this matriculation record shows him to have been born eleven years *later* than was supposed. This is material, for it will be seen from what has preceded that his memory is thus cleared of the imputation under which it at one time seemed to rest, of his having adopted the name of Smithson in circumstances where a son should have remained silent.

We have also an authentic contemporary portrait of him in the dress of an Oxford student, here reproduced [omitted in this reprint], which, it is interesting to observe, confirms the age thus given, by representing him as a mere youth.

Nothing material is remembered of his life at the college, except a tradition that he was the best chemist and mineralogist of his year, though in his journal, when but a youth of nineteen, he gives a description of a geological tour in 1784 through Oban, Staffa, and the Western Islands, in company with De St. Fond, "the celebrated French philosopher," and the Italian Count Androni, in which he carried on observations on the methods of mining and manufacturing processes, made with all the minuteness which the conditions of the journey permitted. The journal indicates that the tour at that time was undertaken, if not at any considerable risk, yet not without a considerable amount of privation and self-denial, such as would not be met by the modern traveler, and shows that he was far more occupied with science than with the ordinary pleasures of so youthful a tourist. We learn also that the young student was noted for diligence, application, and good scholarship, attracting attention by his proficiency in chemistry, then a novel study, while his vacations were ordinarily passed in such excursions as that just referred to, and devoted to the collection of minerals and ores, which it was his favorite occupation to analyze. At Oxford, then, at a time when the study of physical science was almost unknown in the university, he appears to have already conceived that devotion to scientific research which characterized all his future life.

He was graduated at Pembroke College, with the degree of Master of Arts, on May 26, 1786, as James Lewis Macie, and admitted as a Fellow of the Royal Society on April 26, 1787, on the following recommendation:

"James Lewis Macie, Esq., M. A., late of Pembroke College, Oxford, and now of John Street, Golden Square—a gentleman well versed in various branches of Natural Philosophy, and particularly in Chymistry and Mineralogy, being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed, do, from our personal knowledge of his merit, judge him highly worthy of that honor and likely to become a very useful and valuable Member.

RICHARD KIRWAN,
C. F. GREVILLE,
C. BLADEN,
H. CAVENDISH,
DAVID PITCAIRN."

Cavendish, whose name appears here, was the eminent physicist, and, as we learn elsewhere, was an intimate friend.

Smithson's lodgings were for some time in Bentinck Street, where Gibbon wrote much of his "Decline and Fall of the Roman Empire." Here he apparently prepared his first scientific paper, which was signed James Lewis Macie, and was read on July 7, 1791, before the Royal Society. It is entitled "An Account of Some Chemical Experiments on Tabasheer."¹³ We learn of him incidentally in 1792 as journeying from Geneva to Italy through the Tyrol, and find him in the same year in Paris writing from the Hôtel du Parc, Rue de Colombyer, a letter in which he expresses sentiments which represented what would have been then called advanced Jacobinism. "*Ca ira*," he says, "is growing the song of England, of Europe, as well as of France. Men of every rank are joining in the chorus. Stupidity and guilt have had a long reign, and it begins, indeed, to be time for justice and common-sense to have their turn . . . the office of king is not yet abolished, but they daily feel the inutility, or rather great inconvenience, of continuing it and its duration will probably not be long. May other nations, at the time of their reforms, be wise enough to cast off, at first, the contemptible incubrance." Smithson here shares the opinion of a large and influential portion of Englishmen of the time in which he wrote, but the excesses of the French Revolution, which immediately followed, caused a general revulsion of feeling, and it would not be fair to argue from this youthful expression as to his maturer judgment.

The date of his application to the Crown for permission to take his father's name has not been ascertained, but in the will of his half-sister, Dorothy Percy, he is referred to as "Macie" in 1794 (eight years after his father's death). The name of Smithson is first

Coll: Di. Jo. Bap. 4°. Thomas Keck 17 Samuelis de Civitate Londin:—Gen: Fil:

changed to Smithson

Coll: Pemb: 7°. Jacobus Ludovicus Macie 17 de Civit: Londin:—Arm: Fil:

Coll: Ball: 8°. Hon. Archibaldus Cathcart 18 Caroli de Aloa Com: Clackmanan: Baros. Fil:

Coll: Di. Jo. Bap. 9°. Thomas Dethick 17 Thomae de Bombay apud Ind: Orient: Arm: Fil:

Coll: On: Nas: 10mo. Arthurus Townson 18 Joannis de Bentham Com: Eboracensi—Pleb: Fil:

Coll: Christi 10mo. Calverley Joannes Bewicke 17 Benjamin de Clapham Com: Surriae Gen: Fil:

Coll: Magd: 11°. Isaacus Williamson 21 Josephi de Withburn Com: Cambr: Gen: Fil:

¹³ Philosophical Transactions of the Royal Society of London, Volume LXXXI, part II, page 368.

certainly known to have been used by him in connection with his second communication to the Royal Society, "A Chemical Analysis of Some Calamines," by James Smithson, Esquire," read November 18, 1802.

In this paper the author remarks that "Chemistry is yet so new a science; what we know of it bears so small a proportion of what we are ignorant of; our knowledge in every department of it is so incomplete, consisting entirely of isolated points, thinly scattered, like lurid specks on a vast field of darkness, that no researches can be undertaken without producing some facts leading to consequences which extend beyond the boundaries of their immediate object."

The Abbé Haüy had advanced the opinion that calamines were all mere oxides or "calces" of zinc. Smithson's analysis completely overthrew this opinion, and established these minerals in the rank of true carbonates, while his remarks on the action of the ores of zinc before the blowpipe evince much discernment; and the paper, on the whole, is altogether a creditable one.¹⁴

At this period he seems to have ceased his contributions to the Royal Society, and later we find his name more frequently in the "Annals of Philosophy," a journal of high character, where there is a communication from him dated Paris, May 22, 1819, on "Plombe gomme," and about the same time a paper on a native sulphuret of lead and arsenic, with numerous other papers, among which is one in 1822, "On the Detection of Very Minute Quantities of Arsenic and Mercury," where he contributed a method which was generally used by chemists until quite modern tests superseded it. The papers¹⁵ in all number twenty-seven, of which eight here cited were published in the "Philosophical Transactions of the Royal Society," between the years 1791 and 1807, one in the "Philosophical Magazine" in 1807, and eighteen in "Thomson's Annals of Philosophy," between 1819 and 1825, and these all give the idea of an assiduous and faithful experimenter, an impression enlarged by the last one of the series, bearing date of June, 1824, which contains some observations on the formation of the Kirkdale Cave, forcibly combating (with what was then originality) the theories of the time, which referred the bones there found to "The Deluge."

"The most notable feature of Smithson's writings from the standpoint of the modern analytical chemist," says Prof. Clarke,¹⁷ "is the success obtained with the most primitive and unsatisfactory appliances. In Smithson's day chemical apparatus were undeveloped, and instruments were improvised from such materials as lay readiest to hand. With such instruments, and with crude reagents, Smithson obtained analytical results of the most creditable character, and enlarged our knowledge of many mineral species. In his time the native carbonate and silicate of zinc were confounded as one species under the name 'calamine,' but his researches distinguish between the two minerals, which are now known as Smithsonite and calamine respectively.

"To theory Smithson contributed little, if anything; but from a theoretical point of view the tone of his writings is singularly modern. His work was mostly done before Dalton had announced the atomic theory, and yet Smithson saw clearly that a law of definite proportions must exist, although he did not attempt to account for it. His ability as a reasoner is best shown in his paper upon the Kirkdale bone cave, which Penn had sought to interpret by reference to the Noachian deluge. A clearer and more complete demolition of Penn's views could hardly be written to-day. Smithson was gentle with his adversary, but none the less thorough for all his moderation. He is not to be classed among the leaders of scientific thought; but his ability, and the usefulness of his contributions to knowledge, cannot be doubted."

(To be continued.)

MELTING SLEET ON A THIRD RAIL.

By W. A. DEL MAR.

FROM time to time electric heating as a method for removing sleet from the contact rail has been suggested. The idea seems an excellent one at first thought and engineers have been tempted to make experiments with the view to finding the quantity of electrical energy required for the purpose. These experiments have always shown that the energy required to heat the rail is exceedingly large, and principally on this account the method has never been adopted. The

¹⁴ Philosophical Transactions, Volume xciii, page 12.

¹⁵ Smithson's subsequent communications to the Philosophical Transactions are six in number:

"An Account of a Discovery of Native Minium," submitted in a letter dated from Cassel, in Hesse, March 2, 1806. (Volume xcvi, part 1, page 267.)

"On the Composition of the Compound Sulphuret from Huel Boys, and an Account of its Crystals," 1808. (Volume xcvi, page 55.)

"On the Composition of Zeolite," 1811. (Volume ci, page 171.)

"On a Substance from the Elm Tree, called Ulmin," 1813. (Volume ciii, page 64.)

"On a Saline Substance from Mount Vesuvius," 1813. (Volume ciii, page 256.)

"A few Facts relative to the Coloring Matter of Some Vegetables," 1817. (Volume cviii, page 110.)

A paper by him "On Quadruple and Binary Compounds, particularly Sulphurets," was also published in the "Philosophical Magazine," 1807. (Volume xxix, page 275.)

¹⁶ These papers were collected and edited by William J. Bees, and are contained in Volume xxi of the "Smithsonian Miscellaneous Collections," under the title of "The Scientific Writings of James Smithson" (1879).

¹⁷ Communication from Prof. Frank W. Clarke, Chief Chemist, United States Geological Survey.

object of this article is to show why this large amount of energy is required.

It is a difficult matter to show just what expenditure of energy would be necessary to raise the temperature of the rail a certain number of degrees, but it is easy to show that a large amount can be expended without appreciably affecting the temperature.

When one pound of water has its temperature raised one degree Fahrenheit above the air, it absorbs about one thermal unit, equivalent to 0.2835 watt-hour. The specific heat of iron being only about 0.114 that of water, one pound of rail will absorb but 0.323 watt-hour when its temperature is raised one degree. Now, it can be assumed that in order to melt ice from a contact rail, the temperature must, under fairly normal conditions, be raised at least ten degrees Fahrenheit. A system for heating the rail which would fail a few degrees below freezing point would scarcely be worth installing, so that this assumption of ten degrees rise is quite a moderate one. From the figures given above it appears that in order to heat one pound of rail ten degrees Fahrenheit in one hour, 0.323 watt-hour would have to be used, regardless of the losses by radiation, convection, etc. On a 100-pound rail this amounts to 10.75 watts per foot on the assumption that no heat is lost in any way whatsoever; but in actual cases the losses are very great.

The heat radiated from a square foot of rusty iron is found by experiment to be about 0.7 B. T. U. per hour per degree Fahrenheit difference of temperature between the iron and air—provided that such difference does not exceed 30 deg. This is equivalent to 0.198 watt per square foot per degree. Now, on one foot of 100-pound rail there are 2.08 square feet of surface. Hence, the radiation per foot of rail will amount to 0.412 watt per degree. This does not allow for losses by convection, evaporation, etc. Assume that in heating the rail ten degrees the average difference between the air and rail is five degrees. The radiation will then be at the rate of about 2.1 watts. If this quantity be added to the heat used in raising the temperature of the iron, a total of nearly 13 watts is obtained as the power necessary to heat one foot of 100-pound rail ten degrees in one hour. On a railway having fifty miles of 100-pound contact rail, this would amount to 3,432 kilowatts, assuming a dry rail, no ice to melt, and no loss by evaporation and convection. This quantity has to be greatly increased in order to supply energy for melting the ice.

One pound of ice at 32 deg. F. requires the expenditure of 142.65 B. T. U. to melt it without raising its temperature. This is equivalent to 40.44 watt-hours. Hence, in order to melt one pound of ice in one hour, 40.44 watts are required. A deposit of sleet or snow one-eighth of an inch thick covering two-fifths of the surface of a 100-pound rail, weighs about half a pound per foot. Hence on 50 miles of contact rail there would be 132,000 pounds, which if to be melted in one hour would require a provision for that period of 5,280 kilowatts. This is assuming a heating efficiency of 100 per cent; that is, neglecting losses by convection, radiation, etc.

In case of a sleet deposit, it would of course not be necessary to melt a film one-eighth inch thick, for if a film, say 1-100 inch thick were melted, the remainder would be so loosened as to be easily removed with a brush or scraper. A film 1-100 of an inch thick on 25 of the rail surface would weigh 10,560 pounds on 50 miles of 100-pound rail. Assuming a heat efficiency of 100 per cent, this would require to melt it in one hour, a provision of about 427 kilowatts. This would merely supply the latent heat in melting. If the rail were kept 10 deg. F. hotter than the air, the radiation in one hour would require at least 550 kilowatts, assuming a perfectly dry rail. In order to heat the rail 10 deg. F. in one hour about 2,830 kilowatts are required, assuming no losses. Thus the minimum power required to melt 1-100 of an inch of sleet from 50 miles of 100-pound rail, amounts to at least 3,800 kilowatts. This neglects two of the greatest sources of heat loss, namely, by evaporation and by wind convection. It is possible that there might be conditions under which it is not necessary to heat the rail 10 deg. F., but a sleet-melting system would not be worth installing if it could fail at such a moderate temperature as 10 deg. below the freezing point, besides which in practice the ice would have to be melted in much less than one hour.

Experiments with contact rails have shown that if the rail is kept moist with water 10 deg. hotter than the air, the temperature of the rail will not rise even if 16 watts per square foot are expended on it. With 100-pound rail this is 32 watts per foot length. This power on fifty miles of rail amounts to about 8,500 kilowatts. Thus practice shows that an expenditure of 8,500 kilowatts on 50 miles of 100-pound rail has no effect in heating the rail, regardless of the important matter of melting ice.

It might be suggested that it is useless to heat so much rail at a time; that in fact it might be better to heat one section at a time and then go on to another. This is impossible, however, owing to the low heat storing quality of iron. As shown above, the heat capacity of a foot of 100-pound rail is only 10.75 watt-hours, a quantity that would be dissipated in a few minutes. Not only is the cost of energy for electrically heating the third rail enormous, but the cost of apparatus for generating, transforming and distributing this energy is quite absurd, considering the doubtful value of the system under the best conditions.

Contrast the electrical method with the use of hot water. One pound of ice at the melting point can be

melted by using 142.65 B. T. U. A deposit of ice $\frac{1}{2}$ inch thick on 2.5 of the surface of 50 miles of 100-pound contact rail weighs 132,000 pounds. To melt this 18,829,800 B. T. U. are required. If water at 180 deg. F. be used, 104,590 pounds will be required. This is about 1,700 cubic feet at a heating efficiency of 100 per cent. Assuming the heating efficiency to be only 10 per cent, the number of cubic feet required will be 17,000. If the ice be below the freezing point, a few cubic feet must be added to this. Suppose it to amount to 20,000 cubic feet, which can be contained in a few tank cars of moderate size. Of course, in order to prevent this water freezing on the rail, it must contain salt or some other substance that lowers the freezing point of water. There are serious objections to the hot water method, but these may yet be overcome, and then the sleet scare will be relegated to the past with the scores of other bugbears that have worried engineers and set inventors to work on ideas barren and futile.—*Electrical World and Engineer.*

THE PANORAMIC TELESCOPE.*

I. INTERNAL ARRANGEMENT OF THE PANORAMA TELESCOPE.

The panorama telescope, made by C. P. Goerz, of Berlin and New York, owes its name to the characteristic of giving the full or complete view of the field of 360 deg. without compelling the observer to move either himself or the eyepiece of the instrument from its original, and if desired permanently fixed, position.

Fig. 1.—Simple Terrestrial Eyepiece, Looking Forward.

Fig. 2.—Simple Terrestrial Eyepiece, Looking Backward.

While in an ordinary telescope turning about a vertical axis or pivot the field lying about the observer can be swept only by a corresponding movement of the instrument, the ocular end included, thus compelling the observer to follow it around, in other words, to change his position about the standard throughout the complete circle; in the case of the instrument which we now present the ocular end and, as a consequence, also the observer, remains fixed. To make the use of such an instrument practical in every particular the image obtained, aside from the magnification, must of necessity present itself in all respects as if it were seen by the unaided eye.

If to obtain the panoramic effect in an ordinary terrestrial or celestial telescope we should make use of the construction indicated in Figs. 1 and 2, which shows a combination of reflecting prisms, of which the one placed before the objective is adapted to revolve on a vertical axis, the image upon the retina would

For the interior optical construction then of such a panorama telescope, a combination of prisms must be selected which shall—

1. *Give an erect image*; which means that instead of the long unwieldy terrestrial eyepiece the simple eyepiece of a celestial telescope must be used.

2. *Maintain the image, even when sweeping the field about the observer, in its proper position*, i. e., that it shall always appear to the observer as if seen by the naked eye.

From a number of combinations fulfilling these requirements we shall select, and give below, those which prove themselves the most suitable to the development of a panoramic telescope, for the purpose for which it is chiefly intended, viz., the aiming of field guns.

In Fig. 3 we present such a combination, which consists of the following optical elements: A prism of total reflection, A, an image-erecting prism B, the objective C, a gable reflecting prism D, and the astronomical eyepiece O. It is easy to follow the course of the rays which, from the object, fall upon the prism A, are reflected upon the prism B, which effects the erection in one direction. Having passed through the objective C a lateral torsion is effected by the prism D, an image of the object is formed in its true position upon the ocular screen E, where it is magnified by the astronomical eyepiece O. The peculiarity of the prism B, with its quadrilateral cross section, consists in that while it turns through an arc of 180 deg. upon its major axis, the image is made to revolve through 360 deg., that is, the image turns just twice as fast as the prism.

small a target that the probability of being hit by the enemy's projectiles would be very remote.

As a sighting telescope for field guns or larger ordnance, for direct as well as for indirect range finding, the panorama telescope is peculiarly adapted, as will be fully set forth in the following section; and as such it forms a complement to the hydraulic recoil cylinder with shield. Of course the general construction of the instrument, such as the arrangement of its parts, its size, the optical and mechanical combination, depends much upon the nature of the functions it will be required to perform. While for a stable or fixed point of observation, a relatively large field, high magnifying

Fig. 3.—Panorama Telescope, Showing Arrangement of Simple and Compound Prisms. Fig. 4.—Exemplifies the Lateral Torsion of D.

power, precision in reading off the position of the optical axis, play the chief rôles, and shape, size and weight become of minor importance; the reverse is true where a sighting glass is needed for a field piece; for here the instrument must be compact in form, light in weight, and above all provided with substantial and strong securing devices for both lenses and prisms.

II. THE APPLICATION OF THE PANORAMA TELESCOPE TO ARTILLERY.

The application of telescopes as sighting instruments for large and small guns is not new, but up to within a few years it has consisted mostly of attaching a small spyglass with cross hairs over the objective to marine, coast-defense, or fortress guns, and this almost exclusively for direct sighting. With the increase in the effective range of the field gun it became necessary to

Fig. 5.—Front View of Telescope and Quadrant Attached to Arm of Gun.

Fig. 6.—Side View of Telescope, Showing Bent Tangent Rod.

suffer a torsion equivalent to the angle of inclination, or that made by the respective radius of the circle upon the axis of the instrument. To explain more clearly: what appears at the top of the image viewed as in Fig. 1, after the turning of the prism through an arc of 180 deg. will be seen at the bottom in Fig. 2; in other words, it will have suffered a complete inversion of 180 deg.

teeth of the worm drum H. By turning this screw the reflecting prism A, together with the prism B, may be made to describe a complete revolution about the central position, or position of the observer, bringing every point of the circular field into view, thus providing the panorama effect.

Where it may be necessary to reconnoiter from behind a shield in the field or coast defenses or upon vessels of war, the instrument enables the observer to maintain an unchanged position and to present so

employ a sighting glass that should permit the man behind the gun to recognize marks farther away and scarcely discernible to the naked eye, to follow up the effect of each shot, and thus to make the most perfect use of the greater precision attained.

So long as it was impossible to do away with the recoil and shock transmitted to the carriage after each shot, all attempts at a practical solution of the sighting problem were of little avail. In spite of the most approved and substantial construction in the mounting

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.