THE SCIENTIFIC WORK OF THE GOVERNMENT.*

By Otto Klotz.

THE OBSERVATORY.

POSSIBLY in the popular mind no branch of the Government service fills so adequately the idea of scientific work as does that of the Observatory, with a lingering feeling that it is not very closely connected with this mundane sphere. This latter idea is not quite correct, and you are more frequently making use of the astronomer's midnight vigils than you may be aware of.

The Dominion Observatory was the outgrowth of the terms upon which British Columbia entered the Dominion of Canada. She gave lands 20 miles on each side of a railway to be built by Canada to and through the Province. That railway belt, in order to be correlated to the Dominion Lands System of the Northwest, required to be astronomically fixed upon the earth. Thereby began the practical astronomic work of the Government in the accurate determination of latitude and longitude. That was in 1885. The work has been extended across the continent. Ottawa has been made the chief reference point for Canada, and the Observatory was built, which now engages in other work too, work of research, besides the practical work that called the Observatory into being.

The work of the Observatory may be divided broadly into: Astro-physics, Time and Meridian work, and Geophysics.

With the ancient Greeks, Hermes, or, as later known by the Romans, Mercury, was the messenger from heaven; to-day that messenger is light, more fleet-footed than Hermes or Atalanta, for in the twinkling of an eye he could skip from the moon to us. This messenger, this ray of light, this motion of the immaterial,

* The following is that part of the address, given before the National Assembly of Civil Service Commissioners at the luncheon, in the Chateau Laurier, Ottawa, on Friday, June 16, 1916, dealing with the Observatory. The speaker briefly alluded to the scientific work of the various Departments of the Government.

comes to us laden with a story, with a wonderful story from the home he left some time ago, perhaps ten or a hundred or five hundred years ago, travelling all the time at 186,000 miles a second. Only a rigorous cross-examination, however, can elicit any information, and with much difficulty are answers obtained. The principal questioners are the prism and photographic plate on which his handwriting is impressed, which tells us the constituent parts of his home, what gases and elements surround it, and whether the home—the star—is approaching or receding from us. To such analyses the ray of light is put at our Observatory. It may be mentioned too that the photographic plate can obtain the record of stars so faint that no human eye will ever see them, be the telescope ever so large, for the telescope is but a large eye. All researches reveal more and more that all bodies in the universe are of one great family, ultimately with the same finger-print.

In another branch stars are put to a different use. It is well said that "order is the first law of heaven"—would it were so on this earth. You look at your watches a score of times a day, probably never thinking where your time comes from. It comes from some astronomer, perhaps ours, who has spent the night observing and recording the motion of the stars. And this same motion enables us to delineate on the earth our geography. Thus Canada is being put in its accurate position on this globe, takes its position in the sun. You travel by sea o'er this wide world with utmost confidence in the captain of the ship, but you will find in his cabin the nautical almanac, giving the position of the heavenly bodies, for his guidance. In such fundamental work our Observatory is engaged too. It is not spectacular work, but steady, conscientious, exhausting and exhaustive work for the benefit of man.

The nursery rhyme, "Twinkle, twinkle, little star, how I wonder what you are," occurs also to the astronomer. But he trains his spectroscope on the little spot of light—and behold—twins are revealed, hugging too closely, however, to be seen as such by the eye. The astronomer watches them for hours, for days, as they write on the photographic plate, then determines what their rela-

tive masses are and how long it takes them to dance once around their common may-pole. Such work, too, the Observatory does. There are other twins, and even triplets, that take a somewhat wider range of motion, and which can be directly seen and put to observational scrutiny. They, too, fall within our purview.

Next let us put our feet on terra firma—terra firma when it isn't shaken by an earthquake. Let me assure you that earthquakes are very interesting scientific phenomena on this earth—of course we would all like to bar personal experience. However, by means of our modern highly sensitive earthquake instruments, facts and truths of the interior of the earth have been revealed that heretofore were debatable questions. Our earth is solid and has no liquid interior. The seismograph at the Observatory records every decent earthquake, whether on land or in the sea, whether in Asia, the East Indies, South America or in the Aleutian islands. Like the ray of light, the seismic ray writes its message, its hieroglyphics in bold lines on the photographic sheet. It, too, has written its story whence it came, how far away was its hearth, how deep down into the earth it dipped to find its easiest and swiftest path. The hieroglyphs have not all as yet been read, the Rosetta stone has not yet been found, but a good deal has been deciphered. If there has been a good shake in Turkestan, say, we can tell within fifty miles how far away it is from Ottawa, sometimes even less, and how long it took to reach us—hence also the elasticity of the material through which it passed. From the study of earthquakes we are learning of the vulnerable parts of this earth, for there the earthquakes always take place. It is a study in which man is vitally interested, and prediction of earthquakes is not entirely a dream, it comes within the range of scientific investigation. Another branch of geophysics that the Observatory pursues is that of gravity, upon which is dependent the shape and form of the earth. This work rests on the observation of the swing of a pendulum—no clock-work. The number of oscillations a pendulum makes in an hour or a day, depends on the pull that actuates it—not political pull, for that is too uncertain. The farther we

are from the centre of the earth the less the pull or force. If a pendulum clock keeping accurate time in Ottawa were taken to Washington it would lose time, because Washington is farther away from the centre of the earth than we are, and, besides, is more apt to fly off the handle than Ottawa, *i.e.*, the centrifugal force is greater there and decreases the gravitational effect. You don't weight as much in Washington as you do here, for the same reason,—weighed on a spring balance. The pendulum not only reveals to us the shape of the earth, what its flattening is, but also anomalies in structure underneath us, whether there are vast masses of greater or less density than the average below the surface. From the pendulum we have learned that the Rocky Mountains float, so to speak, in the crust of the earth, like an iceberg does in the sea. This means that the roots of the mountains are composed of matter less dense than at the same depth, say, under the sea. The crust of the earth does not support the Rocky Mountains, or any other range, they are in equilibrium. In this investigation of the earth, which is an international undertaking, the Observatory is taking its part. Just one figure in regard to the refinement of pendulum observations, a single swing of the pendulum is determined with an accuracy of the units of the seventh place of decimal, that is, to the ten millionth of a second of time.

The third branch of geophyhics pursued by the Observatory is that of terrestrial magnetism, a subject of concern to man on land and sea, particularly the latter. When the poet exclaims, "True as the needle to the pole," we must make allowance for poetic license, otherwise the captain of a ship steering by compass would never reach his destination. The needle doesn't point to the pole except along a line where its deviation to the west meets or merges into deviation to the east. The needle is almost as fickle as the weather. Our first work is to ascertain its general behavior in the wide extent of Canada from the Atlantic to the Pacific, then to study its daily and annual idiosyncrasies with some odd ones thrown in. These last have been traced pretty well to the sun as the disturbing element, but just how we don't know as yet. There

is scarcely any investigation that we make on this earth that doesn't ultimately lead us back to the sun. We ourselves are vitalized sun-beams, and hence our temperament should be more or less sunny. The sun-worship of the old Aztecs had some sense. Terrestrial magnetism, the northern lights or aurora borealis, disturbances on our telegraph lines, sun-spots have an inter-relationship well worthy of study, research and investigation. There is one more branch that properly comes under scientific work, and that is the Geodetic Survey of Canada, for in the network that is being thrown over the country for subsidiary and detailed survey to connect therewith, the ultimate degree of refinement of measurement is applied and thereafter the crucial application of mathematics to fit the survey to the actual surface of the earth, involving computations of the most intricate nature, yet essential, that the results may stand for all time and inure to the everlasting benefit of the people. In closing the necessarily brief review of the scientific work carried on by the Government, every scientist is fully aware that a Government, which is but a reflex of the people, looks upon scientific work with an eye to its material value—what is it worth—what benefit is it to the people that pay for it? This is quite a natural attitude. But it must not be carried too far. No scientific truth discovered is useless, sooner or later it will find its place and application to some useful purpose for the benefit of man. Let us not forget that nearly all our comforts and amenities of life owe their origin in discoveries of science not made to find means to provide those comforts and amenities, but research into the untold mysteries and fundamentals of nature. Wisely directed scientific research pays, even in this materialistic age.

The scientific work carried on by the Government of Canada is creditable. There is a large field to cultivate, and the people have a right to ask that it be well tilled, and that the harvest may be commensurate with the labor and cost.

DOMINION OBSERVATORY,
OTTAWA, CANADA.