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APPLETONS'
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MONTHLY.

JANUARY, 1900.

ADVANCE OF ASTRONOMY DURING THE NINETEENTH CENTURY.

By Sir ROBERT BALL,
LOWNDEAN PROFESSOR OF ASTRONOMY AT THE UNIVERSITY OF CAMBRIDGE, ENGLAND.

One of the most remarkable chapters in the astronomy of the past century was commenced on the very first night with which that century began. It was, indeed, on the 1st of January, 1801, that the discovery of a new planet was announced. The five great orbs—Jupiter, Saturn, Mercury, Mars, and Venus—had been known from the earliest times of which we have records, and the planet Uranus had been discovered nearly twenty years before the previous century closed. The solar system was thus thought to consist of these six planets and, of course, the earth. On the memorable night to which I have referred, Piazzi, the astronomer, made a remarkable advance. He discovered yet another planet—the seventh, or eighth, if the earth be included. The new body was a small object in comparison with those which were previously known. It was invisible to the unaided eye, and seemed no more than a starlike point even when viewed through a telescope. It revolved around the sun in the wide region between the orbits of Mars and Jupiter. This discovery was speedily followed by others of the same kind, and, as the century has advanced to its close, the numbers of these planets—asteroids, as they are generally called—has been gradually increasing, so much so that now, of these little bodies known to astronomers, the number amounts to about four hundred and fifty.

But just as the beginning of the century was heralded by the discovery of the first of these asteroids, so the close of the century will be signalized in the history of astronomy by the detection among these little objects of 290
one which has entirely cast into the shade all other discoveries of the same nature. On the night of the 13th of August, 1898, a German astronomer, Herr Witt, exposed a photographic plate to the heavens in his telescope in the Observatory of Urania, at Berlin. On that plate a picture of the heavens was obtained, and in that picture a new planet was revealed. At first the discovery of one more asteroid does not imply very much. Hundreds of such planets might be found, and indeed have been found, and yet no particular comment has been called forth. But this planet found by Witt is a unique object; it is more interesting than the whole of the four hundred and thirty-two other minor planets which have preceded it—not, indeed, on account of its size, for Witt's planet is a wholly insignificant object from this point of view. The special interest which this new planet has for us dwellers on the earth lies in the fact that it seems to be the nearest to the earth of all the other worlds in space—the moon, of course, excepted. This is the reason why the attention of all who are interested in the science of astronomy has been concentrated on Witt's discovery. It is certainly the most interesting telescopic revelation which has been made for many years.

It may illustrate a characteristic feature in the progress of modern astronomy if I describe how Witt succeeded in obtaining this picture. He had selected one of the most rapid plates that the skilled manufacturer can supply to the photographer. He put this plate into his telescope, and he directed it to the heavens. If that plate had been used in broad daylight for the more ordinary purpose of obtaining a photographic portrait, an exposure of half a second would have been quite long enough. But the very faint stars can not work their charm on the plate with equal rapidity; a second is not long enough, nor is ten seconds, nor even ten minutes. If we desire to secure an imprint of the faintest stars we must expose the plate for an hour, and sometimes for even much longer than an hour. Of course, an exposure of such duration would utterly ruin the picture if a gleam of any other light obtained access. But in the darkness of night the plate is secure from this danger. Each star is thus given time enough to impress its little image at leisure.

The photographer has often occasion to deplore the poorness of his light. It is, of course, in the endeavor to counteract the poorness of the light that so long an exposure is frequently given. But it will not be any longer supposed that, from the astronomer's point of view, a tedious exposure must necessarily be a disadvantage. Let it be henceforth recollected that it was the very requirement of a long exposure which led to the present 291
important discovery. If the stars had been bright enough to be photographed by an exposure not longer than a few seconds or even than a few minutes, then this new and wonderful planet Eros would not have been revealed.

Many points of light which were undoubtedly stars, and merely stars, were shown on this picture taken by the German astronomer at Urania. Among these points of light was, however, one object which, though in appearance hardly distinguishable from a faint star, was in truth a body of a very different character. No telescope, however powerful, would show by mere inspection any appreciable difference between the dot of light indicating a star and the dot of light indicating the asteroid Eros. The fundamental difference between the star and Eros was, however, revealed by the long exposure. The stars in such a picture are, of course, at rest. They have occupied for years and for centuries the places where we now find them. If they are moving at all, their movements are so slow that they need not now be considered. But this starlike point, or, as we may at once call it, this asteroid, Eros, is moving. Not that its movements seem very rapid from the distance at which alone we are compelled to view it. No casual glance would indicate that Eros was flying along. The ordinary observer would see no change in its place in a second—no change in its place even in a minute. But when the exposure has lasted for an hour this asteroid, in the course of the hour, has moved quite appreciably. Hence arose a great difference between the representation which the photograph has given of the stars, properly so called, and of the asteroid. Each star is depicted as a sharp, well-defined point. This little body which is not a star, this unsteady sitter in the picture, could not be so represented; it merely appeared as a streak. The completed photograph accordingly shows a large number of well-marked dots for the stars, and among them one faint line for the asteroid.

Such a feature on a picture, though very unusual, does sometimes present itself. To detect such a streak on a photograph of the stars is a moment of transcendent joy to the astronomer. It is often for him the exciting occasion on which a discovery is made. This little moving point is in actual fact as different from a star as a pebble is different from a brilliant electric light. The resemblance of the asteroid to a star is merely casual; the resemblance would wholly disappear if we were able to make a closer inspection. The star is a brilliant blazing orb like a sun, but so far away that its luster is diminished to that of a point; the planet is comparatively near us; it is a dark body like our earth, and is like our earth also in this further respect that all the light it enjoys has 292
been derived from the sun.

Though there is this immense difference between a star and a planet, yet the observer must not expect to notice any such difference by merely taking a peep through the telescope. It was only the long exposure in the photograph that revealed the little body.

Such is the manner in which an asteroid is generally discovered in these latter days. A discovery like this comes as the well-earned reward of the skill and patience of the astronomical photographer. There are, indeed, a large number of known asteroids; our catalogues contained four hundred and thirty-two of them up to the time when Witt exposed his now famous plate. Had the asteroid Witt then found been merely as other asteroids, it would never have received the prominent position that has now to be assigned to it in any account of the astronomy of the century. That object found by Witt on this night which is to be henceforth memorable in astronomy is of a wholly exceptional kind. Had Eros been merely an ordinary asteroid, Witt might no doubt have received the credit to which his labors and success would have entitled him. Another asteroid would have been added to the long list of such objects already known, but the newspapers would never have troubled their readers about the matter, and the only persons who would have been affected would have been the astronomers, and perhaps even among them no particular sympathy would have been felt in certain quarters. Those particular astronomers to whom has been intrusted the special work of looking after the asteroids and of calculating the tables of their movements might even have received with no very great enthusiasm the announcement of this further addition to the burden on their heavily laden shoulders.

I have said that Eros is quite a small globe; it may be well for us fully to realize how small that asteroid actually is. If the moon were to be crushed into two million equal fragments, each of those parts would be as big as Eros. If the whole of Eros were to be covered with houses, the city thus formed would not be so large as greater London. So far as mere size is concerned, Eros is quite unimportant. We can further illustrate this if we compare Eros with some of the other planets. The well-known evening star, Venus, the goddess of love, is a hundred million times as big as that tiny orb we now call Eros, the god of love. After all this it may seem strange to have to maintain what is, however, undoubtedly the fact, that the discovery of Eros is one of the most remarkable discoveries of this century.

Until Eros was discovered, our nearest neighbors among the planets were considered to be Venus on one
side and Mars on the other. The other great planets are much more distant, while, of course, the stars properly 293
so called are millions of times as far.

Great, then, was the astonishment of the astronomers when, by the discovery of Eros, Mars and Venus were suddenly dethroned from their position of being the earth's nearest neighbors among the planetary host. This little Eros will, under favorable circumstances, approach the earth to within about one third the distance of Mars when nearest, or about one half the distance of Venus when nearest. We thus concentrate on Eros all the interest which arises from the fact that, the moon of course excepted, Eros is the nearest globe to the earth in the wide expanse of heaven. To the astronomer this statement is of the utmost significance; when Eros comes so close it will be possible to determine its distance with a precision hitherto unattainable in such measurements. Once the distance of Eros is known, the distance of the sun and of all the other planets can be determined. The importance of the new discovery arises, then, from the fact that by the help of Eros all our measurements in the celestial spaces will gain that for which every astronomer strives—namely, increased accuracy.

Seeing that the existence of intelligence is a characteristic feature of this earth, we feel naturally very much interested in the question as to whether there can be intelligent beings dwelling on other worlds around us. It is only regrettable that our means of solving this problem are so inadequate. Indeed, until quite lately it would have been almost futile to discuss this question at all. All that could then have been said on the subject amounted to little more than the statement that it would be intolerable presumption for man to suppose that he alone, of all beings in the universe, was endowed with intelligence, and that his insignificant little earth, alone amid the myriad globes of space, enjoyed the distinction of being the abode of life. Recent discovery has, however, given a new aspect to this question. At the end of this century certain observations have been made disclosing features in the neighboring planet, Mars, which have riveted the attention of the world. On this question, above most others, extreme caution is necessary. It is especially the duty of the man of science to weigh carefully the evidence offered to him on a subject so important. He will test that evidence by every means in his power, and if he finds the evidence establishes certain conclusions, then he is bound to accept such conclusions irrespective of all other circumstances.

Mr. Percival Lowell has an observatory in an eminently favorable position at Flagstaff, in Arizona. He has a superb telescope, and enjoys a perfect climate for astronomical work. Aided by skillful assistants, he has

observed Mars under the most favorable circumstances with great care for some years. I must be permitted to 294
say that, having carefully studied what Mr. Lowell has set forth, and having tested his facts and figures in every way in my power, most astronomers have come to the conclusion that, however astonishing his observations may seem to be, we can not refuse to accept them.

No one has ever seen inhabitants on Mars, but Mr. Percival Lowell and one or two other equally favored observers have seen features on that planet which, so far as our experience goes, can be explained in no other way than by supposing that they were made by an intelligent designer for an intelligent purpose. Mr. Lowell has discovered that there are certain operations in progress on the surface of Mars which, if we met with on this earth, we should certainly conclude, without the slightest hesitation, were the result of operations conducted under what we consider rational guidance.

A river, as Nature has made it, wends its way to and fro; it never takes the shortest route from one point to another; the width of the river is incessantly changing; sometimes it expands into a lake, sometimes it divides so as to inclose an island. If we could discern through our telescopes a winding line such as I have described on Mars it might perhaps represent a river.

But suppose, instead of a winding line, there was a perfectly straight line, or rather a great circle on the globe drawn as straight as a surveyor could lay it out—if we beheld an object like that on Mars I think we should certainly infer that it was not a river made in the ordinary course of natural operations; no natural river ever runs in that regular fashion. If such a straight line were indeed a river, then it must have been designedly straightened by human agency or by some other intelligent agency for some particular purpose. In its larger features Nature does not work by straight lines. A long and perfectly straight object, if found on our earth, might be a canal or it might be a road; it might be a railway or a terrace of some kind; but assuredly no one would expect it to be a natural object.

We have the testimony of Schiaparelli, now strengthened by that of Mr. Lowell and his assistants, that there are many straight lines of this kind on Mars. They appear to be just as straight as a railway would have to be if laid across the flat and boundless prairie, where the engineer encountered no obstacle whatever to make him swerve from the direct path. These lines on Mars run for hundreds of miles, sometimes, indeed, I should say for thousands of miles. They are far wider than any terrestrial river, except perhaps the Amazon for a short part of
its course. The lines on Mars are about forty miles wide. Indeed, the planet is so distant that if these lines were 295
much narrower than forty miles they would be invisible. Each of them is marvelous in its uniformity throughout its entire length.

The existence of these straight lines on the planet contains perhaps the first suggestion of the presence of some intelligent beings on Mars. The mere occurrence of a number of perfectly straight, uniform lines on such a globe would in itself be a sufficiently remarkable circumstance. But there are other features exhibited by these objects which also suggest the astonishing surmise that they have been constructed by some intelligent beings for some intelligent purposes.

Sometimes two of these lines will start from a certain junction, sometimes there will be a third or a fourth from the same junction; in one case there are as many as seven radiating from the same point. Such an arrangement of these straight lines is certainly unlike anything that we find in Nature. We are led to seek for some other explanation of the phenomenon, and here is the explanation which Mr. Lowell offers:

It has recently been found that there are no oceans of water on the planet Mars. In earlier days it used no doubt to be believed that the dark marks easily seen in the telescope could represent nothing but oceans, but I think we must now give up the notion that these are watery expanses. Indeed, there is not much water on that globe anywhere in comparison with the abundance of water on our earth. It is the scarcity of water which seems to give a clew to some of the mysteries discovered on Mars by Schiaparelli and Lowell.

As our earth moves round the sun we have, of course, the changing seasons of the year. In a somewhat similar manner Mars revolves around the sun, and accordingly this planet has also its due succession of seasons. There is a summer on Mars, and there is a winter; during the winter on that globe the poles of the planet are much colder than at other seasons, and the water there accumulates in the form of ice or snow to make those ice-caps that telescopic observers have so long noticed. In this respect Mars, of course, is like our earth. The ice-cap at each pole of our globe is so vast that even the hottest summer does not suffice to melt the accumulation; much of the ice and snow there remains to form the eternal snow which every arctic explorer so well knows. It would seem, however, that the contrast between winter and summer on Mars must be much more deeply marked than the contrast between winter and summer on our earth. During the summer of Mars ice and snow vanish altogether from the poles of that planet.

Mr. Lowell supposes that water is so scarce on Mars that the inhabitants have found it necessary to 296
economize to the utmost whatever stock there may be of this most necessary element. The observations at Flagstaff tend to show that the dark lines on Mars mark the course of the canals by which the water melted in summer in the arctic regions is conducted over the globe to the tracts where the water is wanted. Not that the line as we see it represents actually the water itself; the straight line so characteristic of Mars's globe seems rather to correspond to the zones of vegetation which are brought into culture by means of water that flows along a canal in its center. In much the same way would the course of the Nile be exhibited to an inhabitant on Mars who was directing a telescope toward this earth: the river itself would not be visible, but the cultivated tracts which owe their fertility to the irrigation from the river would be broad enough to be distinguishable. The appearance of these irrigated zones would vary, of course, with the seasons; and we observe, as might have been expected, changes in the lines on Mars corresponding to the changes in the seasons of the planet.

A noteworthy development of astronomy in the last century has been the erection of mighty telescopes for the study of the heavens. It must here suffice to mention, as the latest and most remarkable of these, the famous instrument at the Yerkes Observatory, which belongs to the University of Chicago. Just as the century is drawing to its close, the Yerkes telescope has begun to enter on its sublime task of exhibiting the heavens under greater advantages than have ever been previously afforded to any astronomers since the world began.

The University of Chicago having been recently founded, it was desired to associate with the university an astronomical observatory which should be worthy of the astonishing place that this wonderful city has assumed in the world’s history. Mr. Yerkes, an American millionaire, generously undertook to provide the cost of this observatory. Two noble disks of glass, forty inches in diameter, were produced at the furnaces of Messrs. Mantois, in Paris; these disks were worked by Mr. Alvan Clark, of Boston, into the famous object glass which, weighing nearly half a ton, has now been mounted in what we may describe as a temple or a palace such as had never been dreamed of before in the whole annals of astronomy.

Perhaps if we could now place the science of the nineteenth century in its proper perspective the most remarkable discovery which it contains would be that of the planet Neptune. Indeed, the whole annals of science present no incident of a more dramatic character.

It will be remembered that at the latter part of the eighteenth century William Herschel had immortalized 297
himself by the discovery of a great planet, to which was presently assigned the name of Uranus. After the movements of Uranus had been carefully studied, it was found that on many previous occasions Uranus had been unwittingly observed by astronomers, who regarded it as a star. When these observations were all brought together, and when the track which Uranus followed through the heavens was thus opened to investigation, it was found that the movements of the planet presented considerable anomalies. The planet did not move precisely as it would have moved had it been subjected solely to the supreme attractive power of the sun. Astronomers are, of course, accustomed to irregularities of this description in the movements of the planets. These irregularities have as their origin the attractions of the various other members of the solar system. It is possible to submit these attractions to calculation and thus to estimate their amount. The effect, for instance, of Saturn in disturbing Jupiter can be allowed for, and the nature of Jupiter’s motion as thus modified can be precisely estimated. In like manner, the influence of the earth on Venus can be determined, and so for the other planets; and thus, generally speaking, it was found that when the proper allowances had been made for the action of known causes of disturbance, then the calculated movement of each planet could be reconciled with observation.

The circumstances of Uranus were, however, in this respect wholly exceptional. Due allowance was first made for the attraction of Uranus by Saturn, and for the attraction of Uranus by Jupiter, as well as by the other planets. It was thus found that the irregularities of Uranus could be to some extent explained, but that it was not possible in this manner to account for those irregularities completely. It was therefore evident that some influence must be at work affecting the movement of Uranus, in addition to those arising from any planet of which astronomers hitherto had cognizance. The only available supposition would be that some other planet, at present unrecognized, must be in our system, and that the attraction of this unknown body must give rise to those irregularities of Uranus which remained still outstanding.

A great problem was thus proposed for mathematicians. It was nothing less than to affect the determination of the orbit and the position of this unknown planet, the sole guide to the solution of the problem being afforded by the discrepancies between the places of Uranus as actually observed and the places which were indicated by the calculations, when every allowance had been made for known causes. The problem was indeed a difficult one, but, fortunately, two mathematicians proved to be equal to the task of solving it—Adams, in England, and 298
Le Verrier, in France. Each of these astronomers, in independence of the other, succeeded in determining the place of the planet in the sky. The dramatic incident of this discovery was afforded when the mathematicians had done their work. When the place of the planet had been ascertained, then the telescopic search was undertaken to verify if it were indeed the case that a planet hitherto unknown did actually lurk in the spot to which the calculations pointed. Every one who has ever read a book on astronomy is well acquainted with the wonderful manner in which this verification was made. Just where the mathematicians indicated, there was the great planet discovered! To this object the name of “Neptune” has been assigned, and its discovery may be said to mark an epoch in the history of gravitation. It provided a most striking illustration of the truth of those great laws which Newton had discovered.

The latter half of the century will be also remarkable in the history of science from the fact that within that period mankind has been enabled to make some acquaintance with the chemistry of the celestial bodies. It was in 1859 that Kirchhoff and Bunsen first expounded to the world the true meaning of the dark lines in the solar spectrum. In this they were following out a line of reasoning that had been previously suggested by Prof. Sir G. Stokes, of Cambridge, England. Those who are at all conversant with that wonderful branch of knowledge known as spectrum analysis are aware how these discoveries have rendered it possible for us to determine in many cases the actual material elements found in the most distant bodies.

One of the striking results to which this investigation has led is the demonstration of the substantial unity of the materials from which the earth and the various heavenly bodies have been constructed. Those elements which enter most abundantly into the composition of the earth are also the elements which appear to enter most abundantly into the composition of the sun and of the stars. The iron and the hydrogen, the sodium and the many other materials of which our globe is so largely formed, are also the selfsame materials which, in widely different proportions and in very different associations, go to form the heavenly bodies. This conclusion is as interesting as it was unexpected. It might naturally have been thought that, seeing the sun is separated from us by nearly a hundred million miles, and seeing that the stars are separated from us by millions of millions of miles, all these celestial bodies must be constructed in quite a different manner and of substances quite distinct from the substances which we know on this earth. But this is not the case. Indeed, at the present 299
moment it seems doubtful if there be any element which spectrum analysis has hitherto disclosed in the celestial bodies which is not also a recognized terrestrial body. The well-known case of helium gives a striking illustration. In the year 1868 Sir Norman Lockyer detected the presence of rays in the solar spectrum which were unknown at that time in terrestrial chemistry. These rays appeared to emanate from some substance which, though present in the sun, did not then appear to belong to the earth. This element was accordingly named “helium,” to indicate its solar origin. Twenty-five years later Professor Ramsay discovered a substance on the earth which had been hitherto unrecognized, and which, on examination, yielded in the spectrum precisely those same rays which had been found in the so-called helium from the sun. In consequence of this

discovery this element is now recognized as a terrestrial body. It is indeed a remarkable illustration of the extraordinary character of modern methods of research that a substance should have first been discovered at a distance of nearly one hundred million miles, that same substance being all the time, though no doubt in very small quantities, a constituent of our earth as well as of the sun.

Much has been done within the past century in many other branches of astronomy. I must especially mention the important subject of meteoric showers. For the development of our knowledge of this attractive part of astronomy we are largely indebted to the labors of the late Prof. H. Newton, of Yale. By his investigations, in conjunction with those of the late Professor Adams, it was demonstrated that the shower of shooting stars which usually appears in the middle of November is derived from a shoal of small bodies which revolve around the sun in an elliptic track, and accomplish that circuit in about thirty-three years and a quarter. The earth crosses the track of these meteors in the middle of November. If it should happen that the great shoal is passing through the junction at the time the earth also arrives there, then the earth rushes through the shoal of little bodies. These plunge into our atmosphere, they are ignited by the friction, and a great shower is observed. It is thus that we account for the recurrence of specially superb displays at intervals of about thirty-three years.

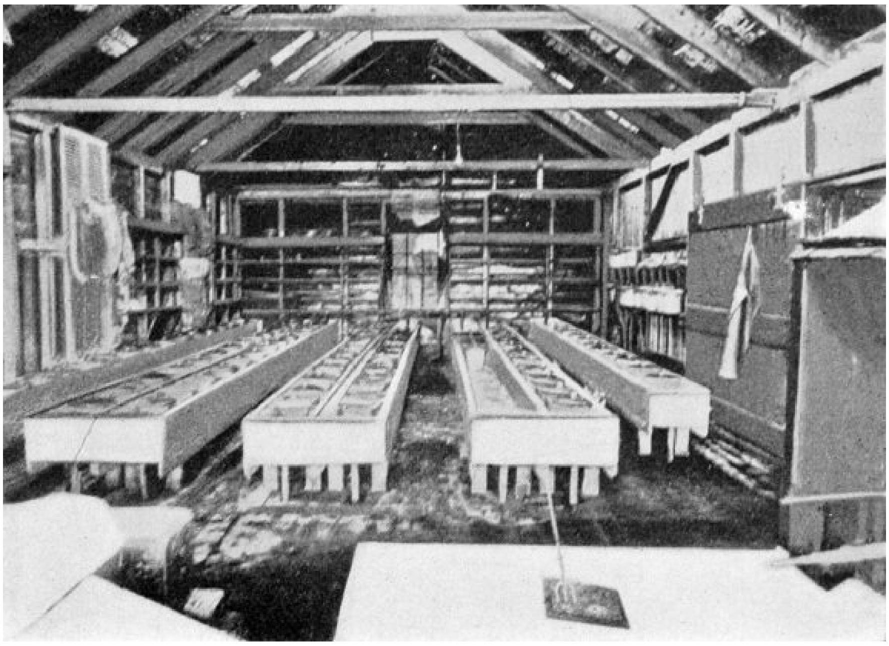
But one more great astronomical discovery of this century must be mentioned, and here again, as in so many other instances, we are indebted to American astronomers. It was in 1877 that Prof. Asaph Hall discovered that the planet Mars was attended by two satellites. This was indeed a great achievement, and excited the liveliest interest and attention. Since the days when telescopes were first invented all the astronomers have been [300] looking at Mars, and yet they never noticed (their telescopes were not good enough) those interesting satellites which the acute observation of Professor Hall detected with the help of the great telescope of the Naval Observatory at Washington. This discovery was followed by another of a still more delicate nature, when that consummate observer, Professor Barnard, using the great Lick telescope, detected the fifth satellite of Jupiter. This is indeed a most difficult object to observe, requiring, as it does, the highest optical power, the most perfect atmospheric conditions, and the most skillful of astronomical observers. We may take this observation to represent the high-water mark of telescopic astronomy in the nineteenth century. This being so, it may fitly conclude this brief account of some of the most remarkable astronomical discoveries which that century has produced.

THE APPLICATIONS OF EXPLOSIVES.

By CHARLES E. MUNROE,
PROFESSOR OF CHEMISTRY, COLUMBIAN UNIVERSITY.

Gun-Cotton Factory. Dipping cotton in nitrating troughs.

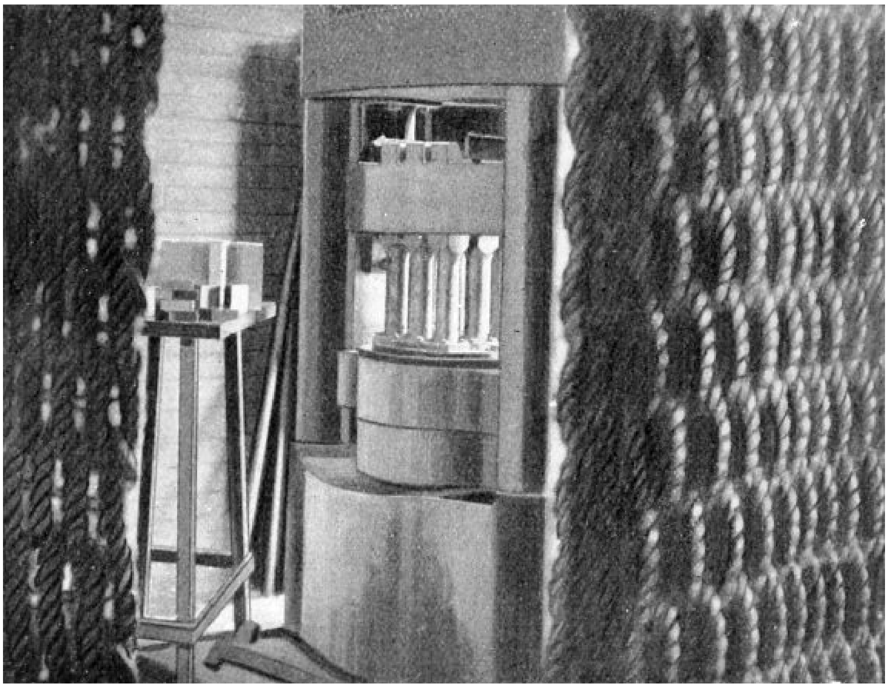
There is something about fire which fascinates every one, yet the action of explosives arouses even a livelier interest, since the accompanying fiery phenomena are more intense and are attended with a shocking report and a violent destruction of the surrounding material, while this train of events, with all its marked effects, is 301
set in operation by what appears to be a very slight initial cause. It is evident on brief consideration that these bodies, like a coiled spring, a bent bow, or a head of water, are enormous reservoirs of energy which can be released at a touch, and which, if the explosive be properly placed in well-proportioned amounts and discharged at the right time, can be made to do useful and important work that can not be as conveniently and quickly accomplished in most cases, and in some cases can not be accomplished at all by any other means.



Gun-Cotton Factory. Digestion troughs.

The marked characteristic of all explosive substances, and especially of the so-called high explosives, is that the energy, as developed, is at high potential, and the uses to which energy in this condition can be economically put are so manifold that the production of explosives has become one of the most important of our chemical industries, this country alone producing, in 1890, 108,735,980 pounds, having a value of nearly $11,000,000.

The number of possible substances possessing explosive properties is exceedingly large; the number actually known is so great that it has taxed the ingenuity of inventors to provide them with suitable names; but these various explosive substances vary to so great an extent in the energy they will develop in practice and in their safety in storage, transportation, and use that but a comparatively small number have met with wide acceptance. All may be classified under the heads of physical mixtures like gunpowder, or chemical compounds 302 like nitroglycerin, and they owe their development of energy to the fact that, like gunpowder, they are mixtures in which combustible substances such as charcoal are mixed with supporters of combustion such as niter; or that, like chloride of nitrogen, they are chemical compounds, the formation of whose molecules is attended with the absorption of heat; or that, like gun cotton, they are chemical compounds whose molecules contain both the combustible and the supporter of combustion, and whose formation from their elements is attended with the absorption of heat; while occupying a middle place between the gunpowder and the gun cotton class, and possessing also to some degree the properties of the nitrogen-chloride class, are the nitro-substitution explosives, of which melinite, emmensite, lyddite, and joveite furnish conspicuous examples.



Gun-Cotton Factory. Final press.

It may lead to a clearer understanding of what is said regarding the applications of explosives to dwell briefly on the methods by which some of them are produced, since, although the raw material in each case is different and the details of the operations vary, the underlying principles of the methods are the same, and a good example is found in the military gun cotton as made by the Abel process at the United States Naval Torpedo Station.

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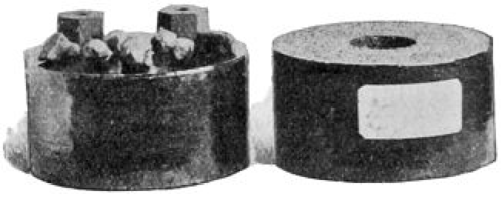
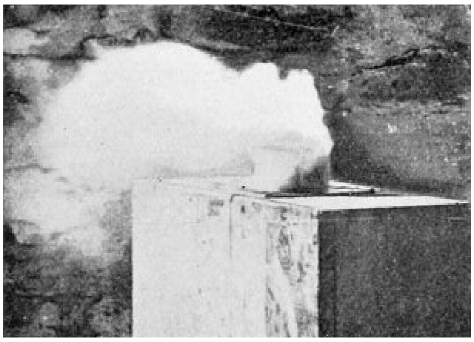
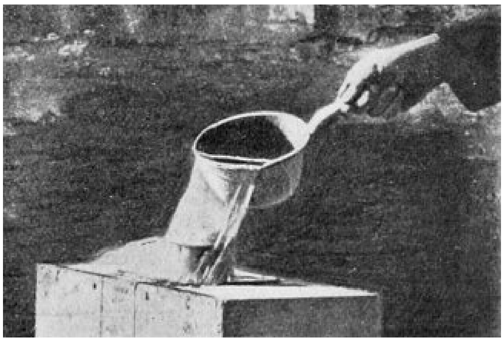


Gunpowder Grains. The large ones are over five pounds weight, each.

The material employed is cotton, but whether fresh from the field or in the form of waste, it must first be freed from dirt by hand picking and sorting, and from grease and incrusting substances by boiling in a weak soda solution. The cotton is now dried by wringing in a centrifugal wringer and exposing to a current of hot air in a metal closet; but as the compacted mass of cotton holds moisture with great persistency, after partial drying the cotton is passed through a cotton picker to open the fiber, so that it not only yields its contained water more readily and completely, but it also absorbs the acids more speedily in the dipping process to which it is subsequently exposed.



Burning Disk of Gun Cotton.

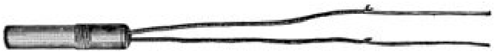


Extinguishing burning Gun Cotton.

When the moisture, by the final drying, is reduced to one half of one per cent the cotton is, while hot, placed in copper tanks which close hermetically, where it cools to the atmospheric temperature and in which it is transported to the dipping room, where a battery of large iron troughs, filled with a mixture of one part of the most concentrated nitric acid and three parts of the most concentrated sulphuric acid, set in a large iron water bath to keep the mixture at a uniform temperature, is placed under a hood against the wall. The fluffy cotton, in one-pound lots, is dipped handful by handful under the acid, by means of an iron fork, where it is allowed to remain for ten minutes, when it is raised to the grating at the rear of the trough and squeezed with the lever press to remove the excess of acid. It still retains about ten pounds of the acid mixture, and in this condition is placed in an acid-proof stoneware crock, where it is squeezed by another iron press to cause the contained acid to rise above the surface of the partly converted cotton. The covered crock is now placed with others in wooden 304
troughs containing running water so as to keep the temperature uniform, where the cotton is allowed to digest for about twenty-four hours. The acid is then wrung out in a steel centrifugal, and the wrung gun cotton is thrown in small lots into an immersion tank containing a large volume of flowing water, in which a paddle wheel is revolving so as to rapidly dilute and wash away the residual acid in the gun cotton without permitting any considerable rise of temperature from the reaction of the water with the acid.

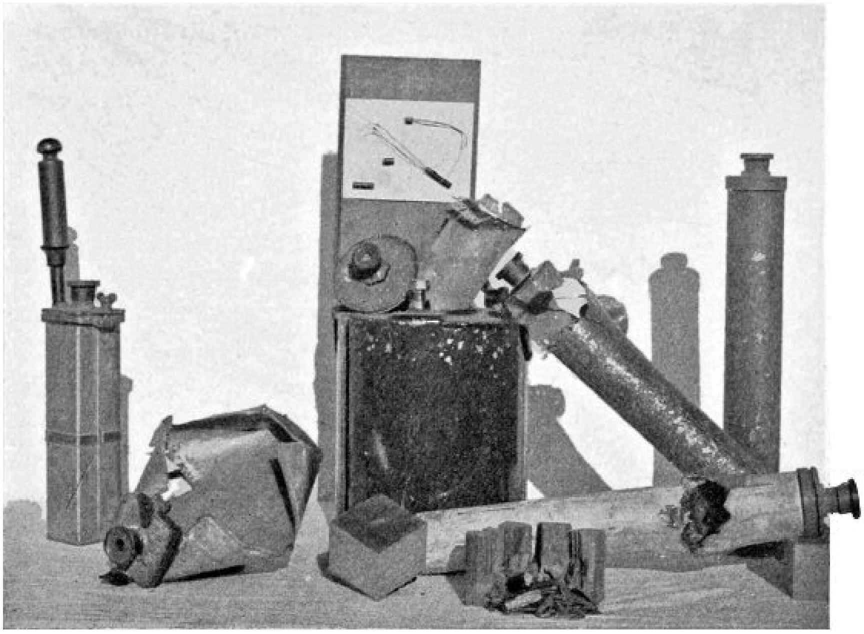
Making Mercury Fulminate.

Even these severe means are not enough, for, as the cotton fiber is in the form of hairlike tubes, traces of the acid sufficient to bring about the subsequent decomposition of the gun cotton are retained by capillarity. Therefore, after boiling with a dilute solution of sodium carbonate, the gun cotton is pulped and washed in a beater or rag engine until the fiber is reduced to the fineness of corn meal, and a sample of it will pass the “heat test.” This is a test of the resistance of gun cotton to decomposition, and requires that when the air-dried sample of gun cotton is heated to 65.5° C. in a closed tube in which a moistened strip of potassium iodide and starch paper is suspended, the paper should not become discolored in less than fifteen minutes' exposure.

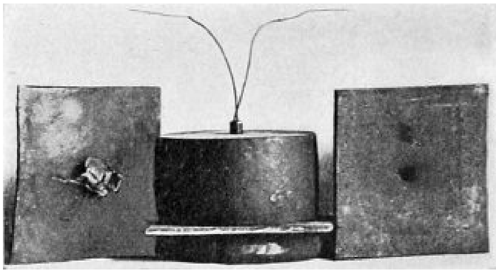


Detonator used in the United States Navy. Contains thirty-five grains of fulminate of mercury.

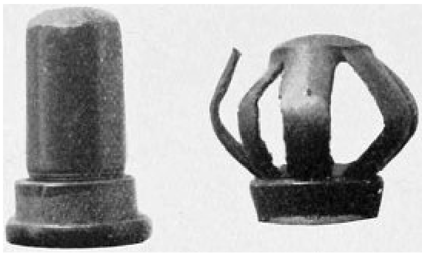
This pulping of the gun cotton not only enables one to more completely purify it, but it also renders it possible to mold it into convenient forms and to compress it so as to greatly increase its efficiency in use. For this purpose the pulp is suspended in water and pumped to a molding press, where, under a hydraulic pressure of one hundred pounds to the square inch, it is molded into cylinders or prisms about three inches in diameter and five inches and a half high, and these are compressed to two inches in height by a final press exerting a pressure of about sixty-eight hundred pounds to the square inch. As this is regarded as a somewhat hazardous operation, the press is surrounded by a mantlet woven from stout rope to protect the workmen from flying pieces of metal in case of an accident. The operation is analogous to that employed in powder-making, where the gunpowder has been pressed in a great variety of forms and into single grains weighing several pounds apiece. 305



Torpedo Cases and Blocks of Wood destroyed by a Naval Detonator.

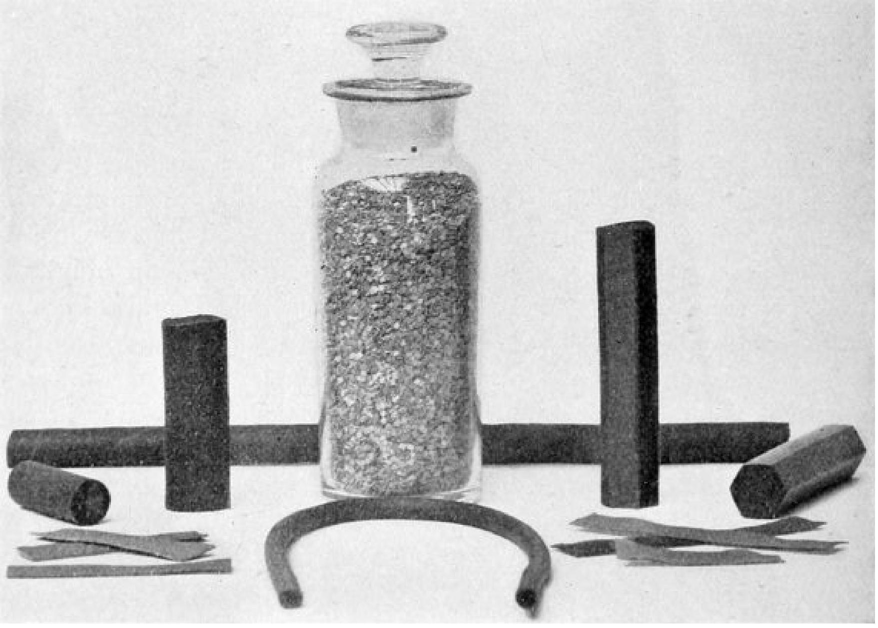


Testing Detonators on Iron Plates.



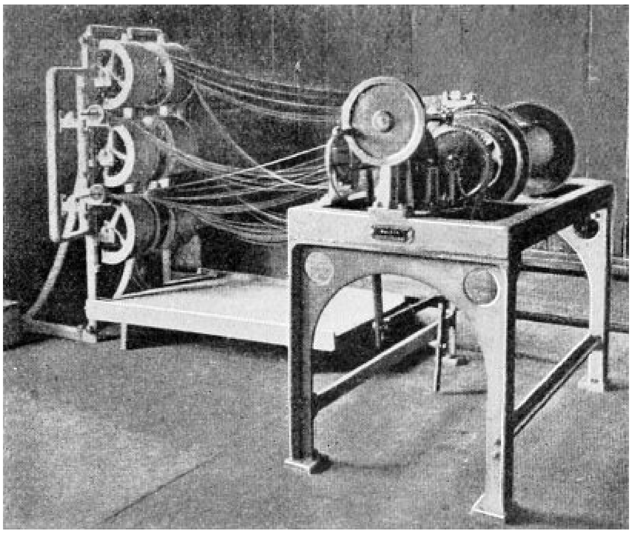
Iron Cylinder filled with Water and containing a Naval Detonator. Before and after firing, shows the work accomplished by thirty-five grains of mercury fulminate.

Even under the enormous pressure of the final press the compressed gun cotton still retains from twelve to sixteen per cent of water, and in this form it is quite safe to store and handle. When dry it is very combustible and burns readily when ignited, but it can be quenched by pouring water upon it. When confined in the 306
chamber of a gun or the bore-hole of a rock, gun cotton will burn like gunpowder when ignited, if dry, and produce an explosion, but, in common with nitroglycerin and other high explosives, gun cotton is best exploded and develops its maximum effect when detonated, a result which is secured by exploding a small quantity of mercury fulminate in contact with the dry material.

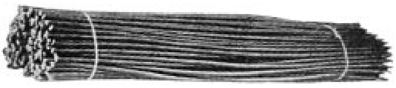


Smokeless Powders. In the bottle is indurite in flake grains. The larger grains are cylindrical and hexagonal multiperforated United States army grains. The bent grain in the foreground, looking like a piece of rubber tubing, is a grain of Maxim powder with a single canal. The flat strips in the foreground on the left are grains of the French B. N. powder. The flat strips in the foreground on the right are grains of the United States navy "pyrocellulose" powder.

Mercury fulminate is made by dissolving mercury in nitric acid and pouring the solution thus produced into alcohol, when a violent reaction takes place and the fulminate is deposited as a crystalline gray powder. This powder is loaded in copper cases and, after drying, it is primed with dry-mealed gun cotton, the mouth of the case being closed with a sulphur-glass plug, through which pass two copper leading wires joined by a bridge of platinum-iridium wire, two one-thousandths of an inch in diameter, which becomes heated to incandescence 307
when an electric current is sent through it. This device is what is known as the naval detonator. Mercury fulminate is so employed because it is the most violent of all explosives in common use, and exerts a pressure of forty-eight thousand atmospheres when fired in contact. Although the naval detonator contains but thirty-five grains of mercury fulminate, yet it will rupture stout iron and heavy tin torpedo cases when fired suspended in them, it will rend thick blocks of wood when placed in a hole and fired within them, and it will even pierce holes through plates of the finest wrought iron one-sixteenth inch in thickness if only the base of the detonator is in contact with the plate, and this has been used as a test of their efficiency. Its force is markedly shown by firing one in a stout iron cylinder filled with water and closed tightly, when the cylinder is blown into a shredded sphere. When used to detonate gun cotton, either when confined or in the open, the detonator is placed in the hole which has been molded in the center of the gun cotton disk or block, so that it shall be in close contact with the gun cotton. I have found that perfectly dry compressed gun cotton is detonated by 2.83 grains of mercury fulminate; but as a torpedo attack is necessarily in the nature of a forlorn hope and should be provided with every possible provision against failure, and since if the detonator fails the attack fails, the naval detonator is supplied with thirty-five grains, so as to give a large coefficient of assurance.

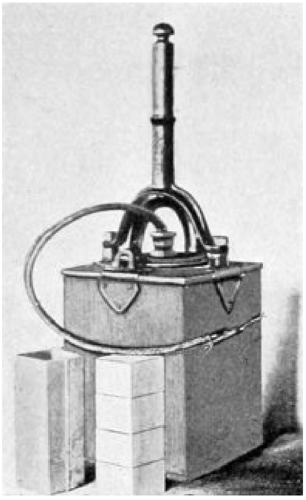


Blending Machine for Cordite.

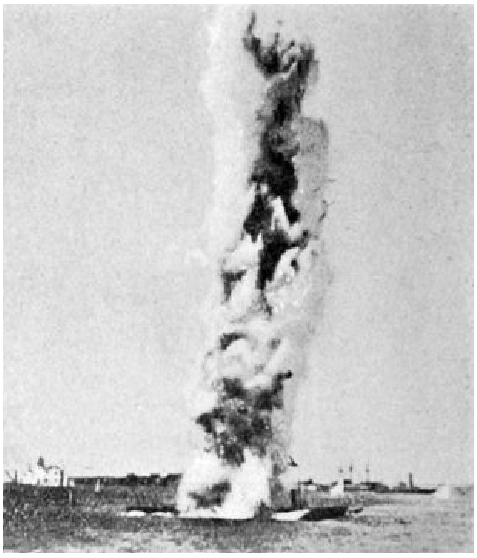


Cartridge of Cordite Smokeless Powder. Charge for 6-inch 2 F gun, 13 pounds, 4 ounces. Cords, 22¾ inches long, 3 inches in diameter.

A characteristic feature of gun cotton is that it may be detonated even when completely saturated with and 308
immersed in water, if only some dry gun cotton be detonated in contact with it. Thus in one experiment a disk of dry gun cotton was covered with a water-proof coating and the detonator inserted in the detonator hole of this disk. This dry disk was laid upon four uncoated disks, the five lashed tightly together, and sunk in Newport Harbor, where the column remained until the uncoated disks were saturated with salt water, when the mine was fired and the saturated disks were found by measurement of the work done to have been completely exploded. I have found that three ounces of dry compressed gun cotton will cause the detonation of wet compressed gun cotton in contact with it, but forty ounces of dry gun cotton are used as the primer in our naval mines and torpedoes, so as to give a large coefficient of assurance.



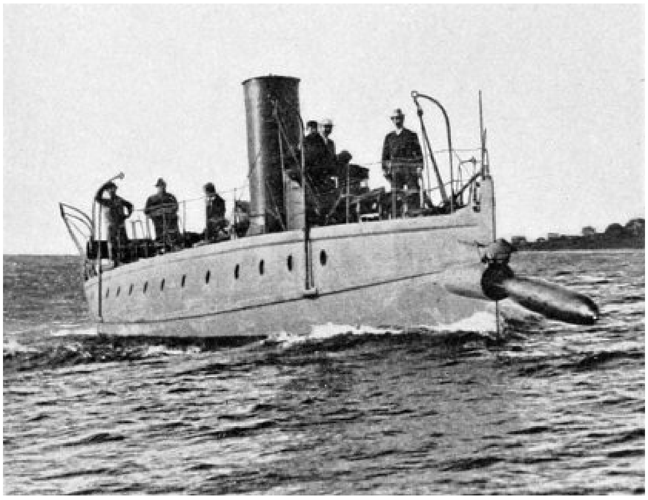
Gun-Cotton Spar Torpedo.



Blowing up the Schooner Joseph Henry.

In the mining and other industries the fulminate is used in smaller quantities and it is generally mixed with potassium chlorate, the mixture being compressed in small copper cases and sold as blasting caps. They are fired by means of a piece of Bickford or running fuse, consisting of a woven cotton or hemp tube containing a core of gunpowder, which is inserted in the mouth of the copper cap and made fast within it by crimping. The capped fuse is then inserted in a dynamite cartridge so that the cap is firmly in contact with the dynamite, the mouth of the cartridge is fastened securely, and the charge inserted in the bore-hole in the rock and tamped. The protruding end of the fuse is lighted, and the fire travels at the rate of three feet per minute down the train 309 of gunpowder to the fulminate, which then detonates and causes the detonation of the dynamite.

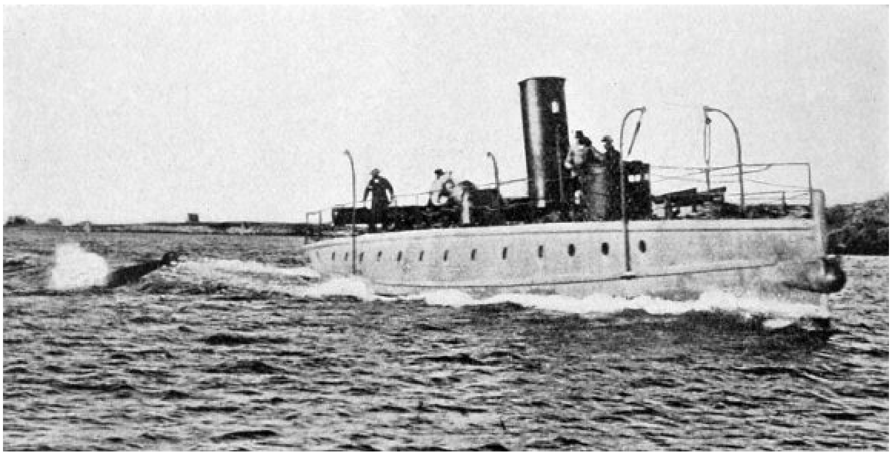
Although gun cotton, nitroglycerin, and their congeners can be and usually are fired by detonation, there has within recent years been a great number of compositions invented which, while formed from gun cotton alone or mixtures of it with nitroglycerin, burn progressively when ignited and are therefore available for use as propellants; and since the products of their burning are almost wholly gaseous, they produce but little or no smoke and are therefore called smokeless powders. As upward of fifty-seven per cent of the products of the burning of ordinary gunpowder are solids or easily compressed vapors, this comparative smokelessness of the modern powders is a very important characteristic, and when used in battle they seriously modify our former accepted methods of handling troops. While this is the feature of these powders which has attracted popular attention, a far more important quality which they possess is the power to impart to a projectile a much higher velocity than black powder does, without exerting an undue pressure on the gun. A velocity of over twenty-four hundred feet per second has been imparted to a one-hundred-pound projectile with the powder that I have invented for our navy, while the pressure on the gun was less than fifteen tons to the square inch.



Torpedo Practice. Bow discharge.

Prior to my work in this field all the so-called smokeless powders were mixtures of several ingredients, resembling gunpowder in this respect. But, considering the precise and difficult work that was expected of these high-powered powders and the difficulty which had always been found in securing uniformity in mixtures, 310 and that this difficulty had become the more apparent as the gun became more highly developed, I sought to produce a powder which should consist of a single chemical substance in a state of chemical purity, and which could be formed into grains of such form and size as were most suitable for the piece in which the powder was to be used.

I succeeded in so treating cellulose nitrate of the highest degree of nitration as to convert it into a mass like ivory and yet leave it pure. In this indurated condition the gun cotton will burn freely, but it has not been possible to detonate it even when closely confined and exposed to the initial detonation of large masses of mercury fulminate.

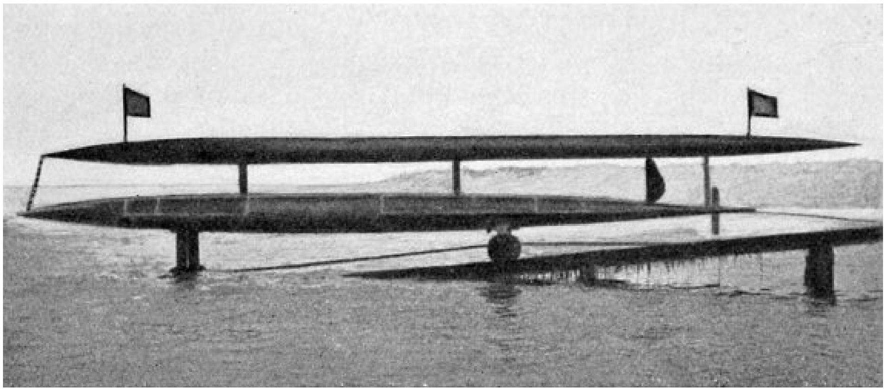


Torpedo Practice on the Cushing. Broadside discharge.

I am happy to say that this principle has now been adopted by the Russian Government, and by our navy in its specifications for smokeless powder; but they have, I think unwisely, selected a cellulose nitrate containing 12.5 per cent or less of nitrogen instead of that of the highest nitration.

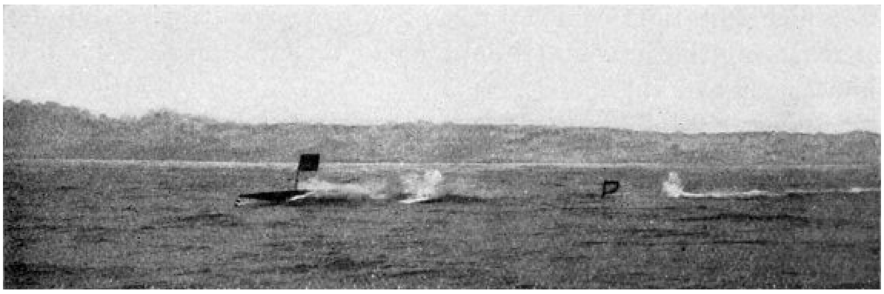
This work was completed, a factory established, and the processes well marked out when I left the torpedo station in 1892. Besides this, there were then already commercial works established elsewhere in this country for the manufacture of the nitroglycerin-nitrocellulose powders of the ballistite class, while large quantities of many varieties could be easily procured abroad. Considering these facts, and that France and Germany had already adopted smokeless powders in 1887, that Italy adopted one in 1888, and England about the same time, it is unpardonable that our services should not yet have adopted any of the smokeless powders available when we were drawn into the conflict with Spain.

Besides their use as ballistic agents, gun cotton, dynamite, and explosive gelatin in their ordinary condition 311
have found employment and been adopted as service explosives in military and naval mining, as their great energy and the violence with which they explode, even when unconfined, especially adapt them for use in the various kinds of torpedoes and mines which are in vogue in the service.



Launching Patrick Torpedo from the Ways.

One form of these torpedoes was attached to the end of a spar or pole which was rigged out from the bow of a launch or vessel so that it could be thrust under the enemy’s vessel, and the detonators of such spar torpedoes were not only connected with electric generators, so that they could be fired at will, but they, in common with mines, were frequently provided with a system of levers so arranged that the enemy’s vessel fired the torpedoes and mines automatically as it came in contact with the levers. It was with such a contact-spar torpedo, containing thirty-three pounds of gun cotton, that the schooner Joseph Henry was blown up in Newport Harbor in 1884.



Patrick Torpedo under way. Moving at the rate of twenty-three knots per hour.

There are many types of the automobile torpedo. Among them the Hall, Patrick, Whitehead, and Howell may be cited. The first three are propelled by the energy resident in compressed gases; the Howell by the energy stored in a heavy fly wheel, which also, by acting on the gyroscopic principle, serves to maintain the direction imparted to the torpedo as it is launched. The Hall, Whitehead, and Howell are launched from tubes or guns by means of light powder charges, and are independent of exterior control after launching. The Patrick is launched from ways, and is controlled from the shore or boat by a wire through which an electric current may be sent to its steering mechanism. The charges are quite variable, but the war heads of the larger torpedoes contain as much as five hundred pounds of gun cotton. 312

[*To be concluded.*]

A PARADOXICAL ANARCHIST.

By Prof. CESARE LOMBROSO.

While I have had the privilege of making several indirect studies of anarchists by means of the data furnished by legal processes, the journals, and the handwriting of the subjects, I have only rarely been able to examine one directly and make those measurements and craniological determinations upon him without which any study can be only approximate, or, we might even say, hypothetical. I had, however, an opportunity a short time ago to observe a real anarchist in person, and study him according to the methods of my criminological clinic. The results have been singular, and it seems to me that they should cast some light upon the dark world of these agitators, and especially upon the phenomena of the strange contradictions presented in their life; manifestations which jurists and police officers, intent only on achieving the judicial triumph of a conviction, consider and call simulations and falsehoods.

He was a fellow who had caused a great excitement, during the crowded days of the exposition at Turin, by saying that he wanted to kill the king. In fact, he gave himself up to the police, saying that the anarchists of Alexandria were seeking the assassination of the king, and had written him a letter directing him to arm himself, but that he, wishing anything else than to commit regicide, had surrendered in order to denounce the scheme. There was no real basis of criminal intent, but our police put him in prison, and there I found him.

His physiognomy presented all the characteristics of the born criminal and of the foolhardy and sanguinary
anarchist. He had flaring ears, premature and deep wrinkles, small, sinister eyes sunk back in their orbits, a 313
hollowed flat nose, and small beard—in short, he presented an extraordinary resemblance to Ravachol, as may be seen from their portraits.

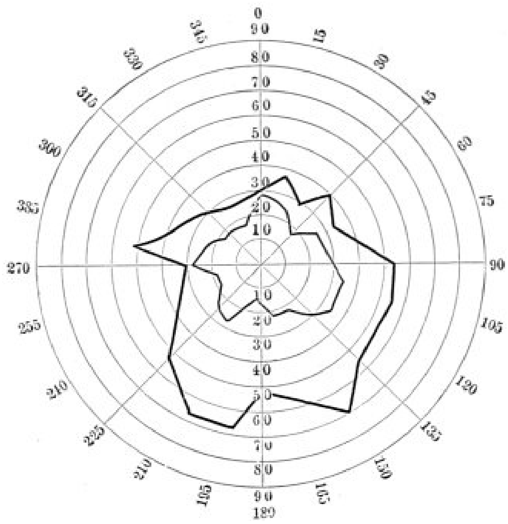
The cranium was a little smaller than the normal, and the upper part of the skull was much rounded and deformed, with a cephalic index of 91—considerably more rounded than the head of Luccheni. The horizontal fold of the hand was of a type much like that of Ravachol.

I add that the biological study, which was made directly, and therefore more satisfactorily than was practicable with Caserio and Luccheni, revealed a series of very singular anomalies; a touch six times more obtuse than the normal—six millimetres on the right, five on the left; a remarkably blunt sensitiveness to pain and dull perception of location; an extraordinarily reduced visual field, particularly in the left eye; a somewhat tremulous handwriting, and slight defects of articulation in speech; and thin hair. There was nothing very striking in his affective nature. He spoke kindly of his parents, whom he would be glad to see. But he had a blunt moral sense, and had committed frequent thefts, especially against his family, so that he had been put into a house of correction. And it was just while he was still in this establishment, at sixteen years of age, that he pretended to have been invited to attend a meeting of about thirty anarchists at Brescia, where he was made to swear, kissing a dagger, to kill the king. He described the room, and spoke of the individual persons present, and then said that he thought no more of the matter after he returned to the house; but a few days ago it had come into his mind to go to the post office, and there he had found a letter from the anarchists of Alexandria, urging him to arm himself to kill the king.

He repeated this story minutely and with great persistence, notwithstanding the postal authorities denied 314
having given him the letter, in the face of the asseverations of the prefects that there were not thirty anarchists in Brescia, where he was in correction, and although all the facts were against him. Observe that he was in prison, that he had been there three months, and that he was told he would be likely to stay there as long as he adhered to his story.

Ravachol.

Efforts to account for the phenomenon were unsuccessful, because his friends and relatives made no mention of any traces of insanity. Light began to break upon the case when it was learned that he had attempted suicide, a few years before, in grief at the death of his mother, and also that on the day before he gave himself up he had stolen a small sum from his drunken brother. These, however, were only distant hints. The matter was fully explained when, after he had drunk a litre of wine in the prison, he began to exclaim, "*Viva l'anarchio!*" (Hurrah for anarchy!), "*Morte al Re!*" (Death to the king!), to kiss a dagger, to break various things against imaginary guards, and, after a short period of quiet, to swear and forswear himself that his companions had done what he had done, that they had shouted for anarchy, had broken the vases, and had desired to kill the king.



Visual Field (Left Eye) of Chie … Giac …

The thin line indicates the normal visual field (left eye).

The thick line indicates the visual field (left eye) under alcoholic excitement.

This cleared up the matter at once for me, but I wished to complete the elucidation with an experiment. I began by giving him ten, then twenty, then thirty, then forty grammes of alcohol, up to eighty. I observed that his personality began to change after forty grammes. He became somewhat insolent and suspicious, and had vague delirious imaginings of persecutions. When invited to sing anarchistic songs he refused, evidently fearing to compromise himself, but sang them voluntarily in an undertone. When the dose of alcohol was increased to ninety grammes his personality seemed immediately to undergo a full change; his touch became twice as fine (three millimetres), and his visual field increased threefold; he declared that there was a spy around. When put into his cell he sang anarchistic hymns, threatened death to the king, handled a box as if brandishing a dagger, 315 climbed to a window and insulted the sentinel, resisted five men who tried to disarm him, and continued in this condition for eight hours.

The next day he denied having done any of these things, avowed that he was a good monarchist and a good citizen, and declared distinctly that he had not done what he had done, in the face of the concurrent testimony of several witnesses. On renewing the experiment a few days afterward with eighty grammes of alcohol, the same series of phenomena recurred—a real anarchistic raving, a genuine mania for regicide, which would certainly have ended in some act if he had not been restrained by force; and this person, who had at first presented an evident obtusity of touch and an extraordinary contraction of the visual field, now exhibited an almost normal touch of three millimetres and a visual field enlarged to triple its extent when he was sober.

On the day after this he recollected none of all the things that had happened the day before. This double personality was determined in him by alcohol, as it is in others by misery or by fanaticism, while it rests with all upon a congenital basis. The fact helps us to explain how some inoffensive man may have a type of physiognomy quite similar to that of Ravachol, showing how often there are true criminals in potency, whose physiognomy, or rather the anomalies of it, bears a prophetic relation to the crime which breaks out on the first determining circumstance. And we have here another explanation of such contradictory characters as those of Ravachol, Caserio, and Luccheni, who, having been once well-behaved, end by becoming criminals.

Applied science was defined by Sir W. Roberts Austen, in his presidential address to the Iron and Steel Institute, 1899, as “nothing but the application of pure science to particular classes of problems.”

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WHAT MAKES THE TROLLEY CAR GO.

By WILLIAM BAXTER, Jr., C. E.

I.

Of all the wonderful operations accomplished by the aid of electricity at the present time, none so completely mystifies the beholder as the action of the trolley car. The electric light, although incomprehensible to the average layman, does not excite his curiosity to the same extent. The glowing filament of an incandescent lamp or the dazzling carbon points of an arc light stimulate the inquisitive proclivities to some extent, but as the popular notion with respect to the nature of electricity is that it is some kind of fluid that can flow through wires and other things like water through a pipe, the conclusion arrived at is that the current, in its passage through the filament or the carbon points, generates a sufficient amount of heat to raise the temperature of the material to the luminous point. The fact that energy is required to raise the temperature of the mass to the incandescent point is not taken into consideration by those not versed in technical matters, owing to the fact that, as nothing moves, it is not supposed that power can be expended. When a trolley car is seen coming down the street at a high rate of speed the effect upon the mind is very different. Here we see a vast amount of weight propelled at a high velocity, and yet the only source through which the power to accomplish this result is supplied is a small wire. The mystifying cause does not stop here, for if we look further into the matter we see that the energy has to pass from the trolley wire to the car through the very small contact between it and the trolley wheel. After contemplating these facts, it appears remarkable that the energy that can creep through this diminutive passage can by any means be made to develop the force necessary to propel a car with a heavy load up a steep grade. An electrical engineer, if asked to explain the action, would say that the force of magnetic attraction was made use of to accomplish the result, but this explanation would fail to throw any light upon the subject. In what follows, it is proposed to explain the matter in a simple manner, and then it will be seen that what appears to be an incomprehensible mystery, when not understood, is, in fact, no mystery at all.

> Note.—The illustrations of railway motor, generator, and switchboard (Figs. 15, 16, 17) were made from photographs kindly furnished by the manufacturers, the Westinghouse Electric and Manufacturing Company.

Electricity and magnetism are two forces that are intimately associated with each other, and, although radically different, it is difficult, if not impossible, to obtain one without the other, although it is a simple matter 317 to make one inactive under certain conditions. It is very generally understood that a magnet possesses the power of attraction, and that it will draw toward it pieces of iron, steel, and other magnets. The laws governing the attractive properties of magnets, however, are not so well understood, and many are not aware of the fact that under certain conditions one magnet will repel another, but such is nevertheless the case.

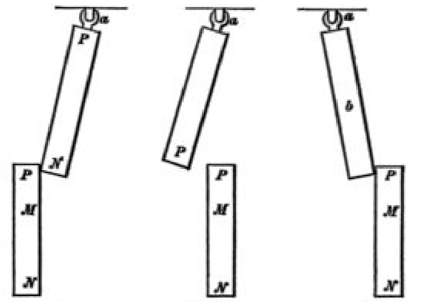

Fig. 1. Fig. 2. Fig. 3.

Figs. 1, 2, 3.—Diagrams illustrating the Attraction and Repulsion of Magnets.

In Fig. 1 the lower outline, *M*, represents a magnet fixed in position, and the upper bar represents another magnet arranged to swing freely around the pivot *a*. A magnet, as is generally known, will arrange itself in a north-to-south position if suspended from its center, like a scale beam, and allowed to swing freely, and the same end will always point toward the north. On this account the ends of a magnet are called its poles, and the one that will point toward the north is designated the north pole, while the other one is the south pole. The terms north and south poles were applied to magnets centuries ago, but at the present time the ends are more commonly designated as positive and negative. In Fig. 1 it will be noticed that the stationary magnet has its positive end upward, and this attracts the negative end of the swinging magnet. If the order of the poles is reversed, so that the positive of the swinging magnet will come opposite the positive of the stationary one, then there will be a repulsive action instead of an attraction, as is shown in Fig. 2. If the two negative ends were placed opposite, the effect would be the same. From this we see that to obtain an attraction we must place the magnets so that opposite poles come together, and that by reversing the order we obtain a repulsive action.

If the swinging magnet is replaced by a bar of iron, as is shown in Fig. 3, there will be an attraction, no matter what end of the magnet may be uppermost, thus showing that either end of a magnet will attract a bar of iron. The explanation of these different actions is that when two magnets are brought into proximity to each other each one exerts its force without any regard to the other, and if the two are set to act together they will attract one another, but if set to act in opposition they will repel. When one of the bars is not a magnet, but simply a piece of iron or steel, this bar, having no attractive or repulsive force of its own, can only obey the 318 attractive action of the other, which is the only one that exerts a force.

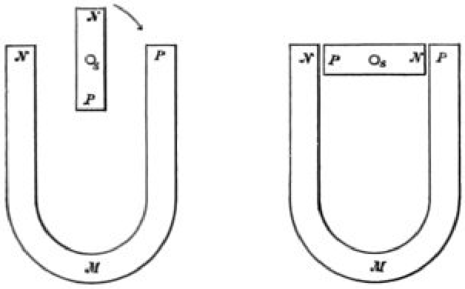

Fig. 4. Fig. 5.

Figs 4, 5.—Diagrams illustrating the Method of obtaining Rotary Motion with Magnets.

In Fig. 4 *M* is a magnet bent into the form of a U, commonly called a horseshoe magnet. The short bar set between the upper ends is also a magnet, and is arranged so as to revolve around the shaft *s*. From what has just been explained in connection with Figs. 1 and 2 it will be understood that, with the poles as indicated by the letters, there will be an attractive force set up between the top end of the straight bar and the *P* end of the horseshoe, and thus rotation will be produced in the direction of the arrow. The rotation, however, will necessarily stop when the bar reaches the position shown in Fig. 5, for then the attraction between the poles will resist further movement. If the straight bar were not a magnet, but simply a piece of iron or steel, it is evident that when in the position of Fig. 4 the attraction would be just as much toward the right as toward the left, and if the bar were placed accurately in the central position it would not swing in either direction. It would be in the condition called, in mechanics, unstable equilibrium. In practice this condition could not be very well realized, as it would be difficult to set and retain the bar in a position where the attraction from both sides would be the same, therefore the rotation would be in one direction or the other; but whichever way the bar might move, it would only swing through one quarter of a revolution, into the horizontal position of Fig. 5.

If we reflect upon these actions we can see that if we could destroy the magnetism of both parts before the straight bar reaches the position of Fig. 5 it would be possible to obtain rotation through a greater distance than one quarter of a turn, for then the headway acquired by the rotating part would cause it to continue its motion. If, after the completion of one half of a revolution, we could remagnetize both parts, we would then set up an attraction between the lower end of the straight bar and the left side of the horseshoe, for then the polarity of the former would be the reverse of that shown in Fig. 4—that is, the lower end would be negative. By means of this second attraction we would cause the bar to rotate through the third quarter of the revolution, and if, just before completing this last quarter, we were to remove all the magnetism again, the headway would 319
keep up the motion through the final quarter of the revolution, thus completing one full turn. From this it will be realized that if we could magnetize and demagnetize the two parts twice in each revolution a continuous rotation could be obtained.

If the magnetizing and demagnetizing action were only applied to the rotating part we would fail to keep up a continuous rotation, for, as was shown in connection with Fig. 3, the action when the straight bar reached the position of Fig. 5 would be the same as if it were magnetized, owing to the fact that a magnet always exerts an attraction upon a mass of iron. Suppose, however, that we were to reverse the polarity of the rotating part just as it reaches the position of Fig. 5, then there would be two poles of the same polarity opposite each other, and, as shown in Fig. 2, the force acting between them would be repulsive, and would push the bar around in the direction of rotation. Not only would the right-side pole of the horseshoe force the end of the bar away from it, but the negative pole, on the left side, would attract this same end, and thus a force would be exerted by the two poles of *M* to keep up the rotation through the next half of a circle. On reaching this last position the rotation would stop if the polarity of the revolving bar were left unchanged, for then the poles facing each other would be of opposite polarity. If, however, we again reversed the polarity, a repulsion would be set up between the poles facing each other, and thus a force would be exerted to continue the rotation. Thus we see that if the polarity of the horseshoe magnet is not disturbed it is necessary to reverse that of the rotating part to obtain a continuous motion, but if we change the magnetic conditions of both parts, then it is only necessary to magnetize and demagnetize them alternately.

From the foregoing it is seen that there are two ways in which the force of magnetism could be utilized to keep up a continuous rotation, and the question now is, Can either of them be made available in practice? To this we answer that, by the aid of the relations existing between electricity and magnetism, both can be and are made available, as will be shown in the following paragraphs:

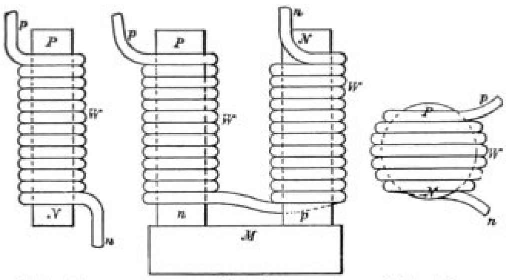

Fig. 6. Fig. 7. Fig. 8.

Figs. 6, 7, 8.—Diagrams illustrating the Principles of Electro-Magnets.

In Fig. 6 *W* represents a coil of wire provided with a cotton covering, so that there may be no actual contact between the adjoining convolutions. If the ends *p n* of this coil are connected with a source of electric energy, an electric current will flow through it, and if a bar, as indicated by *N P*, of iron or steel is placed within the coil it will become magnetized. If the bar is made of steel and is hardened it will retain the magnetism, and become 320
what is called a permanent magnet; such a magnet, in fact, as we have considered in all the previous figures. If the bar is made of iron it will not retain the magnetism, but will only be a magnet as long as the electric current flows through the coil *W*. A magnet of the latter type is called an electro-magnet. If the iron is of poor quality—that is, from an electrical standpoint—it will require an appreciable time to lose its magnetism, but if it is soft and high grade, electrically considered, it will lose its magnetism instantly, or nearly so. If we take two bars of soft iron and arrange them side by side, as in Fig. 7, and wind coils around them as indicated each one will become magnetized when the ends *p n* of the coils are connected with an electric circuit. If the lower ends of the two bars are joined by a piece, as shown at *M*, we will have a horseshoe electro-magnet. If we take a round disk of iron, as in Fig. 8, and wind a coil around it, it will also become a magnet when an electric current traverses the coil. Thus it will be seen that it makes little difference what the shape of the iron may be, providing it is surrounded by a coil of wire and an electric current is passed through the latter. This being the case, it is evident that either of the processes explained in connection with Figs. 4 and 5 can be made available for the production of a continuous rotation by the aid of electro-magnets. Suppose we make a drum, as shown in Fig. 9, and wind a wire coil around it in the direction indicated, then when a current passes through the wire the drum will be magnetized, with poles at top and bottom. If the electric current passes through the wire from end *p* to end *n* the drum will be magnetized positively at the top and negatively at the bottom, and if the direction of the current through the wire is reversed the polarity of the drum will be reversed. If we construct a horseshoe magnet of the shape shown in Fig. 10, and place within the circular opening between its ends the drum of Fig. 9, we will have a device that is capable of developing a continuous rotation, providing we have suitable means for reversing the direction of the electric current through the wire coil; and this machine constitutes an electric motor in its simplest form.

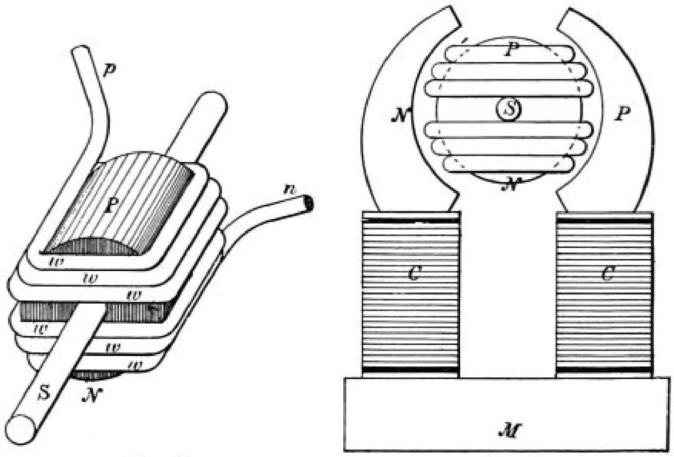

Fig. 9. Fig. 10.

Figs. 9, 10.—Diagrams illustrating the Principles of the Electric Motor.

In an electric motor the horseshoe magnet is called the field magnet, and the rotating part is called the 321
armature, while the device by means of which the direction of the current through the armature coil is reversed is called the commutator. In this last figure it will be noticed that the coils wound upon the field magnet are represented as of wire much finer than that wound upon the armature. In actual practice machines are sometimes wound in this way, and sometimes the field wire is twice as large as that on the armature. When the field wire is very much finer than that of the armature the machine is what is known as shunt wound, which means that only a small portion of the current that passed through the armature passes through the field coils. Although with this type of winding the current that passes through the field coils is very weak, the magnetism developed thereby can be made greater than that of the armature if desired. This result is accomplished by increasing the number of turns of wire in the field coils. Thus if the current through the armature is one hundred times as strong as that through the field coils, the latter can be made to equal the effect of the former by increasing the number of turns in the proportion of one hundred to one, and if the increase is still greater the field coils will develop the strongest magnetism. The reason why a small current passing around a magnet a great many times will develop as strong a magnetization as a large current, can be readily understood when we say that the magnetism is in proportion to the total strength of the electric current that circulates around the magnet. Suppose we have two currents, one of which is one thousand times as strong as the other, then if the weak one is passed through a coil consisting of one thousand turns it will develop just as strong a magnetization as the large current passing through a coil of only one turn. This last explanation enables us to see how it is that 322
the comparatively small current that can pass through the contact between the trolley wire and the trolley wheel can develop in the motor force sufficient to propel a heavy car up a steep grade. When that small current reaches the car motors it passes through a thousand or more turns of wire, and thus its effect is increased a corresponding number of times.

A motor having a single coil of wire upon the armature, as in Fig. 10, would not give very satisfactory results, owing to the fact that the rotative force developed by it would not be uniform. Such motors are made in very small sizes, but never when a machine of any capacity is required. For large machines it is necessary to wind the armature with a number of coils, so that the rotating force may be uniform, and also so that the

current may be reversed by the commutator without producing sparks so large as to destroy the device. When an armature is wound with a number of coils the direction of the current is reversed, by the commutator, in each coil as it reaches the point where its usefulness ends, and where, if it continued to flow in the same direction, it would act to hold the armature back. The effect of this reversal of the current in one coil after another is to maintain the polarity of the armature practically at the same point, so that the strongest pull is exerted between it and the field magnet poles at all times. To explain clearly the way in which the commutator reverses the current in one coil at a time it will be necessary to make use of a diagram illustrating what is called a ring armature. Such a diagram is shown in Fig. 11. The ring *A* is the armature core, and is made of iron; the wire coils are represented as consisting of one turn to each coil, and are marked *w w w*. The current enters the wire through the spring *B*, and passes out through *C*. As can be seen, the current from *B* can flow through the coils *w w* in both directions, thus dividing into two currents, each one of which will traverse one half of the wire wound upon the armature. The two half currents will meet at *C*. If the armature is rotated the springs *B* and *C* (which are called commutator brushes) will pass from one turn of the wire coil to another just back of it as the rotation progresses, and each time that contact is made with a new turn the direction of the current in the turn just ahead will be reversed. The current in the wire as a whole, however, will always be in the same direction—that is, in all the turns to the right of the two brushes; the current will flow toward the center of the shaft on the front side of the armature, and away from the shaft in all the turns on the left side. As the direction of the current on opposite sides of the brushes is always the same, the poles of the armature will remain under *B* and [323]
C, therefore the relation between the position of the poles of the armature and the field magnet will be the same substantially as that illustrated in Fig. 10, and, as a result, the force tending to produce rotation will at all times be the greatest possible for the strength of the current used and the size of the magnets.

Armatures are wound with a number of turns of wire in each coil, unless the machine is very large, and present an appearance more like Fig. 12. In this figure the brushes are arranged to make contact with the outer surface of the ring *C*, which is the commutator. The segments *s s* are connected with the ends of the armature coils *c c c*, but are separated from each other by some kind of material that will not conduct electricity—that is, they are electrically insulated. As will be noticed from this, the armature in Fig. 11 acts as a commutator as well as an armature, its outer surface performing the former office. In the winding the difference between Figs. 11 and 12 is simply in the number of turns in each coil, there being one turn in Fig. 11 and several in Fig. 12.

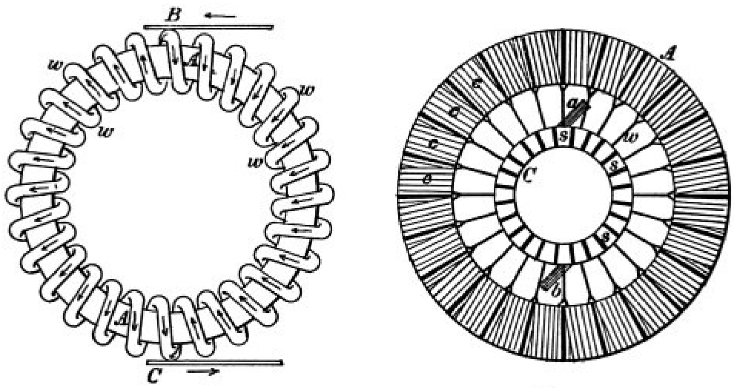

Fig. 11. Fig. 12.

Figs. 11, 12.—Diagrams illustrating the Method of winding Armatures of Electric Motors and Generators.

The armature shown in Fig. 10 is of the type called drum armature, but it can be wound so as to produce the same result as the ring, although it is not so easy to explain this style of winding. It will be sufficient for the present explanation to say that whatever type of armature may be used, the winding is always such that the direction of the current through the wire coils is reversed progressively, so that the magnetic polarity is maintained practically at the same point; therefore there is a continuous pull between this point of the armature core and the poles of the field magnet. The commutator is secured to the armature shaft, and the brushes [324]
through which the current enters and leaves are held stationary; keeping this fact in mind, it can be seen at once that in Fig. 12 the current will flow from the brush *a* through the two sides of the armature wire to brush *b*, hence all the coils on the right of the vertical line will be traversed by the current in the same direction—that is, either to or from the center of the shaft—and in the coils on the left the direction will be opposite, which is just the same order as was explained in connection with Fig. 11.

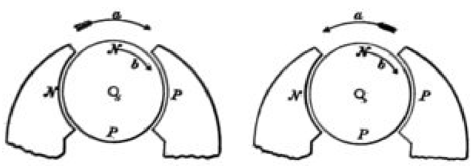

Fig. 13. Fig. 14.

Figs. 13, 14.—Diagrams illustrating the Difference between an Electric Motor and a Generator.

An electric motor can be turned into an electric generator by simply reversing the direction in which the armature rotates—that is, any electric machine is either a generator or a motor. This fact can be illustrated by

means of Figs. 13 and 14, both of which show the armature and the poles of the field magnet. The first figure represents an electric motor, and, as can be seen, the pull between the *N* pole of the armature and the *P* pole of the field is in the direction of arrow *b*, hence the armature will rotate in the same direction, as indicated by arrow *a*. To obtain the polarity of the armature and field it is necessary to pass an electric current through both—that is to say, we must expend electrical energy to obtain power from the machine. As soon as the current ceases to flow, the polarity of the armature and field dies out, and the rotation of the former comes to an end. The magnetism, however, does not die out entirely; a small residue is always left, although it is never sufficient to produce rotation, and even if it were it could only cause the armature to revolve through one quarter of a turn. If, after the current has been shut off, the armature shaft is rotated in the reverse direction, as indicated by arrow *a* in Fig. 14, the motion will be against the pull of the magnetism; therefore, although the poles may be very weak, an amount of power sufficient to overcome their attraction must be applied to the pulley, otherwise rotation can not be accomplished. In consequence of the backward rotation a current is generated in the armature coils, and this current, as it traverses the field coils as well as those of the armature, causes the polarity of both parts to increase. As a result of the increased polarity the resistance to rotation is increased, and more power has to be applied to the pulley. The increase in the strength of the poles results in increasing the current generated, and this in turn further increases the pole strength, so that one effect helps the other, the result being that the current, which starts with an infinitesimal strength, soon rises to the maximum 325
capacity of the machine.

The motor shown in Fig. 10 does not in any way resemble an electric railway motor, nevertheless the principle of action is precisely the same in both. The design of a machine of any kind has to conform to the practical requirements, and this is true of railway motors, just as it is true of printing presses, sawmills, or any other mechanism. A railway motor must be designed to run at a comparatively slow speed and to develop a strong rotative force, or torque, as it is technically called. It must also be so constructed that it will not be injured if covered with mud and water. It must be compact, strong, and light, and capable of withstanding a severe strain without giving out. To render the machine water- and mud-proof it is formed with an outer iron shell, which entirely incases the internal parts. The first railway motors were not inclosed, and the result was that they frequently came to grief from the effects of a shower of mud. When the modern inclosed type of motor, which is called the iron-clad type, first made its appearance it was frequently spoken of as the clam-shell type, and the name is not altogether inappropriate, for while the outside may be covered with mud to such an extent as to entirely obliterate the design, the interior will remain perfectly clean and dry, and therefore its effectiveness will not be impaired.

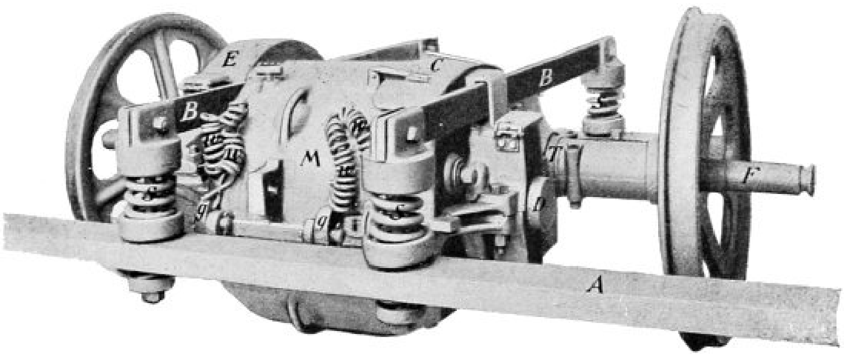

Fig. 15.—External View of Electric Railway Motor mounted upon Car-Wheel Axle.

To enable the motor to give a strong torque and run at a slow speed the number of poles in the field and armature is increased. The design of Fig. 10 has two poles in the field and two in the armature, and is what is known as the bipolar type. Machines having more than two poles in each part are called multipolar machines. The number of poles can be increased by pairs, but not by a single pole—that is, we can have four, six, eight, or any other even number of poles, but not five, seven, or any odd number. This is owing to the fact that there must always be as many positive as negative poles, no more and no less. Railway motors at the present time are 326
made with four poles. The external appearance can be understood from Fig. 15, while Fig. 16 and Fig. 17 will serve to elucidate the internal construction. In Fig. 15 the motor casing is marked *M*, and, as will be seen, it forms a complete shell. The motion of the armature shaft is transmitted to the car-wheel axle *F* through a pinion, which engages with a spur gear secured to the latter. In Fig. 16 the pinion and gear are marked *N* and *L* respectively. As it is necessary that the armature shaft and the axle be kept in perfect alignment, the motor casing *M* is provided with suitable bearings for both, those for the armature shaft being marked *P P* in Fig. 16, and one of those for the axle being marked *T* in Fig. 15. It will be understood from the foregoing that the motor is mounted so as to swing around the car-wheel axle as a center, but, as it is not desirable to have all this dead weight resting upon the wheels without any elasticity, the motor is carried by the crossbars *B B*, Fig. 15, which rest upon springs *s s* at each end. The beam *A* and a similar one at the farther end of the *B B* bars extend out to the sides of the car truck and are suitably secured to the latter. The coils *w w* are the ends of the field coils and the armature connections, and to these the wires conveying the current from the trolley are connected. The cover *C* on top of the motor at one end closes an opening through which access to the commutator brushes is obtained. The armature is shown at *H* in Fig. 16 and the commutator at *K* in the same figure. Directly under the armature may be seen one of the field magnet coils, it being marked *R*.

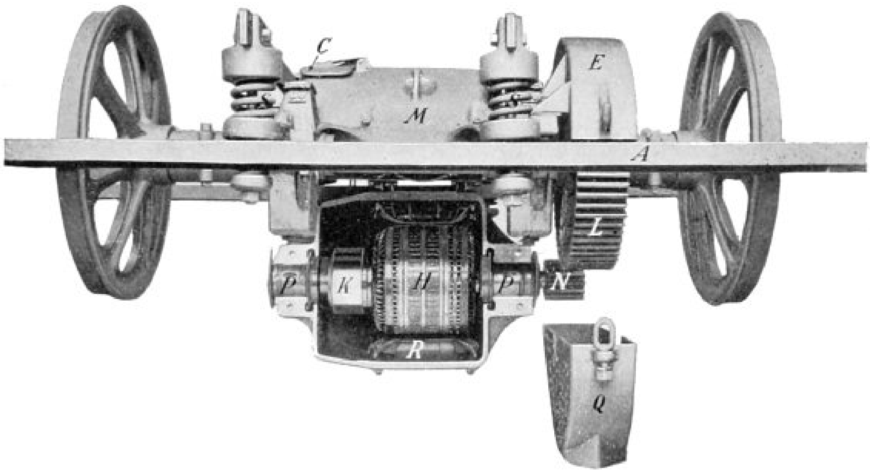

Fig. 16.—Railway Motor with Casing Open, showing Armature in Lower Half.

As will be noticed in Fig. 16, the motor casing is made so as to open along the central line, and the lower half is secured to the top by means of hinges, *g g*, Fig. 15, and also by a number of bolts, which are not so 327
clearly shown. The gear wheels are also located within a casing, which (Fig. 16) is made so as to be readily opened whenever it becomes necessary. All the vital parts of the machine are entirely covered, and are not easily injured by mud or water.

The construction of the armature and commutator is well illustrated in Fig. 17, which shows this part of the machine by itself. The armature is marked *A*, the shaft *B*, and the commutator *C*. In the diagrams, Figs. 9, 10, 11, and 12, the wire coils are represented as wound upon the surface of the armature core, but, from Fig. 17, it will be noticed that they are located in grooves. A railway motor armature core, when seen without the wire coils, looks very much like a wide-faced cog wheel with extra long teeth, not very well shaped for gear teeth. In Fig. 17 the ends of the teeth are marked *D*, and the grooves within which the wire is wound are marked *E*. The coils are not wound so that their sides are on diametrically opposite sides of the armature core, but so that they may be one quarter of the circumference apart, and, as will be noticed, the wires are arranged so as to fit neatly into each other at the ends of the armature core. The bands marked *F F F F* are provided for the purpose of holding the wire coils within the grooves. The flanges *H* and *I* are simply shields to prevent oil, grease, or even water, if it should pass through the bearings, from being thrown upon the commutator or armature. The pinion through which the armature imparts motion to the car-wheel axle is not shown in Fig. 17, but it is mounted upon the taper end of the shaft.

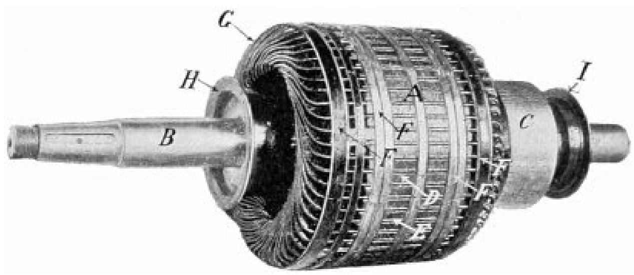

Fig. 17.—Armature of Electric Railway Motor.

An electric railway motor is a machine that is characterized by extreme simplicity (there being only one moving part), compactness, and great strength. In addition, as none of the working parts is exposed it can not be injured, no matter how much mud may accumulate upon it. One of the reasons why the electric railway motor has met with such unparalleled success is that it is a machine that can withstand the roughest kind of usage without being damaged thereby. Another reason is that an electric motor can, if called upon, develop an amount of power two or three times greater than its full-rated capacity without injury, providing the strain is 328
not maintained too long. A steam engine or any other type of motor that has ever been used for railway propulsion if loaded beyond its capacity will come to a standstill—that is, it will be stalled—but an electric motor can not be stalled with any strain that is likely to be placed upon it. If the load is increased the motor will run slower and the current will become greater, thus increasing the pull, but the armature will continue to rotate until the current becomes so great as to burn out the insulation. A railway motor calculated to work up to twenty-five-horse power will have to develop on an average about six-or seven-horse power, but if the car runs off the track on a steep grade, and has such a heavy load that the motor is called upon to develop one-hundred-horse power for a few seconds, the machine will be equal to the occasion. This result a steam, gas, or any other type of engine can not accomplish, and it is this fact as much as anything else that has given the electric motor the control of the street-railway field.

[*To be continued.*]

WOMAN’S STRUGGLE FOR LIBERTY IN GERMANY.

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It is during the latter part of the present century that a general movement has arisen to give women their rights in business life and in political and social affairs. It is the intention of this article to treat of this movement, especially in its relation to education, in Germany, where, of all civilized lands, it has had apparently the smallest results. Progress in the direction indicated has been, however, far greater than appears on the surface, and the movement is slowly taking shape in a form that will gain official recognition and support, and the way is being prepared for scholarly attainments among the women of Germany, superior, possibly, to those of the women of other nations.

There is, moreover, an ideal side to this movement in Germany not altogether found in other lands. The motive for advanced study is more largely joy in the study itself, and desire to supply the spiritual needs of an idle life. In order to understand this ideal tendency it is necessary to cast a glance backward over nearly three hundred years.

Let us begin with the contest which was waged so successfully for the development and protection of the German language, first against the Latin and later against the French. In this struggle women took a prominent 329
part, especially through membership in the society called the “Order of the Palms,” which, before the beginning of the Thirty Years’ War, united the strongest spirits of Germany for this purpose. The first woman to join this society was Sophie Elizabeth, Princess of Mecklenburg, married in 1636 to the Herzog of Braunschweig. She was followed by many others, both of the nobility and the common people, and was named by virtue of this leadership “The Deliverer.”

In the eighteenth century we have the founder of the German theater, Caroline Neuber. In the artistic sense she was the first director of the German stage, the first to turn the attention of the greatest actors of her day to the ideal side of dramatic presentation. Early in the eighteenth century women began to take up university studies. A certain Frau von Zingler received a prize from the University of Wittenberg for literary work, and the wife of Professor Gottscheds entered upon a contest for a prize in poetry with her husband.

We find some old verses published in Leipsic, in a book of students’ songs, in 1736, recognizing the fact that women attended lectures in the university there, although the reference is rather sarcastic, speaking of “beauty coming to listen in the halls of learning.”

In 1754 the first woman received her degree of Doctor of Medicine in Halle—Dorothea Christine Erxleben, *née* Leborin, a daughter of a physician, who attained to this result only after many years of painstaking effort. With her father’s help she studied the classics and medicine, and gradually, in spite of the objections of his brother physicians, began to practice as a doctor under her father’s protection. She is said to have cured her patients *cito tuto*, *jucunde*, and in 1742 she published a book on the right of women to study, the title of which, according to the custom of the day, included the full table of contents. This book passed through two editions, and enabled her to gain the attention of Frederick II, who was persuaded to order the University of Halle to grant her the privilege of taking her examination there. The day arrived, and the hall was crowded for the occasion; the candidate passed the ordeal in a brilliant manner, and took the oath for the doctor’s degree amid a storm of applause from the listeners present.

In the present century the germ of the movement for educational rights for women came into consciousness in Germany in the stormy year 1848, and first found expression and life through the work of two women—
Louise Otto Peters and Auguste Schmidt. The former founded the Universal Association for Women in Germany, 330
and through this society both these women worked for thirty years and did much toward preparing the way for the broader efforts of the present time.

It is a fact granted by all the educational world that scholarship attains a depth and thoroughness in Germany not found in other lands, and this very perfection has been in part the cause of the backwardness of the educational movement among the women, for a high degree of scholarship has often been acquired by the men at the expense of the devoted service of the women connected with them. Yet when the women of Germany demand their educational rights it will be to share also in the rich intellectual inheritance of their land.

The majority of the men thus far regard the movement with distrust and suspicion, but are powerless to crush it out. An amusing instance occurred last year in the family of an official in one of the large university towns. He was a conservative man who had his immediate family in a proper state of subjection, but his mother-in-law, alas! he could not control, and to his dismay she enrolled herself at the university as a *Hospitant*, and, in spite of the protestations of her son-in-law, she was a regular attendant upon the courses of lectures that she had elected.

The regular schools for girls in Germany, above the common schools attended by girls and boys together, are of two grades—the middle schools and the high schools. The avowed object of these schools is to fit girls for society and for the position of housewife, as Herr Dr. Bosse, the Minister of Public Instruction for the German Empire, states in his report on the condition of girls’ schools in Germany, and as he publicly declared before the German Parliament in the discussion regarding the establishment of a girls’ gymnasium in Breslau, referred to later on in this paper.

The girls’ schools established by the Government provide well for the study of the modern languages, and it is the exception to find women in the upper classes who do not speak French and English. Literature, religion, gymnastics, and needlework are also well taught. The course of study in the high school includes a little mathematics, offered under the name of reckoning, and sufficient to enable a woman to keep the accounts of a household, and also a little science of the kind that can be learned without a knowledge of mathematics. Let me quote a paragraph from the report of the Minister of Public Instruction for the year 1898 in regard to the aim of

the mathematical course in the girls’ high schools: “Accuracy in reckoning with numbers and the ability to use numbers in the common relations of life, especially in housekeeping. Great weight is laid upon quick mental 331
computations, but in all grades the choice of problems should be such as especially apply to the keeping of a house.” This is the opportunity which is offered to girls by the Government in the department of mathematics! In addition to the two grades of schools mentioned there are seminaries in many of the large cities for the purpose of educating women teachers. The instructors in these seminaries are well prepared for their positions, are mostly men, and the instruction given is very superior to that given in the girls’ high schools. Latin and Greek are, however, not studied in these seminaries, and mathematics and science are expurgated, we might say, of points that might prove difficult for the feminine intellect.

The ability to learn Latin and Greek seems in the German mind to especially mark the dividing line between the masculine and feminine brain. The writer was at one time studying a subject in Greek philosophy, in the City Library of Munich, requiring the use of a number of Greek and Latin books, and it was amusing to notice the astonishment of the men present that a woman should know the classic languages!

The women who hold certificates from the seminaries are allowed, according to a new law passed in 1894, to continue their studies and to take the higher teachers’ examinations. This is considered a great step in advance, for a woman who has successfully passed this latter examination can hold any position in the girls’ schools, and can even be director of such a school.

That German women have long been discontented with the education provided for them by the Government is proved by the fact that the number of higher institutions offering private opportunities to girls is constantly increasing. As far back as 1868 the Victoria Lyceum was founded by a Scotch woman—Miss Georgina Archer—at her own expense and on her own responsibility, and this institution was well sustained from the beginning. It is now under the patronage of the Empress Frederick, and offers courses to women that run parallel to a certain extent with those given on the same subjects in the university. Professors from the university lecture in the Victoria Lyceum, but a young woman who had listened to the same professor in both places informed me that he (perhaps unconsciously) simplified his lectures very much for the Victoria Lyceum. Fraulein Anna von Cotta is the director of the institution. Among the women who teach there we note the name of the well-known Fraulein Lange, who lectures on psychology and German literature.

There are several girls’ gymnasia in Germany which testify to the demand for higher education. These 332
institutions are all but one private, and three of them—one in Leipsic, one in Berlin, and a third, opened in October, 1898, in Königsberg—are called “gymnasial courses,” and are for girls who have finished the girls’ high school, and who must pass entrance examinations in order to be received into them.

There has been for some time a girls’ gymnasium which corresponds exactly to those for boys in Carlsruhe, under the auspices of the “Society for Reform in the Education of Women,” which receives girls of twelve who must have finished the six lower classes of a girls’ school. This society, to which the girls of Germany owe much, is planning to open another gymnasium in Hannover, to which girls will be received from the junior class of the girls’ high school; the course of study will occupy five years, and will fit girls for the same official examinations as the boys’ gymnasia. The language courses in the highest class will be elective, providing either for Greek or the modern languages, but Latin is obligatory in all the classes. The girls from all these gymnasia are debarred from taking any of the official examinations for which their studies have prepared them.

The next step in the matter of gymnasial education for girls was what might have been expected. The people of the wide-awake city of Breslau voted, by an overwhelming majority, to establish a girls’ gymnasium under the same laws and furnishing the same advantages as the boys’ gymnasia. The completed plan was sent to the Minister of Public Instruction in Berlin in January, 1898, for approval, with the intention of opening the gymnasium at Easter, for which twenty-six girls were already enrolled. Herr Dr. Bosse, however, foreseeing the results such an undertaking would involve, consulted the other departments of the ministry, and two months later a decided refusal came like a thunderbolt upon the people of Breslau. On the 30th of April, 1898, Herr Dr. Bosse was called to account in the Reichstag for his action in the matter, which he justified on the ground that Government approval of girls’ gymnasia would mean the acceptance of the diploma for matriculation in the universities and the opening to women of all Government professional examinations, and that to have granted it would have been to take a step in the direction of the modern movement for women which could never have been recalled, and would open the lecture rooms of Germany in general to women. He contended, further, that the founding of official gymnasia for girls would delegate the existing girls’ high school to a secondary place, an institution which had been planned thoughtfully by the Government for the purpose of educating women in the 333
best manner, not to become rivals of men, but help-meets and able housekeepers.

The demand of the people of Breslau, Dr. Bosse said, was an unnatural one, and his refusal was founded on the fear that such a movement would increase and threaten the social foundations of all Germany, as the idea that women can compete with men in all careers is a false one.

The petition of the magistrate of Breslau was supported in the discussion by some of the national-liberal, free-conservative, and Polish representatives. These took the broad ground that girls have a right to equal education with boys, and that the educational institutions of Germany which have so long stood at the head of those of the world should not, in the matter of education of women, leave the question to be decided according to the whims of private individuals.

Some of the arguments of those who spoke in favor of the enterprise were amusing. One said that the girls of Germany would be grateful if the Minister of Public Instruction would furnish them with husbands, but, as there were not enough to go around, the others should have some career provided for them. Another, that about forty per cent of the girls of the higher classes no longer marry, and they should not be allowed to suffer the consequences of the fact that young men of the present day do not care to marry, but they have a right that the way be shown them to such careers as are suited to their feminine nature.

An objector said that he could not understand how any man of pedagogical culture could approve of a girls’ gymnasium, for it is evident that any such progress for women as that would imply must be at the expense of the men, who would gain less on account of the increased number of candidates for work of all kinds and would more seldom be able to offer the best of all existences to a woman—that of wifehood. The city of Breslau was obliged, therefore, to give up the undertaking for the present, but the agitation of the question has probably prepared the way for more extended plans in the future in the same direction in Prussia.

A similar undertaking in Carlsruhe, in Baden, has met with better success, and resulted in the opening of the first official gymnasium for girls in Germany, in September, 1898. This gymnasium was planned about the same time as that of Breslau, and as the permission of the Minister of Public Instruction in Baden was obtained without difficulty, the institution came into existence according to the will of the people of Carlsruhe. Seventy-nine of the members of the Bürgerauschuss voted in favor of the undertaking in the meeting in which the final action was taken early in the summer of 1898. The Christian-conservative party only decidedly opposed it. The 334
leader of this party was very much excited over the matter, and called out, when the action was taken, “I ask you, gentlemen, on your honor, if any of you would marry a girl from a gymnasium?”

The opening of the Government gymnasium will remove the necessity for continuing the private one in Carlsruhe, under the society in charge of it, and leave that society free to direct its efforts elsewhere.

There had already been several references to the general subject of the education of women in the Reichstag before the question of the gymnasium in Breslau came up. In January, 1898, Prince Carolath spoke in favor of founding several girls’ gymnasia, and admitting women legally to the universities and to pedagogical and to medical state professional examinations, remarking that in all other civilized lands the universities are more open to women than in Germany.

Coming now to the present attitude of the universities to the higher education of women, we find that a great change has taken place during the last few years. While it is still the fact that no German woman can matriculate in any university in Germany, yet the problem of the stand which the universities should take is working out its own solution in the right direction.

The University of Berlin, the largest and in many respects the leading one, has made progress in the matter, although women still work there under great limitations. The cause was injured at the outset in Berlin by the fact that women, often foreigners, who had not the required preparation, rushed into lecture rooms which were open to them from motives of curiosity. This caused such strong feeling among the professors that in one instance a professor, on entering his classroom, saw a lady sitting in the rear, walked up to her, offered her his arm, and led her out of the room.

The first step in the right direction has been to demand either a diploma from some well-known institution, or, as that could not be complied with by German women, the certificate of the teachers’ examinations. The possessors of such credentials may attend lectures in any course, where the professor is willing, as *Hospitants*. The conditions under which women may attend the University of Berlin are the following:

1. A written permission must be obtained from the curator of the university on presentation of a satisfactory diploma, a passport, and, by Russian applicants, a written permission from the police authorities to study in Germany.

2. Written permission from the rector.

3. Written permission from the professors or docents whose lectures the applicant wishes to attend. 335

4. The permission from the rector must be obtained each semester, but from the curator only when a new subject is chosen.

5. The same fee is demanded from women as from men, and women are requested to always carry with them, in attending lectures, the written permission from the rector.

At the public installation of Rector Waldeyer, in October, 1898, both in his address and in that of the resigning rector, Geheimrath Professor Schmoller, the subject of education of women received attention.

Geheimrath Schmoller said that the first condition of further concessions in the matter must be better preparation on the part of the women, and when this deficiency should be provided for the faculty of the university could make the conditions of their attending lectures lighter, perhaps even the same as those for men. Geheimrath Waldeyer made the subject one of three to which he gave equal space, and which he said called for immediate attention in the educational affairs of Germany. The other two subjects were the relation of technical schools to the universities, and university extension. Geheimrath Waldeyer said that he had formerly been opposed to the higher education of women, but had been led to change his mind from seeing that the movement is not an artificial one, but rather the natural result of the present social condition of society, and on the simple ground of right should be forwarded in a legitimate manner. He spoke strongly, however, in favor of the establishment of separate universities for men and women, on account of the natural differences in the working of their minds and the necessity of adapting methods in both instances to their needs.

The number of women in the University of Berlin has increased very rapidly, being in the autumn of 1896 thirty-nine, in the winter of the same year ninety-five. The next year the largest number was nearly two hundred, and in 1897–’98 three hundred and fifty-two were in all inscribed. Nearly half of these were German women. Most of the women in the University of Berlin are in the department of philosophy, but several are pursuing courses in theology and law. These women are of all ages. One from Charlottenburg was sixty-two years old, and, besides this honored lady, there were five others whose white hair testified to an age of from fifty to fifty-five, while the youngest of all was a Bulgarian girl of seventeen.

The first woman to take her degree in the University of Berlin was Dr. Else Neumann, in December, 1898, in physics and mathematics, who succeeded, notwithstanding the difficulties to be contended with in the absence 336
of preparatory study and the necessity for private preparation.

It is not, however, only in Berlin that the desire for university study has taken a strong hold on the German women, but it is shown in other places, not simply by the fact that many of them attend the universities of Switzerland, which are everywhere open to them, but by their also obtaining the advantages in their own land which have so long been denied them.

Heidelberg was the first university in Germany to grant the doctor examination to women, and this was done several years before lectures were open to them. The writer called upon Prof. Kuno Fischer one day in the summer of 1890 to ask permission to attend a lecture which he was to give that afternoon on Helmholtz. He said that he was very sorry indeed, but he was obliged to refuse women the privilege of listening to him, as they were not admitted to the university. I asked when they would probably be admitted, and he replied, speaking in French, "*Jamais, mademoiselle, jamais!*" Four years later, however, a friend of mine took her degree there in the department of philosophy, thus proving that the wisest of men sometimes make mistakes.

Women have for years studied as *Hospitants* in the Universities of Leipsic and Göttingen, but since November, 1897, the conditions of their admission in Göttingen have been made more difficult.

In Kiel the professors who are not willing to allow women to attend their lectures put a star opposite their names in the university programme of the lecture courses, and this star is unfortunately seen opposite the names of all the professors of theology and many of those of medicine. Women began to attend the University of Tübingen in the autumn of 1898, Dr. Maria Gräfin von Linden being the first, who was soon followed by many others.

The degree of Doctor of Philosophy *honoris causa* has been conferred on two women by the University of Munich—in December, 1897, on the Princess Theresa, and in October, 1898, on Lady Blennerhassett, an author, for her researches in modern languages. The Dean of the Philosophical Faculty, accompanied by three professors, visited her in her home in Munich to communicate to her the honor which she had received.

The University of Breslau offers better conditions to women than are provided elsewhere, as might naturally be expected, especially in the department of medicine.

Germany was represented in the International Council of Women, held in London in June of this present year, by Frau Anna Simson, Frau Bieber Boehm, and Fran Marie Stritt, of Dresden. 337

It was also decided at this congress that the next Quinquennial International Council of Women should be held in Berlin, and it will without doubt be an occasion that will mark an era in the history of the progress of liberty for the women of Germany.

SCENES ON THE PLANETS.

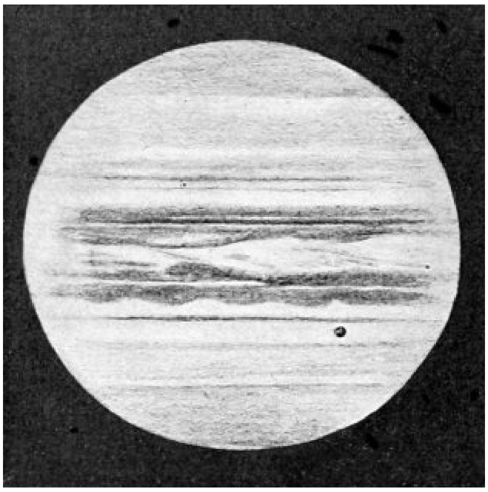
By GARRETT P. SERVISS.

Although amateurs have played a conspicuous part in telescopic discovery among the heavenly bodies, yet every owner of a small telescope should not expect to attach his name to a star. But he certainly can do something perhaps more useful to himself and his friends. He can follow the discoveries that others, with better appliances and opportunities, have made, and can thus impart to those discoveries that sense of reality which only comes from seeing things with one's own eyes. There are hundreds of things continually referred to in books and writings on astronomy which have but a misty and uncertain significance for the mere reader, but which he can easily verify for himself with the aid of a telescope of four or five inches' aperture, and which, when actually confronted by the senses, assume a meaning, a beauty, and an importance that would otherwise entirely have escaped him. Henceforth every allusion to the objects he has seen is eloquent with intelligence and suggestion.

Take, for instance, the planets that have been the subject of so many observations and speculations of late years—Mars, Jupiter, Saturn, Venus. For the ordinary reader much that is said about them makes very little impression upon his mind, and is almost unintelligible. He reads of the "snow patches" on Mars, but unless he has actually seen the whitened poles of that planet he can form no clear image in his mind of what is meant. So the "belts of Jupiter" is a confusing and misleading phrase for almost everybody except the astronomer, and the rings of Saturn are beyond comprehension unless they have actually been seen.

It is true that pictures and photographs partially supply the place of observation, but by no means so successfully as many imagine. The most realistic drawings and the sharpest photographs in astronomy are those of the moon, yet I think nobody would maintain that any picture in existence is capable of imparting a really satisfactory visual impression of the appearance of the lunar globe. Nobody who has not seen the moon with a telescope—it need not be a large one—can form a correct and definite idea of what the moon is like. 338

The satisfaction of viewing with one's own eyes some of the things the astronomers write and talk about is very great, and the illumination that comes from such viewing is equally great. Just as in foreign travel the actual seeing of a famous city, a great gallery filled with masterpieces, or a battlefield where decisive issues have been fought out illuminates, for the traveler's mind, the events of history, the criticisms of artists, and the occurrences of contemporary life in foreign lands, so an acquaintance with the sights of the heavens gives a grasp on astronomical problems that can not be acquired in any other way. The person who has been in Rome, though he may be no archæologist, gets a far more vivid conception of a new discovery in the Forum than does the reader who has never seen the city of the Seven Hills; and the amateur who has looked at Jupiter with a telescope, though he may be no astronomer, finds that the announcement of some change among the wonderful belts of that cloudy planet has for him a meaning and an interest in which the ordinary reader can not share.



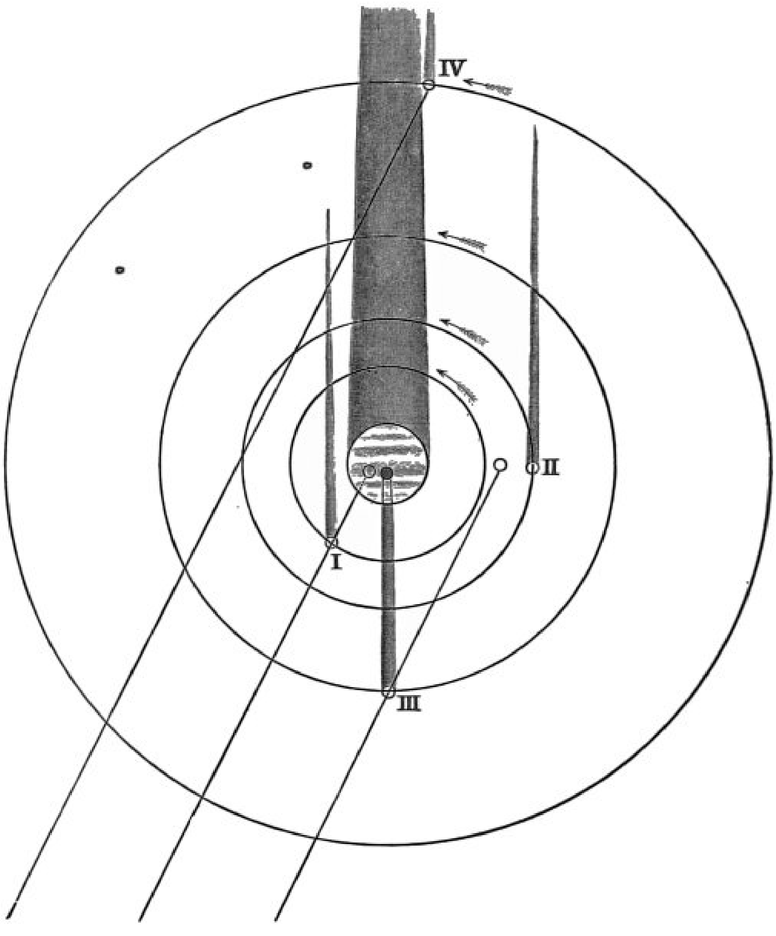
Jupiter seen with a Five-Inch Telescope. Shadow of a satellite visible.

Jupiter is perhaps the easiest of all the planets for the amateur observer. A three-inch telescope gives beautiful views of the great planet, although a four-inch or a five-inch is of course better. But there is no necessity for going beyond six inches' aperture in any case. For myself, I think I should care for nothing better than my five-inch of fifty-two inches' focal distance. With such a glass more details are visible in the dark belts and along the bright equatorial girdle than can be correctly represented in a sketch before the rotation of the planet has altered their aspect, while the shadows of the satellites thrown upon the broad disk, and the satellites themselves when in transit, can be seen sometimes with exquisite clearness. The contrasting colors of various parts of the disk are also easily studied with a glass of four or five inches' aperture.

There is a charm about the great planet when he rides high in a clear evening sky, lording it over the fixed stars with his serene, unflickering luminousness, which no possessor of a telescope can resist. You turn the glass upon him and he floats into the field of view, with his *cortége* of satellites, like a yellow-and-red moon, attended by four miniatures of itself. You instantly comprehend Jupiter's mastery over his satellites—their allegiance is evident. No one would for an instant mistake them for stars accidentally seen in the same field of view. Although it requires a very large telescope to magnify their disks to measurable dimensions, yet the smallest glass differentiates them at once from the fixed stars. There is something almost startling in their 339 appearance of companionship with the huge planet—this sudden verification to your eyes of the laws of gravitation and of central forces. It is easy, while looking at Jupiter amid his family, to understand the consternation of the churchmen when Galileo's telescope revealed that miniature of the solar system, and it is gratifying to gaze upon one of the first battle grounds whereon science gained a decisive victory for truth.

The swift changing of place among the satellites, as well as the rapidity of Jupiter's axial rotation, give the attraction of visible movement to the Jovian spectacle. The planet rotates in four or five minutes less than ten hours—in other words, it makes two turns and four tenths of a third turn while the earth is turning once upon its axis. A point on Jupiter's equator moves about twenty-seven thousand miles, or considerably more than the entire circumference of the earth, in a single hour. The effect of this motion is clearly perceptible to the observer with a telescope on account of the diversified markings and colors of the moving disk, and to watch it is one of the greatest pleasures that the telescope affords.

It would be possible, when the planet is favorably situated, to witness an entire rotation of Jupiter in the course of one night, but the beginning and end of the observation would be more or less interfered with by the effects of low altitude, to say nothing of the tedium of so long a vigil. But by looking at the planet for an hour at a time in the course of a few nights every side of it will have been presented to view. Suppose the first observation is made between nine and ten o'clock on any night which may have been selected. Then on the following night between ten and eleven o'clock Jupiter will have made two and a half turns upon his axis, and the side diametrically opposite to that seen on the first night will be visible. On the third night between eleven and twelve o'clock Jupiter will have performed five complete rotations, and the side originally viewed will be 340
visible again.



Eclipses and Transits of Jupiter's Satellites. Satellite I and the shadow of III are seen in transit. IV is about to be eclipsed.

Owing to the rotundity of the planet, only the central part of the disk is sharply defined, and markings which can be easily seen when centrally located become indistinct or disappear altogether when near the limb. Approach to the edge of the disk also causes a foreshortening which sometimes entirely alters the aspect of a marking. It is advisable, therefore, to confine the attention mainly to the middle of the disk. As time passes, clearly defined markings on or between the cloudy belts will be seen to approach the western edge of the disk, 341
gradually losing their distinctness and altering their appearance, while from the region of indistinct definition near the eastern edge other markings slowly emerge and advance toward the center, becoming sharper in outline and more clearly defined in color as they swing into view.

Watching these changes, the observer is carried away by the reflection that he actually sees the turning of another distant world upon its axis of rotation, just as he might view the revolving earth from a standpoint on the moon. Belts of reddish clouds, many thousands of miles across, are stretched along on each side of the equator of the great planet he is watching; the equatorial belt itself, brilliantly lemon-hued, or sometimes ruddy, is diversified with white globular and balloon-shaped masses, which almost recall the appearance of summer cloud domes hanging over a terrestrial landscape, while toward the poles shadowy expanses of gradually deepening blue or blue-gray suggest the comparative coolness of those regions which lie always under a low sun.

After a few nights' observation even the veriest amateur finds himself recognizing certain shapes or appearances—a narrow dark belt running slopingly across the equator from one of the main cloud zones to the other, or a rift in one of the colored bands, or a rotund white mass apparently floating above the equator, or a broad scallop in the edge of a belt like that near the site of the celebrated “red spot,” whose changes of color and aspect since its first appearance in 1878, together with the light it has thrown on the constitution of Jupiter's disk, have all but created a new Jovian literature, so thoroughly and so frequently have they been discussed.

And, having noticed these recurring features, the observer will begin to note their relations to one another, and will thus be led to observe that some of them gradually drift apart, while others drift nearer; and after a time, without any aid from books or hints from observatories, he will discover for himself that there is a law governing the movements on Jupiter's disk. Upon the whole he will find that the swiftest motions are near the equator, and the slowest near the poles, although, if he is persistent and has a good eye and a good instrument, he will note exceptions to this rule, probably arising, as Professor Hough suggests, from differences of altitude in Jupiter's atmosphere. Finally, he will conclude that the colossal globe before him is, exteriorly at least, a vast ball of clouds and vapors, subject to tremendous vicissitudes, possibly intensely heated, and altogether different in its physical constitution, although made up of similar elements, from the earth. Then, if he chooses, he can sail off into the delightful cloud-land of astronomical speculation, and make of the striped and spotted sphere of 342
Jove just such a world as may please his fancy—for a world of some kind it certainly is.

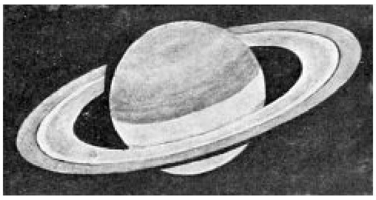
For many observers the satellites of Jupiter possess even greater attractions than the gigantic ball itself. As I have already remarked, their movements are very noticeable and lend a wonderful animation to the scene. Although they bear classical names, they are almost universally referred to by their Roman numbers, beginning with the innermost, whose symbol is I, and running outward in regular order II, III, and IV. The minute satellite much nearer to the planet than any of the others, which Mr. Barnard discovered with the Lick telescope in 1892, is called the fifth, although in the order of distance it would be the first. In size and importance, however, it can not rank with its comparatively gigantic brothers. Of course, no amateur's telescope can show the faintest glimpse of it.

Satellite I, situated at a mean distance of 261,000 miles from Jupiter's center—about 22,000 miles farther than the moon is from the earth—is urged by its master's overpowering attraction to a speed of 320 miles per minute, so that it performs a complete revolution in about forty-two hours and a half. The others, of course, move more slowly, but even the most distant performs its revolution in several hours less than sixteen days. The plane of their orbits is presented edgewise toward the earth, from which it follows that they appear to move back and forth nearly in straight lines, some apparently approaching the planet, while others are receding from it. The changes in their relative positions, which can be detected from hour to hour, are very striking night after night, and lead to a great variety of arrangements always pleasing to the eye.

The most interesting phenomena that they present are their transits and those of their round, black shadows across the face of the planet; their eclipses by the planet's shadow, when they disappear and afterward reappear with astonishing suddenness; and their occultations by the globe of Jupiter. Upon the whole, the most interesting thing for the amateur to watch is the passage of the shadows across Jupiter. The distinctness with which they can be seen when the air is steady is likely to surprise, as it is certain to delight, the observer. When it falls upon a light part of the disk the shadow of a satellite is as black and sharply outlined as a drop of ink; on a dark-colored belt it can not so easily be seen.

It is more difficult to see the satellites themselves in transit. There appears to be some difference among
them as to visibility in such circumstances. Owing to their luminosity they are best seen when they have a dark 343
belt for a background, and are least easily visible when they appear against a bright portion of the planet. Every observer should provide himself with a copy of the American Ephemeris for the current year, wherein he will find all the information needed to enable him to identify the various satellites and to predict, by turning Washington mean time into his own local time, the various phenomena of the transits and eclipses.

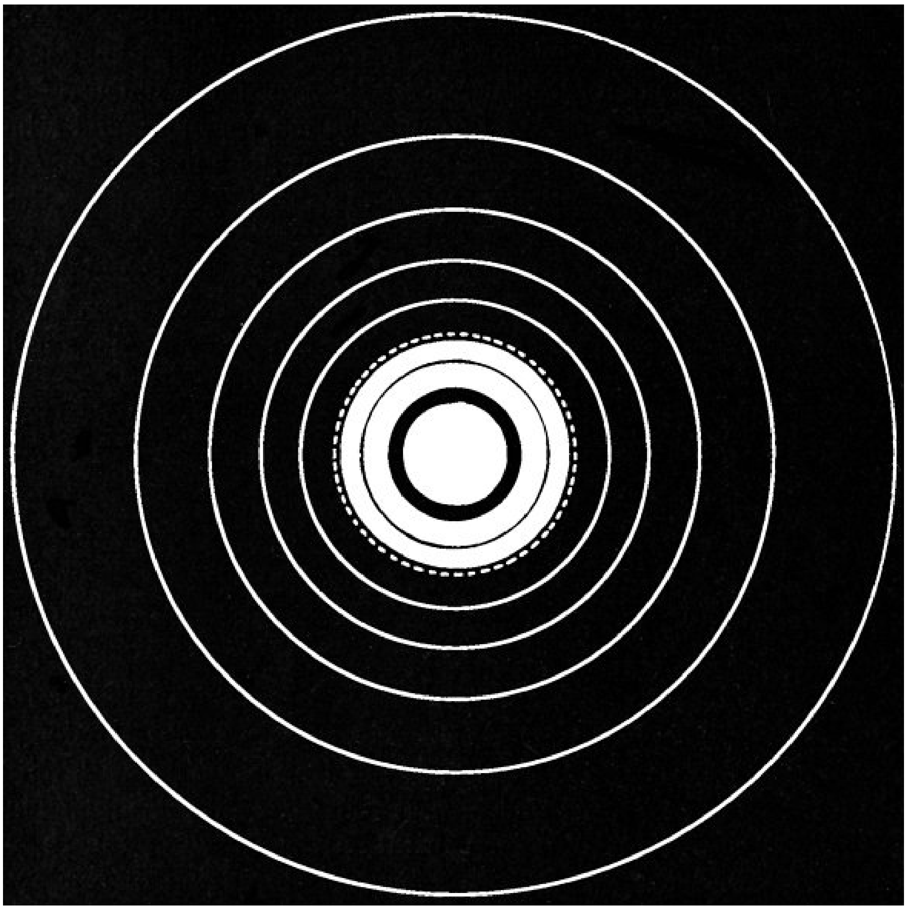
While a faithful study of the phenomena of Jupiter is likely to lead the student to the conclusion that the greatest planet in our system is not a suitable abode for life, yet the problem of its future, always fascinating to the imagination, is open; and whosoever may be disposed to record his observations in a systematic manner may at least hope to render aid in the solution of that problem.



Saturn seen with a Five-Inch Telescope.

Saturn ranks next to Jupiter in attractiveness for the observer with a telescope. The rings are almost as mystifying to-day as they were in the time of Herschel. There is probably no single telescopic view that can compare in the power to excite wonder with that of Saturn when the ring system is not so widely opened but that both poles of the planet project beyond it. One returns to it again and again with unflagging interest, and the beauty of the spectacle quite matches its singularity. When Saturn is in view the owner of a telescope may become a recruiting officer for astronomy by simply inviting his friends to gaze at the wonderful planet. The silvery color of the ball, delicately chased with half-visible shadings, merging one into another from the bright equatorial band to the bluish polar caps; the grand arch of the rings, sweeping across the planet with a perceptible edging of shadow; their sudden disappearance close to the margin of the ball, where they go behind it and fall straightway into night; the manifest contrast of brightness, if not of color, between the two principal rings; the fine curve of the black line marking the 1,600-mile gap between their edges—these are some of the elements of a picture that can never fade from the memory of any one who has once beheld it in its full glory.

Saturn's moons are by no means so interesting to watch as are those of Jupiter. Even the effect of their surprising number (raised to nine by Professor Pickering's discovery last spring of a new one which is almost at the limit of visibility, and was found only with the aid of photography) is lost, because most of them are too faint 344
to be seen with ordinary telescopes, or, if seen, to make any notable impression upon the eye. The two largest—Titan and Japetus—are easily found, and Titan is conspicuous, but they give none of that sense of companionship and obedience to a central authority which strikes even the careless observer of Jupiter's system. This is owing partly to their more deliberate movements and partly to the inclination of the plane of their orbits, which seldom lies edgewise toward the earth.



Polar View of Saturn's System. The orbits of the five nearest satellites are shown. The dotted line outside the rings shows Roche's limit.

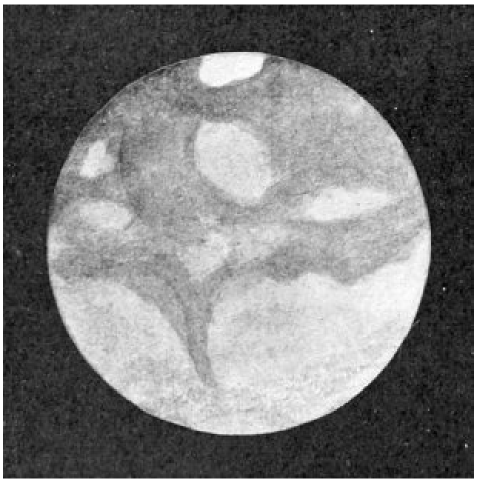
But the charm of the peerless rings is abiding, and the interest of the spectator is heightened by recalling what science has recently established as to their composition. It is marvelous to think, while looking upon their broad, level surfaces—as smooth, apparently, as polished steel, though thirty thousand miles across—that they are in reality vast circling currents of meteoritic particles or dust, through which run immense waves, 345
condensation and rarefaction succeeding one another as in the undulations of sound. Yet, with all their inferential tumult, they may actually be as soundless as the depths of interstellar space, for Struve has shown that those spectacular rings possess no appreciable mass, and, viewed from Saturn itself, their (to us) gorgeous seeming bow may appear only as a wreath of shimmering vapor spanning the sky and paled by the rivalry of the brighter stars.

In view of the theory of tidal action disrupting a satellite within a critical distance from the center of its primary, the thoughtful observer of Saturn will find himself wondering what may have been the origin of the rings. The critical distance referred to, and which is known as Roche's limit, lies, according to the most trustworthy estimates, just outside the outermost edge of the rings. It follows that if the matter composing the rings were collected into a single body that body would inevitably be torn to pieces and scattered into rings; and so, too, if instead of one there were several or many bodies of considerable size occupying the place of the rings, all of these bodies would be disrupted and scattered. If one of the present moons of Saturn—for instance, Mimas, the innermost hitherto discovered—should wander within the magic circle of Roche's limit it would suffer a similar fate, and its particles would be disseminated among the rings. One can hardly help wondering whether the rings have originated from the demolition of satellites—Saturn devouring his children, as the ancient myths represent, and encircling himself, amid the fury of destruction, with the dust of his disintegrated victims. At any rate, the amateur student of Saturn will find in the revelations of his telescope the inspirations of poetry as well as those of science, and the bent of his mind will determine which he shall follow.

Professor Pickering's discovery of a ninth satellite of Saturn, situated at the great distance of nearly eight million miles from the planet, serves to call attention to the vastness of the "sphere of activity" over which the ringed planet reigns. Surprising as the distance of the new satellite appears when compared with that of our moon, it is yet far from the limit where Saturn's control ceases and that of the sun becomes predominant. That limit, according to Prof. Asaph Hall's calculation, is nearly 30,000,000 miles from Saturn's center, while if our moon were removed to a distance a little exceeding 500,000 miles the earth would be in danger of losing its satellite through the elopement of Artemis with Apollo.

Although, as already remarked, the satellites of Saturn are not especially interesting to the amateur telescopist, yet it may be well to mention that, in addition to Titan and Japetus, the satellite named Rhea, the 346 fifth in order of distance from the planet, is not a difficult object for a three-or four-inch telescope, and two others considerably fainter than Rhea—Dione (the fourth) and Tethys (the third)—may be seen in favorable circumstances. The others—Mimas (the first), Enceladus (the second), and Hyperion (the seventh)—are beyond the reach of all but large telescopes. The ninth satellite, which has received the name of Phœbe, is much fainter than any of the others, its stellar magnitude being reckoned by its discoverer at about 15.5.

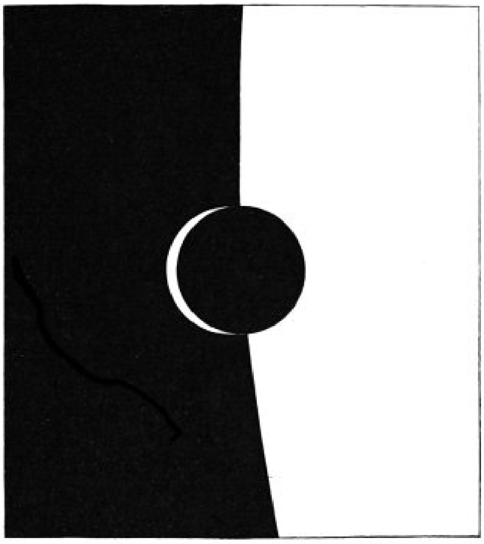
Mars, the best advertised of all the planets, is nearly the least satisfactory to look at except during a favorable opposition, like those of 1877 and 1892, when its comparative nearness to the earth renders some of its characteristic features visible in a small telescope. The next favorable opposition will occur in 1907.



Mars seen with a Five-Inch Telescope.

When well seen with an ordinary telescope, say a four-or five-inch glass, Mars shows three peculiarities that may be called fairly conspicuous—viz., its white polar cap, its general reddish, or orange-yellow, hue, and its dark markings, one of the clearest of which is the so-called Syrtis Major, or, as it was once named on account of its shape, "Hourglass Sea." Other dark expanses in the southern hemisphere are not difficult to be seen, although their outlines are more or less misty and indistinct. The gradual diminution of the polar cap, which certainly behaves in this respect as a mass of snow and ice would do, is a most interesting spectacle. As summer advances in the southern hemisphere of Mars, the white circular patch surrounding the pole becomes smaller, night after night, until it sometimes disappears entirely even from the ken of the largest telescopes. At the same time the dark expanses become more distinct, as if the melting of the polar snows had supplied them with a greater depth of water, or the advance of the season had darkened them with a heavier growth of vegetation.

The phenomena mentioned above are about all that a small telescope will reveal. Occasionally a dark streak, which large instruments show is connected with the mysterious system of "canals," can be detected, but the 347 "canals" themselves are far beyond the reach of any telescope except a few of the giants handled by experienced observers. The conviction which seems to have forced its way into the minds even of some conservative astronomers, that on Mars the conditions, to use the expression of Professor Young, "are more nearly earthlike than on any other of the heavenly bodies which we can see with our present telescopes," is sufficient to make the planet a center of undying interest notwithstanding the difficulties with which the amateur is confronted in his endeavors to see the details of its markings.



The Illumination of Venus's Atmosphere at the beginning of her Transit across the Sun.

In Venus "the fatal gift of beauty" may be said, as far as our observations are concerned, to be matched by the equally fatal gift of brilliance. Whether it be due to atmospheric reflection alone or to the prevalence of clouds, Venus is so bright that considerable doubt exists as to the actual visibility of any permanent markings on her surface. The detailed representations of the disk of Venus by Mr. Percival Lowell, showing in some respects a resemblance to the stripings of Mars, can not yet be accepted as decisive. More experienced astronomers than Mr. Lowell have been unable to see at all things which he draws with a fearless and unhesitating pencil. That there are some shadowy features of the planet's surface to be seen in favorable circumstances is probable, but the time for drawing a "map of Venus" has not yet come.

The previous work of Schiaparelli lends a certain degree of probability to Mr. Lowell's observations on the rotation of Venus. This rotation, according to the original announcement of Schiaparelli, is probably performed in the same period as the revolution around the sun. In other words, Venus, if Schiaparelli and Lowell are right, always presents the same side to the sun, possessing, in consequence, a day hemisphere and a night hemisphere which never interchange places. This condition is so antagonistic to all our ideas of what constitutes 348
habitability for a planet that one hesitates to accept it as proved, and almost hopes that it may turn out to have no real existence. Venus, as the twin of the earth in size, is a planet which the imagination, warmed by its sunny aspect, would fain people with intelligent beings a little fairer than ourselves; but how can such ideas be reconciled with the picture of a world one half of which is subjected to the merciless rays of a never-setting sun, while the other half is buried in the fearful gloom and icy chill of unending night?

Any amateur observer who wishes to test his eyesight and his telescope in the search of shades or markings on the disk of Venus by the aid of which the question of its rotation may finally be settled should do his work while the sun is still above the horizon. Schiaparelli adopted that plan years ago, and others have followed him with advantage. The diffused light of day serves to take off the glare which is so serious an obstacle to the successful observation of Venus when seen against a dark sky. Knowing the location of Venus in the sky, which can be ascertained from the Ephemeris, the observer can find it by day. If his telescope is not permanently mounted and provided with "circles" this may not prove an easy thing to do, yet a little perseverance and ingenuity will effect it. One way is to find, with a star chart, some star whose declination is the same, or very nearly the same, as that of Venus, and which crosses the meridian say twelve hours ahead of her. Then set the telescope upon that star, when it is on the meridian at night, and leave it there, and the next day, twelve hours after the star crossed the meridian, look into your telescope and you will see Venus, or, if not, a slight motion of the tube one way or another will bring her into view.

For many amateurs the phases of Venus will alone supply sufficient interest for telescopic observation. The changes in her form, from that of a round full moon when she is near superior conjunction to the gibbous, and finally the half-moon phase as she approaches her eastern elongation, followed by the gradually narrowing and lengthening crescent, until she becomes a mere silver sickle as she swings in between the sun and the earth, form a succession of delightful pictures for the eye.

Not very much can be said for Mercury as a telescopic object. The little planet presents phases like those of Venus, and, according to Schiaparelli and Lowell, it resembles Venus in its rotation, keeping always the same side to the sun. In fact, Schiaparelli's discovery of this peculiarity in the case of Mercury preceded the similar discovery in the case of Venus. There are perceptible markings on Mercury which have reminded some astronomers of the appearance of the moon, and there are various reasons for thinking that the planet can not 349
be a suitable abode for living beings, at least for beings resembling the inhabitants of the earth. Uranus and Neptune are too far away to present any attraction for amateur observation.

PROFESSOR WARD ON "NATURALISM AND AGNOSTICISM."

By HERBERT SPENCER.

In a recent advertisement, Professor Ward's work entitled as above was characterized as "one of the most important contributions to philosophy made in our time in England," and this was joined with the prophecy that it "may even do something to restore to philosophy the prominent place it once occupied in English thought." Along with laudatory expressions, I have observed in some notices reprobation of the manner adopted by Professor Ward in his attack upon my views—I might almost say upon me; and one of the reviewers gives examples of the words he uses—"ridiculous," "absurd," "blunder," "nonsense," "amazing fallacy," "our oracle."

When, some time ago, I glanced at one of the volumes, I came upon a passage which at once stamped the book by displaying the attitude of the writer; but, being then otherwise occupied, I decided not to disturb myself by reading more. Now, however, partly by the reviews I have seen, and partly by the comments of a friend, I have been shown that I can not let the book pass without remark. The assumption that a critic states rightly the doctrine he criticises is so generally made, that in the absence of proof to the contrary his criticisms are almost certain to be regarded as valid. And when the critic is a Cambridge Professor and an Honorary LL. D., the assumption will be thought fully warranted.

* * * * *

Let me set out by quoting some passages disclosing the kind of feeling by which Professor Ward's criticisms are influenced, if not prompted. In his preface he says:—

> "When at length Naturalism is forced to take account of the facts of life and mind, we find the strain on the mechanical theory is more than it will bear. Mr. Spencer has blandly to confess that 'two volumes' of his *Synthetic Philosophy* are missing, the volumes that should connect inorganic with biological, evolution."

Respecting the first of these sentences, I have only to remark that I have said (as in *First Principles*, § 62) and repeatedly implied, that force or energy in the sense which a "mechanical theory" connotes, can not be that 350
Ultimate Cause whence all things proceed, and that there is as much warrant for calling it spiritual as for calling it material. As was asserted at the close of that work (p. 558), the "implications are no more materialistic than they are spiritualistic; and no more spiritualistic than they are materialistic"; and as was contended in the *Principles of Sociology*, § 659, "the Power manifested throughout the Universe distinguished as material, is the same Power which in ourselves wells up under the form of consciousness."

But it is to the second sentence I here chiefly draw attention. Whether or not there be a sarcasm behind the words "blandly to confess," it is clear that the sentence is meant to imply some dereliction on my part. Now in the programme of the Synthetic Philosophy, the division dealing with inorganic nature was avowedly omitted, "because even without it the scheme is too extensive"; and this undue extensiveness was so conspicuous that I was thought absurd or almost insane. Yet I am now tacitly reproached because I did not make it more extensive still—because an undertaking deemed scarcely possible was not made quite impossible. When blamed for attempting too much, it never entered my thoughts that I might in after years be blamed for not attempting more.

Repeated reference to *First Principles* as "the stereotyped philosophy" are manifestly intended by Professor Ward to reflect on me, either for having left that work during many years unchanged, or for implying that no change is needed. Much as I dislike personal explanations, I am here compelled to make them. If, in 1896, when the ten volumes constituting the Synthetic Philosophy were completed, I had done nothing toward revision of them, the omission would not have been considered by most men a reason for complaint. The facts, however, are, that in 1867 I issued a recast and revised edition of *First Principles*; in 1870 an edition of the *Principles of Psychology*, of which half was revised, and ten years later an enlarged edition of the same work; in 1885 a revised edition of the first volume of the *Principles of Sociology*; and now I have fortunately been able to finish a revised and enlarged edition of the *Principles of Biology*. Any one not willfully blind might have seen that when persisting, under great difficulties, in trying to execute the entire work as originally outlined, it was not practicable at the same time to bring all earlier parts of it up to date. Professor Ward, however, thinks that I should have sacrificed the end to improve the beginning, or else that I should have found energy enough to re-revise an earlier volume while writing the later ones; and my failure to do both prompts sarcastic allusions.[A] 351

[A] Candor often brings penalties, as witness the announcement "stereotyped edition." When another thousand of a work has been ordered, the printers do not always refer to the author for correction of the title-page, but, as a matter of course, put "second edition," or "third edition," as the case may be. When my attention has been drawn to such matters, however, I have directed that the words "stereotyped edition" shall be put on the title-page if the printing is from plates, and if the work is unaltered: objecting to a usage which betrays readers into the false belief that new matter is forthcoming. I did not perceive that an antagonist might transform the words "stereotyped edition" into an assertion that the work needed no changes. Experience should have warned me that adverse interpretations are inevitable wherever they are possible. To the question—"Why did you stereotype?" the obvious reply is—"From motives of economy."

In further illustration of the feeling Professor Ward brings to his task, I may quote the following passage, in which he interposes comments on my mode of writing:—

> "By the persistence of Force [capital F], we really mean the persistence of some Power [capital P] which transcends our knowledge and conception. The manifestations, as recurring either in ourselves or outside

> of us, do not persist; but that which persists is the Unknown Cause [capitals again] of these manifestations.”

The matter itself is trivial enough. It is worth noticing only as indicating a state of mind. Supposing even that capitals were in such cases inappropriate—supposing even that small initial letters would have been more appropriate; it is clear that only one having a strong *animus* would have gone out of his way to notice it.

After thus enabling the reader to judge in what temper the criticisms of Professor Ward are made, I may pass on.

* * * * *

As implied at the outset, my intention is not to discuss Professor Ward’s own philosophy—the less so because I discussed a like philosophy nearly a generation ago. His position is that “Once materialism is abandoned and dualism found untenable, a spiritualistic monism remains the one stable position. It is only in terms of mind that we can understand the unity, activity, and regularity that nature presents. In so understanding we see that Nature is Spirit.” (*Preface.*) This was the position of Dr. Martineau in 1872 (and probably is now). He argued, that to account for this infinitude of physical changes everywhere going on, “Mind must be conceived as there,” “under the guise of simple Dynamics.” My criticisms on this view, given in an essay entitled “Mr. Martineau on Evolution,” can not here be repeated. But I held then, as I hold now, that “the Ultimate Power is no more representable in terms of human consciousness than human consciousness is representable in terms of a plant’s functions.” Briefly the result is, that in saying “Nature is Spirit” (capital N and capital S!), Professor Ward implies that he knows all about it; while I, on the other hand, am sure that I 352
know nothing about it.

* * * * *

And now, passing to my essential purpose, let me exemplify Professor Ward’s controversial method. Specifying an hypothesis of the late Dr. Croll (who, he thinks, had “incomparably more right to an opinion on the question” than I have), he says, that it “at least recognizes a problem with which Mr. Spencer scarcely attempts to deal—I mean the evolution of the chemical elements. It thus suffices to convict Mr. Spencer’s work of a certain incompleteness” (i., 190). Apparently the words “scarcely attempts” refer to a passage in the above-named essay, “Mr. Martineau on Evolution,” where several reasons are given for thinking that the “so-called elements arise by compounding and recompounding.” More than this has been done, however. The evolution of the elements, if not systematically dealt with within the limits of the Synthetic Philosophy, has not been ignored. In an essay on “The Nebular Hypothesis” (*Essays*, i., pp. 156–9), it is argued, that “the general law of evolution, if it does not actually involve the conclusion that the so-called elements are compounds, yet affords *a priori* ground for suspecting that they are such”; and five groups of traits are enumerated which support the belief that they originated by a process of evolution like that everywhere going on. But the point I here chiefly emphasize is that, having reflected upon me for omitting two volumes, Professor Ward again reflects upon me for having omitted something which one of these volumes would have contained. “Sir, you have neglected to build that house which was wanted! Moreover, you have not supplied the stairs!”

* * * * *

From a sin of omission let us pass to a sin of commission. Professor Ward quotes from me the sentence —“The absolutely homogeneous must lose its equilibrium; and the relatively homogeneous must lapse into the relatively less homogeneous.”—*First Principles*, p. 429. Then presently he writes:—

> “In truth, however, homogeneity is not necessarily instability. Quite otherwise. If the homogeneity be absolute—that of Lord Kelvin’s primordial medium, say—the stability will be absolute too. In other words, if ‘the indefinite, incoherent homogeneity,’ in which, according to Mr. Spencer, some rearrangement *must result*, be a state devoid of all qualitative diversity and without assignable bounds, then, as we saw in discussing mechanical ideals, any ‘rearrangement’ can result only from external interference; it can not begin from within” (i., 223).

And then he goes on to argue that “Thus, the very first step in Mr. Spencer’s evolution seems to necessitate a breach of continuity. This fatal defect, &c.” (*ibid.*).

Observe the words “without assignable bounds”—without knowable limits, infinite. So that the law of the 353
instability of the homogeneous is disposed of because it does not apply to an infinite homogeneous medium. But since infinity is inconceivable by us, this alleged case of stable homogeneity is inconceivable too. Hence the proposal is to shelve the law displayed in all things we know, because it is inapplicable to a hypothetical thing we can not know, and can not even conceive! Now let me turn to the essential point. This nominally-exceptional case was fully recognized by me in the chapter he is criticising. In § 155 of *First Principles* (p. 429), it is written:—

> “One stable homogeneity only, is hypothetically possible. If centers of force, absolutely uniform in their powers, were diffused with absolute uniformity through unlimited space, they would remain in equilibrium. This, however, though a verbally intelligible supposition, is one that can not be represented in thought; since unlimited space is inconceivable.”

So that this nominal exception which Professor Ward urges against me as a “fatal defect,” was set forth by me thirty-seven years ago!

A somewhat more involved case may next be dealt with. Professor Ward writes:—

> “Moreover, on the physical assumption from which Mr. Spencer sets out, viz., that the mass of the universe and the energy of the universe are fixed in quantity—which ought to mean are finite in quantity—

there can be no such alternations [of evolution and dissolution] as he supposes” (i., 192).

After some two pages of argument, he goes on:—

> “And so while all transformations of energy lead directly or indirectly to transformation into heat, from that transformation there is no complete return, and, therefore finally no return at all. This then is the conclusion to which Mr. Spencer’s premises lead. Two eminent physicists who accept those premises may be cited at this point: ‘It is absolutely certain,’ they say, ‘that life, so far as it is physical, depends essentially upon transformations of energy; it is also absolutely certain that age after age the possibility of such transformations is becoming less and less; and, so far as we yet know, the final state of the present universe must be an aggregation (into one mass) of all the matter it contains, *i. e.* the potential energy gone, and a practically useless state of kinetic energy, *i. e.* uniform temperature throughout that mass.... The present visible universe began in time and will in time come to an end’” (p. 194).

Mark now, however, that this opinion of “two eminent physicists,” quoted to disprove my position, and tacitly assumed to have validity in so far as it serves that end, is forthwith dismissed as having, for other purposes, no validity. His next paragraph runs:—

> “To this conclusion we are surely led from such premises. But again I ask what warrant is there for the premises? Our experience certainly does not embrace the totality of things, is, in fact, ridiculously far from 354
> it. We have no evidence of definite space or time limits; quite the contrary. Every advance of knowledge only opens up new vistas into a remoter past and discloses further depths of immensity teeming with worlds.”

Thus the truth urged against me is that we can not know anything about these ultimate physical principles in their application to the ultra-visible universe. But, unhappily for Professor Ward’s criticism, I entered this same caveat long ago. Demurring to that doctrine of the dissipation of energy to which he now demurs, I wrote:—

> “Here, indeed, we arrive at a barrier to our reasonings; since we can not know whether this condition is or is not fulfilled. If the ether which fills the interspaces of our Sidereal system has a limit somewhere beyond the outermost stars, then it is inferable that motion is not lost by radiation beyond this limit; and if so, the original degree of diffusion may be resumed. Or supposing the ethereal medium to have no such limit, yet, on the hypothesis of an unlimited space, containing, at certain intervals, Sidereal Systems like our own, it may be that the quantity of molecular motion radiated into the region occupied by our Sidereal System, is equal to that which our Sidereal System radiates; in which case the quantity of motion possessed by it, remaining undiminished, it may continue during unlimited time its alternate concentrations and diffusions. But if, on the other hand, throughout boundless space filled with ether, there exist no other Sidereal Systems subject to like changes, or if such other Sidereal Systems exist at more than a certain average distance from one another; then it seems an unavoidable conclusion that the quantity of motion possessed, must diminish by radiation; and that so, on each successive resumption of the nebulous form, the matter of our Sidereal System will occupy a less space; until it reaches either a state in which its concentrations and diffusions are relatively small, or a state of complete aggregation and rest. Since, however, we have no evidence showing the existence or non-existence of Sidereal Systems throughout remote space; and since, even had we such evidence, a legitimate conclusion could not be drawn from premises of which one element (unlimited space) is inconceivable; we must be forever without answer to this transcendent question.” (*First Principles*, § 182, pp. 535–6.)

See, then, how the case stands. After urging against me the argument of “two eminent physicists” as fatal to my conclusions, he thereupon expresses dissent from the premises of that argument; and the reasons he gives for dissenting are like those given by me before he was out of his teens!

* * * * *

It is not always easy to disentangle misrepresentations; especially when they are woven into a fabric. For elucidation of this matter there needs another section. It may fitly begin with an analogy. An astronomer who “saw reason to think” that the swarm of November meteors this year would be greater than usual, would be surprised if the occurrence of a smaller number were cited in disproof of his astronomical beliefs at large. It 355
would be held that so undecided a phrase as “saw reason to think,” not implying a definite deduction, did not implicate his general conceptions nor appreciably discredit them. Professor Ward, however, thinks a tentative opinion is equivalent to a positive assertion. In the course of the foregoing argument (p. 191) he represents me as saying that “there is an alternation of evolution and dissolution in the totality of things.” He does not quote the whole clause, which runs thus:—“For *if*, as we saw *reason to think*, there is an alternation of evolution and dissolution in the totality of things, &c.” Here, then, are two qualifying expressions which he suppresses; and not only does he here suppress them, but elsewhere he refers to this passage as not speculative, but quite positive. On p. 197 he says:—

> “But of a single supreme evolution embracing them all we have no title to speak: not even to assume that it is, much less to say what it is; least of all to *affirm confidently* that it can be embraced in such a meaningless formula as the integration of matter and the dissipation of motion.” [The italics are mine.]

So that a hypothetical inference (implied by “if”), drawn from avowedly uncertain data (implied by “reason to think”), he transforms into an unhesitating assertion. He does this in presence of my statement that respecting transformations of the Universe as a whole, no “legitimate conclusions” can be drawn, and that we must be forever “without answer to this transcendent question.” Nay, he does it in presence of a still more specific repudiation of certainty. Section 182 begins:—

> “Here we come to the question raised at the close of the last chapter—does Evolution as a whole, like Evolution in detail, advance toward complete quiescence? Is that motionless state called death, which ends Evolution in organic bodies, typical of the universal death in which Evolution at large must end?...

> "To so speculative an inquiry, none but a speculative answer is to be expected. Such answer as may be ventured, must be taken less as a positive answer than as a demurrer to the conclusion that the proximate result must be the ultimate result" (p. 529). Instead of being a positive answer, it is intended to *exclude* a positive answer.

One more instance may be given to illustrate Professor Ward's mode of discrediting views which he dislikes. On p. 198 of his first volume occurs the sentence—

> "At any rate such a conception is less conjectural and more adequate than Mr. Spencer's ridiculous comparison of the universe to a spinning top that begins by 'wabbling,' passes into a state of steady motion or *equilibrium mobile*, and finally comes to rest."

The reader who seeks a warrant for this representation will seek in vain. If, in the chapter of *First Principles* on "Equilibration," he turns to section 171, where the celestial applications of the general law are considered, he 356
will find the Solar System alone instanced as having progressed toward a moving equilibrium; and the moving equilibrium even of this not compared as alleged. Neither in that section nor in any subsequent section of the chapter, is any larger celestial aggregate mentioned as progressing toward a moving equilibrium. Contrariwise, in the succeeding chapter on "Dissolution," it is said that "the irregular distribution of our Sidereal System" is "such as to render even a temporary moving equilibrium impossible" (p. 531). On pp. 533–4 it is contended that even local aggregations of stars, still more the whole Sidereal System, must eventually reach a diffused state without passing through any such stage. And had not conclusions respecting the changes of the Universe been excluded as exceeding the bounds even of speculation (p. 536), it is clear that still more of the Universe would no moving equilibrium have been alleged; but, had anything been alleged, it would have been the reverse. How, then, has it been possible, the reader will ask, for Professor Ward to write the sentence above quoted? If instead of vainly seeking through the sections devoted to "Equilibration" and "Dissolution" in relation to celestial phenomena, he turns back to some introductory pages he will find a clew. I have pointed out that in an aggregate having compounded motions, one of the constituent motions may be dissipated while the rest continue; and that in some such cases there is established a moving equilibrium. In illustration I have taken "the most familiar example"—"that of the spinning top"; and to remind the reader of one of the movements thus dissipated while the rest continue, I have used the word "wabbling"; there being no other descriptive word. What then has Professor Ward done? That mode of establishing an equilibrium which the spinning top exemplifies, he represents as extended by me to celestial phenomena, though no such comparison is made nor any such word used. Nay, he has done so notwithstanding my assertion that a moving equilibrium of our sidereal system is negatived, and regardless of the implied assertion that still more would be negatived a moving equilibrium of the Universe, could we with any rationality speculate about it. Actually in defiance of all this, he says I compare the motion of the Universe to that of a "wabbling" top. Having constructed a grotesque fancy, he labels it "ridiculous" and then debits me with it.

I can not pursue further this examination of Professor Ward's criticisms: other things have to be done. Whether what has been said will lead readers to discount the laudatory expressions I quoted at the outset, it is not for me to say. But I think I have said enough to warn them that before accepting Professor Ward's versions 357
of my views, it will be prudent to verify them.

* * * * *

Postscript.—I said that I did not propose to discuss Professor Ward's own philosophy, and I contented myself with quoting his summary of it—"Nature is Spirit." It occurs to me, however, that as showing the point of view from which his criticisms are made, it may not be amiss to give readers a rather more specific conception of his philosophy, by reproducing a laudatory quotation he makes. Here it is:—

> "If 'rational synthesis' of things is what we seek, it is surely more reasonable to say with Lotze: 'What lies beneath all is not a quantity which is bound eternally to the same limits and compelled through many diverse arrangements, continuously varied, to manifest always the very same total. On the contrary, should *the self-realization of the Idea* [!] require it, there is nothing to hinder the working elements of the world being at one period more numerous and yet more intense; at another period less intense as well as fewer'" (i., 218). [The italics are mine.]

It is worth remarking that on the opposite page some of my views are characterized as "astounding feats of philosophical jugglery"!

DESTRUCTIVE EFFECTS OF VAGRANT ELECTRICITY.

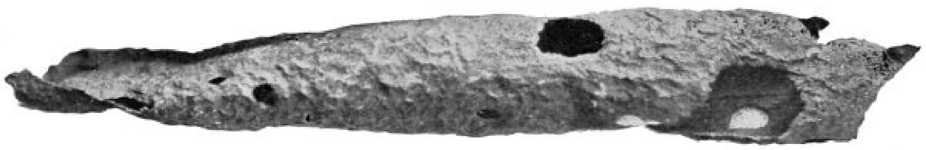
By HUBERT S. WYNKOOP, M. E.

Reverting to the dictionary for a definition, electrolysis is "the process of decomposing a chemical compound by the passage of an electric current through it." Electroplating is a popular illustration of this definition, having been numbered among the industrial arts for nearly a century.

If in a bath of sulphate-of-copper solution are placed a copper plate and a plumbago-covered wax mold, the passage of an electric current through the solution, *from* the plate *to* the mold, will result in the deposition of copper upon the mold, or negative electrode, and the wasting away of the plate of copper, or positive electrode. Generalizing from this and other experiments, it may be broadly stated that the passage of an electric current through a solution of electrolyzable metallic salt, *from* an oxidizable metal *to* some other conductor, will be attended by the separation of the salt into two parts: first, the metal, appearing at the negative electrode; and, second, an unstable compound of the remaining elements. This unstable compound is supposed to unite with the hydrogen of the water, liberating oxygen, and forming an acid. Both oxygen and acid appear only at the positive electrode, which is thus made subject to a double decay—a corrosion by oxygen and a solution by acid. 358

There is nothing new about this. It is not even a novel statement of a fundamental electro-chemical truth. In times past, however, we were wont to consider this matter as pertaining solely to the laboratory or to the electroplating industry; now we are forced to see that the reproduction of this experiment on a grand scale is attended with results as disagreeable as they are widespread.

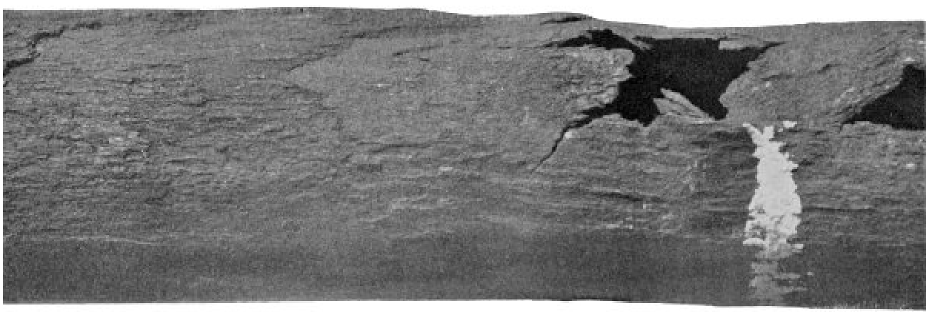
Hidden beneath our highways lie gas pipes, water pipes, railway tracks, Edison tubes, cement-lined iron subway ducts, and lead-covered cables. These are the electrodes. In contact with these conductors is the soil, containing an electrolyzable salt—chloride, nitrate or sulphate of ammonia, potash, soda, or magnesia, generally. In the presence of moisture this soil becomes an electrolyte, or salt solution. In the absence of electricity no appreciable damage occurs; but the passage of an electric current, no matter how small, from one pipe to another is sure, sooner or later, to leave its traces upon the positive conductor in the form of a decay other than mere oxidation. It is to this decay that has been given the name of *electrolysis*; so that when this heading appears in the daily press or in technical journals one may interpret the term popularly as "the electrolytic corrosion of metals buried in the soil."



Copper Drip Pipe after Seventeen Days' Exposure in Salt Water to the Action of Electricity. Half size.

To produce electrolytic disintegration of pipes, etc., on a scale grand enough to cause apprehension, a bountiful source of electricity is essential. Unfortunately, this condition is not lacking to-day in any town in which the usual overhead trolley electric railway is in operation. This system of electric propulsion is based upon the use of a "ground return"—that is to say, the electricity passes out from the power house to the bare trolley wire, thence to the pole on the roof of the car, thence through the motors to the wheels, whence it is expected to return to the power house, *via* the rails.

As a matter of fact, however, the released electricity by no means confines itself to the rails and the copper return feeders—legitimate paths provided for it. It avails itself, on the other hand, of what may be termed, for brevity's sake, the illegitimate return—comprising all underground electrical conductors except the rails and return feeders, and including subterranean water-courses, sewers, and metallic earth veins. 359



Wrought-Iron Service Pipe for Water after One Year's Burial beneath a Trolley Track.

The fibrous appearance of the surface is characteristic of wrought iron and steel.

In the light of our experience of the last eight years, it is easy to identify as electrolysis the effects shown in the accompanying cuts of buried metals that have been actually subjected to a flow of electricity. It is not to be inferred that the destructive action here depicted is universal throughout our towns, but, rather, that the damage occurs in spots, its rate of progress being dependent upon the amount of current and the duration of the flow. Dry, sandy soils tend to keep down the flow of current by interposing a high resistance, so that in such localities electrolytic effects are not as pronounced as in wet, loamy soils. In the same way, the character of the pipe surface—or coating, if there be any—acts as a partial barrier to check the passage of electricity.

Until recently it was generally supposed that cast iron was not attacked—at least not rapidly enough to cause alarm. In Brooklyn the water mains, of very hard, dense, even-grained cast iron, containing alloyed rather 360
than combined carbon, have not been appreciably corroded. At Dayton, Ohio, on the other hand, seventy-seven thousand dollars' worth of damage has already resulted. One peculiarity of electrolyzed cast iron is that the original shape is usually retained, the iron being eaten away and leaving a punky formation of pure or nearly pure graphite. In such a case a superficial examination detects nothing wrong, and it requires a mechanical scraping to show that the strength is not there. For this reason good photographs of cast-iron electrolysis are somewhat hard to obtain.

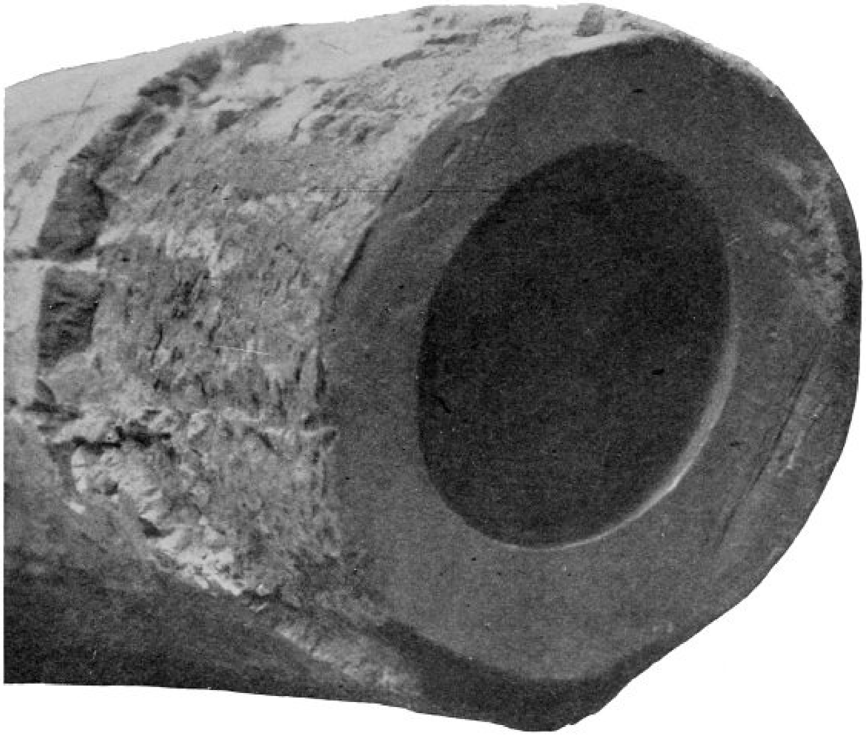
Lead Service Pipe after Eight Months' Burial in Builders' Sand.

The collapsed appearance of the pipe is due entirely to the removal of the lead by electrolysis, the bore retaining its original shape. The dark spot on the upper surface of the pipe is the point of rupture. One third size.

The reason for the comparative immunity of cast iron is not as yet definitely understood. It certainly does not lie particularly in the asphaltic varnish usually applied, for this varnish affords little or no protection when used upon wrought iron or other metals. Nor can it be accounted for by the composition of cast iron itself, inasmuch as a fractured or brightly scraped surface of cast iron shows approximately the same symptoms as other metals when acted upon by a given current for a given time. Whether the iron oxide is the saving feature, or whether the "skin" due to the process of casting acts as an insulator, is not yet settled.

When the trouble first appeared in Boston, in 1891, its cause was promptly identified. The electric-railway construction of those days was so crude, however, that many well-informed electricians fell into the error of assuming that heavier rails, more and larger return feeders, and better bonding (i. e., wire connections from rail to rail, around the joints, designed to decrease the resistance) would prove a panacea for all electrolytic ills. Indeed, this view is still held by a surprisingly large number of men versed in matters electrical.

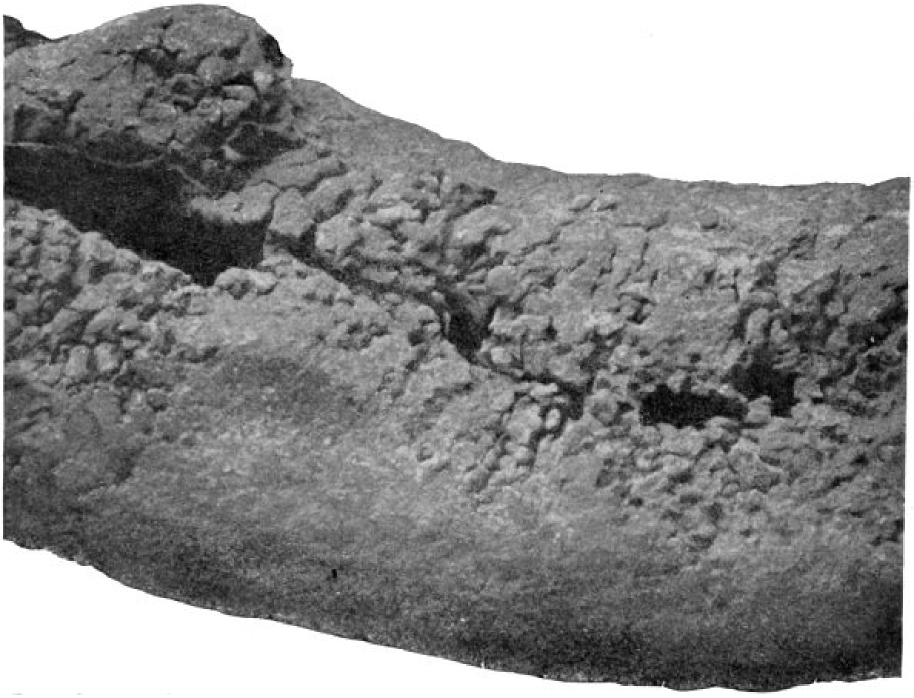
I am of the opinion that it is impossible, from a financial standpoint, to provide so satisfactory a legitimate return that considerable electricity will not seek a path through pipes, cable covers, etc.; for, in order to confine the electric current to the rails, the resistance of the earth and its contained pipes would have to be infinitely great, and this condition can be realized only by making the resistance of the rail infinitely small as compared with that of the earth. The cost of arriving at this condition is prohibitive, and the improved track return is, and 361
always must be, a palliative merely, not a cure.



Lead Service Pipe showing the Effects of Eight Months' Electrolytic Action, and clearly illustrating the Fact that Damage occurs only where the Electricity leaves the Conductor. The interior surface is unattacked.

Assuming, then, that under the most favorable character of electric-railway construction some of the current may be expected to stray from the straight and narrow path, it behooves us to consider how it may best be cared for in order that it may not cause electrolysis. Since corrosion of this nature occurs only at those points where electricity *leaves* the metal, one might suppose that the attachment of a conducting wire to the affected part would result in the harmless carrying away of the current. In isolated cases, in small towns, such a plan might accomplish the desired result. It is open to the objection, however, that it in a measure legalizes the conveyance of electricity on conductors other than those designed for the purpose. In larger towns, with more than one power house and with car lines radiating from and circumscribing the business center, the attachment of conducting wires entails a ceaseless disturbance of the electrical equilibrium, curing the evil in spots and developing new danger points. Furthermore, these connections tend to decrease the resistance of the total illegitimate return, thereby tempting a greater flow of electricity along other paths than the rails and track 362 feeders. It has been generally believed that this increased current would develop electrolysis at the ends of the pipes, due to the jumping of the electricity around the presumably high resistance of the joints; and, indeed, many samples of such corrosion are in existence. I have found, however, that it is possible to calk a bell-and-spigot joint in cast-iron pipe in such a manner that the resistance is practically *nil*; and as for wrought iron or steel, the joint resistance may be made as low as we please by fitting the surfaces so carefully that white-leading is unnecessary.

Arguing from the fact that the negative electrode is not attacked, it has been suggested to employ an auxiliary dynamo and a special system of wiring, in order to maintain the pipes, etc., at all times and at all points, negative to the rails. Could this ideal condition be realized, the rails alone would suffer. We can not hope, however, to thus easily solve the problem in towns where the distribution of buried conductors is at all complex.



Lead Service Pipe showing the Irregularity of Electrolytic Action, or what is technically known as "Pitting."

It has been suggested, also, to discourage the flow of electricity along pipes and cable covers by inserting insulating sections of wood or terra cotta. This plan has never been tried on a scale large enough to afford a suitable demonstration of its utility. While it might reasonably be tried on new construction, its application to old work is almost prohibited by the attendant expense. 363

Lead Service Pipe illustrating the Local Effects of Eight Months' Electrolysis.
The other side of this pipe is smooth and clean.

Attacking the problem from a directly opposite standpoint, there seems to be a chance of successfully invoking the aid of some purely chemical method of rendering lead and iron innocuous, electrolytically speaking. If we can obtain an insulating oxide, lacquer, or varnish that will retain its high-resistance properties during the ordinary lifetime of the buried metal, it will be possible to effectually protect pipes and cable coverings by coating them prior to burial. Or, if we can stumble upon an electrolysis-proof alloy, formed by the addition of a few per cent of some foreign metal to the pipe material during manufacture, the buried conductor will need no protection whatever.

But, supposing that we discover this lacquer or this alloy and by such means guard against damage to all new construction, how are we to care for the metals already buried? We can not dig them all up and paint them, neither can we attempt to replace them by the new alloy. I do not see that the state of the art to-day presents any solution of the difficulty, other than the banishment of the single trolley system. None of the electrical remedies (so called) offers more than partial and temporary relief, and the chemical field is just beginning to be explored.

Permit me to state most emphatically that this is not intended as an argument in favor of the abolishment of single trolley systems. Our civilization owes more to them than could be rehearsed in catalogue form within the limits of one issue of this magazine. We have nothing at present that can be employed as a satisfactory substitute for the ordinary electric railway. The underground trolley is a safe substitute, but the great expense of installation renders it available for very few localities. The overhead trolley, with two wires and no ground return, is cumbersome, vexatious, and unsightly. The storage battery is more or less experimental in its nature. 364

The electro-magnetic contact systems, with plates set in the pavement at stated intervals, make no pretense of avoiding electrolytic troubles. The compressed-air motor has yet to receive popular approval.

Lead Service Pipe showing the Depth to which the Pipe has been affected.

In this instance the outer covering consists of a salt of lead, having no strength whatever.

There seems to be a mistaken impression abroad that the railway companies are indifferent to this subject. So far as my experience and information go, this is not the case. They are only too anxious to find a remedy—not, as some electricians have stated, to save their coal-pile, for energy is wasted in forcing the electricity back to the power house, no matter what the path, but because they fear that at some future date the taxpayer, the corporation, and the municipality will band together, present overwhelming bills for damages, and sweep the 365 trolleys off the face of the earth. The instinct of self-preservation, if nothing else, demands that the electric-railway companies should put forth every endeavor to solve the electrolysis problem.

And yet, conservative judgment requires that the railway companies should not take the initiative. It is one of boyhood's maxims not to shoot arrows at a hornet's nest unless one has mud handy to apply to the subsequently afflicted part. Thus it happens that the railway company remains apparently inactive, bearing the burden of public condemnation, while we, whose lethargy is responsible for failing pipes, read electrolysis articles in the daily press and wonder how soon the impending catastrophe is likely to occur.

This condition of affairs is deplorable; for, while we may not care how extensively or how frequently the city authorities or the private corporations are obliged to renew their underground metals, we are at least vitally concerned as to whether the stray electricity is endangering our steel office buildings, our bridges, our water supply, our immunity from conflagrations, and the safety of the hundred and one appliances that go to make up our modern civilization.

Are the Brooklyn Bridge anchor plates going to pieces, or are they not? Are the elevated railroad structures about to fall apart, or are they not? The consulting electrical engineer says "Yes," the railway man says "No." The municipal authorities say nothing. "When doctors disagree——"

I deem it doubly unfortunate that so much valuable brain energy has been inefficiently expended in the discussion of electrolysis. Each writer has viewed it from his own standpoint. Electrical literature has acquired in this way a series of views, interesting and instructive, but also bewildering. There is no composite view, such as might be obtained from the report of a commission composed of a technical representative of each of the interests affected. So far as I am able to learn, such a commission has never existed.

A curious coincidence of superstitions, illustrating anew how all men are kin, is exemplified in the native belief, mentioned in Mrs. R. Langloh Perkins's book of More Australian Legendary Tales, that any child who touches one of the brilliant fungi growing on dead trees—which are called "devil's bread"—will be spirited away by ghosts. An English reviewer of the book remembers having been dragged away from a fungus of this kind for the same reason. In the north of England children used to be told that, if they touched the dangerous growths, a fungus of the same kind would grow from the tip of every finger.

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WINTER BIRDS IN A CITY PARK.

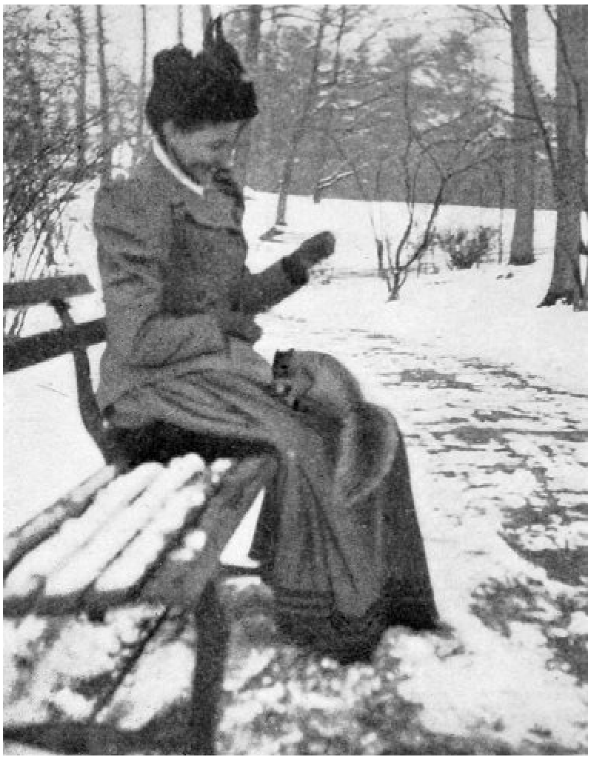
By JAMES B. CARRINGTON.

Most of us are so used to thinking of birds, if we notice them at all, as belonging to spring and summer that we easily fail to see or hear the comparatively few feathered winter visitors. Among these, however, are some of the most attractive and amusing of birds, and to hear their cheery notes and to watch their busy hunt for food on a cold winter day adds a very considerable pleasure to a walk in a city park or the near-by woods. In New York city bird lovers have learned that Central Park is one of the very best places in which to watch birds both summer and winter. There is room enough there and the conditions are varied enough to offer congenial dwelling places for nearly all of the better-known birds. In the spring and fall the beautiful and tiny migrating wood warblers find the park a good feeding ground, and a safe place wherein to linger for a brief time on their journeys north and south.

Mr. Chickadee taking Observations.

With the approach of winter the innumerable fat and saucy robins that have hunted angleworms and strutted about the lawns of the park since early spring disappear, except for an occasional hardy fellow who perhaps prefers the dangers of a northern winter to those of the long journey southward. The wood- and the hermit-thrush; the veery, or Wilson's thrush; the yellow warbler, so abundant and so musical; the perky little redstart, whose song of "Sweet, sweet, sweeter" closely resembles the yellow warbler's; the somber-colored blackbirds; the Baltimore and the orchard oriole; the scarlet tanager; the catbird; Phœbe; Jenny Wren; the tiny chipping sparrow; the vireos; and many other familiar warm-weather friends have also journeyed southward. 367

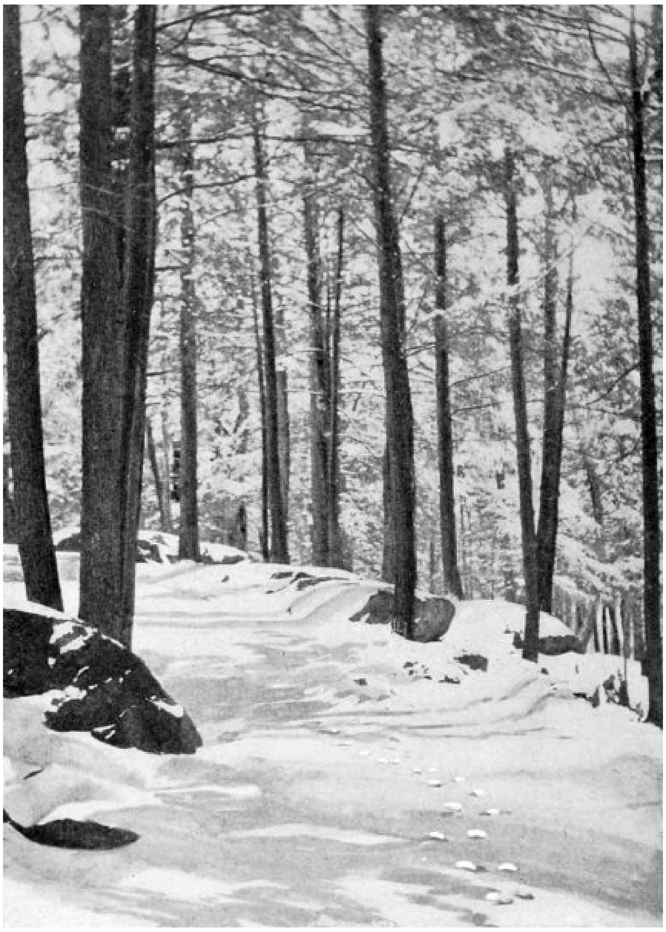
The bare trees and the ground brown with fallen leaves have to some a bleak and dreary look, but this is because a wrong impression has gone abroad concerning them. Nature in winter is not dead, not even sleeping; she is all the time storing up energy to enable her to greet the returning sun in her very best dress. If you will look carefully at the bare limbs and branches of the trees and bushes, you will see the little buds that are slowly but surely swelling up with the pride of young, active, vigorous life, only waiting, with the great patience of Nature, for the proper and suitable time to break away from their winter retirement and take up their part in the new year.



Getting Acquainted.

Some of the pleasantest days I have ever known in the open have been spent in the winter woods, when the snow was on the ground and everything *seemed* still and unfamiliar. Every little sound is accented on a cold day, and the creaking of a swaying limb or the note of a bird comes to you with almost startling distinctness. Somehow you feel on such days that you are more a part of the things about you than in the full flush of summer. It is like meeting people stripped of all the artificial distinctions of clothes and position.

There is something fine in the way the trees stand up in winter; no one can fail to understand what is meant by the “sturdy oak.” They seem to feel pretty much as you do, and show a spirit of vigorous resistance and power to enjoy and cope with the worst that Jack Frost can bring, and the bright sun sends the sap tingling through their limbs just as it does the blood through yours. One day especially that I remember in Central Park brought me a somewhat novel experience, and gave me the privilege of transferring some old bird acquaintance to the list of my bird friends. It was after a fall of snow, and the air was crisp and sharp, indeed it was nipping, and standing still was a chilly occupation. From long familiarity I knew just about where to go to find certain birds, and I was not disappointed in my hunt. My overcoat pocket, it is needless to say, was fully stocked with peanuts and a box of bird seed, and demands were very soon made upon the peanut supply by the fat and friendly gray squirrels that come bravely up to your hand to be fed. They have a most attractive and appealing way of approaching you. The more timid ones stop often to sit up inquiringly, and put one hand on their heart, as if to stop its excited beating.



The Silent Winter Woods.

The first birds I saw were the rugged and noisy English sparrows, written down in most bird books as “pests,” but I confess I could not resist giving them a crumb or two, for they appeal to my sympathies much as the plucky little *gamin* newsboys of the streets do, and then, too, I have learned that their loud chatter and rush for food attract more desirable acquaintances. I soon heard the sharp, shrill peep of the white-throated sparrows, and listened to their scratching “with both feet” under the bushes. Now and then one would try his throat with his full song, two sweet whistles followed by very plain calls for “Peabody, peabody, peabody.” They are called the peabody bird by many. There is no mistaking this beautiful sparrow. Among a bunch of his noisy English neighbors the rich brown of his feathers is easily seen, and the three white stripes on his head and the white patch on the throat attract your eye at once. In a group of thirty or forty whitethroats that were feeding on my bird seed I noticed also two plump song sparrows. They are brown, too, but smaller than the whitethroats, and their breasts are streaked with dark-brown stripes, with a spot right in the center. This is the sparrow that makes music for us from very early spring until late in the autumn. I have heard them in February, with the snow yet on the ground, perched on the tip of some bush and singing away with a joyfulness that made everything take on a more cheerful look. While I was watching the whitethroats I heard the jolly little song that I especially hoped for, and very soon had a near view of wee Mr. Chickadee himself, with his jet-black head, throat, and chin, and gray cheeks. He, in company with several of his friends, came down to feed at once, and hopped about my feet and a near-by bench to pick up the bits of peanut I had dropped for his benefit. The chickadees are always “chummy” little birds, and seem to have found their human acquaintances in general pretty good sort of people. After a time I put some peanut crumbs in my hand and held it out invitingly. The chickadees would alight on the tree over my head, sing their song, look down inquiringly, and then fly off, apparently interested in searching for some important business they had overlooked on the bark of another tree. Gradually, however, one became more familiar and finally lighted on my hand with entire confidence, selected the largest piece of peanut to be had, and flew away to eat it. He held the bit between both feet on a bench, and leaned forward and pecked away until it disappeared. Occasionally he would hold a small piece in one foot only. One little fellow stopped to sing me his Chick-a-dee-dee-dee, as he perched on my little finger, before selecting his morsel. They followed me about the paths, and wherever I stopped there were sure to be several chickadees peeping about the tree trunks asking me to please give them more peanuts. While this was going on I heard a hoarse “Quank, quank, quank!” that sounded very near, and on looking up saw a white-breasted nuthatch, a blue-gray bird with a very distinct black band on the top of his head that extends back across his shoulders. His short tail and legs make him look very funny when on the ground. On a tree, however, he is a regular circus, walking head up or head down on the limbs and trunk, and now and then doing the giant swing, completely circling some twig, just to show what he can do when he tries. He was attracted by the noise and conduct of the chickadees, his winter companions, and was calling for something for himself. His long, slim bill is not made for cracking things as the sparrows can with their short, strong bills, but he punches holes in them very much as the woodpeckers do. When he came down to the path and picked up a peanut he flew off to a near-by tree and hunted up and down until he found a place in the bark where he could wedge the nut in and then proceeded to hatch or crack it into bits to suit his taste. A brown creeper was walking up his tree a short distance away very much as the nuthatch does, poking his long, curved bill into the bark, though I did not see him for some time, as his brown and gray feathers were so like the color of the tree on which he walked. He

circles round the trunk or limb, and you have to keep a sharp lookout to get more than an occasional rapid glance at him. A loud rapping and a noise that sounded a good deal like a giggle attracted my attention to a downy black-and-white woodpecker, with a bright-red spot on the back of his head. He was hammering away with all his might, and the limb on which he hung, back down, fairly rattled as he drove his chisel-like bill into the wood. Another woodpecker, the big and beautifully marked flicker, with his brown back barred with black, his spotted breast with its big black crescent and the red band on the back of his head, stopped for a minute or two on a tree a hundred feet away. His cry of alarm rang out shrilly as he flew away. All of these birds are handsomely marked, though none of them compare, in the mere matter of color, with some of the many beautiful summer species. There was one bird there that day, though, whose brilliant plumage and altogether tropical aspect comes as a great surprise to the unaccustomed visitor to the park in winter. As he lighted on the snow-covered ground among a group of feeding whitethroats the cardinal, with his splendid crest, stood out like a jet of flame, and the black spot at the base of his bill only made the rest of him seem the brighter. Mr. and Mrs. Cardinal spend their winters regularly in Central Park, and I hear or see them every time I go there. His 371
only note now is a sharp squeak of alarm, but a little later he will perch high up in some tree near the lake and awake the echoes with his loud whistling. High over my head, mere specks of shining white against the blue-gray of the sky, I could see several gulls floating along on their way to the reservoir, where hundreds of them often gather in the open water that is usually found in the center. As I walked toward the entrance of the park, on my way to the car, I heard, on some cedars near the border of the lake, the gurgling music of a party of goldfinches. They had on their winter coats of yellowish brown, but their song and dipping flight made them easily recognizable.

Once you become acquainted with a few birds, every flutter of a wing or cheep or peep becomes an object of interest and a motive for many days in the open. It is very easy also to sentimentalize about Nature and to assume a patronizing air toward her, but the more you know of her and her ways the sooner you get over this. You can not help being impressed with the fact that the life and ways of the animals and birds are, after all, in many ways very like your own. Birds, you will find, are very human indeed, and show a wide diversity in disposition and habit. There is one thing sure to follow an interest of this kind, and that is a greater respect and care for wild life. The cruelty of egg-collecting and the wanton destruction of birds for millinery purposes are becoming less tolerable every year in civilized communities.

OLD RATTLER AND THE KING SNAKE.

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

“I only know thee humble, bold,
Haughty, with miseries untold,
And the old curse that left thee cold,
And drove thee ever to the sun
On blistering rocks....
Thou whose fame
Searchest the grass with tongue of flame,
Making all creatures seem thy game,
When the whole woods before thee run,
Asked but—when all is said and done—
To lie, untrodden, in the sun!”—Bret Harte.

Old Rattler was a snake, of course, and he lived in the King’s River Cañon, high up and down deep in the mountains of California.

He had a hole behind and below a large, flat granite rock, not far from the river, and he called it his home; for in it he slept all night and all winter, but when the sun came back in the spring and took the frost out of the 372
air and the rocks, then he crawled out to lie until he got warm. The stream was clear and swift in the cañon, the waterfalls sang in the side gulch of Roaring River, the wind rustled in the long needles of the yellow pines, and the birds called to their mates in the branches. But Old Rattler did not care for such things. He was just a snake, you know, and his neighbors did not think him a good snake at that, for he was surly and silent, and his big, three-cornered, “coffin-shaped” head, set on a slim, flat neck, was very ugly to see. But when he opened his mouth he was uglier still, for in his upper jaw he had two long fangs, and each one was filled with deadly poison. His vicious old head was covered with gray and wrinkled scales, and his black, beadlike eyes snapped when he opened his mouth to find out whether his fangs were both in working order.

Old Rattler was pretty stiff when he first came from his hole on the morning of this story. He had lain all night coiled up like a rope among the rocks, and his tail felt very cold. But the glad sun warmed the cockles of his heart, and in an hour or two he became limber, and this made him happy in his snaky fashion. But, being warm, he began to be hungry, for it had been a whole month since he had eaten anything. When the first new moon of August came, his skin loosened everywhere and slipped down over his eyes like a veil, so that he could see nothing about him, and could not hunt for frogs by the river nor for chipmunks among the trees. But with the new moon of September all this was over. The rusty brown old coat was changed for a new suit of gray and black, and the diamond-shaped checkers all over it were clean and shiny as a set of new clothes ought to be.

There was a little striped chipmunk running up and down the sugar-pine tree over his head, pursing his little mouth and throwing himself into pretty attitudes, as though he were the center of an admiring audience, and Old Rattler kept a steady eye on him. But he was in no hurry about it all. He must first get the kinks out of his neck, and the cold cramps from his tail. There was an old curse on his family, so the other beasts had heard, that kept him always cold, and his tail was the coldest part of all. So he shook it a little, just to show that it was growing limber, and the bone clappers on the end rustled with a sharp, angry noise. Fifteen rattles he had in all —fifteen and a button—and to have so many showed that he was no common member of his hated family. Then he shook his tail again, and more sharply. This was to show all the world that he, Old Rattler, was wide awake, and whoever stepped on him would better look out. Then all the big beasts and little beasts who heard the noise fled away just as fast as ever they could; and to run away was the best thing they could do, for when Old Rattler 373
struck one of them with his fangs all was over with him. So there were many in the cañon, beasts and birds and snakes too, who hated Old Rattler, but only a few dared face him. And one of these was Glittershield,[B] whom men call the King of Snakes, and in a minute I shall tell you why.

[B] *Lampropeltis zonatus.*

And when Old Rattler was doing all that I have said, the King Snake lay low on a bed of pine needles, behind a bunch of fern, and watched with keen, sharp eye. The angry buzz of Rattler’s tail, which scared the chipmunks and the bullfrogs and all the rest of the beast folk, was music for Glittershield. He was a snake too, and snakes understand some things better than any of the rest of us.

Glittershield was slim and wiry in his body, as long as Old Rattler himself, but not so large around. His coat was smooth and glossy, not rough and wrinkly like Old Rattler’s, and his upraised head was small and pretty—for a snake. He was the best dressed of all his kind, and he looked his finest as he faced Old Rattler. His head was shiny black, his throat and neck as white as milk, while all down his body to the end of his tail he was painted with rings, first white, then black, then crimson, and every ring was bright as if it had just been freshly polished that very day.

So the King Snake passed the sheltering fern and came right up to Old Rattler. Rattler opened his sleepy eyes, threw himself on guard with a snap and a buzz, and shook his bony clappers savagely. But the King of Snakes was not afraid. Every snake has a weak spot somewhere, and that is the place to strike him. If he hadn’t a weak spot no one else could live about him, and then perhaps he would starve to death at last. If he had not some strong points, where no one could harm him, he couldn’t live himself.

As the black crest rose, Old Rattler’s tail grew cold, his head dropped, his mouth closed, he straightened out his coil, and staggered helplessly toward his hole.

This was the chance for Glittershield. With a dash so swift that all the rings on his body—red, white, and black—melted into one purple flash, he seized Old Rattler by his throat. He carried no weapons, to be sure. He had neither fangs nor venom. He won his victories by force and dash, not by mean advantage. He was quick and strong, and his little hooked teeth held like the claws of a hawk. Old Rattler closed his mouth because he couldn't help it, and the fangs he could not use were folded back against the roof of his jaw.

The King Snake leaped forward, wound his body in a "love-knot" around Old Rattler's neck, took a "half- 374
hitch" with his tail about the stomach, while the rest of his body lay in a curve like the letter S between the two knots. Then all he had to do was to stiffen up his muscles, and Old Rattler's backbone was snapped off at the neck.

All that remained to Glittershield was to swallow his enemy. First he rubbed his lips all over the body, from the head to the tail, till it was slippery with slime. Then he opened his mouth very wide, with a huge snaky yawn, and face to face he began on Old Rattler. The ugly head was hard to manage, but, after much straining, he clasped his jaws around it, and the venom trickled down his throat like some fiery sauce. Slowly head and neck and body disappeared, and the tail wriggled despairingly, for the tail of the snake folk can not die till sundown, and when it went at last the fifteen rattles and the button were keeping up an angry buzz. And all night long the King of Snakes, twice as big as he ought to be, lay gorged and motionless upon Old Rattler's rock.

And in the morning the little chipmunk ran out on a limb above him, pursed up his lips, and made all kinds of faces, as much as to say, "I did all this, and the whole world was watching while I did it."

REMARKABLE VOLCANIC ERUPTIONS IN THE PHILIPPINES.

By R. L. PACKARD.

Every one knows that the Philippine archipelago, like other regions in its neighborhood, abounds in volcanoes, some of which are still active, while the majority are extinct. Some geologists have tried to distribute the Philippine volcanoes into two parallel belts or lines running in a general northwest and southeast direction, following the trend of the island group, and extending from the southern end of Mindanao to the northern part of Luzon—some sixteen degrees of latitude. Early, possibly prehistoric, volcanic activity in the group has left its imprint upon the native mythology, as was the case in the Mediterranean, and an explanation of some of the mythical stories is to be found in earth movements. The Spaniards have given accounts of many eruptions in the last three hundred years, which were remarkable either from the destruction they caused or the terror they inspired. Some of these accounts were written by the terrified eyewitnesses themselves, such as the monks in 375
charge of parishes where the greatest damage was done, and are sufficiently vivid, however much they may lack of what would now be called "scientific" accuracy.

Probably the most remarkable volcanic outburst in historical times, on account of the distance apart of the simultaneous eruptions, although its intensity might not be regarded as great when compared with that of Krakatoa, was that of January 4, 1641, when a volcano on the southeastern extremity of Mindanao, another on the northern coast of the island of Sulu to the west, and a third in Luzon far to the north, became active at the same time. A translation of the original Spanish report of this extraordinary phenomenon, which is extremely rare and practically inaccessible to students, is given in Jagor's *Reisen in den Philippinen*. From this it appears that upon two occasions, toward the end of December, 1640, volcanic ashes fell at Zamboanga (on the southwest coast of Mindanao) and covered the fields like a light frost. On January 1, 1641, the auxiliary fleet carrying troops from Manila to the island of Ternate was off Zamboanga, and on the 3d, at about 7 P. M., people in the latter place heard what they supposed was artillery and musketry firing at some miles' distance. Believing that an enemy was attacking the coast, preparations were made to meet him, and the commander of the galleys sent a boat out to see if any of the vessels of the fleet needed assistance, but the boat returned without finding the fleet.

On the next day, January 4, 1641, at about 9 A. M., the noise of the supposed cannonading increased to such an extent that it was feared in Zamboanga that the Spanish fleet had been attacked by the Dutch, with whom the Spaniards were then at war. This noise lasted about half an hour, when it became evident that it was not caused by artillery, but proceeded from the outbreak of a volcano, for, toward noon, thick darkness began to spread over the sky to the south, which soon covered that part of the heavens and gradually spread over the whole sky, so that by 1 P. M. it was as dark as night, and by 2 P. M. the darkness had so increased that one could not distinguish objects a short distance off. Candles were lighted, and a great fear fell upon the people, who fled to the churches to pray and confess. This darkness, during which no light was visible in the whole horizon, lasted until 2 A. M., when the moon became visible, to the great joy of both Spaniards and Indians, who were afraid of being buried beneath the ashes which had been falling since 2 P. M. The fleet, which was then passing the southern end of Mindanao, was thrown into confusion by the tumult of the elements, and was in darkness earlier than Zamboanga—viz., at 10 A. M.—because it was nearer the volcano. The darkness was so intense that 376
the crews believed the last day had come, and the vessels were endangered by the heavy shower of stones, ashes, and earth which fell upon them and which the men hastened to throw overboard. The ships' lanterns were lighted as at night. The volcano could be seen, at a considerable distance, throwing up columns of flame which, on descending, set the neighboring woods on fire. The darkness covered the greater part of Mindanao, which is a very large island, and the ashes were carried to Cebu, Panay, and other islands, and there was an especially heavy fall on the island of Jolo (Sulu), which is more than forty leagues west by south from the southeast point of Mindanao, where the volcano burst out. On this island, on account of the darkness and the general uproar, the source of the ashes which fell there was not known at the time, but when it became light enough to see it was found that at the same time with the eruption on Mindanao a second volcano had burst out upon a small island which lies off the mouth of the principal river of Sulu. There the earth had opened with a violent commotion, and had vomited out flames mingled with trees and huge stones. So great was the disturbance that the sea bottom was mingled with the interior of the earth, and the volcano threw out quantities of shells and other things that grow upon the bottom of the sea. The mouth of this volcano remained open afterward. It was very broad, and the eruption had burned up everything upon the island. But what excited the greatest amazement was that a third volcano broke out on the same day and hour with the two just mentioned, in the province of Ilocos, in Luzon, and at least six hundred miles north; and this volcano ejected water. The outbreak was preceded by a violent storm and earthquake. The earth swallowed up three mountains, on the sides of one of which were three villages. All three mountains were torn from their foundations and blown into the air, together with a vast amount of water, and the chasm which took their place formed a broad lake, that showed no trace of the mountains which had stood on the spot. The letter from which the foregoing account is taken goes on to say that the noise of this outbreak, which occurred between 9 and 10 A. M., was heard not only in Manila but in all the Philippine Islands and the Moluccas. It even reached the mainland of Asia in the kingdoms of Cochin China, Champa, and Cambodia, as was learned from priests and others who came to Manila from those countries afterward. The noise sounded like heavy artillery and musketry fire at two or three leagues' distance. In Manila it was supposed that the firing was going on in Cavite, while at Cavite it was referred to Manila, and messengers were sent from one place to the other to make inquiries, and a similar 377
impression prevailed in all the islands, cities, and villages in a circuit of nine hundred leagues, within which the noise was heard. Malacca was taken by the Dutch on the 13th of January, and was already hard pressed on the 4th, and many pious Spaniards believed, after the news had come of the capture of the place, that Heaven had taken this volcanic means of warning them of the great injury which would result to the archipelago from the loss of so important a city.

The missionaries in Cochin China gave January 5th as the date of the outbreak, instead of the 4th, there being one day's difference between the reckoning of the Portuguese, who sailed from west to east, and that of the Spaniards, who sailed from east to west, to their Eastern possessions.

The volcano of Mayon, or Albay, in the province of Camarines, has been in frequent eruption from 1616 down to within thirty years. Some of the eruptions were very destructive to life and property. After an activity in July, 1766, of six days’ duration, accompanied by a great flow of lava, on October 23, 1766, during a violent storm, which began at about 7 P. M. from north-northwest and at 3 A. M. suddenly veered to the south and blew down all the houses of one of the villages in the neighborhood, the volcano ejected such a vast quantity of water that several torrents of thirty varas (ninety feet) wide ran down to the sea between the villages Tibog and Albay. Between Bacacay and Malinao the floods were over eighty varas (two hundred and forty feet) wide, and the highways were obliterated. One village was entirely destroyed, nearly all the houses of the region were swept away, and the fields were covered with sand; another village was partly destroyed, its remainder forming an island, or rather a hill, surrounded by deep, broad ravines, through which the stream of sand and water ran. In another place palms and other trees were buried in sand to their tops. Some fifty persons lost their lives. As far as could be judged, the account declares, this [cold?] water came from the interior of the volcano, while we should be inclined to regard it as a cloudburst. The outbreak of February 1, 1814, however, was the most destructive of all. An eyewitness writes that at about 8 A. M. the mountain suddenly threw out a thick column of stones, sand, and ashes, which quickly rose to the highest layers of the air. The sides of the volcano became veiled and disappeared from the view of the spectators, while a stream of fire ran down the mountain and threatened to annihilate them. Every one fled to the highest attainable point for safety, while the roar of the volcano struck terror into all. The darkness increased, and many of the fleeing ones were struck down by the 378
falling stones. Houses afforded no protection, because the red-hot stones set them on fire, and the most flourishing villages of the Camarines were thus laid in ashes. Toward 10 A. M. the rain of stones ceased, and was replaced by one of sand, and at about 2 P. M. the noise had lessened and the sky began to clear. Twelve thousand persons were killed and many wounded by this eruption. After the mountain had become quiet it presented a frightful appearance, its former picturesque, highly cultivated slopes being covered with barren sand, which enveloped the cocoanut trees to their tops, and some one hundred and twenty feet of its summit had been carried away during the eruption. An enormous opening had been formed on its southern side, near which three other mouths appeared, which continued to emit ashes and smoke. The finest villages of the Camarines were destroyed, and the best part of the province was converted into a sandy waste.

This mountain has been active at short intervals down to the present time. Sometimes its activity has been continuous for a year or more. Its eruptions were frequently accompanied by earthquakes and storms. The next outbreak after that described above was in 1827. In 1834 and 1835 the mountain was active nearly all the time. There was no eruption of ashes, but every night a stream of molten lava could be seen running into the higher ravines. In 1845 there was an eruption of ashes which lasted several days; a violent eruption occurred in 1846, two unimportant ones in 1851, and another violent ash and stone eruption occurred on July 27, 1853, during which thirty-one persons were killed. Others occurred in 1855, 1857, 1858, 1859, 1860, 1865, and 1871. The heights of the Philippine volcanoes vary from ten thousand and nine thousand feet (Albay or Mayon) down to Taal, only seven hundred and eighty feet high. This curious volcano is upon an islet in the middle of Lake Bombon, south of Manila. Lake Bombon was originally probably a vast crater. It is separated from the China Sea by a narrow isthmus. Taal contains secondary craters, crevasses emitting vapors, and lakelets of acid water. It is the principal “show” volcano of the islands, and was in action in 1885, when all the vegetation upon the island was burned up. Lake Bombon was doubtless formerly connected with the sea, the intervening barrier being formed of eruptive *scoriæ*. Its water is still saline, and its marine fauna has adapted itself to its modified environment.

On the small island Camiguin, on the northwest coast of Mindanao, is the extinct volcano Catarman, with a crater lake upon its summit whose level has been subject to great fluctuations. Sometimes the lake dried up, 379
and again it has overflowed and inundated the low lands in the neighborhood, as in 1827 and 1862. Often its water has been set boiling by escaping gases. It would be interesting to know what varying pressure caused the changes in the level of this lake on the top of Mount Catarman.

A further idea of the volcanic activity of this region may be gained from the circumstance that a volcanic island emerged from the sea on the north coast of Luzon in 1856, which grew to seven hundred feet in height by 1860, and is now about eight hundred feet high. Every one has seen photographs of the streets of Manila after an earthquake, which form of subterranean activity is so common that it is taken into account in building.

THE SCAVENGERS OF THE BODY.

By M. A. DASTRE.

The labors of M. Metchnikoff have made known one of the most curious mechanisms—perhaps the most effective—which Nature employs to protect the organism against the invasion and ravages of microbes. We are only beginning to learn the means which are provided for our defense against the countless swarms of enemies of this class, some of them exceedingly dangerous, among which we have to live and move. In the first rank of these defenses is phagocytosis. The struggle of the organism against its minute assailants is an image of human wars. The cutaneous or mucous integument, continuous over the whole body, constitutes a kind of fortified inclosure which the microbe can not penetrate, except where some breach has been made. On one side of that wall, in the living city, the phagocytes or leucocytes (white cells) form an immense defensive army in a state of continual mobilization, or, as M. Duclaux would say, an innumerable and vigilant police.

These phagocytes or leucocytes are the nomadic elements of our economy. The animal body may be compared to an organized city in which all the living corpuscles, all the cellular elements, are sedentary, each having its place and staying there. Hence the comparison, often made, with the stones of a building, which is not exact, however, because these vital elements grow and increase, enlarging the structure without change of arrangement, while the stones do not. The growth and nutrition of these anatomical elements, it should be added, are carried on exclusively at the expense of liquid matters. Nothing solid can enter them or come out from them.

An exception to these two fundamental rules is found in the single case of the leucocytes or white globules of 380
the blood. They have no fixed or determined place in the organism. Besides being carried passively by the flow of the blood in a perpetual circulation along with the red corpuscles, they possess a motion of their own. They can swim in the current that carries them, fix themselves to the walls, and travel in a sort of creeping way, which has been called the amœboid motion.

They are also exceptions to the second law, according to which living cells can dispose only of liquefied matters. All solid bodies that pass within reach of the leucocytes are seized and incorporated by them, provided they are small or inert enough to be enveloped. The nature of the body is of little import. Whatever it may be, it is swallowed and quickly inclosed within the mass of the leucocyte and submitted to the dissolving action of its juices—or, in a way, eaten. Hence the names “phagocyte,” or devouring cell, given to the enveloping white globule, and “phagocytosis” to the process. No other element of the organism, or hardly any other, possesses this singular faculty of seizure and swallowing (*inglobement*).

All the other characteristics of the white globules flow from these two of mobility and phagocytism, the significance of which has been set in a clear light by M. Metchnikoff. These characteristics are the attributes of the most primitive types of animal life. They appertain to cells not yet differentiated, to the unicellular organisms which occupy the first stages of life. They translate the vital energy of elements still independent and isolated, without definite place in the social organization and as yet without special high function, but for that very reason better adapted to the needs of the simplest animality. Their voracity is useful for the preservation of the social organism. By eliminating old, exhausted, diseased cells they rejuvenate the structure and prepare the way for new generations. And when the fecundity of these is exhausted the leucocytes come in to occupy the vacated situations, and conduct the organism thus patched up through a senile degeneracy to natural death.

The leucocytes, white globules, or phagocytes, by virtue of their mobility, are found everywhere—in the blood, in all the organs, and in all parts of the body—but are perhaps most abundant in the blood. The study of them proceeds slowly, and we are still engaged in distinguishing the varieties among them. The most abundant and best known of them—those which answer most closely the description we have given—are those called the polynuclear, neutrophilous leucocytes. They are colored with neutral hues, and have a nucleus like a rolled-up
scroll in structure. Other varieties—the eosinophiles, lymphocytes, etc.—are less mobile and have still less 381
marked phagocytic properties.

The roll-call of the phagocytic army would be a long task. The phagocytes are numerous in the sanguineous fluid, but are still six hundred and fifty times less so than the red corpuscles. They are almost as numerous in the lymph and the conjunctival tissue, where, besides occurring in their normal condition, they sport into a variety which appears to have abandoned its migratory habit, for a time at least, and into a giant variety one hundred times larger than the ordinary leucocytes, which M. Ranvier calls clasmatocytes. They are further found in such tissues as the skin and the mucous membrane, where, notwithstanding the cells are so crowded, they make their way into the intestine, and, by a sort of diapedesis (passage through the pores or interstices) called the phenomenon of Stoehr, toward all the free surfaces, whither exterior soluble substances invite them. As they go they destroy the microbes which, advancing in an inverse direction, would invade the organism and provoke an infection of intestinal origin.

The fact that this immense army of phagocytes is always in motion was first clearly recognized by Cohnheim, in 1867. He saw, in inflamed regions, where the vessels are gorged and distended, the white globules thrusting out a prolongation which seemed to pierce the wall, but in reality simply insinuated itself between its elements, and elongating itself, drew its entire body, as it were, through the narrow channel. This emigration, which is produced without making a break, through the pores and interstices of the vascular wall, has been designated *diapedesis*. It is ordinarily provoked by some foreign body, a pathogenic microbe, for instance, which has introduced itself into the place and spread its irritating secretion or cause of infection there. The phagocytes, attracted from the interior of the vessel, come up and devour the invader. But if they are incapable of dissolving it they bear it away to work their own ruin; they degenerate in their turn, become transformed into globules of pus, and the inflammation results in purulence. The study of the mechanism by means of which the leucocytes traverse the tissues is very interesting.

These remarkable wandering elements are found in all classes of animals, and in all present the same

essential characteristics. They are more like free existences than the other cells living in society which compose the bodies of animals, and their history is substantially like that of the naked one-celled organisms. Their various functions and properties are of the highest interest in all departments of physiology. It has been demonstrated, in particular, that the white globules of the blood give rise to the most energetic and most 382
special agencies of living chemistry, to the ferments which determine the coagulation of the blood when drawn from the vessels (coagulating ferment, or thrombosis) and the consumption of sugar (glycolytic ferment), and to numerous diastases. The presence of nuclein in their bodies involves consequences which we are only beginning to perceive.

Behaving like independent beings, the leucocytes or phagocytes perform similar functions with those of the highest animals, feeding, respiring, and reproducing themselves; they move and feel—that is, are impressed by internal excitants. These operations, however, assume with them a character of extreme simplicity. They seem to be the direct result of the physical and chemical properties of the protoplasm that composes them, so that the mysterious side of those vital functions nearly vanishes when we scan them in these their very beginnings. Their respiration is the effect of a sort of affinity between their substance and the vital gas—a chimiotactism directing them toward oxygen. This may be illustrated by forming a microscopic preparation of fresh lymph, imprisoning a few bubbles of air, and sealing it hermetically with paraffin. After two or three hours we can see the leucocytes grouped around the bubbles. When the provision of air is exhausted, several hours afterward, the leucocytes will cease to move and become inert. On inserting a needle, the contact of the air revives them.

The faculty possessed by the leucocytes of seizing solid corpuscles coming in contact with them, inglobing them, and absorbing them, or, as M. Metchnikoff calls it, intracellular digestion or phagocytosis, is easily observed. If we mix fine granulations of carmine or cinnabar, mingled with slightly salted water, with a drop of lymph, we can see the coloring matter penetrating the leucocytary protoplasmic mass, which is soon stuffed with it. The anatomo-pathologists had already observed, in tattooed subjects, white globules charged with grains of charcoal or vermilion. It is legitimate to conclude that some parts of the coloring matter that had been introduced under the epidermis had been taken up by the white globules. This proceeding has been observed in the very act by M. Metchnikoff.

A classic experiment illustrating this operation is now common in our laboratories, and the fact of phagocytosis has come to be regarded as incontestable.

The generality of the phenomenon results from the leucocyte preserving its phagocytic faculty in all its peregrinations, and these peregrinations are unlimited. The tendency of the nomadic elements to push on and insinuate themselves into the finest interstices and the narrowest passages is a rudiment of a tactile sense, to 383
this extent simply a physical phenomenon, which MM. Mascart and Bordet have clearly distinguished. As soon as a leucocyte touches a resisting body it reacts to the contact by applying the largest possible surface to it. It spreads out, becomes thin, stretches itself along, and ceases deforming itself only after it has obtained the maximum of contact. By such mechanism it penetrates objects that offer it any breach and overcomes them. When the foreign body has been disaggregated into fragments, into small enough grains, phagocytosis intervenes and disposes of the remains. In this way the organism sometimes rids itself of splinters of bone that remain in the tissues after a fracture. So, too, the leucocytes, when occasion arises, repair the blunders of surgeons by extracting and absorbing forgotten objects left in wounds, while at other times they act as auxiliaries by destroying things that have been voluntarily abandoned in them, like threads of catgut in buried sutures and drains of decalcified bone.

There are two conditions, under normal circumstances, in which phagocytosis plays a marked part. The first is the case where vital action brings on the destruction of the organs or the tissues, or, to use exact language, their disintegration in a solid form. The wastes of organic activity are usually in liquid form, and, turned into the blood, they are eliminated in that state through the natural emunctories. Sometimes, however, disintegration results in solid wastes, and the phagocytes do the work of carrying them away. This is the case with the red globules of the blood, which, after a longer or shorter career, are deposited in the spleen and break up into *débris*, some of the parts of which are insoluble in the interstitial liquids. The leucocytes collect around these residues so thickly as sometimes to fuse themselves into a solid mass, a sort of plasmodium or giant cell which digests the *débris*. At other times, and more rarely the isolated leucocytes are not able to absorb the incorporated matters. They then conduct them to the surface of the intestine and discharge them there. A like phenomenon occurs in the liver. The coloring matter of the blood frequently gives rise to insoluble ferruginous deposits which the leucocytes have to convey to the digestive tube. This occurs when a wound provokes an effusion of blood and a mortification of the red globules or of the neighboring anatomical elements. All of the waste that can not take the liquid form and pass in that condition into the circulatory passages is incorporated within the phagocytes. The mechanism of resorption of bone does not seem different.

The phagocytes perform a similar function in another process which very frequently takes place in various animals that pass through metamorphoses, as in insects whose organs are transformed in changing from one 384
stage of their existence to another, and in tadpoles which lose their tails in becoming frogs; the old parts that disappear are devoured by phagocytes.

Especially in the case of infectious diseases has the protective part performed by the leucocytary phagocytes been brought into full view by M. Metchnikoff. He has shown that the white globules rush to meet the bacterides of inflammation that are introduced through any wound, absorb them, and render them powerless to do harm. In the lymphatic organs—the spleen, the lymphatic ganglions, and the marrow—the white globules are normally accumulated, and there is where the struggle is most active between the bacterides of inflammation which are swarming in the blood and the defensive agents of the organism. The same takes place with the spirilla of recurrent typhus and the microbe of erysipelas.

The leucocytes are capable of adapting themselves to conditions different from those in which they usually live, provided the change is not too abrupt. It may sometimes occur that the poison secreted by a microbe will paralyze and kill the leucocyte, unless care has been taken, by inoculations of virus, at first attenuated and afterward gradually increasing in virulence, to create an immunity in the phagocyte, to make it refractory to the poison and capable of swallowing the toxic bacterium without suffering from it. Explanations have been sought in this property for the virtue of vaccination and the immunity that results from it, but they are evidently only fragmentary, and there are other theories of immunity.

The leucocytes are not always victorious over the microbes, and when these excel in numbers or force it sometimes comes to pass that they are overcome and succumb. Poisoned by the substance they have incorporated, they undergo a fatty degeneration and become globules of pus. Pus is therefore formed of the cadavers of conquered leucocytes. Although that humor ought, for the good of the system, to be rejected, like every other mortified part, it is nevertheless true that the production of it is a beneficent effort, and a salutary reaction of Nature against the morbid agent.

It will be an enduring honor to the name of M. Metchnikoff that he has revealed the importance of the function of phagocytes, and has enriched science with a large number of new truths. A part of this honor will be reflected upon the Pasteur Institute, which has welcomed the eminent biologist for many years, and has intrusted the direction of one of its services to him. The learned Russian, in creating the study of phagocytism, with its causes, mechanism, and consequences, has opened a very extensive field of research to which we have given only a distant and cursory glance.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

Editor’s Table.

LIBERAL EDUCATION AND DEMOCRACY.

In a most thoughtful article, in the Modern Education Series of The Cosmopolitan, President Hadley, of Yale, remarks that the conception of a liberal education changes as forms of government change. “It takes one shape,” he proceeds to say, “in a military state, and quite another shape in a state ruled by public opinion. In the former case it will teach the sterner virtues of courage and pride. In the latter case it will teach respect for law, progressiveness, and human sympathy. But in either case a liberal education is an education for citizenship; a development of those distinguishing qualities moral, intellectual, and physical by which the people are to be ruled.”

It is a happy definition of “a liberal education” to say that it is “an education for citizenship.” From this point of view the *most* liberally educated man will be he who is educated to be a citizen of the world and to feel his relation not only to the present but to the past, and the future as well. Comte had much the same idea when he taught that the moral and social education of the individual was accomplished first by the family, then by the state, and finally by the race. In other words, the egoism of the individual is first tamed by family life, then broadened by political life, and, lastly, humanized in the full sense by conscious participation in the age-long progress of mankind. President Hadley has well chosen the qualities which he says a liberal education under a democracy should aim at developing, but we think he might with much advantage have added another. He will remember that when the poet Horace would describe the character of a high-principled citizen, a man just and firm of purpose, he says that his mind is shaken neither by the lowering countenance of a tyrant nor by the frenzy of the populace commanding vicious courses of policy. In our land and time the *vultus instantis tyranni* is no longer, if it ever was, an object of terror, but the *civium ardor prava jubentium* is a danger, we fear, which has yet to be reckoned with.

In a state, therefore, which is ruled by public opinion one of the qualities which a liberal education should most distinctly aim to impart is firmness to resist popular pressure when exerted in a wrong direction. In like manner, under an aristocracy a truly liberal education would not be one that would tend to perpetuate in the rising generation the faults of the preceding one, or to shut out all criticism of the established *régime*; on the contrary, its tendency should be to temper whatever was extreme or one-sided in the views of the ruling class. The liberality of an education comes in just here, in opening out wider views than would probably be acquired in actual contact with private business or public affairs. When William Pitt, while Prime Minister of England, betook himself to the study of Adam Smith’s recently published Wealth of Nations, and began to consider how he could apply the enlightened and philosophical views contained therein to the fiscal policy of the British Empire, he was converting his old-fashioned liberal education into a liberal education of the best kind.

A liberal education, let it be thoroughly understood, is not one which delivers over an individual to the 386
dominant influences of his place and time, whatever they may be, but one which enables him to react, when necessary, against such influences under the guidance of wider views and deeper principles. It is an *illiberal* education, let it embrace what it may, which simply equips a man for exploiting for his own benefit the conditions and tendencies which he finds prevailing in the society around him; and too much of what passes for liberal education has, we fear, had no better result. In a country like ours, liable to be swept by gusts of popular excitement, not to say passion, the aim of all higher education should be to create a class of citizens trained for social influence, and yet able to stand on their guard against sensational politics, to distinguish between true and false patriotism, and to uphold the claims of justice and honor when threatened by popular infatuation and tumult. We read in Thucydides that Cleon, the typical demagogue of ancient Athens, did not hesitate to tell his fellow-citizens that republics were not adapted for holding distant territories in subjection. If Cleon was a demagogue, what are we to think of the highly educated men who in our country echo the popular cry for an imperial policy, and say that millions of people beyond sea who ask only for liberty should be compelled by force of arms to be our subjects? Let our colleges and universities see to it that they understand “a liberal education” in the right sense.

EXTERNAL AND INTERNAL AGGRESSION.

Much surprise has been expressed at the unusual prevalence of violence of all kinds in the United States during the past year. It has seemed quite extraordinary that in a nation devoted, as the American nation is, to vast schemes of philanthropy at home and abroad, such atrocious crimes as the mutilation and burning of negroes and the explosion of dynamite under street cars should be committed. From the sympathetic and self-sacrificing spirit manifested in the enthusiastic response to the appeal to arms to free Cuba and Puerto Rico from Spanish cruelty and despotism, and the repression of the insurrection in the Philippine Islands for the purpose of introducing order and civilization, something quite different was expected. There should have been a deeper interest in the welfare of the negro and a greater effort to protect him in the enjoyment of his rights. There should have been created a tie between capital and labor that no differences about wages or hours of toil could have ruptured with murderous animosities. In a word, there should have been a manifestation of fraternal feeling among all classes and in all sections that would have advanced the United States a long step toward the goal of civilization. So general has been the anticipation of these fruits from the war with Spain that one of the most familiar arguments in favor of it has been the subjective regeneration that would follow the attempt at objective regeneration. That is to say, the American people were to find a cure for their own moral disorders in their cure of the moral disorders of their neighbors.

To a student of the social philosophy of Herbert Spencer it will be no surprise nor disappointment that this expectation, so worthy of a generous and self-sacrificing people, has not been and is not likely to be realized. No truth set forth in his works is more firmly established than his profound induction that external aggression always begets internal aggression—that assaults upon the rights of others abroad leads to assaults upon the 387 rights of others at home. “As it is incredible,” he says, “that men should be courageous in the face of foes and cowardly in the face of friends, so it is incredible that other feelings fostered by perpetual conflicts abroad should not come into play at home. We have just seen,” he adds, alluding to the proofs of this truth that he has given, “that with the pursuit of vengeance outside the society there goes the pursuit of vengeance inside the society, and whatever other habits of thought and action constant war necessitates must show their effects on social life at large.” The facts in support of Mr. Spencer’s generalization are to be found in the history of every militant people. He mentions himself the Fijian’s sacrifice of their own people at their cannibal festivals, and the prevalence of assassination among the Turks from the earliest times down to the present. He mentions also the hideous acts of cruelty that are to be found in the records of Greek and Roman civilization. To these examples may be added the atrocities committed by Italians upon Italians during the last days of the mediæval republics, and those committed by Frenchmen upon Frenchmen during the French Revolution. “The victories of the Plantagenets in France,” said Goldwin Smith, pointing out not long ago the futility of war as a cure for national factiousness, “were followed by insurrections and civil wars at home, largely owing to the spirit of violence that the raids in France excited. The victories of Chatham were followed by disgraceful scenes of cabal and faction, as well as corruption, terminating in the prostration of patriotism and the domination of George III and North.”

It is impossible to hope that the United States can be an exception to the social law thus established. However pure the motive that may lie at the bottom of a war of aggression, it can not annul the law. The shedding of blood and the seizure of territory produce a callousness of feeling and a perverted view of the rights of others that are certain to turn the hands striking a foreign foe to the work of domestic strife. Already we have seen with what bitterness such men as Prof. Charles Eliot Norton and Mr. Edward Atkinson have been assailed. We have seen, too, how attempts have been made to discredit the principles of the Declaration of Independence, and to show that the Constitution must not be permitted to stand in the way of what has been politely called the fulfillment of the destiny of the United States. We have seen, finally, how proposals for the disfranchisement of American citizens have been listened to in all parts of the country with a toleration that must cause the old abolitionists to turn in their graves. But the spirit thus manifested has not, we may be sure, failed to contribute to the perpetration of the outrages that have shocked every right-minded observer of current events. It is not a difference of kind but only one of degree that separates the slaughter of Spaniards in Cuba and Tagals in Luzon from the slaughter of negroes in the South and the explosion of dynamite under street cars in the North. The inhuman instincts that impel to the one impel to the other.

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Fragments of Science.

Zola’s Anthropological Traits.—Mr. Arthur MacDonald has published, originally in the Open Court, a minute anthropological study of the personality of Émile Zola. Passing all the physical points noted, we select a few only of the most peculiar mental traits mentioned by the author. Fear is spoken of as Zola’s principal emotion, connected in him with the instinct of self-preservation. He is not much afraid of the bicycle, but shrinks from a ride through a forest at night. He has no fear of being buried alive, yet sometimes when in a tunnel on a railroad train he has been beset with the idea of the two ends of the tunnel falling in and burying him. Some morbid ideas have developed in him, but they do not cause him pain when not satisfied. He lets them run into their “manias,” and is then contented. The idea of doubt is one. He is always in fear of not being able to do his daily task, or of being incapable of completing a book. He never rereads his novels, for fear of making bad discoveries. He has an arithmetical mania, and when in the street he counts the gas jets, the number of doors, and especially the number of hacks. In his home he counts the steps of the staircases, the different things on his bureau. He must touch the same pieces of furniture a certain number of times before he goes to sleep. Some numbers have a bad influence for him, and there are good numbers. In the night he opens his eyes seven times, to prove that he is not going to die. He is regarded by the author as a neuropath, or a man whose nervous system is painful but does not seem to affect the soundness of his mind. “In brief, the qualities of Zola are fineness and exactitude of perception, clearness of conception, power of attention, sureness in judgment, sense of order, power of co-ordination, extraordinary tenacity of effort, and, above all, a great practical utilitarian sense.”

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The Simplon Tunnel.—The following facts are taken from a brief account of this great engineering feat in the Engineering Magazine: There is at present no direct rail connection between western Switzerland and Italy, and to reach Milan it has been necessary to go around to Lucerne and so on through by the St. Gothard route. The distance by rail from Milan to Calais by the Mont Cenis is 665 miles, and by the St. Gothard 680 miles. The distance by way of the Simplon Tunnel will be only 585 miles. The Jura-Simplon Railway from Geneva around the lake and up the Rhone Valley ascends to Brieg at an altitude of about 2,300 feet, while on the Italian side the railway from Milan stops at Domodossola, at an altitude of 900 feet. Between the two, which are 41 miles apart and over an elevation of 6,590 feet, lies the famous Simplon Pass. Connection is now made by diligence, the trip occupying a whole day. The plan of the new railway includes the prolongation of the present line on the Italian side to Iselle, at an altitude of about 2,100 feet, where the Italian entrance to the tunnel was begun in August, 1898. On the Swiss side the entrance is at Brieg, and the tunnel will connect these two towns, being 12.26 miles long. This is nearly three miles longer than the St. Gothard, but the altitude is only 2,300 feet above the sea, instead of 3,800 feet, as at the St. Gothard. The tunnel is to be straight laterally, but higher in the middle than at either end, the grade being 1 in 143 on the Italian and 1 in 500 on the Swiss side. The principal difference between the Simplon Tunnel and those previously pierced through the Alps is that, instead of one single tunnel, two separate tunnels, fifty-five feet apart, are to be constructed, connected by lateral passageways every 650 feet. At first but one of these is to be completed to the full dimensions, the other being carried through at only about a quarter of the ultimate cross-section, and not enlarged and put into use until the traffic demands it. Both tunnels are now being bored by the use of the Brandt hydraulic rotary drills, water being supplied at a pressure of 70 to 100 atmospheres. The borings are through gneiss, limestone, and slate. 389
Holes two inches and three quarters in diameter and four or five feet deep are bored and the rock dislodged by means of dynamite. A narrow-gauge railway is used to remove the *débris*. It is expected that the tunnel will be completed in five years and a half. At the close of 1898, 300 feet had been penetrated on the south side and 1,300 on the north. The estimated cost of the complete double-track tunnels is 69,000,000 francs. This does not include the construction of the permanent way. The Mont Cenis Tunnel cost 75,000,000 francs, and the St. Gothard 59,750,000 francs. The work is practically controlled by the Jura-Simplon Railway.

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Grant Allen.—The death of our contributor, Mr. Grant Allen, was mentioned in the last number of the Popular Science Monthly. Mr. Allen was born in February, 1848, the son of the Rev. J. A. Allen, of Wolfe Island, Canada. He attended schools in the United States, in France, and in Birmingham, England, and entered Merton College, Oxford, whence he took his degree of B. A. in 1870. He afterward spent a few years in Jamaica as principal of a college for the higher education of the negro, which had only a brief career. He returned to England and settled down in London for literary work, writing rather on social and scientific than political subjects, for various journals. While he loved and appreciated scientific truth, he rather regarded his subject from the æsthetic side, and this gave a peculiar charm to his articles. He published books on Physiological Æsthetics and The Color Sense, which did not prove profitable. Finding it hard to gain a livelihood from his scientific work, he turned to fiction, and soon found, as the London Times has it, “that his worst fiction was more profitable than his best science.” His love of science, however, “approached enthusiasm,” and he contributed frequent popular scientific articles to the magazines, so that “for years past hardly one of those publications has been reckoned complete” without contribution of this character from him. He removed from London to Dorking, and afterward went to southern France and Italy for his health. Then, having so far recovered that he could spend his winters in England, he made himself a home at Hindhead, Surrey. Here he died, October 25th, after several weeks’ suffering from a painful internal malady. Among his scientific works, his books on Physiological Æsthetics, The Color Sense, and the Evolution of the Idea of God deserve special mention.

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Japanese Paper.—The peculiar qualities of Japanese paper, most of them excellent ones, and the great variety of uses to which it is applied, are known everywhere. It is a wood or bark paper, and derives its

properties from the substances of which it is made and the method of its manufacture. Several plants are cultivated for the manufacture, which, in the absence of English names, must be called by their Japanese or scientific ones, of which the principal are "mitsumata" (*Edgeworthia papyrifera*), the "sozo" (*Brossonia papyrifera*), and the "gampiju" (*Wiekstroannia canecensis*). Bamboo bark also furnishes a good paper, but is not much used. The *mitsumata* ramifies into three branches, and is cultivated in plantations, being propagated from seeds and by cuttings. It is fit for use in the second year if the soil is good. Its cultivation and exportation have reached an enormous importance, largely because the Imperial Printing Office uses it for bank notes and official documents. The *sozo* is propagated by seeds, and somewhat resembles the mulberry. The *gampiju* is a small shrub which is cut in its third year. To make paper, the bark is steeped in a kettle with buckwheat ashes to extract the resin in it. When it is reduced to a pulp, a sieve-bottomed frame with silk or hempen threads is plunged within, very much as in Western paper-making. This, letting out the water, holds the pulp, which, felting, is to form the future sheet of paper. This is pressed, to squeeze all the water out, and is left to dry. The uses made of paper in Japan are innumerable, particularly in old Japan, which treasures up its past. The papers, though all made in a similar way, are called by different names, according to the uses to which they are applied and their origin. Window lights are made of paper, and partitions between rooms, when it is stretched on frames, which work as sliding doors. The celebrated lanterns, called *gifu*, are made of it at Tokio and Osaka. 390
Under the name of *shibuganni* it is applied to the covering of umbrellas which are sold in China and Korea. As *zedogawa shi* bank notes are printed on it. Oiled it is *kappa*, impermeable and suitable for covering packages and for making waterproof garments. Handkerchiefs are made from it, cords by twisting. For light, solid articles it is mixed and compressed very much as our papier-maché. Covered with thick paste and pounded, it forms tapestries. Imitations of Cordova leather are made of it by spreading it and pressing it with hard brushes upon boards in which suitable designs have been cut. It is then covered with oil and varnish. Japan produced nearly five million dollars' worth of paper in 1892. Unfortunately, European methods of manufacture have been introduced, and there is danger of the paper losing its distinctive qualities.

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The Deeps of the Ocean.—In his geographical address at the British Association, Sir John Murray showed that the deep oceanic soundings are scattered over the different ocean basins in varying proportions, that they are now most numerous in the North Atlantic and Southwest Pacific, and in these two regions the contour lines of depth may be drawn with greater confidence than in the other divisions of the great ocean basins. On the whole, it may be said that the general tendency of recent soundings is to extend the area with depths greater than one thousand fathoms, and to show that numerous volcanic cones rise from the general level of the floor of the ocean basins up to various levels beneath the sea surface. Considerably more than half of the sea floor lies at a depth exceeding two thousand fathoms, or more than two geographical miles. On the Challenger charts all areas where the depth exceeds three thousand fathoms have been called "deeps," and distinctive names have been conferred upon them. Forty-two such depressions are now known—twenty-four in the Pacific Ocean, three in the Indian Ocean, fifteen in the Atlantic Ocean, and one in the Southern and Antarctic Oceans. The area occupied by these deeps is estimated at 7,152,000 geographical square miles, or about seven per cent of the total water surface of the globe. Within these deeps more than 250 soundings have been recorded, of which twenty-four exceed 2,000 fathoms, including three exceeding 5,000 fathoms. Depths exceeding 4,000 fathoms, or four geographical miles, have been recorded in eight of the deeps. Depths exceeding 5,000 fathoms have been hitherto recorded only within the Aldrich Deep of the South Pacific, to the east of the Kermadecs and Friendly Islands, where the greatest depth is 5,155 fathoms, or 530 feet more than five geographical miles. This is about 2,000 feet more below the level of the sea than the summit of Mount Everest, in the Himalayas, is above it.

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Death of Sir William Dawson.—By the death of Sir J. William Dawson, at Montreal, November 19th, America loses one of its most highly distinguished geologists. Sir William was born at Pictou, Nova Scotia, in October, 1820, and was deeply interested in the study of Nature from his early college days, when he made extensive collections of various kinds. When he was twenty-two years old a happy fortune brought him in contact with Sir Charles Lyell, then visiting America, and he was that eminent geologist's traveling companion during his scientific tour of Nova Scotia. He studied chemistry at the University of Edinburgh. Returning to Nova Scotia in 1850, he engaged in teaching, and was associated with the first normal school in the province. He was afterward connected with the new University of New Brunswick, and from 1855 to 1893 was Principal of McGill College and University. Although his duties in the college were very exacting, Professor Dawson's industry in scientific research was never relaxed, and he was the author of contributions of very great value to the geology and paleontology of Canada. Among these were the discoveries of the *Dendrepeton acadianum*—the first reptile found in the American coal formations—and the *Pupa vetusta*—the first-known Paleozoic land shell. His discovery and exposition of the *Eozoon canadense* attracted great attention, and was much discussed, but his views of its importance do not seem to have been justified, for some doubts now exist among geologists 391
whether it represents any organic structure. He was the first President of the Royal Society of Canada, which was organized in 1882; was one of the sectional presidents of the British Association at its Montreal meeting (1884), and was president of that body at its Birmingham meeting, 1886. Among his published works are the Description of the Devonian and Carboniferous Flora of Eastern North America, constituting two volumes of the Reports of the Geological Survey of Canada; Air-Breathers of the Coal Formation; Acadian Geology; The Story of the Earth and Man; Origin of Animal Life; Fossil Men; the Canadian Ice Age; the Meeting Place of Geology and History; the Geological History of Plants (in the International Scientific Series); Relics of Primeval Life (Lowell Lectures); The Chain of Life in Geological Times; Modern Science in Bible Lands; the Dawn of Life; Modern Ideas of Evolution; a book of travels in Egypt and Syria; and many contributions to scientific periodicals. He received numerous degrees and honors from learned bodies and institutions, among them the Lyell medal of the Geological Society of London, in 1882. A sketch of Principal Dawson, as he was then called, was published, with a portrait, in the Popular Science Monthly for December, 1875 (vol. viii, p. 132).

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Glacial Lakes in New York.—A glacial lake is defined by H. P. Fairchild, in his paper on Glacial Waters in the Finger Lake Region of New York (Geological Society of America, Rochester, N. Y.), as a body of static water existing by virtue of a barrier of ice. Such impounded waters may exist where a glacier blocks a stream, or where the general land surface inclines toward the glacier foot. The lakes described in Mr. Fairchild’s paper belongs to the second class, and were formed in the southern part of the Ontario basin, where the land slopes northward from a plateau of two thousand feet elevation down to Lake Ontario, two hundred and forty-six feet. The high plateau was deeply gashed by the preglacial stream erosion, and in these trenches along the northern border of the plateau lie the present “Finger Lakes.” The topography was peculiarly favorable to the production against the bold ice front of a series of distinct valley lakes, in many respects unequaled elsewhere. Between twenty and thirty of these lakes are described in Professor Fairchild’s paper, which occupied sites now partly represented by nineteen streams and lakes, beginning with Tonawanda Creek on the west and extending to Butternut Creek (Jamesburg and Apulia) on the east. The local lakes were not of long duration, and their surface level was unstable, changing with the down-cutting of the outlets and with the greatly increased volume of the summer melting of the ice sheet. Consequently, true beaches are usually wanting. The conspicuous evidences are the deltas of land streams, with their terraces, embankments, bars and spits, and the outlet channels. The records of these extinct waters are the very latest phenomena connected with the ice invasion, and are the connecting link between the glacial condition and the present hydrography. They are of lively interest, perhaps, to only a few persons, but the details are necessary to the more general study of the Pleistocene. No economic or practical result from the knowledge is foreseen, “but as pure science the study of these waterless lakes, waveless shores, and streamless channels has a fascination and romance.”

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The Environment In Education.—“Two considerations of equal and fundamental importance,” says Mr. Wilbur S. Jackman, “are included in teaching—the choice of the subject-matter and its presentation, and the reaction of the pupil as the result of the presentation. No presentation ever reaches consciousness without a reaction, however feeble, from which results an immediate and inevitable corresponding mental construction. Certain instincts called primitive, it may be generally agreed, exist in children, and, by taking intelligent advantage of these, definite educative presentation may be begun at a much earlier age than was once supposed. Under the theory that the child repeats the racial history in its growth, a practice has arisen of meeting the early instincts of childhood with presentations from the adult lives of primitive peoples. Presentations are made to stimulate the idea of hunting and fishing, of building wigwams and the like.” But it is 392 a fundamental error, Mr. Jackman believes, to suppose that while the child may be Indianlike in his instincts he is to be considered or treated as an Indian. Another factor of which evolution makes a great deal—the nature of the environment—must be considered, and it is very powerful. The material for satisfying the cravings of the early instincts should therefore be chosen from the immediate environment, to which the pupil’s reaction is at once positive and definite. “It is scarcely possible to overmagnify the benefits of an education that seeks first to make the most out of the immediate things of life. Its results and its ideals are about us everywhere. The ability to use in the most intelligent and skillful way the materials of our environment is the necessary condition for the highest purposes and the most glorified ideals. One must have a profound respect for the education that proposes to give us clean cities and hygienic homes.”

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An Athabascan Indian Lodge.—The caribou-skin lodge of the northern Athabascan Indians is described by Mr. Frank Russell, in his Explorations in the Far North, as supported by a framework of from twelve to thirty poles. In pitching camp in winter, sticks are thrust through the snow in order to find solid earth for a floor. If the stick enters soft moss the place is avoided, as the camp fire would spread and undermine the lodge. When a suitable site is found, the men clear away the snow with their snowshoes, and perhaps assist the women in cutting and carrying the lodge poles. It is the women’s duty to carry bundles of spruce boughs with which to cover the floor of the lodge. The brush is carefully laid, branch by branch, so that the stems are under the tops and point away from the center. This floor is renewed every Saturday afternoon. The fireplace is surrounded by a pole of green wood, three or four inches in diameter, cut so as to be bent in the form of a polygon. Above the doorway a pole eight feet long is lashed to the lodge-poles in a horizontal position, six feet from the ground; this, and a similar pole on the opposite side, support from six to twelve poles, crossing above the fire, making a stage on which to thaw and dry meat. Each hunter’s powder-horn and shot-pouch are suspended from a lodge-pole or his back, while his gun stands in its cover against a pole or lies on a stage outside. Near the door flap are several hungry and watchful dogs, which, by constantly running in and out, make an opening for the cold wind to enter. The dogs are tied at night. The side of the fire next to the entrance is allotted to the children and visiting women. On either side sit the wives, for there are usually two families in one lodge. Behind them are *muskimoots* and an inextricable confusion of rags, blankets, bones, meat, etc. If a crooked knife, a tea bag, or anything that is in the heap is needed, everything is tumbled about until it is found. The sled-wrapper is extended behind the lodge-poles and serves as a catch-all for stores of meat, bones to be pounded and boiled to extract the grease, and odds and ends not in constant use. The next space is occupied by the men of the house; that farthest from the door is reserved for the young men and the men guests. At night each adult rolls up in a single three-point blanket or a caribou-skin robe, and sleeps on an undressed caribou skin. A piece of an old blanket generally covers the small children in a bunch.

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The Sand Grouse.—Pallas’s sand grouse is a native of the Kirghiz steppes of central Asia, and occasionally, driven by some pressure of circumstances of which we can only conjecture the nature, makes visits to England. Its presence in that country has never been recorded till this century—more, perhaps, for lack of observers than

of migrating birds—but it has appeared in 1863, 1872, 1873, 1888, 1889, and 1899. The principal migration in recent years was in 1888, when many examples were seen and shot in different parts of the country. In the same year it was seen "far and wide" in western Europe, and as far north as Trondhjem, in western Norway. A writer in the Saturday Review remarks on the resemblance of this sand grouse, as described by Prjevalski in central Asia, to the various sand grouse he has seen in South Africa. At the drinking places they circle round the water. Presently they alight and, Prjevalski says, "hastily drink and rise again, and, in cases where the flocks 393
are large, the birds in front get up before those at the back have time to alight. They know their drinking places very well, and very often go to them from distances of tens of miles, especially in the mornings, between nine and ten o'clock, but after twelve at noon they seldom visit these spots." In the Kalahari country, at the scant desert waters, the Saturday Review writer says, three kinds of sand grouse "are to be seen flocking in from all parts of the country from eight to ten o'clock A. M. for their day's drink. Circling swiftly round the pool with sharp cries, they suddenly stoop together toward the water. The noisy rustle of their wings as they alight and ascend is most remarkable. We noticed that the birds nearest the water drank quickly and moved off, allowing those in the rear to take their places and slake their thirst, the whole process being accomplished with unfailing order and regularity.... The spectacle of these punctual creatures, streaming in from all points of the compass with unfailing regularity between eight and ten o'clock was always most fascinating. After drinking they circled once or twice round the water pool, and then flew off with amazing swiftness for their day of feeding in the dry, sun-scorched desert. The seeds of grass and other desert plants seem to constitute their principal food. The sand grouse has some characteristics of the pigeon and some of the grouse, which suggest a 'singular blending' of the two orders."

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Plantations for Rural School Grounds.—A paper on the Laying out and Adornment of Rural School Grounds, by Prof. L. H. Bailey, published as a Bulletin of Cornell University Experiment Station, lays down as a general principle in plantation that it should be in the main for foliage effects. "Select those trees and shrubs which are the commonest, because they are the cheapest, hardiest, and likeliest to grow. There is no district so poor and bare that enough plants can not be secured without money for the school yard. You will find them in the woods, in old yards, along the fences.... Scatter in a few trees along the fences and about the buildings. Maples, basswood, elms, ashes, buttonwood, pepperidge, oaks, beeches, birches, hickories, poplars, a few trees of pine or spruce or hemlock—any of these are excellent. If the country is bleak, a rather heavy planting of evergreens about the border, in the place of so much shrubbery, is very good. For shrubs, use the common things to be found in the woods and swales, together with the roots which can be found in every old yard. Willows, osiers, witch-hazel, dogwood, wild roses, thorn apples, haws, elders, sumac, wild honeysuckles—these and others can be found in every school district. From the farmyards can be secured snowballs, spireas, lilacs, forsythias, mock-oranges, roses, snowberries, barberries, flowering currants, honeysuckles, and the like. Vines can be used to excellent purpose on the outbuildings or on the schoolhouse itself. The common wild Virginia creeper is the most serviceable on brick or stone schoolhouses. The Boston ivy or the Japanese ampelopsis may be used, unless the location is very bleak. Honeysuckle, clematis, and bittersweet are also attractive." Flowers may be used for decorations.

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Destruction of the Birds.—A circular sent us by the New York Zoölogical Society opens with the declaration which is only a moderate expression of the truth, that "the annihilation of the finest birds and quadrupeds of the United States is a crime against civilization which should call forth the disapproval of every intelligent American." The second annual report of the society (for 1897) contains an article on this subject by Mr. William T. Hornaday, which sets forth some remarkable facts concerning the rate at which the destruction of Nature's fair creatures is proceeding. It is not creditable to American science or American manhood that most of the measures that have been adopted for the protection of animal life in this country have been taken in the interest and at the urgency of sportsmen; or, to prevent killing the poor creatures in an irregular way, in order that they may be more conveniently killed in the regular way. Mr. Hornaday has a fairly satisfactory number of reports in answer to his inquiries concerning the rate at which birds are disappearing from thirty-six States. From these he has compiled a graphic table for thirty States, taking care to keep within the conservative 394
limit in every particular, which shows that forty-six per cent of the birds of the country have been destroyed within the last fifteen years—the State averages ranging from ten per cent in Nebraska and twenty-seven per cent in Massachusetts to seventy-five per cent in Connecticut, Indian Territory, and Montana, and seventy-seven per cent in Florida. In North Carolina, Oregon, and California the balance of bird life has been maintained; and in Kansas, Wyoming, Washington, and Utah it has increased—Kansas, with its law absolutely forbidding traffic in certain birds, being the "banner State." "The western part of the State of Washington reveals the uncommon paradox of a locality being filled up with bird forms because of the clearing away of the timber." The agencies bringing about the destruction of our animal life are many and various. There are the "sportsmen," of whom Mr. Hornaday registers five kinds, all eager to "kill something," hunting for one hundred and fifty-four species of "game birds," and when these fail, taking the song birds in their place. If the reports are true, the boys of America are the chief destroyers of our passerine birds and other small non-edible birds generally. "The majority of them shoot the birds, a great many devote their energies to gathering eggs, and some do both." Then there are the women wearing birds or feathers in their hats. Egg collecting, which was fostered at one time as encouraging interest in natural history, has increased till it has become an abuse as dangerous and destructive as any of the others, and even genuine scientific collectors are advised to call a halt. Mr. Hornaday concludes that "under present conditions, and excepting in a few localities, the practical annihilation of all our birds, except the smallest species, and within a comparatively short period, may be regarded as absolutely certain to occur."

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Annual Flowers.—In a Cornell University Agricultural Experiment bulletin on Annual Flowers the authors, G. N. Lauman and Prof. L. H. Bailey, teach that the main planting of any place should be trees and shrubs. The flowers may then be used as decorations. They may be thrown in freely about the borders of the place, but not in beds in the center of the lawn. They show off better when seen against a background, which may be foliage, a building, a rock, or a fence. Where to plant flowers is really more important than what to plant. “In front of bushes, in the corner of the steps, against the foundation of the residence or outhouse, along a fence or a walk—these are places for flowers. A single petunia plant against a background of foliage is worth a dozen similar plants in the center of the lawn.... The open-centered yard may be a picture; the promiscuously planted yard may be a nursery or a forest. A little color scattered here and there puts the finish to the picture.” If the person wants a flower garden, the primary question is one not of decoration of the yard, but of growing flowers for flowers’ sake. The flower garden, therefore, should be at one side of the residence or at the rear, for it is not allowable to spoil a good lawn even with flowers. A good small garden is much more satisfactory than a poor large garden. Many annual plants make effective screens and covers for unsightly places. Wild cucumber, cobœa, and sweet peas may be used to decorate the tennis screen or the chicken-yard fence. Efficient screens can be made of many strong-growing and large-leaved plants, such as cannas, castor-beans, sunflowers, or tobacco.

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A Thirteenth-Century Miracle.—The legend of St. Prokopy relates that on the 25th of June, 1290, the city of Wilikij Ustjug, government of Vologda, southern Russia, was imminently threatened by a violent storm. The populace appealed to the saint, and, by virtue of his prayers, the storm changed its direction, and, passing on one side of the city, spent its fury upon a desert spot about fifteen miles away, where it left, with hail, a mass of fire-marked stones, the fall of which wrought great havoc with the undergrowth. The incident made a deep impression upon the minds of the people, so that the story is still current and alive after the lapse of six hundred years. A testimony to what the people believe is its truth may be found by visiting the spot, where a surface extending along about four miles is covered with blocks of stone, assumed to be meteorites. A church dedicated to St. Prokopy has been built in the neighboring village of Loboff or Catoval, and near it stands a curious little wooden chapel of great antiquity, the foundation of which was made of the stones that fell. The church is decorated with pictures of St. Prokopy and of incidents of the meteoric storm, and one of the stones that fell has been mounted on a pedestal in the cathedral of Ustjug, where it is an object of devotion. Mr. Melnikoff, Conservator of the Mineralogical Collections of the Mining Institute of St. Petersburg, has examined the place and the stones, and finds that they are not meteoric and heavenly at all, but simply earthly granite and sandstone. Yet M. Stanislas Meunier suggests, in *La Nature*, that the story, so carefully treasured up for six hundred years, may have a foundation. That such stones as lie on the ground at Catoval may have been taken up and transplanted by a tornado of extreme violence he regards as within the possibilities. M. Meunier has himself investigated a phenomenon of the kind in France, where the ground was “mitrailled” with stones measuring one, two, and three cubic centimetres, which had been brought a distance of one hundred and fifty kilometres. Another possible explanation is that the stones were already there, so concealed by the dense growth as not to attract particular attention, but became more plainly obvious when the ground had been cleared by the tornado.

MINOR PARAGRAPHS.

While it recognizes the desirability of agreeing upon some language as a general medium of communication between nations, the London Spectator presents certain forcible reasons for not seeking to institute one universal language. “Mankind,” it says, “will never adopt a universal language, nor is it to be desired that it should. The instrument for expressing thought must vary with the character, history, and mental range of those who have thoughts to express, and if all men spoke alike, ninety-nine per cent of them would be speaking stiffly—not using, that is, a natural and self-developed vehicle of expression. Arabic could not have grown up among Englishmen, or English among Arabs. The seclusion of nations, too, from one another by the want of a common tongue is by no means all loss, and we may doubt with reason why the higher races would not be degraded if they understood without effort all that the lower races say to one another. They would be bred, as it were, in the servants’ hall, not to their advantage.”

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In a recent address on The Chemistry of the Infinitely Little, M. Grimaux referred to the fact, with which all who have thought about it have been struck, that pathogenic microbes being diffused all through the atmosphere, everybody must breathe and absorb all sorts of them, including germs of typhoid fever, scarlet fever, diphtheria, etc., and yet we are not all attacked with those diseases. Why? Because each person has a peculiar temperament, and cells adapted, to a greater or less extent, to resist the microbe, to destroy it when it enters the organism, and thus constitutes, as the case may be, a good or a bad cultural medium. Every one, we might say, is immune against some or other of the pathogenic microbes. Like immunity belongs also to certain animal species, and if a microbe pathogenic to man or to some other species is injected into them they will resist it. The blood of refractory animals probably contains principles not yet known which oppose the development of the infectious microbe. From this fact the idea has been suggested of injecting the blood of refractory animals and communicating an artificial immunity to the individual to whom the injection is applied.

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M. J. Crépin, of Paris, “an enthusiast concerning the goat,” as M. de Parville calls him in *La Nature*, has established a model goat dairy, and is endeavoring to diffuse a taste for goat’s milk and its products. As a means to this end, he has sought to procure an improved breed of goats, and has obtained a stock of very satisfactory quality by crossing the best native goats with the Nubian buck. The latter animal is rather awkward in form and [396] movement, but M. Crépin hopes to breed that out. Otherwise the Nubian is well acclimated, vigorous, and indifferent to cold, hornless, and a most excellent milker. Goat’s milk generally is richer in caseine than cow’s milk, and owes some of its special qualities to this fact, and to the further circumstance that the flecks of goat-milk cheese are smaller, softer, and more easily broken up—consequently more digestible—than those of cow’s milk. Further, goat’s milk is more nearly than any other common milk like in composition to human mother’s milk; and it has the very great advantage that, the goat being less subject to attacks of tuberculosis and other dangerous disorders, it is comparatively free from the liability to convey infection. A single objection to the general use of goat’s milk is the odor which is supposed to be characteristic of it, but M. Crépin affirms that this is not apparent when the goats are properly bred and kept. M. Crépin is experimenting with butter from goat’s milk, and represents that he finds it very nice.

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The fundamental principle involved in the new form of telemeter, or instrument for estimating the distance of visible objects without actual measurement, invented by Herr Zeiss, of Jena, is that of the stereoscopic effect which appears in natural vision, where the inclination of the eyes in concentrating on the object gives the sense of distance. The base line between the eyes is increased in the Zeiss instrument by means of a system of prisms so as to give a widened base of binocular vision, and of mirrors which give magnifying power. Double images are formed, the distance between which varies in proportion to the distance from the observer, and appliances are provided for measuring how far apart they are. The arrangement is fairly satisfactory for moderate distances—say of 3,000 metres, or about 10,000 feet.

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M. Moissan believes that he has found a solution of the problem of the manufacture of ammonia from the atmosphere, and consequently of rendering atmospheric nitrogen available in agriculture, by the artificial production of calcium nitride. While calcium undergoes no change in contact with nitrogen at the ordinary temperature, it is affected by it under the operation of heat, and finally burns in it, absorbing it rapidly and giving rise to a bronze-colored nitride. Thrown into water, this substance decomposes with effervescence, producing ammonia and calcium hydrate.

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Prof. A. E. Dolbear, of Tufts College, Massachusetts, patented an invention for telegraphing without wires in 1886, which he claims covers all that Marconi is doing. He has sent messages with it for as long distances as five miles. According to his account he invented the system and made successful experiments with it as far back as 1882. He made an application for a patent, which was rejected by the Patent Office with the statement that it was contrary to science and would not work. “But as it did work, the claim was maintained in the office, and four years later, in 1886, a patent for it was issued.” Professor Dolbear does not wish it to be understood that his patent is on the “art of wireless telegraphy,” but that it covers everything that has been so far done in the art.

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On the occasion of the visit of the French Association to the British Association, Prof. J. J. Thomson gave an exposition of the lines of research by which it has been concluded that the atom is not the smallest existing quantity of matter. Electro-chemical phenomena teach us to associate a definite amount of electricity with each atom of matter; but these recent researches indicate that under certain circumstances a much larger quantity of negative electricity may be conveyed by the atom, or else that the negative electrical charge resides on a small detachable portion of the "atom," which alone is concerned in the experiments. The positive charge seems to be distributed over the whole mass of the atom.

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The merits of two methods of clarifying sewage—by dilution and by bacterial action—are discussed by Mr. Rudolph Hering in articles in the Engineering Magazine. Disposal by dilution in large streams of water is regarded as satisfactory in many places—where the water of the stream is not to be used for drinking or 397 cooking—provided the flow of the stream is always copious enough to dilute and disperse the sewage so widely as to prevent putrefaction and substitute oxidation. For purification by bacterial action no single method is found adapted to all conditions. The method by filtration and aëration is declared practicable only in localities where a sufficient area of porous land is available, upon which the crude sewage can be spread in sufficient quantity, into which it can filter with the proper velocity, and from which it can emerge as a thoroughly purified water. Where these conditions are absent, other methods must be adopted, of which the experiments in artificial filtration by tanks, as practiced at Exeter and Sutton, England, are described. These experiments promise to improve the present method, but perhaps not as greatly as is anticipated by the promoters. The author regards a prior separation of the suspended or dissolved organic matter as essential to permanent success when the amount of land is limited.

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By using the tuberculin test the faculty of the Ohio Agricultural Experiment Station have learned that in cattle the tubercle bacillus usually first obtains its foothold in some of the minor glands, that it may exist there for months and years before any other organs are affected, and that it is only in advanced cases that the lungs become diseased. While the growth of the organism is limited to these minor glands the health of the animal usually shows no sign of impairment. During this period there is no evidence that any unwholesome effect is being produced upon the flesh, and so long as the infection is localized in this way in one or two organs the Government inspectors pass the meat as sound. Tuberculosis, therefore, is a very different complaint from such diseases as pleuropneumonia or Texas fever, in which the whole system is saturated from the first instant with the febrile symptoms.

NOTES.

Mr. James Weir tells of a spider which stretched its web in the division between two parts of a sawmill, where the lower fastenings of the structure were frequently broken by the repeated passing of lumber through. Discovering the situation, the insect gave up the use of guy threads, and, finding a nail, wove it into the lower edge of its web, so that it should operate as a sinker to keep the web stretched.

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N. G. Johnson, of the Maryland Agricultural Experiment Station, telling the Society for the Promotion of Agricultural Science the story of his fight with the pea louse, represented that the pea raisers in his State had lost this year more than three million dollars by the ravages of this insect. A parasite had been discovered which practically annihilated the pest, but the discovery was not made in time to save the crops in some parts of the State from destruction.

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The American Society for the Promotion of Agricultural Science, after hearing the account of the work of the Gypsy Moth Commission of Massachusetts, which has spent more than a million and a half of dollars in trying to exterminate the mischievous insect, approved the action of the Massachusetts Legislature in maintaining the commission, and requested that the work be kept up for a short time longer. This was because it was represented that the moth was now confined to a limited area, and could be easily exterminated by the expenditure of a small amount more of money.

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The history of science has sustained a great loss by the burning of most of the relics which had been collected for the Volta Centenary Exhibition at Como, Italy. Only a few things were saved, comprising a sword presented by Napoleon Bonaparte to Volta, a cast of the skull of the great electrician, his watch, and a few personal relics. On the other hand, his books and manuscripts, his collection of batteries, the only authentic portrait of him, and his will, were destroyed. Nevertheless, the celebration was not stopped. The fire was attributed to the fusing of some electric wires.

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An example of patient industry is the sorting of hogs' bristles as it is carried on at Tientsin, China. Each one of the hairs of the six hundred thousand kilogrammes exported from that place in 1897 had to be picked out, measured, and placed in the bundle of hairs of corresponding length; and the different lengths by which the hairs are sorted are very numerous.

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It is stated by M. Léon Vaillant that the late M. A. d’Abbadie had and used an effective remedy against the 398
bites of insects and the infections they bring by fumigating the entire body with sulphur. For this purpose he covered the unclothed body with a suitable envelope, under which the sulphur was burned. The remedy was communicated to M. d’Abbadie by a hippopotamus hunter who had, by using it, escaped all the diseases incident to the swamps to which he had to resort.

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The Gregorian Calendar is to be adopted by the Russian Government on January 1, 1901, or at the beginning of the new century.

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The following figures, from the Engineering and Mining Journal, are of interest as showing the enormous quantity of iron and steel which was manufactured in 1898, and the leading position which the United States has already assumed in the industry:

Iron and Steel Production, in Metric Tons.[C]

Countries.	Pig Iron.		Steel.	
	1897.	1898.	1897.	1898.
United States	9,807,123	11,962,817	7,289,300	9,045,815
United Kingdom	8,980,088	8,769,249	4,559,736	4,639,042
Germany	6,889,087	7,402,717	5,091,294	5,784,807
Total	25,626,296	28,134,383	16,940,330	19,418,664
Austria-Hungary	1,205,000	1,250,000	553,000	605,500
Belgium	1,024,666	982,748	616,604	658,130
Canada	41,500	46,880	—	—
France	2,472,143	2,584,427	1,281,595	1,441,638
Italy	12,500	12,850	57,250	58,750
Russia	1,857,000	2,228,850	831,000	1,095,000
Spain	282,171	261,799	121,800	112,605
Sweden	533,800	570,550	268,300	289,750
All other	450,000	545,000	310,000	355,000
Grand total	33,506,076	36,507,487	20,979,179	24,030,032

[C] A metric ton is about 2,200 pounds.

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Although fewer casual members or members for the year than usual were present at the recent meeting of the British Association at Dover, the attendance of distinguished men of science and of active scientific workers, according to the London Times, seemed to be greater. And so far as the proper work of the association is concerned, the meeting should take a high rank. Excellent and serious work was done in all the sections.

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A paper has been published by Pliny T. Sexton, of Palmyra, N. Y., setting forth reasons for favoring the unification of the whole educational system of the State of New York under the jurisdiction of a single board—that of the Regents of the University. The reasons are presented in the form of various newspaper articles which were published last year against a proposition of an opposite character—to abolish the present Department of Public Instruction and create a State Commission of Education, the affiliations of which would be political. Mr. Sexton has further offered two prizes of one hundred dollars each for articles or essays by women and similar productions by men in support of the proposed unification.

* * * * *

M. Hildebert Richard, of Avignon, France, relates that he experimented upon two adult geranium plants, both healthy and of vigorous growth, under like conditions of exposure, watering one (A) with well water and the other (B) with water containing a measured proportion of butylic alcohol daily. A kept on with its healthy growth. B, after four days of alcoholization, showed an enfeebled growth, with symptoms of jaundice, drowsiness, and intoxication; a special odor perceptible in all parts of the plant, partially burned spots, and melanosis and geotropism in the leaves.

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In his papers on The Art and Customs of Benin, Mr. Ling Roth concludes that the art of that savage land consists of mixed elements, partly European forms which the native mind was prone to copy, partly introduced from other parts of Africa. It is characterized by boldness, freedom, clearness in execution, originality, and variety. Among the customs he mentions are the practice of human sacrifice and the sprinkling of the blood of the animals killed at the periodical sacrifices on the ivories and on the cast-iron or bronze figure-heads placed on the altars. When there was too much rain, a woman had a message saluting the rain god put into her mouth. She was then killed and set up in the execution tree, so that the rain might see.

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Our scientific obituary list of the month includes the names of Sir William Dawson, the distinguished Canadian geologist, of whom a fuller notice is given in another place; Dr. Luther Dana Woodbridge, Professor of Anatomy and Physiology in Williams College, at Williamstown, Mass., of heart disease, November 3d, aged forty-nine years; Dr. Oscar Baumann, African explorer, geographer to the Austrian Congo Expedition of 1885, who made studies for the projected railroad from Tanga to Karog; Dr. F. Kuhla, botanical explorer, at Manáos, Brazil; Percy B. Pilcher, inventor of flying machines, from an accident while experimenting, September 2d; 399
Professor Hayduck, Privat Docent in Chemistry in Berlin; M. A. Snow, Instructor in Entomology in Leland Stanford Junior University, drowned October 10th in San Francisco Harbor; he had also been Instructor in Entomology in the Universities of Kansas and of Illinois, and was the author of several systematic papers on *Diptera*; Prof. J. B. Carnoy, of the Catholic University of Louvain, author of *Biologie Cellulaire* and of papers on the development of sexual elements, and founder of the journal *La Cellule*, at Schuls, Switzerland, September 6th; Dr. A Ernst, Director of the National Museum, Caracas, Venezuela; Dr. Edward Petri, Professor of Geography and Anthropology in the University of St. Petersburg, aged forty-five years; Dr. Ottmar Mergenthaler, inventor of the linotype type machine, in Baltimore, Md., October 28th; and Dr. Henry Hicks, an English geologist and Lyell medalist, at Hendon, England, November 18th, aged sixty-two years.

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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.

Page 315: The illustration's caption, describing line thickness, was printed as actual lines, but has been changed to words by the Transcriber.

Page 329: "*cito tuto*" may be two separate terms that should be separated with a comma.

Page 339: "*cortége*" was printed with an acute accent.

Page 352: Unmatched right-parenthesis removed after "p. 429."

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