

all competitors at the Fair, and around the lower structure was a balcony nearly 150 feet in circumference, from which an impressive idea of the height of the tower was obtainable.

#### THE BICYCLE UPON RAILS.

It is from Russia this time that comes to us a curious cycling apparatus. The accompanying engraving reproduces a photograph taken in the vicinity of Moscow a few hours previous to the passage of the imperial train. Some Russian gendarmes, one of whom is seated upon the apparatus, have just made an inspection of the track. The Czar may now pass, as there is nothing to be feared from the Nihilists!

As will be understood, the person in the center is utilizing a sort of bicycle for his police service which rolls upon the rails of a railway track. In reality, the word bicycle is a misnomer for this apparatus, which rests upon three wheels. Through its two principal wheels it rests upon the rail to the right, but is kept in equilibrium by a metallic arm terminating, on the rail to the left, in a small wheel. It is a crude apparatus, moreover, whose two heavy main wheels are connected by a compact body, the various parts of which are roughly shaped, and which weighs no less than 110 pounds.

As primitive as the machine is, however, it exhibits some very original peculiarities. It is actuated both by the arms and legs of the rider, and thus puts one somewhat in mind of the Valere running machine. Here, the rider, not having to occupy himself with the steering of the machine, since the latter, being fitted to the rails, follows all the curves thereof, devotes his entire attention to its propulsion. Two levers, actuated by the arms, are, through a slide at their lower extremity, connected with each of the cranks of the bicycle. It will be remarked that, contrary to the arrangement of the Valere machine, which causes its rider to take an ambling gait (that is to say, causes him to put forward at the same time the leg and arm of the same side), the Russian railway bicycle employs the ordinary gait of man's trot, that is to say, causes the rider to put forward at the same time the right arm and left leg, and reciprocally.

We shall not expatiate here upon the genuine services that may be rendered by this inexpensive and very rapid apparatus, which necessitates scarcely any cost of maintenance and which one man can easily remove from the track, in order to allow a train to pass, and afterward replace upon the rails. It is too evident that the switchmen, inspectors and engineers of railways would find it of great interest to utilize it according to circumstances.

Much is being said about military cycling; we are not so very sure whether in time of war railways would not be the only routes cyclable. We may remark, however, that this homely Russian apparatus is not an innovation, but far from it. Almost from the inception of cycling it has been understood that the railway is the most practical, the surest and best rolling roadway. The oldest example of cycling upon rails that we know of is mentioned in the *Albany Courier* of August 20, 1869, which states that upon the banks of the Mohawk, two landowners had had constructed for themselves, in order to visit their possessions, small cars that they actuated by their arms and legs upon the railways.

This journal adds that one evening, in a fit of jealousy, the two inventors ran into each other upon an embankment one hundred feet in height, in a sort of real Yankee duel, and that the cars were smashed and one of the duelists was killed outright. Without dwelling upon this perhaps fanciful story, we shall further recall that at Paris, on the 28th of December, 1887, the military engineers, represented by Capt. Houdaille, tried a railway quadricycle, constructed by Mr. Vincent, upon the line of the East, near Villette. A speed of 18 miles per hour was obtained. Unfortunately the apparatus weighed 198 pounds, and for this reason was abandoned. Afterward, Truffaut, the bicycle manufacturer, who played so important a part in the history of cycling, established after the manner of the Americans a railway quadricycle that weighed but 55 pounds, and gave a speed of 24 miles per hour upon a level. The French state railways began some ex-

periments in 1891. It is now 1894, and the experiments are being carried on without any conclusion as yet. It is fortunately necessary now to rely much in France upon the example of Russia.—*La Nature*.

#### THEODOR BILLROTH.

One of the brightest stars in medical science—the last of the triple star—Langenbeck-Volkman-Billroth—is extinguished.

Theodor Billroth was born April 26, 1829, at Bergen, on the island of Rugen. His father, who was pastor at Bergen, died early, leaving the son to be brought up by his mother. Later he went to school at Greifs-



THEODOR BILLROTH.

walder, and in the years 1848 to 1852 he studied medicine in Griefswald, Gottingen and Berlin. He carried his studies farther than many, working as diligently at the natural sciences as at medicine.

In addition to the usual journeys to Vienna and Paris for the purpose of study, Billroth had a thorough drill in the surgical clinic in Berlin, where he acted as Langenbeck's assistant in 1853. The master soon recognized the ability of the youth in working out microscopic, anatomical and histological questions, and the importance of such fundamental investigations for practical surgery. Thus we see him here occupied chiefly with study of an anatomical and physiological nature, and with experimental pathological work which paved the way for a new era in surgery. With wonderful adaptability he studied many subjects during his seven years in Berlin. Embryonic studies led him to an understanding of the development of the blood vessels and a careful study of unhealthy formations. He also produced at this time an excellent work on "Umwandlung von Muskel- und Nervengewebe" ("Transformation of Muscle and Nerve Tissue"), an historical study of the treatment of gunshot wounds from the fifteenth century to the present time, and his "Beitrage zur Pathologischen Gewebelehre" ("Contributions to the Science

of Pathological Histology"), an especially important work that brought to light much that was new.

It took him only ten years to rise from the position of student to that of professor and scientist. In 1859 he was called to Greiswald as professor of pathological anatomy. Fortunately for surgery, he refused this flattering call, but two years later he accepted a call as professor and director of the surgical clinic in Zurich. He left here in 1867 for a similar position in Vienna. When in the Swiss high school his great industry and brilliant surgical talent showed to advantage, and his methods of work here, following up the questions of the day in his studies and his teaching, are set forth not only in his "Clinical Reports," but also in his "Fifty Lectures on General Surgical Pathology and Therapeutics," a work of classical value and universal importance that lived through many editions and was translated into all civilized languages. In Vienna he continued to publish his experiences in "Clinical Reports," and he and Pitha produced the great compilation "Handbuch der Allgemeinen und Speciellen Chirurgie" ("Handbook of General and Special Surgery"), which is prized by physicians in all parts of the world as a mine of surgical experience.

Lister's epoch-making discovery of the use of antiseptics in operations, which opened to surgery heretofore unsuspected paths, was not without its effect on Billroth. He was one of the first in Germany to acknowledge and appreciate the importance of the antiseptic method. With his accustomed zeal he undertook the study of the suppression of surgical fevers and diseases; but he was not tempted even by his great success to perform unnecessary operations. Step by step he followed up carefully the branch of surgery which had been so suddenly opened, and we have to thank him for many operations in internal surgery that are of the greatest importance in saving life, and such as no one had dared to perform before. Among these we may mention the removal of the larynx and the resection of the pylorus end of the stomach, which added new leaves to his crown of laurel. This was before the time of Koch; but Billroth was then a pioneer. By his work on the vegetable nature of the septic coccus bacteria, he increased the knowledge of wound infection so that he might be called the apostle of antiseptic surgery.

His ability in two other branches should be mentioned here, viz., that of military surgery and popular authorship. As a result of his voluntary service in the Franco-German war, he presented the medical world with "Chirurgischen Briefen aus den Kriegslazarethen von Weissenburg und Mannheim," 1872 ("Surgical Letters from the Hospitals of Weissenburg and Mannheim"), as well as with his dissertations on the transportation by railroad of those wounded and taken ill on the field (1874). As a teacher of the people he published, in 1881, a handbook on "Die Krankenpflege im Hause und im Hospital" ("Care of the Sick at Home and in the Hospital"), that has been universally translated, and shows how a true German savant can present questions of hygiene in a form that is agreeable and at the same time comprehensible to the uninitiated.

Billroth has taught many famous pupils, and the students' thorough appreciation of his ability as a teacher is shown by the document which they presented to him on the occasion of the anniversary of his fiftieth term at Vienna (1892). In his "Lehren und Lernender Medicinischen Wissenschaften" ("Teaching and Learning Medical Science"), 1876, he made a valuable gift to those who are interested in reform in medical instruction.

Billroth was a person of the greatest charm; his finely formed head, clear eye, and brilliant oratorical gifts will long be remembered by all who knew him. He was a real "path finder" for his associates, his bold and successful methods of performing operations restored thousands of suffering people to health, and being extremely self-sacrificing and magnanimous, he was a true benefactor to the sick and a fatherly friend to the student.—*Illustrirte Zeitung*.



BICYCLE FOR THE INSPECTION OF RAILWAY TRACKS.

THE strongest animals in the world are those that live on a vegetable diet. The lion is ferocious rather than strong. The bull, horse, reindeer, elephant and antelope, all conspicuous for strength, choose a vegetable diet.

[CHAUTAQUAN.]

**What is Chemistry?**

Everybody who thinks must be impressed by the great variety of things found on this earth, and the question, What does the earth consist of? must often suggest itself. Among the important results reached in studying the things around us is this, that notwithstanding their great variety they are made of simple things, and these in turn of still simpler—that there are, in fact, only about seventy distinct kinds of matter, and that all the complex things around us are made up of these seventy elements. The solid crust of the earth, as far as it has been possible to investigate it, all living things, both animals and plants, the air and water, consist essentially of twelve elements. The elements do not, as a rule, occur as elements. They are generally found in combination with one another. Oxygen and nitrogen are, to be sure, found in the air as elements, uncombined; but such familiar substances as water, salt, and quartz consist of elements in combination. Thus water consists of hydrogen and oxygen. Hydrogen, the element, is a colorless, tasteless, inodorous, and very light gas that burns readily. Oxygen, the element, is also a colorless, tasteless, inodorous gas. It does not burn, but burning things burn with much increased brilliancy in it. When hydrogen and oxygen are mixed together in a vessel under ordinary conditions, no action takes place. They mix thoroughly, forming a mixture that is also a colorless, tasteless, inodorous gas. If a spark is applied to this mixture, a violent explosion occurs, and this is the signal of a great change. The two gases have entered into chemical combination; they are no longer the gases hydrogen and oxygen; they have entered into combination and now form the liquid water, a substance with properties entirely different from those possessed by the constituents.

Again, chlorine, the element, is a greenish-yellow gas that acts violently upon other things and causes changes in them. Inhaled even in small quantity it gives rise to distressing symptoms, and in larger quantity it causes death. Its odor is extremely disagreeable. Sodium, the element, is an active substance that has the power to decompose water and set hydrogen free. When chlorine gas is brought together with sodium, the two combine chemically and form the well known compound salt, or, as the chemist calls it, sodium chloride. From this the elements chlorine and sodium can be obtained by the chemist. These two examples serve to show what is meant by chemical combination and by a chemical compound. Chemical compounds are generally found mixed with other compounds. This is shown, for example, in many of the varieties of rocks, as granite, which consists of three different chemical compounds. It is shown much more strikingly in living things, all of which are made up of a large number of chemical compounds, mixed, to be sure, not in a haphazard way, but beautifully adjusted and working together in wonderful harmony. Just as

elements combine chemically to form compounds, so elements act upon compounds and cause changes in their composition. Thus, oxygen is constantly acting upon other things, sometimes slowly, but, in the case of fire, rapidly and with tremendous energy. It is commonly said that fire destroys things. In fact, it changes their composition, and the principal products of the change are gases. This kind of chemical change is the most familiar that is brought about by the action of an element upon compounds. Compounds, too, act upon compounds, and cause an infinite number of changes in composition. Thus the food we partake of consists of chemical compounds. In the body these compounds find others and they act upon one another so as to repair the wasted tissues and cause growth. The gas known as carbonic acid, that is contained in the air, acts upon the compounds in the leaves of plants and causes changes that are absolutely essential to the life and growth of the plant.

Look, then, in any direction and you will see evidence of changes in composition that are constantly taking place, and that are essential to the existence of the world as it is. These changes in composition and the compounds themselves that are involved in the changes form the subject of chemistry. In the light of what has been said it is clear that chemistry must be a very broad science. Remembering that chemical action is the cause of the formation of chemical compounds, that without chemical action the compounds would cease to exist and would be resolved into their elements, it is impressive to think what would take place if chemical action should cease. Most of the things familiar to us could not exist. The solid portions of the earth would, to a large extent, be replaced by the element silicon, something like charcoal, and by oxygen and a few metals such as sodium, potassium, and aluminum. Water would be resolved into the two gases hydrogen and oxygen. All living things would fall to pieces, and in their place we should have the

gases, hydrogen, oxygen, and nitrogen, and the solid element carbon, most familiar to us in the form of charcoal. Life would, therefore, be impossible.

**New Cave Discoveries at Mentone.**

The first discovery of a skeleton and some other remains at Mentone, France, was made in 1872.

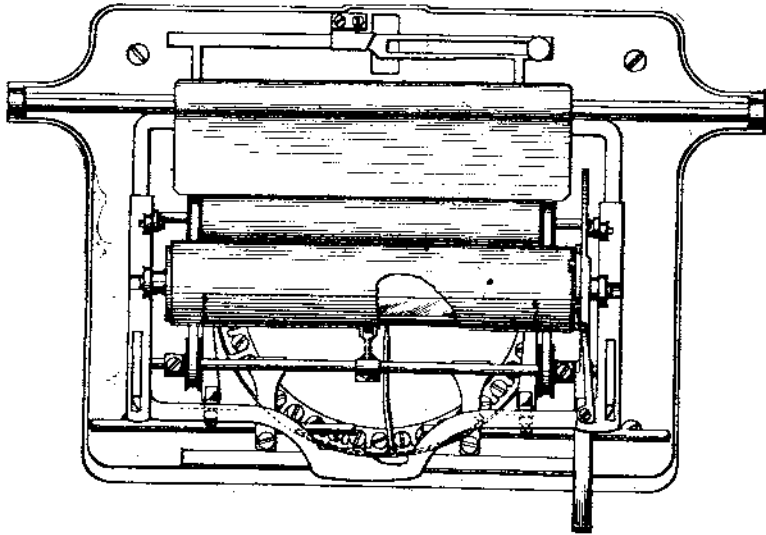
In January last another skeleton was found. It is that of a man almost six and a half feet tall; it was lying on the back with the left hand under the head. Around it were bones of animals, perforated shells and stag's teeth. Near by were a very sharp unused flint knife and a crystal of carbonate of lime. In the neighborhood vertebræ of the mammoth and what appears to be a paleolithic stone implement were found.—*Globus*.

**A DEVICE ENABLING THE TYPEWRITER TO SEE AND READ WORK AS IT IS WRITTEN.**

One of the annoying features of several of the most deservedly popular of the typewriting machines is the fact that the carriage has frequently to be lifted, that the operator may examine the work as it progresses. The necessity for this is obviated by a simple device recently introduced and styled the "Typewriter Prism," a rod of polished cut glass fastened to the carriage beneath the impression roller. Two of its sides are flat and inclined to each other at an angle of 45 degrees, and the third side is a strong cylindrical curve, perfectly reflecting the writing and presenting it right side up and in normal position to the eye of the operator.

The accompanying engraving illustrates the application of the improvement to the Smith-Premier machine, the position of the prism being shown by dotted lines on and in a broken-away portion of the impression roller. The prism can also be adjusted with best results to the Remington, Caligraph and Yost machines.

The prism in no way interferes with the operation



TYPEWRITER PRISM APPLIED TO SMITH-PREMIER MACHINE.

of the machine, and when a letter has been omitted or a wrong letter struck, the carriage can be instantly moved to the desired point and the correction made without lifting the carriage to locate the error, while it is the only device yet invented enabling the operator to tabulate conveniently. The prism has been in use in the office of the SCIENTIFIC AMERICAN for some time and has given much satisfaction. A great many operators are using this improvement, of which Mr. Birket Clarke, 106 Fulton Street, New York, is the general agent.

**Liquids and Gases.**

It requires some effort of imagination to think of a gas so compressed as to have a density nearly equal to the density of water, and to possess the consistence of tar or of honey; very slightly compressible, like a liquid, and nevertheless a gas. So we need not wonder that even physicists, who at times are bold enough in their hypotheses, were rather slow in accepting a conception so widely different from our daily experience of liquids and gases. Such a state of matter is, however, known; it has been observed in our laboratories, and its existence was indicated as early as 1822, by Cagniard-Latour, and later on by Faraday. But it was only in the seventies, after two such bright minds as the Belfast professor, Andrews, and the Russian professor, Mendeleeff, came—the one through experiment and the other theoretically—to recognize its reality and significance, that scientists came round to the view that matter may exist in a state intermediate between its liquid and gaseous states. The idea is now generally accepted, and during the last five and twenty years immense researches have been made upon or in connection with this subject. Andrews made his discovery while liquefying carbonic acid gas. Unlike oxygen or nitrogen, which both require very low temperatures for being brought into their liquid state, carbon dioxide liquefies very easily. At the temperature of the

freezing point it is sufficient to exert upon it a pressure thirty-six times greater than the pressure of our atmosphere to have it as a liquid, the density of which is four-fifths of the density of water. If its temperature be raised to 59° Fahrenheit, a pressure of 52 atmospheres is again sufficient to overcome the tendency of its molecules toward scattering in space; it becomes a liquid.

But when Andrews took the same gas at a temperature of 96°, he could exert upon it a pressure of 108 atmospheres and more without seeing any traces of liquefaction. Under this pressure the gas was reduced to  $\frac{1}{10}$  part of the volume it occupied at the freezing point; its density was equal to the density of liquid carbonic acid, and yet it was not a liquid, although, like a liquid, it yielded but little to a further increase of pressure. However, as soon as its temperature was brought below 88°—the pressure remaining the same—the gas was found to be in a liquid state, without any alteration of its volume, or any sudden evolution of heat, having taken place. A temperature of 88° is thus its critical point. Below that limit its liquefaction is easy; above it, it is impossible. Further experiments convinced Andrews that other gases behave in the same way at their own critical temperatures, and he at once understood the philosophical bearing of his observations. There is, he wrote, a close and intimate connection between the ordinary gaseous and the ordinary liquid state of matter. The two are but widely separated forms of the same condition, and they may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present a breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid the transition may be accomplished by a continuous process. But if any one ask whether the carbonic acid, taken at a temperature above its critical point, be in its gaseous or liquid state, the question does not admit of a positive reply. It stands "nearly midway between the two, and we have no valid ground to assign the one or the other." As to the explanation of this state, it must be sought for in the cohesion between the molecules; and further research, he added, will probably disclose the continuity of the liquid and solid states as well.

Andrews came to his discovery by starting from the gaseous state of matter; Mendeleeff came to the same discovery by starting from the liquid state. All liquids, he wrote in 1861, have a certain cohesion between their particles; this is what distinguishes them from gases; but the heating of a liquid steadily diminishes its cohesion, and consequently there must be for each liquid a certain temperature (the absolute boiling point) at which cohesion between its particles must entirely vanish, so that at and above that temperature it cannot exist as a liquid. It must then form a gas, and so long as it has not been cooled below the above limit, no amount of pressure will be able to restore it to its liquid state. Thus, starting from the two opposite ends of the scale, Andrews and Mendeleeff came to identical conclusions. Deduction and induction had joined hands. It is now known that their generalization was correct. All physical bodies have their critical temperatures or absolute boiling points, above which they cannot exist as liquids, whatever pressure they might be submitted to. For water this critical point is 689° of the Fahrenheit scale; for ether it is 383° or 386°; but for several gases it lies so deep that in order to liquefy them one must approach the absolute zero (459° below the freezing point), at which no thermic vibrations exist and even chemical affinity disappears unless stimulated by electricity. Thus, oxygen must be cooled down to 299° below the Fahrenheit zero, and nitrogen to -315° in order to be liquefied; while the critical temperature of hydrogen must be still lower—somewhere about 360° of cold. This is why Professor Dewar, who liquefies air in an open tube—that is, at the ordinary atmospheric pressure—could not yet liquefy hydrogen in the same way; and Amagat saw this gas at the ordinary temperature of our rooms remaining a gas, even under a pressure of 2,800 atmospheres, when it was squeezed within one-thousandth part of its previous volume.—*Prince Kropotkin, Nineteenth Century*.

**Opening of the Exhibition at Lyons, France.**

The great Exhibition of Arts, Sciences, and Industries was opened at Lyons April 29. A throng of conspicuous men attended the ceremonies. The whole Cabinet was present, but the President was unable to come. The exhibition, although formally opened, is far from ready for the public. The interior of the main building is still in the hands of the carpenters and the decorators. The main building covers 5,000 square yards, and is surmounted with a fine cupola. There are large pavilions for exhibits of viticulture and agriculture, greenhouses, and buildings for the fine arts.