts of churches and houses as were shrines and fireplaces.

Having very cursively reviewed the elements of form, we are in a position to understand decoration, which is simply the application to form of ornament.

The highest authenticated points at which flowering plants have heretofore been found growing upon the Andes are at about 17,000 feet, although the Kew Herbarium contains several specimens labeled as having been found at altitudes of from 17,000 to 18,000 feet. Sir Martin Conway has brought back from his recent explorations in the Bolivian mountains at least half a dozen species from 18,000 feet and upward, the highest being from about 18,500 feet. They include a saxifrage, a mallow, a valerian, and several *Compositæ*. *Compositæ* likewise attain the upper limit of phanerogamous vegetation in Thibet, where, in latitudes from 30° to 34°, one was found by Dr. Thorold at 19,000 feet.

696

STEAM TURBINES AND HIGH-SPEED VESSELS.[F]

By the Hon. CHARLES A. PARSONS, F. R. S.

[F] Abstract of the Presidential Address to the Institution of Junior Engineers, November 3, 1899.

All heat engines at present in use take in heat from a source at a high temperature and discharge most of it at a lower temperature, the disappearance of heat in the process being the equivalent of the work done by the engine. In all cases at the present time the source of heat is from fuel of some kind, and after working the engine the residue is discharged in the case of the steam engine either to the condenser or in the exhaust steam when non-condensing. In the gas engine it is discharged in the waste gases and into the water jacket around the cylinder.

The earliest records of heat engines are found in the Pneumatics of Hero of Alexandria, about 200 B. C. He describes a reaction steam turbine, a spherical vessel mounted on axes supplied with steam through one of the trunnions from a boiler beneath; the steam escaping through two nozzles diametrically opposite to each other and tangential to the sphere, causing the sphere to rotate by the reaction or momentum of the issuing steam, and analogous to a Barker's water wheel.

Thus, the first engine deriving its motive power from fuel was a crude form of steam turbine, and though it could have been applied to useful work, and could easily have been made sufficiently economical to replace manual and horse power in many instances, yet it lay dormant till 1629 A. D., when Bianca suggested the same principle in a different form. Bianca's steam turbine consisted simply of a steam jet fed from a boiler impinging against vanes or paddles attached to the rim of a wheel which was blown round by the momentum of the steam issuing from the jet.

The piston engine is, however, of comparatively modern origin, and dates from about the year 1700 A. D. Engines of this class are so well known that it suffices to say that they have been practically the sole motive-power engines from fuel in use from 1700 up to 1845, and have constituted one of the most important factors in the development of modern engineering enterprise.

Air engines were introduced about the year 1845, and although the larger engines of the Stirling type were very economical in fuel, yet, on account of the inherent difficulty of heating large volumes of air within metal chambers or pipes—a difficulty arising from the low conductibility of air and consequently the overheating and burning of the metal—they have only come into commercial use for very small powers. 698

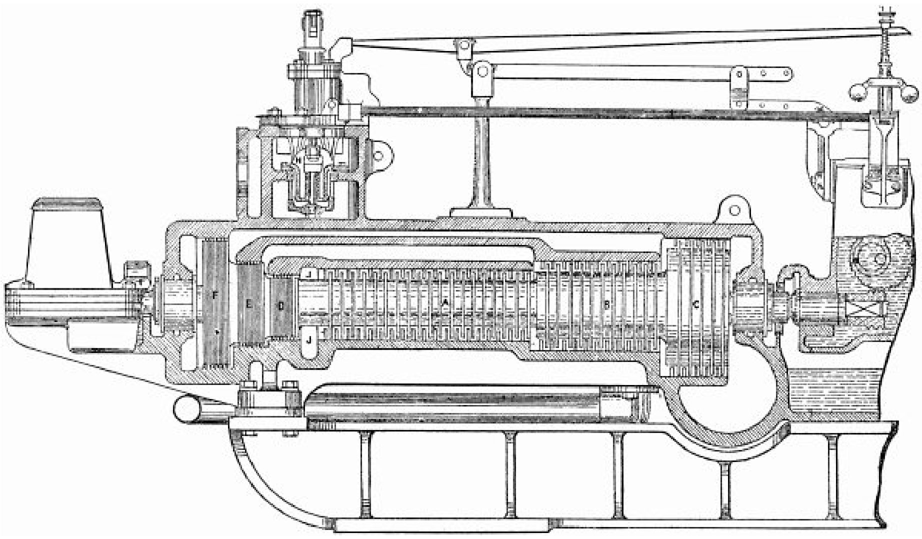


Fig. 1.—Longitudinal Diagram of Parsons's Steam Turbine, with Side of Containing Case removed. The construction of the blades and guide vanes is more clearly shown in Fig. 2. The steam enters at *J* and exhausts after leaving the low-pressure cylinder *C*.

During the last thirty-five years gas engines have been perfected, and more recently oil engines, and in point of efficiency both convert a somewhat larger percentage of the heat energy of the fuel into mechanical energy than the best steam engines. All successful oil and gas engines are at present internal-combustion engines, the fuel being burned in a gaseous form inside the working cylinder.

Very numerous attempts have, however, been made to construct internal-combustion engines to burn solid fuel instead of gas. Some have been so far successful as to work with good economy in fuel, but the bar to their commercial success has been the cutting of the cylinder and valves by fine particles of fuel. This difficulty is not present when the fuel is introduced in the gaseous or liquid form, and hence the success of gas and oil engines; but could this difficulty be overcome, the solid fuel would be the cheaper to use.

Internal-combustion engines, gas engines, oil engines, cannon, etc., owe their superior economy in fuel to the very high temperature at which the heat is transferred from the fuel to the working substance of the engine, and consequently the great range of temperature in the working substance of the engine. In steam engines the temperature is limited by the practical difficulties of deterioration of metal and materials involved in the construction.

About fifteen years ago I was led by circumstances to investigate the subject of improving the steam turbine. In recent times several attempts had been made to apply steam turbine wheels of the Hero and Bianca types to the driving of circular saws and fans. The velocity of rotation with either of these types must necessarily be very high in order to obtain a reasonable efficiency from the steam, a velocity much in excess of that suitable for the direct driving of almost all classes of machinery; gearing was considered objectionable, and it therefore appeared desirable to adopt some form of turbine in which the steam should be gradually expanded in small steps or drops in pressure so as to keep the velocity of flow sufficiently low to allow of a comparatively moderate speed of rotation of the turbine engine.

The method adopted was to gather a number of turbines of the parallel flow type on to one shaft and contained in one case, the turbines each consisting of a ring of guide and a ring of moving blades, the successive rings of blades or turbines being graduated in size, those nearer the exhaust end being larger than those near the steam inlet, so as to allow a gradual expansion of the steam during its passage through the turbines.

The form of the turbine was that of a rotating drum, with outwardly projecting rings of blades which nearly 699
touched the containing cylindrical case, and on the case inwardly projecting rings of guide blades which nearly touched the drum. In the first examples of the engine there were two groups of turbines right-and left-handed on each side of the steam inlet, the exhaust taking place at each end of the turbine case, so as to completely balance end pressure from the steam. More recently one series of turbines only has been used, those on the other side of the steam inlet being replaced by packing rings or rotating balance pistons which balance the end pressure and divert the whole of the steam through the turbines on the other side.

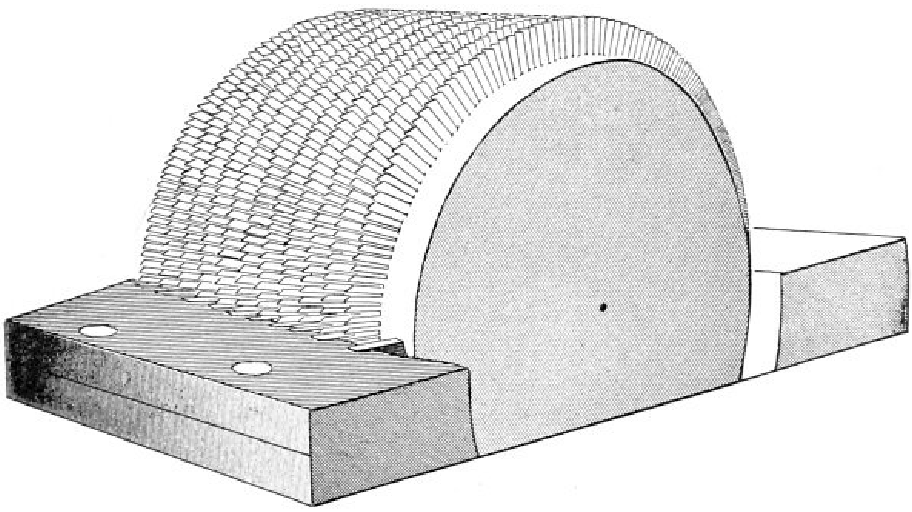


Fig. 2 shows the Arrangement of Moving Blades and Guide Vanes in a Parsons's Turbine. The top outer cover has been removed. The cylinder containing the revolving barrel has, as will be seen, a greater internal diameter than the diameter of the drum. It is the annular space thus formed through which the steam flows and which contains the revolving blades and the fixed guide blades. Between each two rings of moving blades there is a ring of guide blades, the latter being keyed into the containing case. The vanes are set at an angle, so that the steam acts on them as wind on the sails of a windmill.

The steam entering the annular space between the shaft and the case passes firstly through a ring of guide blades attached to the case, and is given a rotational direction of flow; it then passes to the succeeding ring of blades attached to the shaft, by which its direction of rotation is reversed, thereby impressing the difference of its rotational momentum in torque to the shaft. The steam then passes to the second ring of guide blades, and the process is repeated, and so on, gradually expanding by small increments at each ring of blades; the succeeding rings of blades get longer and wider, and at intervals the diameter of the turbine drums, cylinders, and rings are also increased. In condensing turbine engines of the larger size an expansion ratio in the turbines 700
of one hundredfold and upward is attained before the steam passes to the exhaust pipe and condenser.

The loss of power present in engines of the piston class, due to cylinder condensation arising from the variation of steam pressure in the cylinder, is not present in the steam turbine, as the steam pressure remains constant at each turbine ring and each part of the cylinder and barrel, and the numerous tests of steam consumption that have been made have shown that compound steam turbine engines of moderate sizes when working with a condenser are comparable in steam consumption per effective horse power with the best compound or triple condensing steam engines of the piston type. They have been constructed in sizes up to about one thousand horse power for driving alternators and dynamos, and several sets of about two thousand horse power are nearing completion.

The application of the compound steam turbine to the propulsion of vessels is a subject of considerable general interest, in view of the possible and probable general adoption of this class of engine in fast vessels.

In the turbine is found an engine of extremely light weight, with a perfectly uniform turning moment, and very economical in steam in proportion to the power developed, and, further, it can be perfectly balanced so that no perceptible vibration is imparted to the ship. The problem of proportioning the engine to the screw propellers and to the ship to be driven has been the subject of costly experiments extending over several years, with the result that a satisfactory solution has been found, giving very economical results in regard to pounds of steam consumed in the engines per effective horse power developed in propelling the vessel, results which are equal or superior to those so far obtained with triple-expansion engines of ordinary type in torpedo boats or torpedo-boat destroyers. The arrangement adopted may be best described by saying that instead of placing, as usual, one engine to drive one screw shaft, the turbine engine is divided into two, three, or sometimes more separate turbines, each driving a separate screw shaft, the steam passing successively through these turbines; thus when there are three turbines driving three shafts, the steam from the boiler passes through the high-pressure turbine, thence through the intermediate, and lastly through the low, and thence to the condenser.

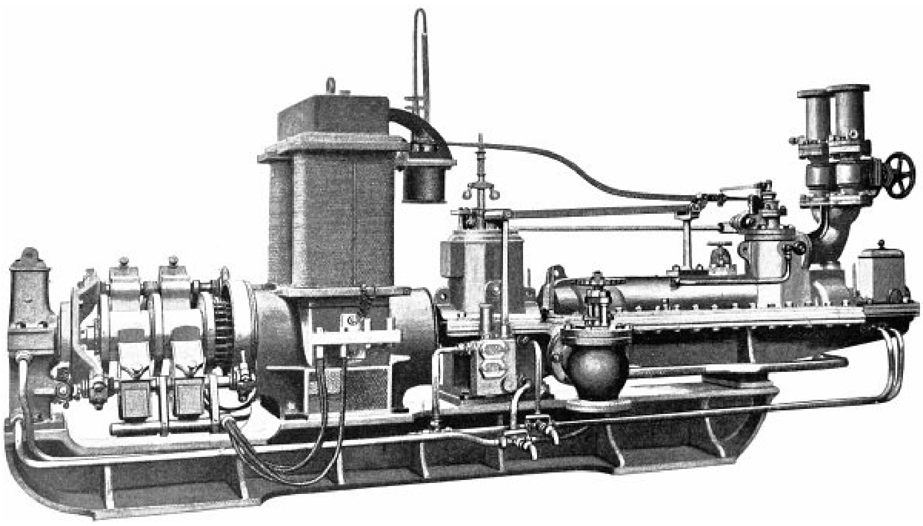


Fig. 3.—A Seventy-five Kilowatt Turbine Engine directly connected to a Dynamo. The turbine engine is on the right.

As to the propellers, these approach closely to the usual form. It has, however, been found best to place two propellers of approximately the same pitch on each shaft at some considerable distance apart, so that the after one shall not be seriously affected by the wash of the one in front. The advantage of this arrangement is that a 702
sufficient blade area is obtained to carry the thrust necessary to drive the vessel with a lesser diameter of propeller, and so permitting of a higher speed of revolution of the engines.

The problem was complicated by the question of cavitation, which, though previously anticipated, was first practically found to exist by Mr. Thornycroft and Mr. Barnaby in 1894, and by them it was experimentally determined that cavitation, or the hollowing out of the water into vacuous spaces and vortices by the blades of the propeller, commences to take place when the mean thrust pressure on the projected area of the blades exceeds eleven pounds and a quarter per square inch. This limit has since been corroborated during the trials of the Turbinia.

This phenomenon has also been further investigated in the case of model propellers working in an oval tank of water, and to permit of cavitation at more moderate speeds than would otherwise have been necessary, the following arrangement was adopted: The tank was closed, plate-glass windows being provided on each side, through which the propeller could be observed, and the atmospheric pressure was removed from the surface of the water by an air pump; under this condition the only forces tending to prevent cavitation were the small head of water above the propeller, and capillary attraction.

In the case of a propeller of two inches in diameter, cavitation commenced at about twelve hundred revolutions, and became very pronounced at fifteen hundred. Had the atmospheric pressure not been removed, speeds of twelve thousand and fifteen thousand respectively would have been necessary.

Photographs were taken with a camera made for the purpose, with a focal plane shutter giving an exposure of about one thousandth of a second, the illumination being by sunlight concentrated on the propeller from a twenty-four-inch concave mirror.

Photographs were also taken by intermittent illumination of the propeller from an arc lamp, the arrangement consisting of an ordinary lantern condenser, which projected the beam on to a small concave mirror, mounted on a prolongation of the propeller shaft, the reflected beam being caught by a small stationary concave mirror at a definite position in each revolution and reflected on to the propeller. By this means the propeller was illuminated in a definite position at each revolution, and to the eye it appeared as stationary. The cavities about the blades could also be clearly seen and traced, the photographs being taken with an ordinary camera and about ten seconds' exposure.

A series of experiments was also made with model propellers in water at and just below the boiling point, 703
dynamometric measurements being taken of power and thrust with various widths of propeller blade, the conclusion arrived at being that wide and thin blades are essential for fast speeds at sea, as well as a coarse pitch ratio of propeller.

The first vessel fitted with steam turbine machinery was the Turbinia. She was commenced in 1894, and, after many alterations and preliminary trials, was satisfactorily completed in the spring of 1897. Her principal features are: Length, one hundred feet; beam, nine feet; five-foot draught of water under the propellers; forty-four tons and a half displacement on trial; she is fitted with a water-tube boiler of eleven hundred feet total heating surface, and forty-two square feet of grate area, with closed stoke-holds supplied with air from a centrifugal fan mounted on a prolongation of the low-pressure turbine shaft. The engines consist of three compound steam turbines, high pressure, intermediate, and low pressure, each driving one screw shaft; on each of the shafts are three propellers, making nine in all; the condenser is of the usual type, and has four thousand square feet of surface.

When officially tested by Professor Ewing, F. R. S., assisted by Professor Dunkerley, she attained a mean speed on a measured mile of thirty-two knots and three quarters, and the consumption of steam for all purposes was computed to be fourteen pounds and a half per indicated horse power of the main engines. Subsequently, after some small alterations to the steam pipe, she was further pressed, and is estimated to have reached the speed of thirty-four knots and a half. She was, and still is, therefore, the fastest vessel afloat; she has been out in very rough weather, is an excellent sea boat, and at all speeds there is an almost complete absence of vibration.

In the Turbinia the exceptional speed results principally from two causes: 1. The engines, screws, and shafting are exceptionally light. 2. The economy of steam in the main engines is greater than usual.

At full speed the steam pressure in the boiler is two hundred and ten pounds; at the engines, one hundred and seventy-five; and the vacuum in the condenser twenty-seven inches, representing an expansion ratio in the turbines of about one hundred and ten after allowance has been made for wire-drawing in the exhaust pipe.

The first vessels of larger size than the Turbinia to be fitted with steam turbine machinery are the torpedo-boat destroyer Viper for the British Government, and a similar vessel for Messrs. Sir W. G. Armstrong, Whitworth & Company.

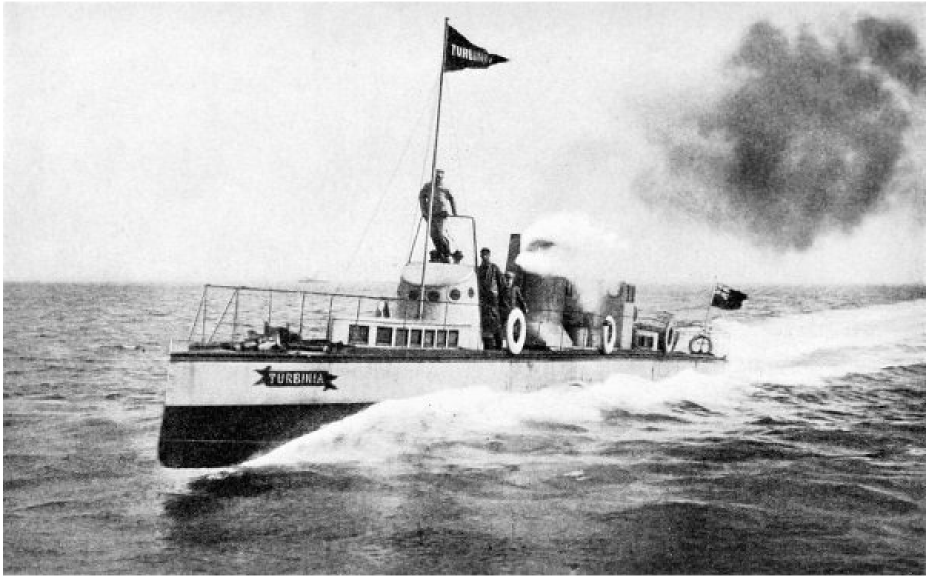


Fig. 4.—The Turbinia running about Forty Miles an Hour.

These vessels are of approximately the same dimensions as the thirty-knot destroyers now in her Majesty's service, but have slightly more displacement. The boilers are about twelve per cent larger, and it is estimated that upward of ten thousand horse power will be realized under the usual conditions, as against sixty-five hundred with reciprocating engines. 705

The engines of these vessels are in duplicate. Two screw shafts are placed on each side of the vessel, driven respectively by a high- and a low-pressure turbine; to each of the low-pressure turbine shafts a small reversing turbine is permanently coupled for going astern, the estimated speed astern being fifteen knots and a half, and ahead thirty-five knots; two propellers are placed on each shaft.[G]

[G] On her second trial trip the Viper attained a mean speed of 34.8 knots, her fastest trial being over 35 knots, or about 41 statute miles per hour, with an indicated horse power of 11,000. This vessel is of about 350 tons displacement.

The latter of these two vessels has commenced her preliminary trials, and has already reached a speed of thirty-two knots. The manipulation of the engines is a comparatively simple matter, as to reverse it is only necessary to close one valve and open another, and, owing to there being no dead centers, small graduations of speed can be easily made.

In regard to the general application of turbine machinery to large ships, the conditions appear to be more favorable in the case of the faster class of vessels such as cross-Channel boats, faster passenger vessels, cruisers, and liners; in such vessels the reduction in weight of machinery, as well as economy in the consumption of coal per horse power, are important factors in the case, and in some vessels the absence of vibration, both as regards the comfort of passengers, and in the case of ships of war permitting greater accuracy in sighting of the guns, is a question of first importance.

As regards cross-Channel boats, the turbine system presents advantages in speed, absence of vibration, and, owing to the smaller diameter of the propellers, reduced draught.

As an instance, a boat of two hundred and seventy feet length, thirty-three feet beam, one thousand tons displacement, and eight feet six inches draught of water could be constructed with spacious accommodation for six hundred passengers, and with machinery developing eighteen thousand horse power; she will have a sea speed of about thirty knots, as compared with the speed of nineteen to twenty-two knots of the present vessels of similar size and accommodation.

It is, perhaps, interesting to examine the possibilities of speed that might be attained in a special unarmored cruiser, a magnified torpedo-boat destroyer of light build, with scanty accommodation for her large crew, but 706
equipped with an armament of light guns and torpedoes. Let us assume that her dimensions are about double those of the thirty-knot destroyers, with plates of double the thickness and specially strengthened to correspond with the increased size—length, four hundred and twenty feet; beam, forty-two feet; maximum draught, fourteen feet; displacement, twenty-eight hundred tons; indicated horse power, eighty thousand; there would be two tiers of water-tube boilers; these, with the engine space, coal bunkers, etc., would occupy the whole of the lower portion of the vessel; the crew’s quarters and guns would be on the upper decks. There would be eight propellers of nine feet in diameter revolving at about four hundred revolutions per minute, and her speed would be about forty-four knots.

She could carry coal at this speed for about eight hours, but she would be able to steam at from ten to fourteen knots with a small section of the boilers more economically than other vessels of ordinary type and power, and, when required, all the boilers could be used, and full power exerted in about half an hour.

In the case of an Atlantic liner or a cruiser of large size, turbine engines would appear to present some considerable advantages. In the first place they would effect a reduction in weight of machinery and some increase in economy of fuel per horse power developed, both thus tending either to a saving in coal on the one hand, or, if preferred, some increase in speed.

The advantages are, however, less pronounced in this class of vessel on account of the smaller relative power of the machinery and the large quantity of coal necessary for long voyages, but the complete absence of vibration at all speeds, not to mention many minor considerations of saving in cost and reduced engine-room staff, are questions of considerable importance.

A SURVIVAL OF MEDIÆVAL CREDULITY.

By Professor E. P. EVANS.

[*Concluded.*]

In the seventeenth year of her age Miss Diana Vaughan joined the Freemasons, entering the lodge ("triangle") of "The Eleven Seven," at Louisville, and passing rapidly through the different grades until the "Elect Palladistic Knighthood" was conferred upon her after she had given satisfactory proofs of her Luciferian orthodoxy. One thing she refused to do—namely, to stab the host with a dagger—since this act implied a recognition of the sacramental character of the Eucharist. She maintained that there would be no sense in 707
piercing the consecrated wafer unless it was believed to be the real body of Christ; but as she rejected the doctrine of transubstantiation as a childish superstition, she was unwilling to make a fool of herself by assaulting a piece of ordinary bread with a show of wrath. She would not hesitate to commit sacrilege, but did object to being silly. This scruple, or rather this lively sense of the ridiculous, rendered her unpopular with the Freemasons, inasmuch as it marred the performance of their most important and impressive Satanic ceremony, and thus gave her rival, Sophia Walder, an advantage, which she was quick to improve.

We need not follow the career of Sophia Walder, known to the infernals as Sophia Sapho. She is said to have been born in Strasburg, September 29, 1863, as the supposititious daughter of a Protestant parson, Philias Walder, and a Rosicrucian dame, Ida Jacobsen, with whom the clergyman lived after having murdered his wife in Copenhagen. Her real father, however, was the devil Bitru, who declared her to be the predestined great-grandmother of antichrist. In 1896, while in Jerusalem, she gave birth to a daughter, the grandmother of antichrist; this child was also of demoniac paternity. Owing to her uncompromising Luciferianism, she was a favorite of the Freemasons, and excited the jealousy of Diana Vaughan, who tells with zest of the practical jokes played on her. Thus, at a banquet of the Freemasons, somebody put a few drops of Lourdes water in her glass of lemonade, which caused terrible pain and threw her into spasms, from which she finally found relief by vomiting fire. This incident is cited by a Catholic writer, Dr. Michael Germanus,[H] in his Secrets of Hell (*Geheimnisse der Hölle*), as conclusive proof that "Sophia was possessed."

[H] Michael Germanus (a Latinization of "*Der deutsche Michel*," the personification of the German nation, analogous to the English "John Bull" and the American "Brother Jonathan") is the pseudonym of a priest, Parson Künzle, of Feldkirch, in the Tyrolese Voralberg.

Bitru's proclamation of Sophia Sapho as the prospective great-grandmother of the incarnate antichrist is given in full. It was dictated in Latin by Bitru at a meeting of Freemasons in Italy, and written down by Luigi Revello, and bears the devil's signature, composed of Satanic signs and symbols, darts, sword, cords, lightning, bugle-horn, trident, and crowing cock.

This climax of absurdity ought to have served to expose the trickery and trumpery of the whole affair, but it 708
produced the very opposite effect. Dr. Germanus refers to "Bitru's sign-manual as highly interesting," and characterizes "the documentary evidence as thoroughly convincing"; those who refuse to recognize the truth in the face of such positive proof he accuses of imitating the ostrich and willfully shutting their eyes to the light.[I]

[I] A photographic reproduction of this document is given in Diana Vaughan's biography of the Italian statesman Crispi, which contains numerous illustrations and portraits of Crispi, Mazzini, Lemmi, Garibaldi, Giordano Bruno, and other "Palladists," or Masonic worshipers of Satan. The original French title of the book is "Le 33e ⁂ Crispi. Un Palladiste Homme d'État démasqué. Biographie documentée du Héros depuis sa Naissance jusqu' à sa deuxième Mort. Par Miss Diana Vaughan."

The salvation of Diana Vaughan is described as due to her intense admiration for Joan of Arc, a feeling which was ardently fostered by the priests with whom she chanced to come in contact. One day, as she was attended by Asmodeus, Astaroth, Beelzebub, and Moloch, incarnate in "the counterfeit presentment" of fine gentlemen, she obeyed a sudden and irresistible impulse to invoke the Maid of Orleans, when these devils were immediately stripped of their disguise, and stood before her in their true character as imps of hell, with hoofs and horns, and emitted an intolerable stench. No sooner did they perceive that they were unmasked than they vanished with a fearful howl. This miracle made a deep impression upon her, and led to her conversion. She took refuge in a Parisian cloister, and, after severe penance and proper instruction, was received into the bosom of the Catholic Church. During this period of penitential seclusion she wrote her Memoirs, which produced an immense sensation in clerical circles, and were pronounced by a high ecclesiastical dignitary to be "worth more than their weight in gold."

It must be confessed that in weaving this tissue of fabrications Taxil showed consummate skill as a romancer

and a profound knowledge of the possibilities of human credulity. He made a happy hit in calling the heroine of his Stygian story Diana, since in the annals of witchcraft the pagan goddess of the chase is wont to frequent the nocturnal assemblies of demons, and in mediæval theology the phrase “*congressus Sabathi cum Diana*” was a common expression for intercourse with Satan. Another masterly stroke was to represent her deliverance from the snares of evil spirits and the hallucinations of Luciferianism as a miracle of grace wrought through the mediation of Joan of Arc, thus furnishing an argument in favor of the canonization of the Maid of Orleans, which the cleverest *advocatus diaboli* would be unable to answer. At this time Taxil prepared also a Catholic prayer
book entitled *Eucharistic Novena*, published under the name of Diana Vaughan, and containing forms of 709
supplication against unbelief, worldly indifference and lukewarmness, hardness of heart, blasphemy, and unchastity. The covert sarcasm which pervades the entire manual of devotion comes out most clearly in the section on the violation of the seventh commandment. A copy of the work, which had been approved by the Archbishop of Genoa, was sent to Cardinal Parocchi, with a letter signed “Your Eminence’s most devoted servant in Jesus, Mary, and Joseph, Diana Vaughan,” and five hundred francs, of which two hundred and fifty were to be used for organizing an international antimasonic congress, and the rest to be given as Peter’s pence to the Pope. The cardinal replied with great cordiality to his “dear daughter in our Lord,” called her conversion “one of the most glorious triumphs of grace,” and added, “I am reading at this very moment your Memoirs with burning interest.” He gave her his blessing, and conveyed “the thanks and special benediction of his Holiness.” Numerous letters of a like character were received from the Vatican. On May 27, 1896, the General Secretary of the Apostolic See, Verzichi, wrote that “his Holiness had read her *Eucharistic Novena* with extreme pleasure”; two months later the Pope’s private secretary, Vincenzo Sardi, thanked her in the name of Leo XIII for her exposure of Crispi, and bade her “continue to write and to unmask the godless sect,” and the *Civiltà Cattolica*, the official organ of the papacy, praised her “inexhaustibleness in precious revelations, which are unparalleled for their accuracy and usefulness. Freemasonry is confounded, and seeks to evade the blows of the valiant championess by denying her existence, and treating her as a myth. It is a pitiable shift, but Freemasonry can find no better refuge.” “Your pen and your piety,” wrote Monsignore Villard, October 15, 1896, “are predestined to demolish the foes of mankind. The good works of the saints have always met with opposition, and it is no wonder, therefore, that yours should be combated.”

Naturally, there was intense curiosity to see this new convert and powerful defender of the faith. This inquisitiveness was easily allayed at first by the plea that the cloister to which she had retired must be kept secret, in order that she might be safe from assassination by the Freemasons. Meanwhile the medium of correspondence was a bright American girl, employed as copyist in a Parisian typewriting establishment, who wrote all the letters at Taxil’s dictation, and received a monthly salary of one hundred and fifty francs for her services. After a time he deemed it politic to introduce her privately to select circles of Catholics, who were
thereby enabled to testify to her existence, since they had seen and conversed with her. The following incident 710
may be mentioned to illustrate the adroitness with which she played her part: M. Pierre Lautier states that he once breakfasted with her, and offered to pour a little Chartreuse into her coffee, but she refused it with a singular sign of aversion, and took a few drops of old cognac instead. As an ex-Luciferian, she instinctively shrank from a drink made in a cloister, or what she called “an Adonaïc liquor.” That she should have thought of such a feint on the spur of the moment indicates that she had not only made a thorough study of her rôle, but also had been endowed by Nature with genuine theatrical talent. A full account of the solemn sham, published in the *Revue Mensuelle*, served to strengthen the faith of waverers in the reality of Diana Vaughan, and furnished an admirable opportunity for discoursing on the difficulty of throwing off Satanic influences; for here was a young lady who, although she had received absolution and thus become a child of grace, could not forget the terrible effect of a few drops of Lourdes water on one of her former demonolatrous associates, and recoiled with horror from a glass of Chartreuse. Taxil and his confederates confess that they often “doubled up with laughter” over the success of their imposture, and indulged in jokes about it in their writings. Thus Dr. Bataille, in the first volume of The Devil in the Nineteenth Century, remarks, as a peculiarity of Diana Vaughan, that she “is very fond of wearing male attire,” but no allusions of this kind, however pointed, seemed to have excited any suspicion of guile in minds predisposed to credulity by Nature and by education.

Taxil’s long series of mystifications, extending over a dozen years, culminated in the convocation of an antimasonic congress at Trent, on September 26, 1896, to the president of which Leo XIII addressed an apostolical brief with his benediction, and expressed the hope that the assembled representatives of the Church would not rest until the “detestable sect” had been unmasked and the evil utterly eradicated. A “central executive committee,” consisting of a score of Italian papists, issued a circular summoning all Catholics to join “the new crusade,” and declaring that the Vatican had now raised a war-cry against Freemasonry, “the den of Satan,” as it did eight centuries ago against Islam. Taxil was received with ovations, and did not hesitate to poke fun at the venerable prelates to their very faces. With an assumption of modesty he reproved them for what might be misplaced enthusiasm. “One can never be sure,” he said, “of a converted Freemason, but must always fear lest he may return to his former friends. Not until the convert is dead can one be wholly free from
this anxiety. I am well aware that this general principle applies also to myself.” But even this daring dash of 711
irony, hardly hidden under the gauzy disguise of self-distrust, did not cool the ardor of his admirers, who continued to greet the harlequin with “*Evviva Taxil*!” His photograph hung among the pictures of the saints, and the mere mention of his name called forth loud applause, whereupon the prince of mountebanks rose and bowed. A few Germans had the good sense and courage to protest against these demonstrations, and to doubt the existence of Diana Vaughan and the sincerity of Taxil, whose sole object, as Dr. Gratzfeld asserted, was to “lay a snare for Catholics and anti-Freemasons, and scoff at them when they are caught in it.” This skepticism created intense excitement, and was severely rebuked by an Italian priest and a Parisian prebendary, who averred that they knew Diana Vaughan personally, and could vouch for her saintliness. A French monk used such violent language in his reply to Dr. Gratzfeld that the presiding officer, although indorsing his views, felt constrained to call him to order. “Any doubt of Diana Vaughan’s existence or of the genuineness of her revelations,” exclaimed the Abbé de Bessonies, “is a sin against the antimasonic cause!” The Spanish delegates introduced a resolution demanding that all Freemasons should be legally incapacitated to hold any civil office or military command; the resolution was adopted, with the amendment that “wherever it may be feasible” such laws should be enacted and executed. The manner in which Taxil met the allegations of his opponents is highly

characteristic. “A priest of the Holy Sacrament, Father Delaporte, had often declared that he would gladly give his life for the conversion of Diana Vaughan. She attended mass in the cloister for the first time on Corpus Christi, and left her sacred retreat on the following Saturday. On the very day of her departure Father Delaporte died. And yet there are persons who doubt the existence of Miss Vaughan!” The burst of applause elicited by this irrefragable argument proved his accurate appreciation of the logical powers of his auditors, whose minds had been fed on the nutriment which may be wholesome as “milk for babes,” but, when persistently administered to adults, converts them into intellectual milksops.

Although the congress was attended by many of the chief dignitaries of the papal hierarchy, and the Romish Patriarch of Constantinople sat there in state with a golden crown on his head, Taxil was its ruling spirit. On his motion, it was resolved to establish antimasonic associations in every land under the auspices of the bishops and the direction of national committees, and a commission was appointed to investigate the Diana Vaughan affair. A few months later, on January 22, 1897, this commission made an indecisive and utterly nugatory 712
report, to the effect that “no thoroughly convincing evidence had been furnished for or against the existence and conversion of Diana Vaughan and the authenticity of the writings attributed to her.” This evasion of the issue, however, did not shake the confidence of the ultramontane press, nor prevent its positive affirmation of the points which the commission had discreetly left in doubt. As a reward for this fanatical zeal and steadfast credulity, the editor of The Pelican received a special apostolical benediction, and was thus encouraged to “resist the raging of Satan.” “Stand firm!” he exclaimed. “The Holy Father is with us, and who is over him?”

With the Congress of Trent the mystification which Taxil had been playing off on papacy for so many years had reached the acme of success, and nothing now remained but to wind up the plot with a drastic *denouement*. Accordingly, Diana Vaughan issued an invitation to a conference to be held on April 19, 1897, in the great hall of the Geographical Society of Paris. It was also stated that other conferences would be held in the principal cities of France, Italy, England, and the United States. The programme for the evening was quite elaborate, beginning with a lottery for an American typewriter and ending with a series of fifty-four stereopticon pictures representing, among other fantastic scenes, Sophia Walder and her serpents, events in the life of Diana Vaughan, the apparition of the devil Bitru in Rome, Eden and Eve with the fatal apple, sacrilegious stabbing of the host on a Satanic altar in a Masonic lodge at Berlin, and finally Leo XIII with the encyclical letter *Humanum genus* as a flaming sword in his hand, the archangel Michael on his right and the apocalyptic St. John on his left treading the triple-headed dragon of Freemasonry under foot. The audience consisted chiefly of priests, with a few Protestant clergymen and Freemasons, and an unusually large number of newspaper reporters. The typewriter was won by Ali Kemal, correspondent of the Constantinople journal *Ikdam*, who only regretted that it did not write Turkish. Taxil then appeared on the platform, and began his address with the words: “Reverend sirs, ladies, and gentlemen! You wish to see Diana Vaughan. Look at me! I myself am that lady!” After this startling exordium, he proceeded to relate how from his youth up he had always had an irresistible inclination to play practical jokes. Once he frightened the inhabitants of Marseilles by discovering a shoal of sharks in the harbor, and again he set the archæologists all agog by announcing the existence of a city, built on piles, at the bottom of Lake Leman. But these were “childish things” compared with the manner in which he had humbugged the Catholic clergy for nearly a dozen years. We need not report the details of his discourse; it is sufficient to 713
say that he gave a full account of the deep-laid plot from its first conception to its final consummation at the Congress of Trent. Each new disclosure called forth cries of “Liar!” “Scoundrel!” “Vilifier!” “Villain!” and similar epithets, but nothing could disturb the cynical composure of the speaker. As a precautionary measure, all persons had been required to give up their canes and umbrellas at the entrance, otherwise the angry words would have been emphasized by blows. The shameless impostor coolly referred to the numerous presents received, among which was an Emmenthaler cheese, sent by the Marquis de Morès, with pious sayings carved in the rind. “It was an excellent cheese,” he added, “and served to strengthen me in my fight against Freemasonry.” The money remitted to Diana Vaughan in ten years amounted to more than half a million francs, and flowed into the pockets of Taxil and his confederates. He expressed his thanks to the clergy for their aid in carrying out his scheme, and attributed their co-operation chiefly to ignorance and imbecility, but partly also to dishonesty, declaring that among the many dupes there were not a few knaves. As he left the hall he was threatened with violence, and took refuge in a neighboring *café*, under the protection of the police. No one thought any longer of the pictures which were to form such a novel and attractive feature of the entertainment; indeed, this forgetfulness constituted an important although unprinted part of the programme in the minds of those who arranged it.

How difficult it is for constitutionally credulous persons, in whom this disposition has been nurtured by education, to take a rational view of things when a strong appeal is made to their prejudices, is evident from a statement published in the *Osservatore Cattolico* of Milan, in May, 1897, that Leo Taxil was held in durance vile by the Freemasons, one of whom personated him on the occasion just described. Another Catholic writer asserted that Diana Vaughan did not appear at the conference because Taxil had been bribed by the Freemasons to have her shut up in a lunatic asylum.

The history of Taxil’s imposture has been circumstantially narrated in a book entitled *Leo XIII und der Satanskult*, by Dr. J. Ricks (Berlin: Hermann Walther, 1897, pp. xiv-301; price, three marks). The author, a doctor of divinity and pastor of a Lutheran church at Olvenstadt, near Magdeburg, has collected his materials from authentic sources and treated the whole subject with remarkable thoroughness and impartiality. His work is a valuable contribution to the voluminous annals of religious superstition and credulity.

The ease with which Taxil succeeded in duping so many prominent representatives of the papal hierarchy 714
naturally disturbed the equanimity of the most intelligent Catholics, especially in Germany, and caused them to sound a note of alarm. How is it possible, they asked themselves, for a large body of educated men, claiming to be the spiritual guides of the people, to become the victims of so plump an imposition? Is it not due to radical defects in the development and discipline of the intellectual faculties? Nearly a century ago Madame de Staël remarked that “since the Reformation the Protestant universities stand unquestionably higher than the Catholic, and the whole literary fame of Germany emanates from these institutions”; and this opinion has been quoted and indorsed by the unimpeachable authority of an eminent Catholic theologian, the late Professor

Döllinger.[J] Recently another Catholic, Dr. Hermann Schell, Professor of Apologetics in the University of Würzburg, has called attention to the latest statistics of religious denominations in Germany, showing the inferiority of Catholics, as indicated by their comparative lack of interest in higher education and the smaller percentage of them in the learned professions.[K] In this connection he refers to Taxil's successful exposure of the intellectual deficiencies, which render the hierophants of Roman Catholicism incapable of resisting the most palpable delusions of superstition. His two "tracts for the times," as they might fitly be termed, *Der Katholicismus als Princip des Fortschritts* and *Die neue Zeit und der alte Glaube*, maintain that Catholicism should be progressive, and that the old faith can remain a living force in each new era only by adapting itself to every real advance of mankind in knowledge and thus becoming reanimated by the spirit of the age. Professor Schell expresses his sympathy with the movement in favor of greater freedom of thought and independence of 715
research, known as "Americanism" in the Catholic Church, and regards its extension to the Old World as a vital necessity.[L]

[J] *Cf.* Ignaz von Döllinger. Sein Leben auf Grund seines schriftlichen Nachlasses dargestellt von J. Friedrich. München: Beck, 1899, vol. i, p. 77.

[K] In confirmation of this statement we may cite the statistical tables of Dr. Von Mayr for 1896, giving the number in every ten thousand of the different denominations attending the gymnasia or classical schools, the scientific schools with Latin, and the scientific schools without Latin:

Protestants	27.7	13.2	12.5
Catholics	21.4	3.8	6.7
Dissidents	17.7	13.2	18.7
Jews	173.7	65.8	92.7

The Catholic students in the gymnasia are mostly candidates for the priesthood. "Dissidents" are members of free religious associations. A noteworthy feature is the large proportion of Jews, and curiously enough this laudable characteristic is made by anti-Semitic agitators a ground of crimination and used to prejudice the public mind. Not long since a demagogue of that ilk in Berlin charged the Jews with putting forth every effort for the education of their sons, in order that they might more effectually compete with Christians; "therefore down with the Jews!"

[L] Since these lines were written Professor Schell has been disciplined and threatened with excommunication by the See of Rome. We regret to be obliged to add that he did not have the courage to maintain his opinions, but made a public recantation of them. The cause of progress in the Catholic Church has now found a new and apparently more fearless advocate in a Bavarian priest, Dr. Müller, of Munich, whose pamphlet on Reformkatholizismus can hardly escape the interdict of the papal hierarchy.

It is creditable to the Catholic prelates in the United States that they were not among the foolish birds caught with the lime laid by Leo Taxil. Indeed, the Bishop of Charleston went to Rome for the express purpose of warning Leo XIII against this trickster, but was sharply reprehended and admonished to be silent. A similar rebuke was given to the Apostolic Vicar of Gibraltar for denying the existence there of Tubal-Cain's subterranean laboratory for manufacturing microbes.

The *Breviarium Romanum*, the daily use of which, as a manual of devotion and edification, is enjoined by the Pope on the clergy, is full of legends which are recorded as historical facts, and quite equal in absurdity to Taxil's most extravagant and fantastic inventions. The tales there told of the miracles wrought by saints, their communion with angels, and their combats with devils may have easily suggested many incidents narrated in The Devil in the Nineteenth Century and the Memoirs of Diana Vaughan. It is no wonder that minds accustomed to accept the marvels of hagiology as actual events should be readily deceived by a clever caricature of them, especially when appealing to a prejudice so absurd and yet so strong as that entertained by the papacy against Freemasonry. It would seem from many indications that the Romish Church, as an ecclesiastical organization, bears about the same relation to contemporary culture that Roman paganism did to the best thought of the period when Lucian wrote his sprightly dialogues and Lucretius his genial and comprehensive didactic poem *De Rerum Natura*. Is it doomed to the same fate, or has it, as Professor Schell and Dr. Müller assert, a saving, recuperative power?

Of the geological age of the building stones used in the United States, George P. Merrill observes, in his report to the Maryland Geological Survey, that few stones are used to any extent that are of later date than the Triassic, and few, if any, of our marbles are younger than the Silurian, while nearly all our granites, as now quarried, belong at least to Palæozoic or Archæan times. Stones of later age than Triassic are, so far as relates to the eastern United States, so friable or so poor in color as to have little value.

GENUINE STARCH FACTORIES. 716

By BYRON D. HALSTED, Sc. D.,
RUTGERS COLLEGE.

Much in this world is neither upon first nor last analysis true to name. From the corner grocery we buy a pound of starch in a rectangular package highly decorated with lithograph and lettering, setting forth the excellences of the product, “superior to all others,” and manufactured, with the utmost care, by Messrs. So-and-So. The fact is that the big seven-story establishment did not make a grain of the starch, and the best that can be claimed is a satisfactory method of bringing the product already formed into the present acceptable condition.

But it is not the purpose of this paper to decry the refineries, whether they be of starch, sugar, or this or that of a hundred natural products, but to direct attention to the source of that very common and, it may be safely said, indispensable substance known to the English-speaking people as starch.

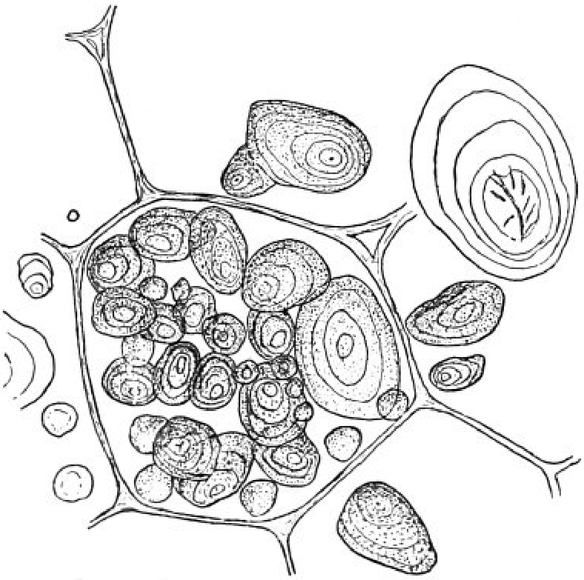


Fig. 1.—Starch Granules of the Potato.

It will be no new surprise to state, by way of introduction to the subject, that starch is the ordinary everyday product of ordinary everyday plants. So humble a vegetable as the potato has gained its way into all lands of the more civilized peoples almost solely because it has a habit of storing away, in large underground stems, a vast amount of starch. Let this provident tendency disappear in this plant for a single season, and the crop growers would discard it from their list of remunerative plants, while millions of people would turn with dismay to some other source of a daily supply of starch. What this change in the nature of a single kind of plant would mean to the human race words can not describe. If the famine in Ireland of 1845 and some later years, induced by a rot in the potato, is any index, the misery would be something worse than we should care to even dream of. When 717
there is a shortage of starch in India, a distress follows that is felt through the bonds of sympathy, if in no other way, the whole world round. Let rice fail to mature its grain, which means, in short, not to store its starch in available form for man, and the dependent race is brought to the ghostly condition of starvation and thrown upon the charity of those people whose starch is in their grain elevators, sacks, and barrels almost without number.

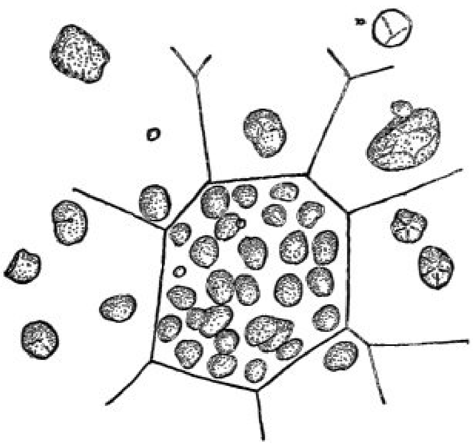


Fig. 2.—Starch Granules of Corn.

Starch, it would seem from this, is the prime food element of the human family, the chief factor in the upbuilding of a race, because a fundamental aliment of our bodies.

If the starch factories do not make, in the true sense, the product of their mills, it may be to the point to consider how this all-important substance comes into existence. The organic chemist tells us that starch is a ternary compound, and this agrees closely with the definition laid down by the dictionaries, only they add that it is odorless, tasteless, and insoluble in water. It is one of the proximate principles of plants, and is stored in the form of granules wonderfully variable in size and shape, but each kind having a type that is adhered to with much regularity. For example, the ordinary potato (*Solanum tuberosum* L.) produces a starch granule that is characterized by a form resembling the shell of the oyster. Fig. 1 is from a camera drawing of a cell from the center of a potato, with portions of adjoining cells, all of which were packed full of starch, a few grains only being represented.

Starch is acted upon differently by reagents, one of the leading tests for it being a solution of iodine. A drop of a very weak solution will determine the presence of starch in a cuff or shirt front by leaving a blue spot or streak where the iodine has been applied. By means of this reagent the student of plant tissues is readily able to locate starch when present in any slice of tissue he may have made. He would, for example, find much more starch in the tuber of the potato than in any other portion of the plant, and there the grains will be found many times larger than in the stem or the cells of the green leaves. Of the relation of the starch in the leaves to that in [718] the underground stem something may be said later in this paper.

In the corn plant the starch is stored chiefly in the grain, and not in the subterranean portions, as in the potato. The granules of the corn starch are much smaller than those of the potato, as indicated by Fig. 2, which is from a camera drawing of a cell from a grain of corn and made to the same scale as Fig. 1. The granules are oval and not much marked with striæ or lines, but chemically the substance is the same in both cases.

Another leading starch is that of wheat, the form of the grains of which is shown in Fig. 3. While somewhat larger than the corn-starch granules, they are not otherwise widely different.

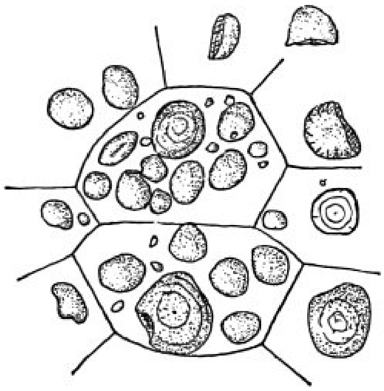


Fig. 3.—Starch Granules of Wheat.

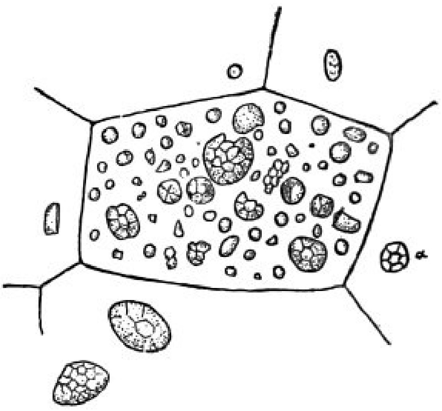


Fig. 4.—Starch Granules of Rice.

One could scarcely overlook the starch produced by the rice plant, for it feeds more people than the potato, corn, or wheat. The relative size and form of the rice-starch granules are shown in Fig. 4. It is seen that the grains are not large, and with a strong tendency to break up into small angular pieces.

There are almost as many forms of starch as plants producing it, some of them being very odd in shape. Thus the tapioca starch has a characteristic form, as also the sago; but it is not the purpose here to more than call attention to the form in which the substance under consideration is laid down in plants. The student of food adulterations is an expert in the detection of starches, and, with his microscope and skill, is able to decide how much of one kind of starch and how much of another is offered in the product under examination. It is a matter of congratulation that Nature has set herself so strongly against fraud in food stuffs as to record the origin of each grain of starch in the grain itself.

And that brings us to a consideration of that origin. We must accord to plants the exalted prerogative of being the exclusive and universal starch-formers in the world. Whether we note the growth of the potato tubers [719] or the plumping out of the grains of corn, wheat, or rice, the same fact remains that storehouses are being filled with the same organic compound. There must be many preliminary steps before this process of storing is complete, and for these we need to seek elsewhere in the growing plant.

Even the most careless observer can not but be at home with the fact that the whole port and bearing of ordinary plants is for sun exposure. They rise from the ground as closely placed stems of grass or less neighborly orchard or forest trees, and hang out their leaves to catch the sun. The economy of substance is so well studied that there is a very large exposure at a minimum of expenditure of tissue. In short, the leaves are the organs for association with the sunlight. They reach toward the sun where light is scanty, as in the window, and even turn their faces to the orb of day, shifting the position hour by hour from sunrise to nightfall. The rapidity with which we come to the fundamental fact that leaves are for the sun almost surprises one. The purpose is as easily inferred, but the steps in the process are not so quickly taken. The facts that leaves are *par excellence* the starch factories and the sunlight the inobtrusive chemist are granted, and it remains only to show something of the steps of proof that science may have discovered.

We need, therefore, to consider starch from the standpoint of its composition, and upon this the chemists are fairly well agreed. It consists of three elements, with their atoms so arranged that the molecule of starch has the composition of six parts of carbon, ten of hydrogen, and five of oxygen, or, to express the formula in terse chemical terms, it stands $C_6H_{10}O_5$. If we can account for the bringing of these atoms together in the production of a single molecule of starch the laboratory has been explored and the secret is ours, even if we can not put it to practical use in our so-called “starch factories.”

The independent plant, beyond serious question, gets its food from outside itself. There are two sources for these substances—namely, the soil-water bathing the absorbing roots, and the atmosphere, with which the aërial branches and their leaves are constantly surrounded. From the soil come the water and all the salts, ash constituents, and the like that may be dissolved therein, while the gases of the atmosphere bring, among its chief contributions, a constant and, in an always exceedingly diluted form, the carbon dioxide, or, sometimes called, the carbonic-acid gas. This compound, familiar to us as a product of combustion, fermentation, and decay, is composed of carbon and oxygen, and has the symbol CO_2 associated with it by chemists.

In short, for the formation of our starch the water (H_2O) from the soil and the CO_2 of the atmosphere, when 720
brought together, may be made to combine with the formation of starch. A single diagram, while not perhaps an absolute statement of fact, may serve to represent the final result:

$$\left\{\begin{matrix} 6CO \\ 5H_2O \end{matrix}\right. = C_6H_{10}O_5 + 12O.$$

In other words, the six molecules of carbon dioxide and five of water combine with the formation of one molecule of starch and the liberation of twelve atoms of oxygen.

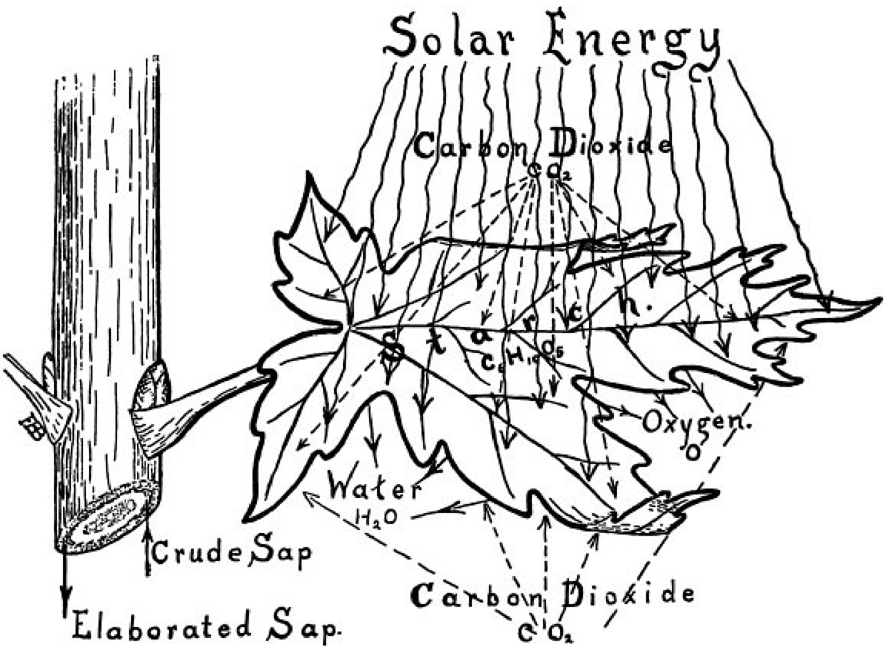


Fig. 5.—Diagrammatic View of the Process of Photo-Synthesis.

This driving off of such a large amount of oxygen, entirely against the whole tendency of that element, it is assumed, is at the expenditure of much force. The only one adequate to this work is solar energy, and this is abundantly at hand. That we need not seek further for this power is proved by many and conclusive tests. Vegetable physiologists to-day are able not only to locate the sun as the chemist, that effects the changes necessary for the production of starch, but can show in what cells and portions of those cells the forces effect the synthesis. The chlorophyll granules in the living cell are the microscopic laboratories in which a silent chemist, powerful beyond all measurements, builds out of inorganic materials the food substance of the whole world of animals and plants.

721

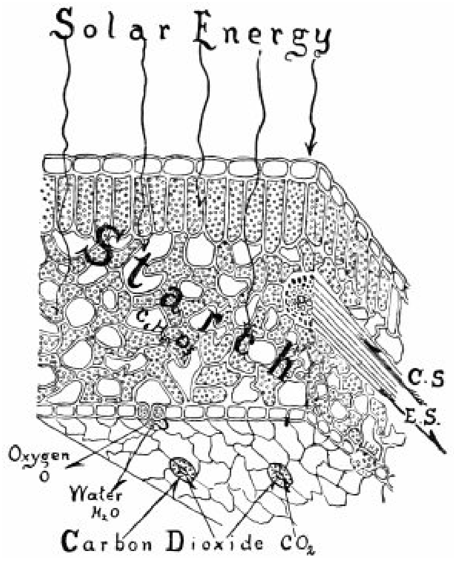


Fig. 6.—Portion of Leaf Magnified, illustrating Photo-Synthesis.

Fig. 5 is an attempt to present the above statements as to photo-synthesis in plants in such a form that it may appeal to the eye of the reader. A bit of maple twig is shown with one leaf in position. Passing up the stem in the young wood is the crude sap from the soil to the leaf. There is a downward flow of elaborated sap in the inner bark also represented. Solar energy is indicated by the wave lines as playing upon the upper side of the leaf, while the direction of the carbon dioxide is shown by the dotted lines entering from both above and below the leaf. Water of transportation is indicated as being given off, and upon a dry, hot day this is considerable, which, as it vaporizes in the tissue, tends to keep the latter cool. Lastly, with the formation of starch there is the escape of oxygen set free from the broken molecule of carbon dioxide or water or both in the formation of the starch.

Fig. 6 is a similar attempt to show the process of starch formation with the use of a portion of the leaf in section as it might appear under the microscope. The under portion of the leaf is seen as having openings in the skin, through which the gases and vapors pass, and the middle portion above shows the porous nature of that part that is most active in synthesis. The small oval bodies in all the cells, except those of the upper and under epidermis, represent the chlorophyll granules, the special seat of the special activities which result in the formation of the carbohydrate, familiar to all as starch. To the right is a leaf vein, through which the crude sap (*c. s.*) reaches the synthetic cells, and the elaborated sap (*e. s.*) descends to places where it is needed for growth or for storage.

With the above facts in mind, there is no wonder at the activity that may reside in a field of corn during a bright day in August. Starch is being made almost by the ton daily, and, if the conditions favor, the next month will find a rich harvest for the husbandman who has assisted in supplying the conditions for the desired output of the leading carbohydrate.

The genuine starch factories of the world are exceedingly small and equally numerous, and, with the sunlight as the active force, each green cell may contribute to the world’s gain in the food substances that enable all creatures to live and move and enjoy a fairly comfortable existence. 722

TRADE CORPORATIONS IN CHINA.

By M. MAURICE COURANT.

The remarkable longevity of a large number of business houses in China is not due solely to the general conditions of society or to those which are peculiar to the commercial class, but their stability and their fame rest upon a special organization, under which they are united in groups. It is customary for all the houses possessing the same specialty to form an association which I shall call a corporation, reserving to myself the privilege of pointing out a few exceptions to the rule. These corporations, which seem to date from at least three centuries back, are difficult subjects to study. Various in type, formed by the individuals interested, without the state having had anything to do with their regulations or even perhaps authorized them, they exist by force of custom and live conformably to their traditions, while some, I have been told, have written regulations and even, perhaps, archives—which they have not thought fit to communicate to the public. What is to be learned of them has, therefore, to be deduced from their visible transactions.

The corporation fixes the minimum price of articles of sale, and has secret agents to watch that no house takes less, thereby setting bounds to competition and preventing the injurious depreciation of goods. Only the public suffers from the existence of the minimum, but it does not seem to perceive it, and the Government never interferes except in respect to the price of grain, for which it fixes a maximum, and in times of great stress sells from its own granaries. The corporation, too, as represented in the banks and loan offices, fixes the rates of interest to be paid or received, and the kinds of securities and moneys that shall be accepted. In short, it adjusts the general regulations of business transactions, and defends the common interests of all those associated in it. If one of them is implicated in a judicial proceeding of general interest the corporation sustains him with its credit and its funds. It further takes in hand injuries to the interests of its associates. In 1883 the tea merchants' corporation of Hankow suspecting frauds by the agents of certain foreign houses, asked those houses to 723
designate themselves some foreigner to superintend the weighings. Notwithstanding the good reputation of the corporation and the moderation of its requests, the foreign houses refused. All transactions were suspended, and the official in authority declared that he could not compel the merchants to sell contrary to their wish, and the foreign houses were eventually obliged to yield, one at a time.

The corporations likewise watch the transactions of their members, oppose fraud which might harm the good name of the association so far that the silversmiths will not permit one of their number to sell alloyed jewelry, even when the purchaser knows it is such. Some see that the taxes and duties on production are regularly and properly paid. Others, in the interest of the stability of the houses, forbid all fictitious sales and purchases, and most of the stock operations and a large number of commercial transactions which seem very simple to us would not be tolerated by them. The custom of selling short having been introduced upon the silver exchange in Peking a few years ago, a censor reported it as a kind of gambling, and the Government interdicted the operation—a very rare example of official intervention. Under a similar old-fashioned view, the corporation of bankers inquires into the total amount of the notes issued by its members. Every banker and every broker is free to issue notes, and little attention is paid to the precautions required by the law. But the corporation has an infallible means of restricting extravagance in the emission of bills. If a house is going so fast as to be in danger of compromising its credit and perhaps endangering the capital of others associated with it, an order is given, all the notes are thrown before the public, and the imprudent bank has to suspend its payments and retire.

The corporation further maintains its reputation and keeps on good terms with public powers by expenditures on ceremonials and charities. Every year it appropriates a sum for the opening of the kitchens from which rice and millet broths are distributed to the poor of Peking. In case of famine or inundation, the quotas of the corporations do not have to be waited for, while the more prominent commercial men also contribute largely under their own names. They will subscribe for a testimonial to a mandarin who has done good service, will help prepare the road over which an imperial procession is to pass, and will contribute to the pageantry of popular religious ceremonials.

Each corporation has its patron divinity, who is the object of a special cult. With one it is the god of riches; with another Koan Yu, god of war; with others a spirit of more limited competency, like Lou Pan, a famous 724
mechanician of the time of Confucius, now patron of the carpenters. Adored in every shop by all the patrons and clerks, the festivals of the protecting genius are celebrated by the whole corporation at fixed dates. To some divinities a sacrifice of meats and incense is offered in each warehouse, after which all the chiefs and the men employed take part, while the spirit is supposed to be present. To others, more rarely, a more bountiful sacrifice is made in a temple, and the banquet, held in a large hall, is enlivened by dramatic entertainments. The patron is also duly honored in the celebration of the general feasts of the Chinese people.

The corporations have tribunals of arbitration and a common treasury, but the method of operation of those departments is among the things they do not reveal to the public. I have only learned a few general facts on the subject. The corporations intervene, I have been told, in the disputes of the members and to prevent dishonest dealings and attempts to cheat one another, but I have not learned that they have any real judiciary authority. Their treasury is sustained by means of assessments and fines, and loans may be contracted on its account, for the salt merchants of Tientsin are still paying interest on a number of debts contracted by the corporation in the last century.

Great differences might be expected to exist between the corporations in respect to these points and many others. They have been constituted at different epochs, independently of one another, and are similar only in their essential features. The minimum price fixed by the assembly is not equally imperative in all. Thus, the price fixed by the fur merchants at the beginning of the winter does not bind the members. In most branches of commerce all the houses composing the corporation are on a footing of substantial equality, though, of course, the large banks prevail over the small brokers, but there is no unlikeness in the business or the situation. The policy of the tea trade is mainly controlled in Peking by the houses of the families Fang and Oou. They fix the price, determine the equivalence of weight (the standard is a pound of four ounces instead of sixteen), and lead

the corporation. In fact, the retail dealers use their capital in the decoration of their shops with gilding and sculpture, at a cost of between sixteen hundred and two thousand dollars, while the goods are lent them by one of the importers, who holds the decoration as security, so that the whole corporation is in the hands of these two families. This is a special condition, and there is nothing else like it, even among other importers of southern products. While most branches of trade are independent of official action, slaughter houses, of which 725
there are only five in Peking, have to be authorized by the Government. A religious motive may be at the bottom of this restriction, the large cattle being reserved for the imperial sacrifices. Moreover, the killing of animals has been interdicted at different times, and even now the slaughter houses are ordered closed, as an act of public penitence, in times of drought.

The loan houses also need an official authorization. They pay a tax on their operations to the local authorities, and are divided into three classes, according to the importance of their business. Those of the first class receive deposits from the authorities of various sums, on which they pay interest, the administration reasoning that by helping them increase their capital and enlarge their business it will be doing a philanthropic work and assisting the people. These loan offices are not at all like our pawnbrokers' shops, but are a credit institution, to which the middle class as well as the poor Chinaman has constant recourse. Being conducted on equitable terms and serving their convenience in various ways, they render great services to the Chinese people, and have become necessary to their life, and this explains the departure of the Government from its usual policy of non-interference to supervise and favor them. China has, further, large and small capitalists, and numerous credit establishments very much like ours. They may be classified as exchange offices, banks, and banks of discount. The last are at Peking, where they were founded a few decades ago by some men from Chan-Si. Their single industry is trading notes in all China and some of its dependencies. They have no monopoly, for some of the larger banks and more important traders were all doing the same; but they have regulated the business, extended it to more places, and have almost entirely suppressed the transportation of money in bulk.

The banks of exchange perform a variety of functions on a restricted scale, charging two per cent for exchanges, issuing notes without any supervision, and lending money at two per cent a month in normal times. They are not, however, always able to pay their notes at sight, and it is well, therefore, not to keep them too long. In the provinces a bank usually accepts only its own notes. In Peking some well-known signatures are accepted everywhere after examination by an expert, who places his seal on the note he declares good, charges a fee for each verification, and is responsible for his mistakes.

The large banks, by accepting or refusing the notes of any house or by throwing money or *sapiques* on the market, rule in the corporation and have the whole fate of the market in their hands. The four Hengs, by the amount of their reserve, the solidity of their credit, and the number of their branches or correspondents, have 726
no rivals in north China. All exchange operations are carried on in the money market, which is held every day in the south-eastern part of the city, on the street, near the Tauist Temple, where all the houses in Peking are represented, and every one takes care to be so, lest he be thought in default. When the rate is fixed the news is dispatched by couriers, pigeons, etc., to all whom it concerns. The couriers of the corporation, who communicate with the brokers and bankers, are also the confidential agents of the syndics, are acquainted with the amounts of the emissions of each house, know whether a certain patron is really ill or only feigning, and by their reports decide who shall be boycotted or declared insolvent. All this goes on in full liberty, without surveillance by the state, without any tax on the transactions, and without any other interference than the prohibition of fictitious dealings. The corn market is in the same way the almost exclusive domain of the corn corporation, the state never interfering except in the case of a famine in the region.

Besides the merchants' corporations, there exist also corporations of artisans. The embroiderers, the makers of *cloisonné*, the tanners, and the carpenters have theirs. The carriers and the boatmen, who, before the opening of the railway, had the monopoly of transportation between Peking and the provinces without forming associations, met at their respective inns and established rules and rates for their business. Informal organizations, varying among the different towns in their degrees of development, exist among the barbers—who at Peking meet every year for a sacrifice and a banquet—the chair-bearers, and the *jinrikisha* men, and so every city has its corporations and associations which are not like those of the next city.

Some branches of trade have no corporations, and the peasants, when they come to town to sell their produce, trade on their own account, for the best terms they can get, and have to accept, in the market, an organization the origin of which is forgotten. Every year, on the appearance of each sort of crop, the *King ki* of the market, having agreed with the dealers, fixes the minimum price of the commodity for the season. He also polices the market. The function of *King ki* is the property of the person who exercises it, who has bought it from his predecessor and will sell it to his successor by private contract, and nobody contests his right. In the market for *azaroles* the position is hereditary. The monopoly of the corporations is often complicated with a provincial question. The Chinaman regards every man who was born in another district as a foreigner—still more if he is of another province. Those who are of the same local origin, on the other hand, stand by one 727
another. Hence it has come to pass that some trades have been monopolized by the people of some one province. Most of the bankers were originally from Chan-Si; all the great merchants came from Anhoei. The people of Chan-tung have three special occupations in Peking. They have the exclusive privilege of killing pigs and retailing meat. They are the only water carriers, each one having his well on the public highway, his watering place for horses and mules, and his district where he sells water without permitting the people to provide for themselves elsewhere. Such privileges are consecrated by usage and zealously defended by their holders, and respect for them is enforced, when necessary, by the authorities. Associations are formed, also, even among the coolies who work on the docks.

These details show by how great a variety of forms all the corporations assure the same result—the organization of labor. We see also how they extend beyond commerce. The Chinaman is in fact a social being bound closely to his fellows—of the family, province, trade, or class—by every tie and in every sphere of life. He is never a man living by himself and for himself, and is not accustomed to independence. Hence the authority of the corporation, instead of seeming strange, is a necessity to him. Consequently the corporation has the right, by universal consent, to exact obedience from its members, and to compel those who would stay out to come into it.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

M. L. Azoulay suggests, in the *Revue Scientifique*, that the invitation given to Señor Rámon y Cajal, the celebrated Spanish neurologist, to visit the United States and attend the celebration of the tenth anniversary of Clark University, furnishes a good example for France to follow. "It causes grievous chagrin to me to think," he says, "that while Germany, England, Austria, Switzerland, and the United States are regularly accustomed to invite to their scientific ceremonials, of which there are more than one every year, students of other countries who have illustrated any branch of human knowledge, France, formerly so hospitable, refuses these international appeals."

* * * * *

At the recent meeting of the British Archæological Association, at Buxton, Dr. Brushfield described the prehistoric circle of Arbor Low as, upon evidence which he cited, the earliest neolithic monument in Britain. There are thirty-two stones in the circle, all now lying prostrate, but they must originally have been erect. The dolmen in the center is now level with the ground. The mound and ditch—the latter being inside, between the mound and the stone circle—are in a very perfect condition, notwithstanding the lapse of time. The work has two openings—on the northeast and southwest.

Editor’s Table.

SCIENCE AND DOGMA.

After many uncomfortable turnings in his narrow theological quarters, the eminent biologist, Professor St. George Mivart, seems to have made up his mind that he may as well, before he dies, know what it is to enjoy the air of liberty. For many years he has been pining for this, and almost inviting the authorities of the Church to give him his passports. The Church was not anxious, however, to quarrel with a man of recognized ability and wide knowledge, and therefore writings which might well have been expected to give serious umbrage were allowed to pass unnoticed. The professor then made a most audacious raid upon the venerable doctrine that there remains for the majority of mankind a place of unutterable and eternal misery. He ventured to speak of The Happiness in Hell, maintaining that, while the inhabitants of that abode would always have a profound and harrowing sense of having missed the supreme happiness of heaven, they would still be able to occupy themselves in a variety of ways which would give them a certain amount of happiness, just as in this world a man may carry a profound sorrow in his heart and yet, under the stimulus of business or society or intellectual study, have his attention happily diverted for many hours every day. At this point the authorities drew the line. It is related of an old Scotch lady that, referring to the Universalists, she said, “Those people say that all men will be saved at last, but *we* hope for better things.” Whether this was the point of view of the ecclesiastical powers or not, certain it is that they refused to sanction the notion of any happiness, of howsoever humble an order, in the abode of gloom, and gave a peremptory order to the professor to take it all back. Well, he took it back as a matter of submission to those whom he regarded as his lawful spiritual guides, but the submission did not give him rest. If ecclesiastical authority was entitled to respect on one side, science was urging even stronger claims on the other. In August last, as we now learn, the professor wrote to the Prefect of the Sacred Congregation of the Index, explaining how he wished his submission to be understood, and as he and the prefect could not come to an agreement about it, he withdrew the submission altogether. Then he resolved to relieve his mind. It took two articles in two separate magazines to do it—one in the Fortnightly and one in the Nineteenth Century—but then it was done in a manner admitting of no recall. No sooner had these articles appeared than Cardinal Vaughan drew up an iron-clad declaration affirming the falsity of every position the writer had taken, and required him to sign it. Too late! The biologist and evolutionist in Professor Mivart had finally triumphed over the theologian, and he met the cardinal’s demand with a flat refusal. Thereupon his Eminence issued an order excluding the recalcitrant *savant* from the sacraments of the Church.

Mr. Mivart now knows where he is. He occupies the broad ground of scientific truth. He breathes the free air of intellectual and moral liberty. He still professes loyalty to the Church according to his own conception of it, but he will no longer bow down to an authority that assumes to prescribe his opinions in matters which he is 729
quite capable of judging for himself. He has arrived at the conclusion that even as regards the interpretation of Scripture the Church is just as liable to err as the humble layman. He quotes most persistently the case of Galileo, in which the Church, in the most formal and official manner, declared that Scripture taught what for nearly a century now it has admitted Scripture does not teach. If the highest organs of ecclesiastical authority could make such a blunder in Galileo’s day, what blunders may they not commit in our day? But if the Church can err egregiously in what is its own peculiar province—if anything is—how great is likely to be its inaptitude when it undertakes to deal with scientific questions!

“God has taught us,” says Mr. Mivart, “through history, that it is not to ecclesiastical congregations but to men of science that he has committed the elucidation of scientific questions, whether such questions are or are not treated of by Scripture, the Fathers, the Church’s common teaching, or special congregations or tribunals of ecclesiastics actually summoned for the purpose. This also applies to all science—to Scripture criticism, to biology, and to all questions concerning evolution, the antiquity of man, and the origin of either his body or his soul or of both. For all ecclesiastics who know nothing of natural science it is an act necessarily as futile as impertinent to express any opinion on such subjects.”

The opposition of the rulers of the Church to the true theory of the solar system in the sixteenth and seventeenth centuries is paralleled, according to Mr. Mivart, by their opposition to the doctrine of evolution to-day. He refers to the fact that two Catholic professors who had ventured to give a partial support to the doctrine in question—one of them Father Zahm, who contributed an article, as many of our readers will remember, to this magazine a couple of years ago—had both been compelled to retract and disavow what they had published on the subject. Professor Mivart draws a distinction, however, between the rulers of the Church and the Church. The latter he idealizes—and we by no means dispute his right to do so—as a vast organization the office of which is to keep alive man’s sense of spiritual things, and to bear eternal testimony in favor of those truths of the heart which do not admit, like intellectual truths, of logical demonstration. Though cut off by authority from participation in the rites of the Church, he feels himself still one in sympathy with all who in the Church are aspiring to a higher life. We look upon his case as a very instructive one, affording as it does clear evidence of the absolute incompatibility between any authoritative system of dogma and the free pursuit of truth. It has taken Professor Mivart a long time to arrive at his present standpoint, but it is well that he has got there at last. His example, we believe, will encourage not a few to assert in like manner their right to think freely and to utter what they think.

A MORE EXCELLENT WAY.

When our article of last month, entitled A Commission in Difficulties, was written we had not seen the paper by Mr. Theodore Dreiser, in Harper’s Magazine for February, describing the important educational work which the Western railways are doing with a view to promoting the prosperity of the agricultural regions through 730 which they pass. In our article we observed that "the more interference there is between parties who, in the last resort, are dependent upon one another's good will, the less likely they are to recognize their substantial identity of interest." What Mr. Dreiser clearly shows is how great the community of interest is between the railroads on the one side and the farming community on the other, and how fully that community of interest is recognized by the railways at least. The freight agent of a given line is charged with the duty of developing to the utmost—in the interest, primarily, of his road, it may readily be granted—the agricultural resources of the country through which it runs. He has his assistants, who look after different branches of the work, such as crop-raising, cattle-grazing, dairying, poultry-raising, etc. "Through this department," the writer says, "the railroads are doing a remarkably broad educational work, not only of inspecting the land, but of educating the farmers and merchants, and helping them to become wiser and more successful. They give lectures on soil nutrition and vegetable growing, explain conditions and trade shipments, teach poultry-raising and cattle-feeding, organize creameries for the manufacture of cheese and butter, and explain new business methods to merchants who are slow and ignorant in the matter of conducting their affairs." An agent of the railway will visit every town along the line a certain number of times every year to see what he can do to quicken trade. Finally, in the great centers there are special agents who "look after incoming shipments, and work for the interests of the merchants and farmers by finding a market for their products." Examples are given showing how the railways are able to impart, and do impart, information of the highest value to the farmers, such as puts them in the way of getting greatly improved returns from their land.

Of course, the railways want business, but it is eminently satisfactory when one party who wants business uses his best efforts on behalf of another in order that by making him prosperous he himself may prosper. When things get into this shape they are all right, as the phrase is. The accepted definition of a perfect action is one which benefits all who are parties to it. Things are on a much better foundation when people are mutually benefiting one another, each primarily in his own interest, than when it is all philanthropy on one side and passive acceptance of benefits on the other. Philanthropy is an uncertain thing, and its effects are uncertain. Its quality will take, in general, a good deal of training; but business, on an honest and reciprocally helpful basis, is good all through.

It is a happy circumstance that there are natural laws and forces at work which tend to produce a healthful social equilibrium. The true statesman is he who is on the watch to discern these forces and these laws, resolved that if he can not aid their operation he shall at least throw no obstacle in the way of their activity. The amount of harm that is done by coming between people who would be certain to arrange their business relations satisfactorily, if they were only left to do it without interference, can hardly be estimated. Man is fundamentally a social animal, and he wants, if he can possibly get it, the good opinion of his fellows. This is a principle which legislation too much overlooks, but it is one on which, as we believe, the future progress of society depends, and which, in spite of the blunders of legislators, will more and more assert itself as the years go on.

Fragments of Science.

Religious Suicides.—Suicides from religious fanaticism, which are still prescribed by some sects, are compared, as having a common origin, with propitiatory or expiatory human sacrifices, by Herr Lasch, in an article of which we find a review in the *Rivista Italiana di Sociologica*. Voluntary sacrifices, which abound in the history of ancient peoples, had nearly always in view the removal of perils or the cessation of public calamities by appeasing the anger of the divinity through the offering of a human victim. Thus Macaria, the daughter of Hercules, at Athens during the Peloponnesian war, and Codrus and the Athenian youth Cratinus voluntarily offered their lives to aid their country by the sacrifice. The consul Decius gave himself up to assure victory to his legions, and Adrian's favorite Antinous to save his imperial protector. Spontaneous offerings of human victims to appease offended divinities are mentioned in the traditions of the ancient Germans, and it was usually their chief or king who suffered for the good of the people. Offerings of this sort are far from infrequent among barbarous and half-civilized peoples. Among some tribes in China a man is sacrificed every year for the public welfare. Such voluntary renunciations of life to acquire merit with the divinity, to gain favors, to atone for sins, and fulfill vows are very common in India, particularly where Brahmanism is most influential. Special methods were pointed out in the Hindu laws for performing such sacrifices as would be sinful for a Brahman, but not for a Sutra, who, before abandoning life, should make gifts to the Brahmans. A favorite method was to drown one's self in the Ganges, and particular spots in the river were designated for this act. The sacred books mention five methods of performing sacrifice to assure a better fortune in the next life: Starving to death, being burned alive, burial in snow, being eaten by a crocodile, and cutting the throat or being drowned at a particular spot in the Ganges. In fulfillment of vows, sons would sacrifice themselves for their mothers by jumping from a rock. To keep up the courage of the victim, the Sivaitic rituals promised many beatitudes to him who courageously met death for his sins, and threatened eternal punishment to one who performed the sacrifice in a base manner. And when the suicide had been decided upon they allowed no retreat or repentance, but forced its consummation. A special apparatus for suicide formerly existed in some of the villages in central India, consisting of a guillotine which the victim himself set in action. Casting one's self under the wheels of the car of Juggernaut was another method of religious suicide. Some philosophical schools prescribed subjection of the body to various pains for the purification of the soul; and the books of Manu, which also impose the destruction of human sensibility, have contributed much to preserve this idea in India and spread abroad, especially in the Malay Archipelago, the usage of voluntary sacrifice to the divinity. The aborigines of the Canary Islands have employed voluntary sacrifices on the coming of an epidemic, and the ancient Mexicans and Peruvians observed them in honor of the divinity.

*   *   *   *   *

"Manuring with Brains."—"New Soil Science" is the name Mr. D. Young gives, in the Nineteenth Century, to the results of the studies of soil bacteriology prosecuted by Mr. John Hunter and Professor McAlpine on Lord Roseberry's estate of Dalmeny, and "manuring with brains" to the application of them. Attention has been called to the value of the bacteria in the soil as nitrifying and fertilizing elements by the experiments of Sir John Bennet Lawes and Sir Joseph Henry Gilbert at Rothamsted, and more forcibly by experiments coming after them but suggested by them. It had also been found that caustic lime used upon the soil is liable to destroy the nitrifying and other advantageous organisms, while carbonate of lime is surely useful, and a due proportion of lime compounds is essential to the best discharge of their functions. The discovery that the bacteria of the root nodules of leguminous plants possess the power of absorbing the free nitrogen of the atmosphere and rendering it available for the use of the plant was made by Messrs. Hunter and McAlpine, according to Mr. Young, and was taught by them to their students several years before Hellriegel, to whom it is usually ascribed, fell upon it. They found that several well-defined sets of bacteria were concerned in the work of nitrification, and isolated and cultivated the nitrous germ, but could accomplish nothing with the nitric germ till they used old mortar or some lime dressing with it. They also found that lime compounds in the surface soil served a further important use by preventing the soluble silicates from being taken up by the roots of the plant, the lime taking up those salts and forming insoluble silicates which were retained in the soil and did not diffuse into the plant. So a non-silicated stem, or a cellulose stem, was formed, which would bend before the wind without breaking, while the non-silicated straw was much superior in value to the silicated straw. Messrs. Hunter and McAlpine denied that silica in the plant gave strength and solidity to the stem, and pointed out that it rather, like glass, made the straw brittle. They found out, further, that large quantities of carbonic acid were produced in the soil through the operation of the ferments, and found an outlet through the subsoil drains. They made other discoveries which threatened to render it necessary to revise the whole fabric of agricultural science, and were called to account by the institutions in which they were teachers for their heresies. They maintained their position till the opportunity came to them to make tests of their theories on Lord Rosebery's Dalmeny farm. Among the results of the Dalmeny experiments are proof of the value of a dressing of ground lime in proportions not large enough to kill the bacteria, emphasis of the value of potash for every crop, and the discovery of a remedial treatment for the finger-and-toe pest in turnips. "When these experiments were commenced, ground lime for agricultural purposes had never been heard of, whereas now there are at least six lime works where extensive grinding plants are kept hard at work to supply the ever-increasing demand for that substance. Since the principles for the new soil science have been put in successful practice at Dalmeny the scientific authorities, who at first had branded these principles as absurd heresies, have changed their tune," and now the chemical adviser of the Highland Society has declared that he accepts the new doctrines.

*   *   *   *   *

Plague Antitoxin.—In justifying his belief in the efficacy of the inoculation treatment against the plague, Lord Curzon, the Viceroy of India, said, in a recent address at Poonah: "If I find, as I do find, out of one hundred plague seizures among uninoculated persons, the average number who die is somewhere about seventy to eighty per cent, while, in a corresponding number of seizures among inoculated persons, the proportions are entirely reversed and seventy to eighty per cent, if not more, are saved—and these calculations have been furnished from more than one responsible quarter—I say figures of that kind can not fail to carry conviction; and I altogether fail to see how, in the face of them, it is possible for any one to argue that inoculation is not a wise and necessary precaution.” He had been personally visiting the plague hospitals and camps about the city, and had already supported his advocacy of this treatment by having himself and his party inoculated at Simla with the plague antitoxin.

*   *   *   *   *

Cultivation of India Rubber.—An article in the Bulletin of the Bureau of American Republics represents that there are lands in Mexico and Central America equally adapted to the cultivation of the India-rubber tree with the Brazilian plantations, and having, in addition, a salubrious climate. Formerly dependence for the supply of India rubber was placed in the product of wild trees, but with the increase in the uses for it, and the consequent rise in prices, capital is being invested in this industry, and its profitable cultivation is being largely engaged in. The trees do not flourish at an elevation exceeding five hundred feet above sea level, and low land, moist but not swampy, is the best. Land suitable for planting could be bought for twenty-five cents an acre in 733
large tracts, but it now brings from two dollars to five dollars Mexican. These lands can be used for other crops while the trees are growing up, and thus made partly to repay the cost of starting the plantation. So the expense of clearing the land preparatory to planting it is largely met, if facilities for transplantation are at hand, by the sale of the dyewoods, sandalwood, satinwood, ebony, and mahogany that are cut off. The land should be chosen along the banks of streams, where the soil is rich, deep, and loamy, and the presence of wild rubber trees is a sure indication of its suitability. These wild trees should be left standing, and young seedlings should be kept and transplanted into their proper places. The densest plantation compatible with good results is fifteen feet apart, giving about one hundred and ninety-three trees to the acre. Once in the ground, the tree needs no attention or cultivation beyond keeping down the undergrowth, which can be effected by the aid of a side crop. The tree propagates itself by the seeds or nuts, which drop in May and June. By the sixth or seventh year the grove will be in bearing, and thereafter should yield from three to five pounds of India rubber per tree.

*   *   *   *   *

The New York Botanical Garden’s Museum.—The museum building of the New York Botanical Garden is substantially completed, and most of the works are in an advanced state of forwardness. The museum cases (for public inspection) and the herbarium cases (for students) are in position, and the herbarium cases are filled. Among the recent gifts of value to the institution are the miscellaneous collection of John J. Crooke, made about thirty years ago and containing about twenty thousand specimens, among which are a set of the plants obtained by the United States Pacific Exploring Expedition of about 1850; the collection of between twenty and thirty thousand specimens made by Dr. F. M. Hexamer in Switzerland and the United States; a collection of seven or eight thousand numbers, made by Mr. and Mrs. A. A. Heller, representing between twelve and thirteen hundred species, some of which are new to science; and specimens of crude drugs, for the Economic Museum, presented by Parke, Davis & Co. A permanent microscopic exhibition is to be established by Mr. William E. Dodge, at his own expense. It will be furnished with at least twenty-five microscopes, and with specimens carefully prepared and inclosed, to secure them from injury. A set of more than two hundred volumes on botany and horticulture, which formed a part of the library of Dr. David Hosack, founder of the first botanical garden in New York, has been presented by the New York Academy of Medicine, which received it from the New York Hospital.

*   *   *   *   *

Action of Sea Water on Cements.—As the result of examinations of many masonry structures immersed in sea water, Dr. Wilhelm Michaelis has found that Portland cement does not resist the chemical action of such water so well as do Roman cement and the hydraulic cements. The soluble sulphates in the sea water appear to enter into a substitution combination with the lime which exists in the cement in a free state or is liberated in the hardening, and it is converted into a sulphate, while disintegration ensues. In Roman cement the lime exists in combination, and there is no inclination toward the formation of a sulphate, and hydraulic limes resemble Roman cement in physical qualities. Dr. Michaelis suggests that hydraulic cementing materials containing more lime than is required for the formation of stable hydro-silicate and aluminate may be made suitable for submarine work by an admixture of trass or puzzolana, whereby the cementing strength of the mass will be greatly increased, and it will be enabled to withstand the disintegrating action of the sea water.

*   *   *   *   *

Stories of Amazonian Pygmies.—Dr. D. G. Brinton subjected the stories of the existence of pygmy tribes on the upper tributaries of the Amazon to a careful examination, and came to the conclusion that the facts did not show anything more than that there are undersized tribes in that part of South America, with occasional individual examples of dwarfs, such as occur in all communities. It is still a question, he observed, “whether the rumor of a pygmy people somewhere in the tropical forests is not to be classed with the stories which threw a 734
strange glamour about those inaccessible regions in the early days of the discovery. There were many of these, for I am speaking of the part of the map where was located the El Dorado, the golden city of Manoa, the home of the warlike Amazons; where dwelt the men with tails and the mysterious *Oyacoulets*, warriors with white skin, blue eyes, and long, blond beards. All have vanished from history but the pygmies, and their turn will probably soon come.”

*   *   *   *   *

Relief and Pension Funds of Railroad Men.—In instituting a pension fund for the men in its employ the Pennsylvania Railroad established, in addition and supplementary to the relief fund of which they enjoy the privilege, a special fund for those who are retired or superannuated, which is adjusted according to their length of service and the pay they have been receiving. The relief fund affords every man employed an opportunity to provide for himself in case of sickness or disability. It is co-operative, and is supported jointly by the employed men, its members, and the company, the expenses of operation and the deficiencies in it being met by the company. The additional pension is the company's own undertaking. Besides the manifestly humane purpose of this arrangement—to care for the present and future interests of its men—it promises to work to increase and improve the effectiveness of the company's service. Its tendency will be to give the men greater heart in their work, and to cause them to identify themselves more fully with it. Decent provision being made for the retirement of old hands, the service can be kept manned by a younger and more robust class. The new fund will effect the entire force on the lines of the Pennsylvania system east of Pittsburg and Erie, extending over a trackage of more than forty-one hundred miles.

* * * * *

The Broom as a Spreader of Disease.—Dust being now generally recognized as one of the most efficient vehicles of the germs of disease, Dr. Max Girsdansky finds the broom to be one of the most active agents in sending them into air, where it is diffused by whatever breezes may be blowing there. The housewife digs the dust out of her carpets and stirs it out of the quiet corners where it has accumulated, wearing an old dress and covering her head while she leaves her lungs exposed, then shakes her rugs in the yard, and the street sweeper transfers the dust he has charge of from the pavement to the atmosphere, where we can breathe our fill of consumption from day to day. Therefore, the author holds, the broom, "far from serving any hygienic purpose, is the cause of the maintenance of organic dust in the atmosphere of the large cities of the world, and as such is the most important cause of the existence and spread of tuberculosis." Further, the carpet is pronounced "an unhygienic article, serving as a fine breeding ground for vegetable parasites, necessitating the use of the broom and the duster, and thereby becoming a reason for the existence of organic dust." As the only proper and safe way of procuring the cleanliness of the floors and streets of our large cities, Dr. Girsdansky advises the free use of water in the shape of showers, or with sprinkling wagons, hoes, mops, etc., and that all floors and floor coverings of the house and the street be so constructed as to facilitate the free use of water in these ways.

* * * * *

Alkali Soils in Montana.—Mr. F. W. Traphagen, of the Montana Agricultural Experiment Station, ascribes the origin of the alkali soil in the arid regions to the failure of the elements to remove the soda salts set free on the disintegration of the rocks, which in humid regions are taken up and washed away by the rains. The soluble salts are dissolved by the water that falls on the surface, and are carried down when it soaks through the ground, to form an element in the ground water. They return thence to the soil when water is brought up by capillary action to supply the place of that lost by surface evaporation, and accumulate there. Then, as the water evaporates they are left on the surface, forming, when in sufficient quantity, the white crusts seen in badly alkalied places. The most effective remedy for alkali might probably be found in underdrainage, which would prevent the ground water rising to the top, and would carry off the salts. This being at present 735
impracticable on the large scale that would be required, such expedients as surface flooding and such cultivation of crops as would tend to check evaporation are suggested. The pernicious effects of "black alkali" or sodium carbonate are seen when it forms as much as about one tenth of one per cent of the soil, in the corrosion and solution of vegetable matter—the stems of plants—exposed to it. It also dissolves the humus or vegetable mold, forming dark-colored solutions and depositing a black residue upon the evaporation of the water—whence its name—and it destroys the tillability of many soils. The "white alkali" or sodium sulphate can be borne in much larger proportions in the soil, and promotes the best crops just before it completely destroys them. The author remarks that the foundations of a number of buildings in Billings, Montana, are gradually becoming insecure because of the disintegration of the rock, due to the absorption of alkali salts, followed by the evaporation of the water and the deposit of salts within the pores of the rock. As the process continues, the rock particles are forced apart.

* * * * *

Future of the New York Canals.—The Committee on Canals of New York State recommend decidedly in their report to the Governor that those highways should not be abandoned but maintained, and the principal ones enlarged, while the others should be kept up as navigable feeders. Of two projects for enlarging the Erie Canal, that undertaken in 1895, with modifications to be executed at a cost of $21,161,645, and a larger one to cost $58,894,668, the committee prefer the larger one, because it will permanently secure the commercial supremacy of New York, while the other is "at best only a temporary makeshift." An important principle emphasized in the report is that the efficiency of the canals depends upon their management as well as upon their physical size. Therefore a policy should be followed that will encourage transportation companies to seek the use of them; mechanical means of traction should be employed, and mechanical power should be substituted for hand power in certain operations; the force engaged upon them should be organized on a more permanent basis of fitness, so as to furnish an attractive career to graduates of scientific institutions; and efficient guards should be thrown over the expenditure of money "so as to make impossible a repetition of the unfortunate results of the $9,000,000 appropriation."

* * * * *

Floating Stones.—While engaged in scientific research in southwest Patagonia, Mr. Erland Nordenskiold observed a considerable number of small fragments of slate floating upon the surface, packed together in larger or smaller clusters. The surface of the stones was dry, and they sank immediately when it became wet. Their specific gravity was 2.71, that of the water being 1.0049. The fragments contained no air cavities perceptible to the naked eye, but small, gaseous bubbles could be seen attached to their under surfaces, and stones on the very fringe of the beach which were just beginning to float were observed to be lightened by gaseous bubbles. The author was not able to investigate the phenomenon more closely, but believes that besides the visible bubbles they were surrounded by an envelope of gas, supported by an insignificant coating of algæ, by which they are enveloped. The greasy surface of the mineral also prevented the water from adhering to them, and caused them to be surrounded with a concave meniscus, which contributed much to their floating.

* * * * *

The "Periodicity of War."—The doctrine of "the periodicity of war" was presented at the Lake Mohonk Conference on International Arbitration in May-June, 1899, by General Alfred C. Barnes, with the introductory remark that "no one deprecates war more than the soldier who serves from a sense of duty." The speaker said that "with all our privileges, and in spite of the elevated spirit that undeniably prevails among us, the original savage lurks in the hearts of men here as elsewhere." In two hundred and twenty-five years we have had ten principal wars—five during the colonial period and five since our independence was undertaken. The average interval between wars has been about twenty years—"an extremely interesting periodicity, as it brings into the 736
arena a new race of fighting young men. So it seems that for each fresh generation of our youth the temple gates of Janus have to be opened, that the furies there confined may rush forth and devastate the earth. It looks almost like the operation of a natural law." General Barnes's theory of the origin of the war that the United States is still engaged in is the simple one that we were "spoiling for a fight."

* * * * *

Expert Opinions respecting Food Preservatives.—At a recent hearing before an English Official Committee on Preservatives and Coloring Matters in Food, the representative of an eminent firm of preservers said that preservatives were not very generally used with fruits and jams. His firm regarded them as quite unnecessary, but he would not say they ought to be prohibited if used in moderate quantity. Besides coloring matter in vegetables, the only article used by his firm for coloring was an extract of cochineal. Mr. John Tubb Thomas, a medical officer, told of children who were injured by milk containing boracic acid, and said that in his experiments upon himself about fifteen grains of that substance a day had upset his digestive organs and produced sickness, with diarrhœa and headache. The use of the acid, he said, should certainly be prohibited in new milk, which was so largely the food of invalids and infants. Dr. W. H. Corfield said he had found salicylic acid in the lighter wines and beers. It was a slightly acrid, irritating substance, which was used externally for the removal of corns and warts, and was a most undesirable article to put in food. Mr. Walter Collingwood Williams, a public analyst, had found salicylic acid in a number of temperance, non-alcoholic drinks. Dr. Kaye, a medical officer of health, showed that the number of infant deaths was increasing, while the general death rate was decreasing, and attributed the fact, partly at least, to the growing and excessive use of preservatives.

* * * * *

Pawnshops in Germany.—Between half a dozen and a dozen of the state pawnshops which were common in Germany in the seventeenth and eighteenth centuries still exist. The United States vice-consul at Cologne has given a considerable list of municipal pawnshops in the more important cities of all parts of Germany. On the whole, the number of these institutions is larger in Germany than in France, but smaller than in Belgium, Holland, and Italy. The business of pawnshops appears, at least more recently, to depend less upon general economic than on special, local causes. The German law has usually required private persons doing a pawnbroking business to take out special licenses, and has exercised a more or less strict supervision over them. The supervision practically lacked efficiency, and more stringent regulations were imposed by a statute enacted in 1879, which is now the basis of the existing law of the German Empire. Under this law license is refused to persons who are unfitted for the business, and is not issued at any rate unless a necessity is shown for the institution. The imperial law is supplemented by special laws of the various German states.

* * * * *

Animals of the Ocean Depths.—While plant life in the ocean is limited to shallow waters, Sir John Murray says fishes and members of all the invertebrate groups are distributed over the floor of the ocean at all depths. The majority of these deep-sea animals live by eating the mud, clay, or ooze, or by catching the minute particles of organic matter which fall from the surface. It is probably not far from the truth to say that three fourths of the deposits now covering the floor of the ocean have passed through the alimentary canals of marine animals. These mud-eating species, many of which are of gigantic size when compared with their allies living in the shallow coastal waters, become in turn the prey of numerous rapacious animals armed with peculiar prehensile and tactile organs. Many deep-sea animals present archaic characters; still, the deep sea can not be said to contain more remnants of fauna which flourished in remote geological periods than the shallow and fresh waters of the continents.

* * * * *

The Site of Ophir.—Dr. Carl Peters, an African explorer recently returned to London, believes that he has 737
found the Ophir whence King Solomon's gold was brought, in the country between the Zambesi and the Pungwa Rivers, in Portuguese Africa and eastern Mashonaland. Many rivers, some quite extensive, of undetermined origin, and traces of ancient mining enterprises, are found in the region, and gold is still washed there. One site is Fura, on the Muira River, about fifteen miles south of the Zambesi. The name Fura is said to be a native corruption of the word Afur, by which the Arabs of the sixteenth century called the district, and that to be the Saharan or south Arabian form of the Hebrew Ophir. The natives are unlike the ordinary Africans, and have a distinctly Jewish type of face. A chief informed Dr. Peters concerning the position of some ancient workings, and, following his directions, the explorer found ruins "of an undoubtedly Semitic type." Dr. Peters's hypotheses and evidences must be accepted for what they are worth. Other explorers have found Ophir at various points in Africa and Arabia, and even in India and elsewhere, and have been as satisfied and as sure as he with their identifications.

MINOR PARAGRAPHS.

An instructive address, before the Iron and Steel Institute of Great Britain, was recently delivered by Sir W. Roberts Austen on the progress made in the iron and steel industries during the past century. The great revolution which the discovery of steel brought about is dwelt upon at length, and its far-reaching importance, not only in the iron industry itself but in all other industries and in the destinies of England herself, pointed out. In the early days of the industry it was held that the different qualities of iron were due to the different localities from which the ore was obtained, but late in the eighteenth century the great Swedish chemist, Bergman, of Upsala, clearly showed that carbon is the element to which steel and cast iron owe their distinctive properties. Clouet’s celebrated experiment on the carburization of iron by the diamond followed. “Well might Bergman express astonishment at the action of carbon on iron. Startling as the statement may seem, the destinies of England throughout the century, and especially during the latter half of it, have been mainly influenced by the use of steel. Hardly a step of our progress or an incident of our civilization has not in one way or another been influenced by the properties of iron and steel. It is remarkable that these properties have been determined by the relations subsisting between a mass of iron, itself protean in its nature, and the few tenths per cent of carbon it contains.” In 1800 the production of pig iron in England was about 200,000 tons; in 1898 it was 8,769,249 tons.

*   *   *   *   *

A note in Nature describes an ingenious arrangement for controlling the direction of torpedoes by means of ether waves. Two solenoids, into which are drawn iron cores, are attached to the rudder head, the core which is drawn in depending, of course, upon the direction of the received current. Two rods projecting above the surface of the water receive the waves and are in circuit with a coherer of special type, which affects a relay in the usual way. The actual processes involved in steering and controlling a torpedo are somewhat as follows: The torpedo, containing a suitable combination of the apparatus above mentioned, is launched from a vessel containing the necessary sending apparatus. Suppose the torpedo goes off its course. Then, by means of a switch, an induction coil is supplied with an electric current, and waves or oscillations are generated. These, on reaching the torpedo, pass into the projecting wire and thence reach the coherer. This operates the relay, closing the secondary circuit. An electric current now flows through a “selector” to one of the solenoids, the iron core is sucked into right or left, and the helm is thus turned. When the torpedo has attained a proper course the switch is opened and the waves cease. The vibration in the neighborhood of the coherer restores it to the original resistance; the current passing through it becomes weaker and ceases to affect the relay coil, which therefore opens the secondary circuit and allows the helm to fly back to the midship position. A large model of the apparatus has been constructed, and it is said to work with entire success under all kinds of conditions. The inventors are Mr. Walter Jameson and Mr. John Trotter. It is stated that Nikola Tesla has American patents for a somewhat similar device.

*   *   *   *   *

In the absence of the author, Professor Dewar’s paper on the solidification of hydrogen was read in the British Association by Sir William Crook. It shows that solid hydrogen presents the appearance of frozen water, and not, as had been anticipated by many, of frozen mercury; hence it is now definitely decided that it is not metallic. The temperature of the solid is 16° absolute at thirty-five millimetres pressure, and it melts at 16° or 17° absolute, the practical limit of the temperature obtainable by its evaporation being 14° or 15° absolute. Thus the last of the old gas has been solidified. It was further mentioned, in connection with these statements, that Professor Dewar had succeeded in liquefying helium.

*   *   *   *   *

The organizing committees of the Congresses of Aëronautics and Meteorology—these being cognate subjects—of the Exposition of 1900 have decided to hold the meetings of these bodies in such a manner that all members can attend the sessions of both. The programme arranged for the Aëronautical Congress contemplates the discussion, under aspects which are set forth in detail, of “problems” relating to free balloons, their management and use; captive balloons, steerable balloons, and aviation; and the scientific applications of balloon observations to problems in astronomy, meteorology, and physiology; also of their use for purposes of reconnoissance and topographical surveys, and of photography from balloons. In a different order of ideas, the congress may occupy itself with questions of legislation and international law which concern aëronauts in times of peace and of war.

*   *   *   *   *

Three State catalogues of Ohio plants have heretofore been issued. The first, by J. S. Newberry, was published in the State Agricultural Report in 1859; the second, by H. C. Beardslee, was published in 1874, and was reprinted in the Agricultural Report for 1879; and the third, by W. A. Kellerman and W. C. Werner, was included in the State Geological Report for 1893. This work contains a bibliography, and gives the names of the first known collectors of the less common species. A fourth catalogue, consisting of a checklist of the *Pteridophytes* and *Spermophytes*, recently published by Prof. W. A. Kellerman, contains the species and varieties numbered serially, as in the State Herbarium of nearly ten thousand sheets, with the sequence of groups as by Engler and Prantl, and the nomenclature as used by Britton and Brown.

NOTES.

The committee of the St. Petersburg Astronomical Society for the revision of the Russian calendar, to make it agree with the Gregorian, has found it necessary to move slowly. The festivals prove a formidable obstacle to the desired reform, and the people will have to be prepared for the change before it can be instituted. The plan now is to use both dates, Russian and Gregorian, together till the new style can be made familiar, and it is proposed to make the double use compulsory on private as well as on public documents and papers.

* * * * *

A steamboat company is placing its little vessels on the canals of Venice, and the gondolas, which were one of the charms of the city to travelers, are destined to disappear—unless a few may be reserved to gratify the curiosity of tourists.

* * * * *

The Commissioner of Education of Rhode Island has issued a circular to teachers, calling attention to the work of the Audubon Society for the Preservation of Birds, and to the incalculable value, from various points of view, of bird life, and advises them to foster Nature study as furnishing a natural channel by means of which instruction and information on the subject may readily be brought before the children, and through them to the people generally.

* * * * *

In a paper on The Ultimate Basis of Time Divisions in Geology, T. C. Chamberlin accepts it as proved that there were no universal breaks in sedimentation or in the fundamental continuity of life, no physical cataclysms attended by universal destruction of life, and that sedimentation has been in constant progress somewhere and life continuous and self-derivative since the beginning. He then raises the question whether this continuity of physical and vital action proceeded by heterogeneous impulses or by correlated pulsations. The author’s conclusion is in favor of the hypothesis of correlated pulsations involving a rhythmical periodicity.

* * * * *

Nettle fiber is said to be coming into great favor for the manufacture of fine yarns and tissues. Several factories in Germany are using it, and the introduction of the extensive cultivation of nettles into the African colony of the Cameroons is contemplated.

* * * * *

There are now, according to the last annual Report of the Commissioner of the General Land Office, thirty-six forest reservations (exclusive of the Afognak Forest and Fish-Culture Reserve in Alaska) in the United States, embracing an estimated area of 46,021,899 acres. This estimate is for the aggregate areas within the boundaries of the reservations, but the lands reserved are only the vacant public lands therein. The actual reserved area is therefore somewhat less than the estimate.

* * * * *

Experiments made by Professor Dewar and Sir W. Thisleton Dyer, and reported to the British Association, upon the effect of the temperature of liquid hydrogen upon the germinative power of seeds, go to show that life goes on at a temperature so low that ordinary chemical action is practically stopped. Seeds of barley, vegetable marrow, mustard, and the pea were immersed in liquid hydrogen for six hours, cooled to a temperature of 453° F. below the temperature of melting ice, and came out unchanged to the eye, and, when planted, all germinated.

* * * * *

Sir John Lubbock, having been raised to the peerage, has adopted Lord Avebury as his title, and will be henceforth so known.

* * * * *

In our obituary list of men known to science are the names of N. E. Green, F. R. A. S., who was distinguished for the excellence of his planetary observations, particularly of Mars, made at Madeira in 1877, and was the second President of the British Astronomical Association, died November 10th, in his seventy-sixth year; Prof. E. E. Hughes, inventor of the Hughes printing telegraph machine, the microphone, and the induction balance, Fellow of the Royal Society, gold medalist, and Chevalier of the Legion of Honor, who was born in London in 1831 and was brought to the United States at an early age; Mr. J. R. Gregory, mineralogist; M. Marion, professor in the Scientific Faculty in the University of Marseilles and Keeper of the Natural History Museum there, who took part in the dredging trips of the Travailleur and the Talisman, and contributed to the *Annales* of the museum at Marseilles; Dr. Hans Bruno Geinitz, geologist and paleontologist, at Dresden, Saxony, in his eighty-sixth year; Walter Götze, botanist, while on an expedition to German East Africa, December 9th; and Mr. W. T. Suffolk, treasurer of the Royal Microscopical Society of Great Britain.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. Connecticut: Twenty-third Annual Report. Part I. Fertilizers. Pp. 92; Bulletin No. 130. Commercial Feeding Stuffs in the Connecticut Market.—North Dakota Weather and Crop Service, November, 1899, and January, 1900. Pp. 8 each.—United States Department of Agriculture: Agrostology Circular No. 54. Smooth Brome-Grass. Pp. 10; No. 57. Experiments with Forage Plants in Ontario. Pp. 3; Meteorological Chart of the Great Lakes. Summary for the Season of 1899. Vol. II, No. 9. By Alfred J. H. Henry and Norman B. Conger. Pp. 28, with maps.—West Virginia: Bulletin No. 61. Sheep-Feeding Experiments. By J. H. Stewart and Horace Atwood. Pp. 10; No. 62. A Study of the Effect of Incandescent Gaslight on Plant Growth. By L. C. Corbett. Pp. 38, with plates.

American Grocer Publishing Company. Scientific Testimony against the use of Alum in Food. (Evidence before the United States Senate Investigating Committee.) Pp. 12.

Andrews, William. The Diuturnal Theory of the Earth, or Nature's System of constructing a Stratified Physical World. New York: Myra Andrews and Ernest G. Stevens, 18 West Forty-fifth Street. 740

Benson, Lawrence Sluter. Principles of Finite Values in Mathematics. Pp. 6.

Bland, Rev. J. P., Cambridge, Mass. What we Know about God. Pp. 12.

Bulletins, Reports, Announcements, etc. American Association for the Advancement of Science: Forty-eighth Annual Meeting, Columbus, Ohio, 1899. Proceedings. Pp. 527, with plates of portraits.—Annals of the Astronomical Observatory of Harvard College. Vol. XXXII, Part II. Visual Observations of the Moon and Planets. By. W. H. Pickering, Director. Pp. 212, with plates; Vol. XXXIII. Miscellaneous Researches, 1897–1899. Pp. 287, with plates; Vol. XLII, Part II. Observations made at the Blue Hill Meteorological Observatory, Massachusetts, 1897 and 1898, under the Direction of A. Lawrence Rotch. Pp. 150.—Columbia University, New York: Summer Session, 1900. Announcement. Pp. 24.—Cuba, Department of Posts: Annual Report for the Fiscal Year ending June 30, 1899. Pp. 215.—Interstate Commerce Commission: Preliminary Report on the Income Account of Railways in the United States, to June 30, 1899. Pp. 70.—Massachusetts Institute of Technology, Boston: Annual Catalogue, 1899–1900. Pp. 357.—Michigan: Thirty-eighth Annual Report of the Secretary of the State Board of Agriculture, and Twelfth Annual Report of the Experiment Station. Pp. 465.—Missouri Botanical Garden: Twelfth Annual Report. By William Trelease. Pp. 151, with plates.—New York State: Report of the Committee on Canals, 1899. Pp. 231, with charts; Sixteenth Annual Report of the Bureau of Labor Statistics, 1898. Pp. 1179—Perkins Institution and Massachusetts School for the Blind: Sixty-eighth Annual Report. Pp. 325.—United States Department of Labor: Bulletin No. 26. January, 1900. Pp. 236.—United States Geological Survey: Nineteenth Annual Report. Part V. Forest Reserves. Pp. 400, with portfolio of maps.

Burns, J. J. The Story of English Kings according to Shakespeare. New York: D. Appleton and Company. (Home-Reading Books.) Pp. 272.

Chambers, G. F. The Story of Eclipses. (Library of Useful Stories.) New York: D. Appleton and Company. Pp. 222, with plates. 40 cents.

Citator, The. Ohio Edition. (Register of Citations in Legal Practice.) Quarterly. Lapeer, Mich. Pp. 102.

Clinical Excerpts. Elberfeld Company, New York. Pp. 20.

Coulter, John M. Plant Structures. A Second Book of Botany. New York: D. Appleton and Company. (Twentieth Century Text-Books.) Pp. 348. $1.20.

Deniker, J. The Races of Men. An Outline of Anthropology and Ethnography. New York: Charles Scribner's Sons. (Contemporary Science Series.) Pp. 611. $1.50.

Echeveria i Reyes, Anibal. Voces Usadas en Chile. (Errors of Speech.) Santiago. Pp. 246.

Hannay, P. M. How to gain Health and Long Life. Chicago: The Hazel Pure-Food Company. Pp. 114.

I am that I am. A Dialogue of the Gods. By Sum quod Sum. New York: Library of Liberal Classics. Pp. 21. 10 cents.

Kent, Rev. Alexander. The Plan of Salvation. Pp. 16.

La Pouge, G. Vachet de. L'Aryen Son Role Social. (The Aryan, his Social Office.) Paris: Albert Fontemoing. Pp. 569. 10 francs.

Macmillan, The, Company. Announcements of New Books, Spring, 1900. Pp. 44.

McIlwraith, J. N. Canada. (History for Young Readers.) New York: D. Appleton and Company. Pp. 252.

Manning, Warren H. A Handbook for Planning and Planting Small Home Grounds. Stout Manual-Training School, Menomonee, Wis. Pp. 76.

Richter, Victor von. Organic Chemistry, or Chemistry of the Carbon Compounds. Edited by Prof. R. Anschütz and Dr. G. Schroeter. Authorized translation by Edgar F. Smith. Philadelphia: P. Blakiston's Son & Co. Pp. 671. $3.

Richardson, Harriet. A New Species of Idotea, from Hakodate Bay, Japan. Pp. 4.

Ward, Lester F. Description of a New Genus and Twenty New Species of Fossil Cycadean Trunks from the Jurassic of Wyoming. Pp. 32, with 7 plates.

Wooster, L. C. Educational Value of the Natural Sciences. Pp. 18.

INDEX.

ARTICLES MARKED WITH AN ASTERISK ARE ILLUSTRATED.

Aggression, External and Internal. (Table), 386
Agnosticism and Naturalism, Professor Ward on. H. Spencer, 349
Agricultural Education in Foreign Countries. W. E. De Riemer, 218
Agriculture: Alkali Soils in Montana. (Frag.), 734
” Manuring with Brains. (Frag.), 731
” Sea Water, Effect of, on Soil. (Frag.), 508
Air Flight, Early Experiments in. M. B. Rivet, 603
Alkali Soils in Montana. (Frag.), 734
Allen, Grant, Death of. (Frag.), 389
Amazonian Pygmies, Stories of. (Frag.), 733
A More Excellent Way. (Table), 729
Anarchist, A Paradoxical. C. Lombroso*, 312
Anglo-Saxon Superiority. (Frag.), 620
Animals of the Ocean Depths. (Frag.), 736
” Reason? Do. Rev. E. R. Young*, 105
” ” ” (Corr.), 122
Annual Flowers. (Frag.), 394
Anthropological Traits, Zola’s. (Frag.), 388
Anthropology: Amazonian Pygmies, Stories of. (Frag.), 733
” Anglo-Saxon Superiority. (Frag.), 620
” A Survival of Mediæval Credulity. E. P. Evans, 577
” Malay Folklore. R. C. Ford, 239
” Origins of the American Races, Professor Putnam on. (Frag.), 507
Appleton, William H., The Late. (Table), 265
Archæology: Athabascan Indian Lodge, An. (Frag.), 292
” Egyptian Exploration, Recent Years of. W. M. Flinders Petrie, 625
” Ophir, The Site of. (Frag.), 736
” Vinland and its Ruins. C. Horsford*, 160
Art Form, The Study of. D. Cady Eaton*, 685
”Value of the Study of. G. Perrot, 204
Artificial India Rubber. (Frag.), 136
Astronomy, Advance of, in the Nineteenth Century. Sir R. S. Ball, 289
” Forenoon and Afternoon. C. F. Dowd, 492
” Gegenschein, The. (Frag.), 618
” Scenes on the Planets. G. P. Serviss*, 337
Athabascan Indian Lodge, An. (Frag.), 392

Bacteria of the Dairy. (Frag.), 284
Ball, Sir R. S. Advance of Astronomy in the Nineteenth Century, 289
Baxter, William, Jr. What makes the Trolley Car go*, 316, 408, 564 742
Becker, W. F., M. D. The Morbid Sense of Injury, 596
Birds, Busy. (Frag.), 138
Blind Fishes of North America. C. H. Eigenmann*, 473
Books Noticed, 126, 268
Anthropological Institute of Great Britain, Quarterly Journal of, 277.
Astronomy, Elements of Practical. W. W. Campbell, 129.
— Stars and Telescopes. D. B. Todd, 132.
Barrett, John. The Philippine Islands and American Interests in the Far East, 133.
Beeman, W. W., and Smith, D. E. New Plane and Solid Geometry, 273.
Binet, Alfred. The Psychology of Reasoning, 274.
Biology. Living Organism, The. A. Earl, 131.
Botany. California Plants in their Homes. A. M. Davidson, 130.
— Plant Relations. J. M. Coulter, 131.
British Race, The Story of the. J. Munro, 272.
Buckley, J. M. Extemporaneous Oratory, 270.
Bullen, F. T. Idylls of the Sea, 271.
Campbell, W. W. Elements of Practical Astronomy, 129.
Chemical Jurisprudence, Notes on. H. Huntington, 133.
Cities, Growth of, in the Nineteenth Century. A. F. Weber, 126.
Civil Engineers, Proceedings of the American Association of. April, 1899, 278.
Cope, E. D. Vertebrate Remains from the Port Kennedy Deposit, 133.
Coulter, John M. Plant Relations, 131.
Cragin, Belle S. Our Insect Friends and Foes, 273.
Croke, W. J. D. Architecture, Painting, and Printing at Subiaco, 134.
Crook, James K. Mineral Waters of the United States and their Therapeutic Uses, 127.
Dalton, D. How to Swim, 277.
Davidson, Alice M. California Plants in their Homes, 130.
Diet in Illness and Convalescence. A. W. Winthrop, 271.
Earl, A. The Living Organism, 131.

Economics. Liquor Laws, Centralized Administration of. C. M. L. Sites, 275.
Electricity. Accumulators, Small. P. Marshall, 276.
Entomology. Butterflies, Everyday. S. H. Scudder, 128.
— Insect Friends and Foes. B. S. Cragin, 273.
Erlingsson, T. Ruins of the Saga Times, 277.
Fish and Fisheries, Report of United States Commission of, for Year ending June 30, 1898, 276.
Fiske, John. Through Nature to God, 268.
Gardiner, C. A. Our Right to Acquire and Hold Foreign Territory, 134.
Gellé, M. E. L’Audition et ses Organes, 128.
Gelman, F. H. Elements of Blowpipe Analysis, 279.
Geological Survey, United States, Eighteenth Annual Report, 272.
Geometry, New Plane and Solid. Beeman and Smith, 273.
Heilprin, A. Alaska and the Klondike, 270.
History of the American Nation. A. C. McLaughlin, 129.
Huntington, H. Notes on Chemical Jurisprudence, 133.
Idylls of the Sea. F. T. Bullen, 271.
Insect Friends and Foes. B. S. Cragin, 273.
Interstate Commerce Commission, Tenth Annual Report of, 276.
Jacoby, J. The Object of the Labor Movement, 279.
Knowledge, Methods of. W. Smith, 273.
Kruger, F. T. A Step Forward, 275.
Labor Movement, The Object of the, 279.
Leonard, J. W. Who’s Who In America, 274.
Lucas, F. A. The Hermit Naturalist, 133.
Luquer, L. McI. Minerals in Rock Sections, 130.
McLaughlin, A. C. History of the American Nation, 129.
Marshall, P. Small Accumulators, 276.
Mathematics. Trigonometry, Elements of. H. C. Whitaker, 130.
Medicine. Transactions Wyoming State Medical Society. First and Second Regular Meetings, 279.
Memory, The Philosophy of, and Other Essays, 274.
Mineralogy. Blowpipe Analysis, Elements of. F. H. Gelman, 279. 743
— Colombia, The Ores of. H. W. Nichols, 132.
— Crystals, The Characters of. A. J. Moses, 129.
— Microscopic Identification of Minerals in Rock Sections. L. McI. Luquer, 130.
Mineral Waters of the United States. James K. Crook, 127.
Montaigne on the Education of Children. L. E. Rector, 278.
Moore, J. H. Better World Philosophy, 276.
Morehouse, G. W. The Wilderness of Worlds, 131.
Moses, A. J. The Characters of Crystals, 129.
Munro, John. The Story of the British Race, 272.
Naturalist, The Hermit. F. A. Lucas, 133.
Nichols, H. W. The Ores of Colombia, 132.
Oratory, Extemporaneous. J. M. Buckley, 270.
Philosophy, Better World. J. H. Moore, 276.
— Through Nature to God. John Fiske, 268.
Physiology. Hearing and its Organs. M. E. Gellé, 128.
Port Kennedy Deposit, Vertebrate Remains from. E. D. Cope, 133.
Psychologique, L’Année. A. Binet, 278.
Psychology of Reasoning, The. A. Binet, 274.
Railway Statistics in United States, Tenth Annual Report of Interstate Commerce Commission, 276.
Reasoning, The Psychology of. A. Binet, 274.
Reason, The Dawn of. J. Weir, Jr., 275.
Rector, L. E. Montaigne on the Education of Children, 278.
Saga Times, Ruins of the. T. Erlingsson, 277.
Scudder, S. H. Everyday Butterflies, 128.
Sites, Clement M. L. Centralized Administration of the Liquor Laws, 275.
Smith, D. T. The Philosophy of Memory and Other Essays, 274.
Smith, W. Methods of Knowledge, 273.
Southern Magazine, The, 278.
Subiaco, Architecture, Painting, and Printing at. W. J. D. Croke, 134.
Swift, M. L. Anti-Imperialism, 134.
Swim, How to. D. Dalton, 277.
Todd, D. B. Stars and Telescopes, 132.
Weber, Adna Ferrin. Growth of Cities in the Nineteenth Century, 126.
Weir, J., Jr. The Dawn of Reason, 275.
Whitaker, H. C. Elements of Trigonometry, 130.
Who’s Who in America. J. W. Leonard, 274.
Wilderness of Worlds, The. G. W. Morehouse, 131.
Winthrop, Alice W. Diet in Illness and Convalescence, 271.
Witt, H. Fundamental Principles of Nature, Some Observations on the, 132.
Wyoming State Medical Society, Transactions of First and Second Regular Meetings, 279.
Botanical Garden’s Museum, New York. (Frag.), 733
Botany: Annual Flowers. (Frag.), 394
” Genuine Starch Factories. B. D. Halsted*, 716
” Plant Names, English. (Frag.), 140

”   The New Field of. B. D. Halsted, 98
Briggs, C. A. Is the Christian Religion Declining?, 423
Brooks, W. K. The Wonderful Century, 25
Broom as a Spreader of Disease, The. (Frag.), 734
Bunsen, Death of. (Frag.), 281

Calcium, Metallic. (Frag.), 283
California, Forestry in. (Frag.), 509
Cambridge University. (An English University.) H. Stotesbury*, 14
Canals, Future of the New York. (Frag.), 735
Carbonic Acid and Climate. (Frag.), 621
Carrington, James B. Winter Birds in a City Park*, 366
Cements, Action of, on Sea Water. (Frag.), 733
Chemistry: A Hundred Years of. F. W. Clarke, 673 744
”   Calcium, Metallic. (Frag.), 283
”   Hydrogen, The Solidification of. (Frag.), 618
”   New Element, Another. (Frag.), 509
Children, Literature for. (Frag.), 618
China, Trade Corporations in. M. Courant, 722
Christian Religion Declining? Is the. C. A. Briggs, 423
City Roadways, Modern. N. P. Lewis*, 524
Civilized and Savage. (Frag.), 141
Clarke, F. W. A Hundred Years of Chemistry, 673
”   ” ” The Man of Science in Practical Affairs, 487
Climate and Carbonic Acid. (Frag.), 621
Colored Labor, Educated. (Frag.), 141
Columbus, Ohio, Geology of. (Frag.), 141
Commission in Difficulties, A. (Table), 614
Cook, O. “Ribbon Lightning”*, 587
Courant, M. Trade Corporations in China, 722
Criminal Jurisprudence, Decline of, in America. G. C. Speranza, 466
Criminology: Anarchist, A Paradoxical. C. Lombroso*, 312
”   Typical Criminals. Rev. S. A. Smith*, 539

Dairy, Bacteria of the. (Frag.), 284
“Dark Lightning.” (Frag.), 505
Dastre, M. A. The Scavengers of the Body, 379
Dawson, Sir William, Death of. (Frag.), 390
Democracy, Real Problems of. F. Smith, 1
Destruction of the Birds. (Frag.), 393
Development of the American Newspaper. W. L. Hawley*, 186
Diamonds, Emigrant, in America. William H. Hobbs*, 73
Dover Meeting of the British Association. (Frag.), 135
Dowd, C. F. Forenoon and Afternoon, 492

Eaton, D. Cady. The Science of Art Form*, 685
Economics: A More Excellent Way. (Table), 729
”   Commission in Difficulties, A. (Table), 614
”   Monopolies, The War against. (Frag.), 508
”   Pawnshops in Germany. (Frag.), 736
”   Pension Funds for Railroad Men. (Frag.), 734
”   Taxation, A State Official on Excessive. F. Smith, 645
Economy, A Question of. (Frag.), 283
Education: An English University. H. Stotesbury*, 14
”   Cross-. E. W. Scripture*, 589
”   Language and Life. (Table), 503
”   Liberal, and Democracy. (Table), 385
”   Literature for Children. (Frag.), 619
”   Plantations for Rural School Grounds. (Frag.), 393
”   Specialization. (Table), 125
”   The Environment in. (Frag.), 391
Egyptian Exploration, Recent Years of. W. M. Flinders Petrie, 625
Eigenmann, C. H. Blind Fishes of North America*, 473
Electricity: Dark Lightning. (Frag.), 505
”   From Thales to Faraday. E. T. Lesueur, 242
Electricity: “Ribbon Lightning.” O. Cook*, 587 745
Electrolysis. H. S. Wynkoop*, 357
Element, Another New. (Frag.), 509
Emigrant Diamonds in America. William H. Hobbs*, 73
Entomology: Spider Bites and “Kissing Bugs.” L. O. Howard*, 31
Evans, E. P. A Survival of Mediæval Credulity, 577, 706
Evolutionary Variation in the Past, Rate of. (Frag.), 285
Exploration and Geography in 1899. (Frag.), 619
Explosives, The Applications of. C. E. Munroe*, 300, 444

Faith and Knowledge. (Corr.), 497
Fiske’s Views Compared. (Corr.), 498
Flinders, Petrie, W. M. Recent Years of Egyptian Exploration, 625
Floating Stones. (Frag.), 735
Food Poisoning. V. C. Vaughan, 47
” Preservatives, Expert Opinions respecting. (Frag.), 736
Ford, R. C. Malay Folklore, 239
Forenoon and Afternoon. C. F. Dowd, 492
Forestry, American Advances in. (Frag.), 506
” in California. (Frag.), 509
Fossiliferous Formation below the Cambrian, A. (Frag.), 139
Funafuti Atoll, Constitution of the. (Frag.), 283
Future of the New York Canals. (Frag.), 735

Gegenschein, The. (Frag.), 618
Geography and Exploration in 1899. (Frag.), 619
Geology, A Century of. J. Le Conte, 431, 546
” Fossiliferous Formation below the Cambrian. (Frag.), 139
” Funafuti Atoll, Constitution of the. (Frag.), 283
” of Columbus, Ohio. (Frag.), 141
Gerhard, William P. Needed Improvements in Theater Sanitation, 84
Giddings, F. H. Exact Methods in Sociology, 145
Glacial Lakes in New York. (Frag.), 391
Glangeaud, P. Wingless Birds, 254

Halsted, B. D. Genuine Starch Factories*, 716
” ” ” The New Field of Botany, 98
Hawley, W. L. Development of the American Newspaper*, 186
Heat Insulators. (Frag.), 507
Heilprin, A. A Year’s Progress in the Klondike*, 455
” ”The Gold Sands of Cape Nome*, 633
High Altitudes, Dangers of, for Elderly People. (Frag.), 136
Hobbs, W. H. Emigrant Diamonds in America*, 73
Home Burdens. (Table), 125
Horsford, Cornelia. Vinland and its Ruins*, 160
Howard, L. O. Spider Bites and “Kissing Bugs”*, 31
Hydrogen, Solidification of. (Frag.), 618
Hygiene: Bacteria of the Dairy. (Frag.), 284

India Rubber, Artificial. (Frag.), 136
” ”Cultivation of. (Frag.), 732

Japanese Paper. (Frag.), 389 746
Jew, The Dread of the. (Frag.), 280
Jordan, D. S. Old Rattler and the King Snake, 371
” ” ” The Education of the Neminist, 176
Jordan’s (President) Neminism. A. Pangloss, 494

“Kissing Bugs” and Spider Bites. L. O. Howard*, 31
Klondike, A Year’s Progress in the. A. Heilprin*, 455

Language and Life. (Table), 503
Law: Criminal Jurisprudence, Decline of, in America. G. C. Speranza, 466
Le Conte, Joseph. A Century of Geology, 431, 546
Lesquereux and Sullivant, Honors to. (Frag.), 285
Lesueur, E. A. Electricity from Thales to Faraday, 242
Lewis, N. P. Modern City Roadways*, 524
Literature for Children. (Frag.), 619
Lombroso, C. A Paradoxical Anarchist*, 312

Malaria, The Mosquito Theory. Major R. Ross, 42
Malay Folklore. R. C. Ford, 239
Man of Science in Practical Affairs. F. W. Clarke, 487
“Manuring with Brains.” (Frag.), 731
Medalists, Royal Society. (Frag.), 620
Medicine: Plague Antitoxin. (Frag.), 732
” Rats and the Plague. (Frag.), 509
Meteorology: Climate and Carbonic Acid. (Frag.), 621
Mexico, Prosperity and Enterprise in. (Frag.), 283
Mineralogy: Emigrant Diamonds in America. William H. Hobbs*, 73
Miracle, A Thirteenth-Century. (Frag.), 394
Monopolies, The War against. (Frag.), 508
Montana, Alkali Soils in. (Frag.), 734
Mosquito Theory of Malaria, The. Major R. Ross, 42
Munroe, E. C. The Applications of Explosives*, 300, 444

Natural History: “Salamanders” and “Salamander” Cats. N. Robinson*, 556
” ” Whales, Longevity of. (Frag.), 618
Negro Question: Educated Colored Labor. (Frag.), 141
” ” Transplantation of a Race. N. S. Shaler, 513
Neminism, President Jordan’s. A. Pangloss, 494
Neminist, The Education of the. D. S. Jordan, 176
New York Botanical Garden’s Museum. (Frag.), 733
” ”Glacial Lakes in. (Frag.), 391
Nome, The Gold Sands of Cape. Angelo Heilprin*, 633

Ocean Depths, Animals of the. (Frag.), 736
” The Deeps of the. (Frag.), 390
Old Rattler and the King Snake. D. S. Jordan, 371
Ophir, The Site of. (Frag.), 736
Oregon, Eastern Oyster Culture in. F. L. Washburn*, 233
Ornithology: Birds, Destruction of the. (Frag.), 393 747
” Sand Grouse, The. (Frag.), 392
” Wingless Birds. P. Glangeaud, 254
” Winter Birds in a City Park. J. B. Carrington*, 366
Orton, Edward, Sketch of. (Portrait), 607
Outdoor Improvement, For. (Frag.), 284
Oyster Culture, Eastern, in Oregon. F. L. Washburn*, 233

Packard, R. L. Remarkable Volcanic Eruptions in the Philippines, 374
Pangloss, A. President Jordan’s “Neminism”, 494
Paper, Japanese. (Frag.), 389
Paris Exposition in 1900, The, and Congresses. (Frag.), 140
Park-making among the Sand Dunes. (Frag.), 139
Parliamentary Amenities Committee, The. (Frag.), 137
Parsons, C. A. Steam Turbines and High-Speed Vessels*, 696
Patrick, Mary M. Woman’s Struggle for Liberty in Germany, 328
Pawnshops in Germany. (Frag.), 736
Pearl Mussels. (Frag.), 621
Pension Funds for Railroad Men. (Frag.), 734
Periodicity of War. (Frag.), 735
Perrot, G. Value of the Study of Art, 204
Petrie, W. M. Flinders. Recent Years of Egyptian Exploration, 625
Physical Investigation, Where it fails. (Frag.), 284
” Measurements of Asylum Children. (Frag.), 138
Physiology: Scavengers of the Body. M. A. Dastre, 379
Plague Antitoxin. (Frag.), 732
” Rats and the. (Frag.), 509
Plantations for Rural School Grounds. (Frag.), 393
Plant Names, English. (Frag.), 140
Pseudo-Science: Neminist, The Education of the. D. S. Jordan, 176
Psychology: Animals Reason? Do. Rev. E. R. Young*, 105
” A Survival of Mediæval Credulity. E. P. Evans, 577
” Morbid Sense of Injury, The. W. F. Becker, M. D., 596
” “Warming Up.” (Frag.), 506
Public Library, The Function of the. (Table), 616
Putnam, Professor, on the Origins of the American Races. (Frag.), 507
Pygmies, Amazonian, Stories of. (Frag.), 733

Rats and the Plague. (Frag.), 509
Religion, Is the Christian, Declining? C. A. Briggs, 423
Religious Suicides. (Frag.), 731
“Ribbon Lightning.” O. Cook*, 587
Riemer, W. E. De. Agricultural Education in Foreign Countries, 218
Rivet, M. B. Early Experiments in Air Flight, 603
Roberts, Comptroller, on Excessive Taxation. F. Smith, 645
Robinson, N. “Salamanders” and “Salamander” Cats*, 556
Ross, Major R. The Mosquito Theory of Malaria, 42
Royal Society Medalists. (Frag.), 620

“Salamanders” and “Salamander” Cats. N. Robinson*, 556
Sand Dunes, Park-making among. (Frag.), 139
Sand Grouse, The. (Frag.), 292 748
Sanitation: Broom, The, as a Spreader of Disease. (Frag.), 734
Scavengers of the Body. M. A. Dastre, 379
Science and Dogma. (Table), 728
” of Art Form, The. D. Cady Eaton*, 685
” South-Sea Bubbles in. J. Trowbridge, 401
” The Man of, in Practical Affairs. F. W. Clarke, 487
Scripture, E. W. Cross-Education*, 589
Sea Water, Effect of, on Soil. (Frag.), 508

”   ”on Cements, Action of. (Frag.), 733
Serviss, G. P. Scenes on the Planets*, 337
Shaler, N. S. The Transplantation of a Race, 513
Simplon Tunnel, The. (Frag.), 388
Smith, Rev. S. G. Typical Criminals*, 539
”   Franklin. A State Official on Excessive Taxation, 645
Sociology: Democracy, Real Problems of. F. Smith, 1
”   Exact Methods in. F. H. Giddings, 145
South-Sea Bubbles in Science. J. Trowbridge, 401
Specialization. (Table), 125
Spencer, H. Professor Ward on Naturalism and Agnosticism, 349
Speranza, G. C. Decline of Criminal Jurisprudence in America, 466
Standard Time, How Obtained. T. B. Willson, 213
Starch Factories, Genuine. B. D. Halsted*, 716
Steamships, Sixty Years’ Improvements in. (Frag.), 506
Steam Turbines and High-Speed Vessels. C. A. Parsons*, 696
Sternberg, George M., Sketch of. (Portrait), 116
Stones, Floating. (Frag.), 735
Stotesbury, H. An English University*, 14
St. Prokopy, A Thirteenth-Century. (Frag.), 394
Suicides, Religious. (Frag.), 731
Survival of Mediæval Credulity. E. P. Evans, 577, 706

Taxation, A State Official on Excessive. F. Smith, 645
Theater Sanitation, Needed Improvements in. William P. Gerhard, 84
Trolley Car, What makes the, go? William Baxter, Jr.*, 316, 408, 564
Trowbridge, John. Latest Developments with the X Rays*, 659
”   ”South-Sea Bubbles in Science, 401
”   ”Wireless Telegraphy*, 59

Vagrant Electricity, Destructive Effects of. H. S. Wynkoop*, 357
Vaughan, V. C. Food Poisoning, 47
Vinland and its Ruins. Cornelia Horsford*, 160
”   The Location of. (Corr.), 500
Volcanic Eruptions in the Philippines, Remarkable. R. L. Packard, 374

“Warming Up.” (Frag.), 506
War, Periodicity of. (Frag.), 735
” Spirit, The. (Table), 501
Washburn, F. L. Eastern Oyster Culture in Oregon*, 233
Whales, Longevity of. (Frag.), 618
Willson, T. B. How Standard Time is Obtained, 213
Wingless Birds. P. Glangeaud, 254 749
Wireless Telegraphy. John Trowbridge*, 59
Woman’s Struggle for Liberty in Germany. Mary M. Patrick, 328
Wonderful Century, The. W. K. Brooks, 25
Wynkoop, H. S. Destructive Effects of Vagrant Electricity*, 357

X Rays, Latest Developments with. J. Trowbridge*, 659

Young, Rev. E. R. Do Animals Reason?*, 105

Zola’s Anthropological Traits. (Frag.), 388
Zoölogy: Blind Fishes of North America. C. H. Eigenmann*, 473

THE END.

Transcribers' Notes

Punctuation, hyphenation, and spelling were made consistent when a predominant preference was found in this book; otherwise they were not changed.

Simple typographical errors were corrected; occasional unbalanced quotation marks retained.

Ambiguous hyphens at the ends of lines were retained.

In some editions of this eBook, the superscript "e" in the address on page 708 appears as a normal "e", the asterism immediately following it appears as ::, and subscripted numbers in chemical formulas appear as normal numbers, such as H2O.

Links in the Index to the other five issues of Volume 56 will not function on all reading devices. When they do work, the first use in each session may lead to the beginning of the other issue, rather than to the specified page, but subsequent uses of any link in the same session should lead to the specified page. Links in the Index were not checked for accuracy, and the external links were not checked for validity. Due to the way two of those eBooks were prepared, links to the first article in the first two issues lead to the second page of those articles.

The other five issues of Volume 56 also are available at Project Gutenberg. The eBook numbers are 44725, 47024, 47180, 47181, and 46473.

Page 635: "wofully" was printed that way.

Page 649: Missing closing quotation mark added after "howling wilderness,".

Page 683: "Boisbandran" is a misprint for "Boisbaudran".

Page 731: "Adrian's" was printed that way; may refer to "Hadrian".

Page 734: "Pittsburg" was printed that way.

to our email newsletter to hear about new eBooks.