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THE EQUATORIAL OF THE PARIS OBSERVATORY.

The accompanying engraving is the first representation that has been given of the remarkable instrument recently mounted at the Paris Observatory, and the ingenious arrangement of which is due to Mr. Loewy, the Subdirector of the establishment. It was begun under the administration of Mr. Delauny, was interrupted during the war, and has just been finished, thanks to further liberality on the part of Mr. Bischoffstein.

The equatorial is one of the essential instruments of astronomy. What is named thus is a telescope by means of which observations can be made on a star situated at any point whatever above the horizon, and which consequently allows such star to be followed during the whole period of its apparent motion, in such a way that nothing connected with the incidents that occur during its course, nor with the modifications that may take place in its form, luster, or dimensions, shall escape the attentive observer.

In order to answer the needs of modern astronomy, equatorials must be of gigantic size. As with cannons, each new apparatus possesses dimensions that are greater than those of the older ones, although we do not aim at celestial bodies in order to destroy them! Every one has seen, on the Observatory terrace, the cupola which protects the equatorial, and may thus judge of the size of the apparatus, although this is not of the greatest. Its weight is considerable, and this renders it hard to move, despite the simplicity and perfection of the mechanism by means of which it is maneuvered. The star under observation moves continuously in the heavens, and this necessitates a corresponding motion of the apparatus and observer, not only from the right to the left and *vice versa*, but downward and upward. Besides, the cupola itself must be set in motion and revolve around its axis, so that its aperture may be constantly opposite the telescope. Observation requires, then, to speak of the principal motions only, a motion of the telescope, of the observer, and of the cupola. When we add that the observer is obliged to sit or lie prostrate, sometimes in a very inconvenient position, it will be seen, on the one hand, that the duration of the observations becomes diminished by the length of time consumed in the maneuver, and, on the other, that the fatigue of the astronomer interferes with the accuracy of the observation.

Such inconveniences are so serious that, in certain cases (when, for example, it concerns a search for comets, where a great extent of space must be gone over), the astronomer is obliged to dispense with the use of large equatorials, and is reduced to the employment of smaller and less advantageous apparatus. But these are not the sole inconveniences, for there are others of a graver nature, such as a want of stability in large equatorials, so as to render it impossible to accurately measure great angular distances; the effects of flexion; and that getting out of center of the objective, which is so prejudicial to the sharpness of the image. We are thus in a position to appreciate the advantages of the new equatorial, which permits, as we shall see, (1) of the measurement of great angular distances, and (2) of making observations with relative ease and rapidity. Seated upon a stationary chair, independent of the support of the instrument, the astronomer is placed as if in front of his table, writing. The instrument obeys him, and not he the instrument.

The new telescope is bent at right angles. One part runs in the direction of the world's axis, and the other, which is perpendicular to it, consequently moves in the plane of the equator. At the extremity of this latter part there is a mirror, and at the elbow of the telescope, and in the interior, another one, both making with the axis an angle of 45°. These two mirrors are designed for sending from one to the other, and to the observer seated with his eye to the ocular, the image of the star to be observed.

The loss of light as a consequence of these successive reflections is scarcely perceptible. Any distortion of the images that might have resulted from the use of too thin mirrors has been avoided. So, as regards its optical qualities, the new equatorial is not surpassed by any of the telescopes of the Observatory. A double result is here attained: first, the possibility of measuring great angular distances, and second, that of the astronomer's exploring the entire heavens without moving, and while governing the apparatus personally.

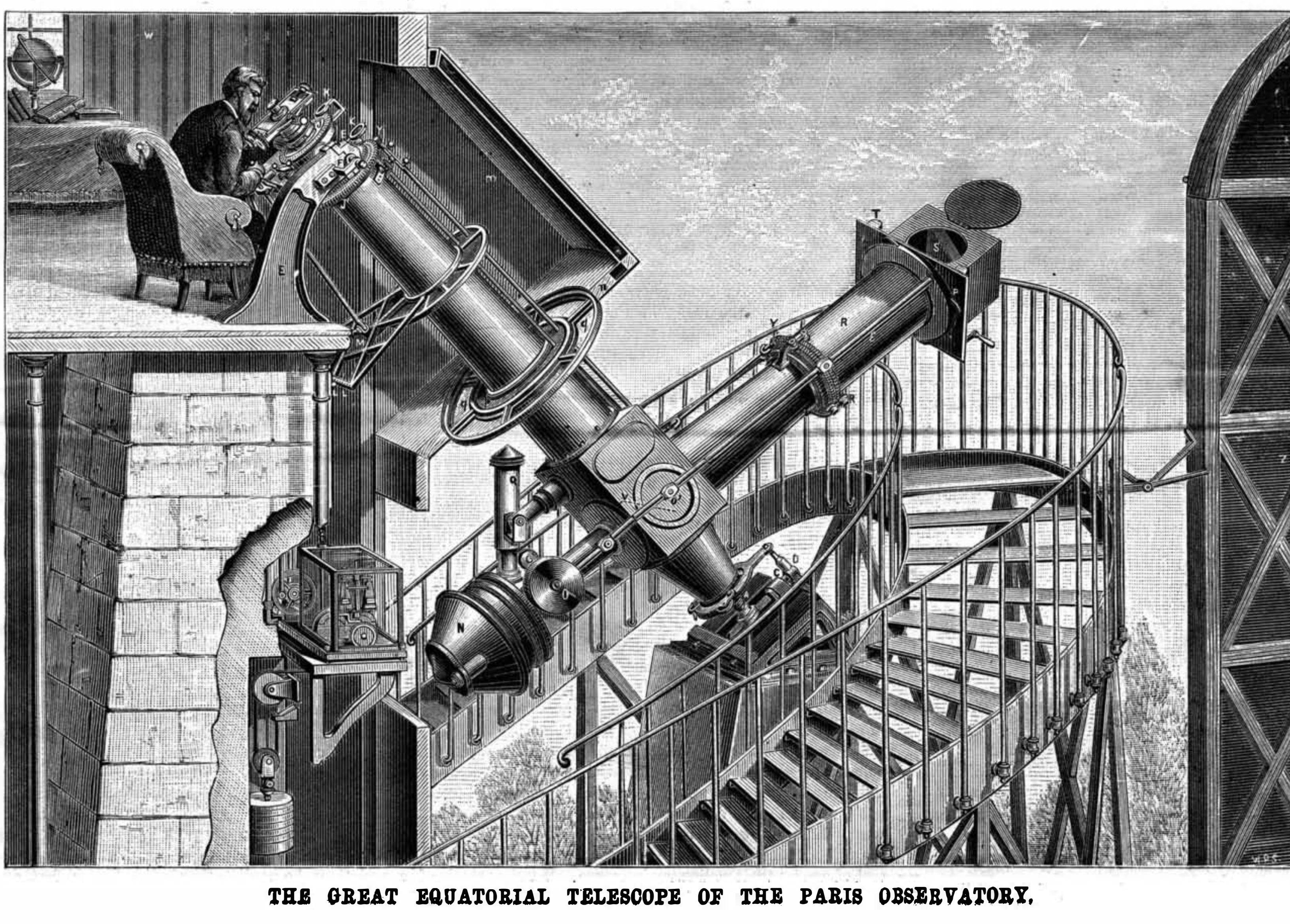
One consequence of these happy arrangements is the suppression of the heavy, ugly, and costly cupola, this being replaced by a pavilion that occupies less space and is simpler in construction. It consists of a movable part that shelters that portion of the instrument that carries the objective, and of a fixed part wherein sits the observer. When it is desired to proceed with observations the movable part, which slides easily upon a railway, is shoved back. The extremity of the telescope that carries the objective is thus uncovered, while the astronomer, seated in the fixed part as if in his study, and sheltered from inclement weather, studies the infinitely great under the same conditions as the naturalist who examines the infinitely small with his microscope.

The optical part of the instrument was made by Messrs. Henry Brothers, and the mechanical by Messrs. Eichers & Gauthier.

Technical Description.—The body of the telescope is formed of two cast iron tubes mounted at right angles upon a rectangular parallelopipedon having a square base, and prolonged by a trunnion, A, on the side opposite that on which is fixed one of the tubes, with which it forms the horary axis of the instrument. At the upper part of this tube there is fixed a piece of bronze, which serves both as the upper trunnion of the axis and as a slide ring for the reception of the micrometer. This piece of bronze, which forms the extremity of the polar axis, rests, itself, in a bearing provided with trunnions adjusted in the uprights, E, which latter are fixed upon a cast iron base sealed into stone and isolated from the flooring. The instrument may be regulated in azimuth by stops, F, which act upon the bearing, E. The screws of these stops, on acting upon this bearing, move the polar axis from east to west. The trunnion, A, rests in a conical bush adjusted by screw in a slide, C, which may be moved by a screw in order to regulate the inclination of the axis. The point of the trunnion, A, is finished off with a piece of tempered steel, and bears on the tempered extremity of a screw that enters the bush. The effect of this screw is to limit the friction of the trunnion, A, in the bush. The system of friction rollers, D, which is held by a lever, D', serves likewise to ease the friction of the trunnion in its bush.

The horary circle, J, which is carried by the upper trunnion of the axis, gives the seconds of time by means of verniers, three in number, the reading being made through a movable lens, K. The declination circle, which is placed a little to the rear of the horary one, gives the ten seconds of an arc through verniers that are likewise three in number and connected by the lens, K. The alidade is fixed to the horary axis. The circle revolves upon an axis and is moved by a pinion, Y, that transmits the circular motion of the sleeve, R. A strong toothed wheel that gears with a pinion makes

(*Continued on page* 372.)



THE GREAT EQUATORIAL TELESCOPE OF THE PARIS OBSERVATORY.

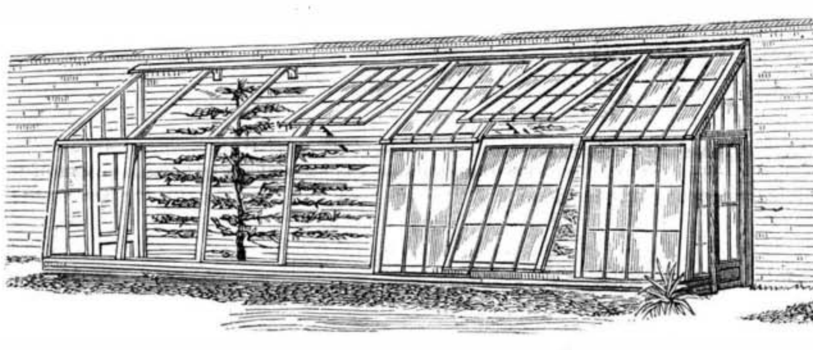
THE EQUATORIAL OF THE PARIS OBSERVATORY.

(Continued from first page.)

it possible for the observer to quickly move the instrument into any position by revolving the winch placed at his right. The toothed arc, L, revolves upon the horary axis and slides upon the bronze limb of a circle which is likewise fixed to the axis. A lever, M, renders the arc immovable at will, so that the latter need not be freed from the tangential screw when it is desired to free the instrument itself. The weight that actuates the wheelwork is wound up on a rod by means of a winch that may be removed at will. The back motion in right ascension is given by a button, and the tangential screw is disengaged with a key by acting upon a button. The clockwork movement is capable of being stopped when in motion, and *vice versa*. The steel sleeve, R, which is adjusted by slight friction on the cast iron tube of the telescope, is provided with two toothed circles. With the first of these gears the pinion, Y, which transmits motion to the divided circle placed near the ocular. With the second gears another pinion, which causes the revolution of the sleeve, through the winch placed within reach of the observer. The sleeve is carried and held at its base by three double rollers, R', fixed to the telescope tube. The counterpoise, O, is fixed to jointed levers, E, which pivot upon studs, O', and act upon the four rollers upon which the sleeve rests. At the upper part of the latter is fixed the mounting of the mirror, S, of 40 centimeters. This mirror is adjusted in a cast iron cylinder, in which it rests upon a layer of flannel. The bottom of the cylinder, which contains apertures 40 millimeters square, is movable, and gives a means also of regulating the pressure. The cylinder is held in its mounting by two trunnions, and is regulated by an adjusting screw. The mirror is inclosed in a square metallic box having in each end an opening that is closed by hinged covers. Upon the sides of this box are placed two comet seekers, T. The objective is fixed to the tube of the telescope, and the small mirror, V, which is placed in the square box, rests also on a layer of flannel in a cast iron cylinder carried by an adjustable mounting. A gas lamp, Q, serves for lighting up the interior of the telescope, and makes the black threads show upon a brilliant field, and the bright threads upon a dark background. The threads are accurately brought into the focus of the objective by revolving the small sleeve to the right or left.—*La Nature.*

SIMPLE GARDEN IMPROVEMENT FOR PROMOTING WINTER GROWTH.

The accompanying engraving so well shows the idea of the sort of half hothouse proposed that it cannot fail to be at once understood. The winters over a large portion of the United States have so few extremely cold days and nights that, with a cheap and simple protector like this, many plants and shrubs might live through the year, when they would not otherwise do so. It will be seen from the illustration that the frame which holds the glass is designed to be attached to a wall or high fence on one side, and may be put up in sections small and light enough to be easily moved from one place to another. A similar device, or one on the same principle, might, we should think, be useful in the way of encouraging the laying of fowls during the winter months.



FRAME FOR PROTECTING TREES IN WINTER.

The Northern Pacific as seen by an Englishman.

At a recent meeting of the Institution of Civil Engineers, Mr. G. B. Bruce, Vice-President, gave an account of his recent visit to the United States of America as the representative of the Institution, on the occasion of the opening of the through line of the Northern Pacific Railroad.

The railroad is based upon a concession from the government, the company making the road, and the government giving 25,000 acres of land per mile of road constructed, in alternate sections, the government holding one block and the company the next. The railroad lies mainly between the 46th and 47th parallels of north latitude, about 200 miles ~~south from the boundary between Canada~~ and the States, and 300 miles south of the Canadian Pacific Railway. The distance between the termini, Lake Superior and Puget Sound, was about 2,200 miles. Besides this, there was a branch from Brainerd on the main line to St. Paul on the Mississippi, which would probably be the chief route for traffic between the Northern Pacific towns and the Eastern ports.

Proceeding northwestward from St. Paul, the country at first was chiefly under wheat; some distance after passing the Missouri it was mainly devoted to raising cattle. Mr. Bruce was particularly struck with the bridges on the line. The crossing of the Missouri at Bismarck was effected by an iron bridge 1,450 feet long, having ~~three~~ spans of 400 feet each and two spans of 113 feet each, and was 50 feet above the highest level of summer floods. The large girders were 50 feet deep. The majority of the bridges throughout the road were of timber, the most remarkable being among the Rocky Mountains. Here, too, were the steepest gradients on the line, the maximum being 116 feet to the mile. The crossing of the summits of the two ranges would be by two tunnels, each 1,200 yards long; at present temporary roads had been laid over the mountains. Mr. Bruce considered the passage of the Columbia River through the Cascade Range the most imposing feature of the line.

The road at this point, for a considerable distance, is carried along a ledge made by blasting away the almost perpendicular hillside into the river below. The rails were of steel, 56 pounds to the yard; the road was well sleepered and reasonably ballasted; and there were all the elements of a good and substantial road, which in time will rank doubtless among the best in the United States. There was no signaling apparatus, but great use was made of the telegraph. In one feature the American engineers seemed to be particularly distinguished—namely, in the arrangement of their work, and in the strictly systematic manner in which they carried it forward under very difficult and trying circumstances. The visitors were conducted in four trains of about ten Pullman carriages each. They all left New York, and were ready to start from Chicago on the 1st of September.

They met with a hearty reception at the cities of St. Paul and Minneapolis, which, though not forty years old, each contain a population of between 80,000 and 90,000, and are the centers of large industries. Notwithstanding the lack of timber over many hundreds of miles in the center, the discovery of coal in that very locality would make it easy to supply the engines with fuel. The Westinghouse brake seemed to be in general use in America. The whole trip was carried out with very few mishaps; one or two slight accidents were the outcome of the running together of carriages from different lines, the couplings of which did not correspond. The great ceremony of the occasion was driving the last spike at the "Garrison" Station, at the foot of the eastern side of the Rocky Mountains, when about half a mile of track was laid in about half an hour.

Mr. Bruce then alluded briefly to some things not connected with the Northern Pacific Railroad. He was struck with the much greater use made of the electric light in America than in England. In many little cities in the prairies, a high pole in the middle of the town with a light on it illuminated the whole place. He very much admired the steamboat accommodation in the United States, and remarked that the arrangements for landing in Liverpool, in a steam tug without even a covering to keep off the rain, contrasted most unfavorably therewith, and were a disgrace to England and to the companies which perpetuated them. While at Chicago, Mr. Bruce went to see the new works of the Pullman Car Company. There was now there a town of 7,000 inhabitants, where three years ago there was nothing but an unoccupied stretch of country. The chief feature was in the surroundings of the works; everything had been done for the welfare and comfort of the workmen, and the whole had been a great financial as well as moral success.

Gutta-Percha Stopping.*

CHAS. E. FRANCIS, D.D.S., NEW YORK.

Among the various preparations for filling carious teeth, gutta-percha stopping holds an exceedingly important place.

Cases are commonly presented where defective teeth can be better preserved if filled with this material than with any other substance. Owing to its nice adaptability to the dentinal walls, together with its slightly expansive nature, it can be made to seal cavities in which it is packed, with a remarkable degree of thoroughness.

For bucco-cervical cavities of second and third molars, it will stand for years, and prove exceedingly effective in preventing renewed decay.

It is frequently and advantageously used for packing against cervical walls of large buccal or approximal cavities, prior to introducing fillings of oxyphosphate of zinc or amalgam; also for repairing large gold fillings with cervical borders slightly undermined.

As a stopping for deciduous teeth, it can be quickly introduced, and in most cases answers admirably; also for impoverished or poorly calcified teeth when attacked by caries, and is peculiarly well adapted in cases of white decay or where the tooth structure is undergoing rapid decalcification.

As a temporary stopping for early decay in permanent teeth, nothing can surpass or perhaps equal it for safety. It holds good until the dentine becomes more dense, and the patient older and better able to tolerate the introduction of compact gold fillings.

In cases where the dental pulp is nearly or quite exposed, protection should be afforded by a covering of oxyphosphate of zinc to prevent pulpitis, which might be occasioned by the expansion and consequent pressure of gutta-percha stoppings. Similar care should also be observed where the enamel walls are so exceedingly frail as to become easily fractured.

Although these stoppings are liable to wear away when much exposed to attrition, the surrounding cavity walls usually remain well preserved. They are, moreover, easily repaired or renewed, and with no loss to the tooth structure.

For large stoppings, much exposed to wear, caps of gold plate can be fitted to cover them accurately, on the cavity surface of which may be soldered small loops or "T" shaped anchors. Such a cap, warmed over a spirit lamp, can be embedded in or united with the fillings, leaving a firm gold surface on which to masticate.

With a degree of tact and experience, gutta-percha stoppings can be manipulated readily and with comparatively little trouble. Cavities should be prepared as nicely as possible, and kept dry while filling is introduced.

Small pellets of the stopping heated to a plastic condition can be carried to the cavity on the point of a small curved and flattened instrument. Gentle pressure against the walls packs it securely. The excess can be trimmed away with flat heated instruments, and the surface rubbed with burnishers. A bit of cotton or spunk moistened with chloroform, held with tweezers and passed over the filling, will also aid in smoothing it.

Great care is requisite to avoid over-heating the material. If warmed over a spirit lamp it must be held considerably above the flame. It is safer to place bits of the stopping on a piece of heated porcelain or a small covered vessel of boiling water, preparatory to use.

Gutta-percha stoppings, if well impacted in properly prepared cavities, seldom prove treacherous, but as a rule are exceedingly safe and reliable.

* Frequent inquiries concerning the practical value of this material and the method of manipulating it, the writer states to be his excuse for printing the following communication, which we copy from the *Independent Practitioner.*

Analysis of Luminous Rays.

A means of isolating the heat rays from any luminous source, intercepting the illuminating and chemical rays, has been communicated to the Academie des Sciences by M. Van Assche. Upon a piece of glass he lets fall a drop of melted and sublimated selenium, which is immediately covered by a thin glass; and the melted material is then squeezed gently until it is extended into a very thin, homogeneous sheet. The glass is then placed under pressure and gradually cooled. It is necessary that the selenium should not boil on the glass, or otherwise cells are ~~formed by means~~ of the vapor, which interfere with the action of the material. When properly made the cell is of uniform thickness, and is free from bubbles and striations. Cells so constructed, when placed in the path of a ray of light, reflect the chemical rays, and convert the luminous ones into electrical energy. Only the calorific rays pass through the cell; being at the same time subjected to a definite refraction. The transmitted light is monochromatic, of a ruby-vermilion tint, only showing one luminous band in the spectroscope. If the light of burning sodium is passed through this form of cell, there is annihilation of luminosity. The author contends that an arrangement of this kind will form a considerable addition to the apparatus used for analyzing light and determining the constituents of flames.

Purification of Sewage.

Experimental trials of the Andrews-Parker process for deodorizing and purifying the sewage of London have been in operation since last May. The 90,000,000 of gallons daily and nightly flows into subterranean reservoirs located beyond Beckton. By the action of water and repeated pumping before the last station is reached all the fecal matter in the sewage is reduced to a liquid having a grayish-black appearance and an extremely offensive odor. The sewage, after having been drawn into a tank, is subjected to a powerful stream of water, under heavy pressure, charged with ground clay, caustic soda, hydrochloric acid, and sulphate of iron. The mixture is then turned into large tanks, where it is allowed to remain until the action of the precipitates has thrown all the sediment to the bottom, when the liquid is drawn off into the Thames, it being a pure, colorless, and odorless water. The sediment is kiln dried and pulverized, and makes a fertilizer which chemical analysis has shown to contain a large proportion of ammonia and phosphates, and to be of much commercial value.

Underground Cables.

Considering the interest which attaches now to the question of overhead *v.* underground cables, it may be useful to give the figures of the underground cables in existence at the end of 1881. They were as follows:

Countries.	Length in kilometers of cables.	of wires.
1 in Germany	5,500	37,605
2 in Austro-Hungary	29½	511
3 in Belgium	11	232
4 in Denmark	3	79
5 in France (including colonies)	851	11,880
6 in Great Britain and Ireland	771	17,700
7 in The Netherlands	96	591
8 in Roumania	11	56
9 in Russia	202	250
10 in Switzerland	45	327
	7,519½	69,231