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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

PAUCITY OF MONUMENTS TO ENGINEERS.

The commemorative honors recently paid to the memory of John A. Roebling, whose name will be forever famous for the daring and skill with which he flung his beautiful suspension bridge across the East River, New York, suggest the thought that, if the winning of posthumous public memorials is reserved for those who have done not merely good service, but the most distinguished, widespread, and lasting service for their country, there should be many such memorials erected to commemorate the great engineers of the United States. We think it may be asserted without fear of contradiction that the engineer has had more to do with the phenomenal physical development of the United States than any other professional man. We mention the civil rather than the mechanical engineer first, for the reason that, in the development of a new country, it is he that blazes the way. Far in advance of the oncoming tide of civilization, he may have been found at any time during the past seventy-five years which cover the history of the railroad development of this country (to instance his greatest field of activity), solving with his transit and level and steel tape the problem of opening a highway through the prairies, mountains, and trackless forests of the middle and farther West. More often than not, he was a quiet, thoughtful man, making up in resourceful energy what he might lack in volubility and the arts of display. But where he has passed, he has left an imperishable record. As James J. Hill recently remarked, "The civil engineer is pre-eminently a man that does things"; and truly, he has done things with the hand of a Titan, as witness the 230,000 miles of railroad, freighted with a nation's wealth, with which he has covered the country. In his adaptation of means to ends, where the means were often all too scanty, he has shown the true hand of genius; for had he not broken away from the conservative methods of older and richer countries, the problem of the prairies and mountains of the West would be to-day unsolved, and we would still be speaking of the "Great American Desert."

Where, at the present writing, can we find any monument to these engineers who have made possible a railroad system which is one of the marvels of the twentieth century? Similar neglect has been shown in the broad field of mechanical and electrical engineering; whose pioneers have surely lain long enough in their graves to give an appreciative public time to determine to whom it should first erect its commemorative marbles.

We cannot be accused of being a people averse to the building of commemorative works, whether in the form of shaft, tablet, or statue; as witness the lavish hand with which the cities of the country and its battlefields have been adorned with memorials of our leading military men. Unfortunately, our work in this direction has been very much out of balance; and for one monument raised to men who have done service in the arts of peace, we may find fifty devoted to those who have gone forth to war. But perhaps the recent unveiling by the people of the city of Trenton of their statue to an engineer, whose fame was wider than any city or municipality could contain, may prove to be a suggestion that will bear fruit in the addition to the tributes to Ericsson and Holley, of others to men whose services were none the less distinguished because they were but little heralded.

INTERNATIONAL ELECTRICAL UNITS.

To secure the better definition of international electrical units and standards is the main reason for an international electrical congress, which will convene at London on October 12. Since the electrical congresses of Chicago in 1893 and of St. Louis in 1904, the subject of units and standards has been under the careful consideration of leading physicists and electrical engineers, and much experimental work has been carried on in various national and other laboratories with the object of obtaining data which would lead to the amplification and more accurate statement of the definitions adopted at Chicago. In the interval since that congress, each investigator concerned has been most anxious to introduce every possible refinement into his work, as any new decisions must be based largely on experimental evidence. At the St. Louis congress the delegates considered that the question could not be settled then by direct legislation, but should be considered by experts and taken up by a subsequent congress. First suggested for 1906, the coming congress has been twice postponed, but now, apparently, matters are in shape to enable it to consider the steps which should be taken to bring about agreement in the definition of electrical units which shall form the basis of legislation in different countries, and in the methods of constructing and employing the electrical standards necessary to give effect to these definitions. In discussing the units and standards the main question will be whether the volt or the ampere shall be recognized as the primary unit with the ohm. For as all electrical measurements are derived from Ohm's law, $I = E/R$, or the intensity of the current varies directly as the electromotive force and inversely as the resistance, if we have any two of these units we can derive the third. Now it is universally agreed that the ohm, or practical unit of resistance, shall be one of the primary units, but when it comes to the other there is a difference of opinion as to whether it should be the ampere, or unit of current, or the volt which is the unit of electromotive force. These practical units are all defined in terms of the C. G. S. or absolute system, but this is purely theoretical; and just as we refer to a certain platinum-iridium meter bar as our standard of length, so in electricity we must have certain standards that actually realize any definition adopted. Thus for the ohm there is little difficulty in realizing the definition of the Chicago congress, that the international ohm, based on 10^9 units of resistance of the C. G. S. system, should be represented by a column of mercury at 0 deg. C., 14.4521 grammes in mass, of constant cross-sectional area and 106.3 centimeters in length. But the Chicago congress also defined the ampere as the current depositing 0.001118 gramme of silver under specified conditions in a coulometer or silver voltameter, and the volt as 1000/1434 of the electromotive force of a Clark cell under standard conditions. These separate definitions of the ampere and volt, however, did not meet with universal acceptance, and in several countries other definitions legally were authorized. In the meantime the coulometer was subjected to further investigation as well as the Clark cell, while the Weston cadmium cell was developed and found superior to the Clark in several important particulars. In fact, those working with the standard cells pointed to their greater accuracy and reproducibility, and urged that the volt as thus defined be taken as the fundamental unit. In behalf of the American physicists this view was vigorously presented at a meeting of representatives from various national laboratories and bureaus of standards which was held at the Reichsanstalt at Charlottenburg near Berlin in October, 1905, by Prof. H. S. Carhart, and backed by additional arguments the claims of the standard cell will again be urged at the coming congress. While the conference at the Reichsanstalt was informal, yet it passed resolutions recognizing the ohm and the ampere as the fundamental units, and recommended that the Weston cell be adopted as the standard of electromotive force, but without any value of its E. M. F. being specified in any legislative enactment. Further, it was recommended that at each national laboratory standard ohms realizing the international definition should be constructed, while at the same time a technical commission should be appointed to prepare detailed specifications for realizing the definitions adopted by the next congress. These decisions simply presented the questions in a concrete and direct form, which has been embodied in the formal programme for the London congress.

Accordingly, this body will be concerned largely with the discussion of the following propositions:

1. That the ohm shall be the first primary unit.
2. That the ampere shall be the second primary unit.
3. That in consequence the volt shall be treated as a secondary or derived unit.
4. That the international ohm shall be defined as the resistance at the temperature of melting ice of a column of mercury of uniform cross section terminated by planes at right angles to its length 106.3 centimeters in length and 14.4521 grammes in mass.
5. That the international ampere be defined as the unvarying electrical current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.001118 gramme per second.
6. That the international volt be defined as that E. M. F. which when applied steadily between the ends of a conductor of resistance 1 international ohm produces a current of 1 international ampere.
7. That the Weston cadmium cell be adopted as a convenient standard of E. M. F.
8. That specifications dealing with the methods of setting up mercury standards of resistance, of realizing the ampere by the deposition of silver, and of preparing standard cells be issued with the authority of the congress, and that for this purpose a technical commission be appointed to prepare these specifications.
9. That the congress consider and advise as to the best method of securing uniformity with regard to the fundamental electrical standards in the future.

While it is earnestly to be hoped that the American view of the volt and standard cell will prevail in the congress, yet in any event considerable progress is to be expected toward putting electrical standards on a more accurate basis, even if the matter of permanent definitions is not settled, but referred to a technical commission for further investigation.

IMPROVEMENT OF NEW YORK-NEW JERSEY SUBURBAN SERVICE.—II.

ERIE RAILROAD.

In our issue of June 20 we published the first of the present series of articles on the important improvements which are being made in the railroad terminals in Jersey City and the approaches thereto, with a view to facilitating the movement of the ever-increasing number of trains, both suburban and long-distance, which make use of these terminals. In that article, which dealt with the improvements of the Delaware, Lackawanna & Western Railroad, it was shown that, in addition to an entirely new terminal and ferry-house, the company had built an additional two-track tunnel through Bergen Hill, parallel to its old tunnel, thus doubling at once the capacity of its tracks at that point. The Erie Railroad, which has been perhaps even more hampered by scarcity of tracks, is making larger additions than the Lackawanna Railroad; for it is now engaged in excavating a huge four-track open cut through Bergen Hill, adjoining and parallel to its existing two-track tunnel. Bergen Hill, which is really a continuation of the Palisades of the Hudson, lies about three-quarters of a mile to the west of the Hudson River, and at the point where it is pierced by the present Erie tunnel it averages about 100 feet in height and 4,000 feet in width at track level. Of late years the congestion at the Erie tunnel has become intolerable. It is due to the fact that upon its two tracks has to be carried, in addition to an unusually heavy suburban traffic, both a large through express and a freight traffic. The construction of the new four-track open cut and the rearrangement of the approaches thereto form part of an extensive plan of improvement which will include eventually a new terminal building and ferry-house.

At the present time the two-track tunnel, during the morning and evening rush hours, is reserved exclusively for the use of passenger trains, while during the rest of the day it is used by both freight and passenger trains. The traffic of the Erie road converges to the Jersey City terminal from six different branch lines, which merge to the west of Bergen Hill in three groups of two lines each. The New York, Susquehanna & Western Railroad and the Northern Railroad of New Jersey approach from the north; the main line of the Erie and the New Jersey & New York Railroad come in from the west; and the Greenwood Lake division and the Newark branch from the south. The only possible arrangement by which the traffic of these six roads could be accommodated through the one tunnel was to operate the two tracks in the same direction during the morning rush hours, and allow no trains to travel through the tunnel in a westerly direction. In the evening the difficulty is solved by doubling up the trains and placing two locomotives at the head of them, for the trip through the tunnel. When the point of divergence is reached, the trains are cut in two, and each locomotive picks up its respective part of the train. When the open cut is completed, its four tracks will be devoted exclusively to passenger trains, and the freight traffic will be handled through the existing tunnel. It is proposed to operate three of the new tracks in one direction, and the fourth in the opposite direction during the rush hours, and to operate two of the tracks in each direction during the hours when traffic is lighter. Under this arrangement three trains will be able to enter or leave the terminal abreast of each other, and the tracks on the farther side of Bergen Hill have been so rearranged that these trains will be able to proceed to their respective destinations without interfering with each other, or with the inbound trains coming over the fourth track.

The rearrangement of the tracks west of Bergen Hill provides for a system of separated crossings, so arranged that none of the tracks intersect at a common level. The four tracks on emerging from the open cut are carried below the Delaware, Lackawanna & Western Railroad and beneath Tonnele Avenue. Here they diverge into six tracks, one inbound and one outbound for each of the three groups of trains. From Tonnele Avenue the Susquehanna tracks rise on an embankment and cross the west-bound main line and west-bound Newark branch. They are carried on a viaduct across the freight tracks of the Erie Railroad, after which the two tracks run side by side to the point at which the Susquehanna and the Northern Railroad trains separate. The west-bound tracks of the Erie main line pass under the passenger and freight tracks of the Susquehanna. The Erie main line east-bound track passes below the Susquehanna freight tracks, and then both these tracks rise on separate embankments and run parallel on a bridge over the west-bound Newark branch, and the Newark branch freight connection. The two tracks then descend on an embankment and run parallel to a point at which the main line trains and those of the New Jersey and New York lines diverge. Similar skill has been shown in working out the arrangements of the other lines that converge to the open cut through Bergen Hill.

From the above description it will readily be understood that the construction of the new layout of the tracks called for some heavy and costly work, involving a large amount of embankment and bridge work. Altogether 8.4 miles of new double track have been constructed and 8.7 miles of the existing double track have been abandoned, the last named, however, being very largely available for future freight traffic. Included in the bridge work is the construction on one of the new lines of a two-track drawbridge with 449 feet of girder approaches and a draw-span measuring 339 feet over all. The construction of the new embankments calls for the moving of over half a million cubic yards of material, part of which will come from the big cut, and part will be taken from "borrow pits" at the side of the embankment.

Although the new four-track system through Bergen Hill has been spoken of as an open cut, it is not strictly such, since it contains four short tunnels where the tracks pass beneath the various avenues and streets. Going west the first tunnel, below Hudson County Boulevard, is 190 feet in length. The next, beneath St. Paul's Avenue and Bevan Street, is 285 feet in length. Following that is a tunnel 235 feet long below Summit Avenue, while the fourth tunnel, the longest of all, is 580 feet in length and lies below Central and Hoboken Avenues.

Several considerations led to the choice of an open cut in preference to a continuous tunnel. First, there are the constructional difficulties attending the excavation of a tunnel wide enough to accommodate four tracks, and the extra cost as compared with an open cut; secondly, there are the advantages of comfort for the passenger and convenience of operation; and, lastly, there is the great value of the crushed trap rock of this vicinity for use as ballast, and for making concrete. The excavation of the cut involves the taking out of 114,000 cubic yards of earth and 420,000 cubic yards of rock, and the four tunnels call for 79,000 cubic yards of rock excavation. The earth excavation is being used for building the embankments upon the Hackensack meadows, and the rock is carried to a large crushing plant, erected a little to the west of Bergen Hill, where an enormous pile of the crushed material has already been collected.

The new improvements are being carried out on such an extensive scale that they will be more than sufficient to take care of the present traffic, and will allow for an extensive growth in the future. One important result will be that the New York, Susquehanna & Western, which at present makes use of the Pennsylvania terminal station in Jersey City, will in the future run its trains into the Erie terminal.

SCIENCE AND THE SCHOOLBOY MIND.

BY H. W. HORWILL.

If the study of one's failures is part of the preparation for future success, teachers of science would do well to ponder the significance of the amusing examination answers that occasionally get into print. These are ordinarily published for the entertainment of the general reader, and they certainly serve that purpose well. But they may easily be made a means of edification as well as diversion. They often point to some flaw in methods of teaching, and suggest in what direction there is need for reform.

Of late years many educational authorities have shown a tendency to minimize the use of textbooks and trust to oral instruction. But the risk attached to teaching by word of mouth is clearly seen in numerous instances of a pupil's confusing some important word with another that resembles it in sound. Here are some examples: "The equator is a menagerie lion running round the earth." "The earth's climate is the hottest next the creator." "Sound effects the oratory nerves." "The blood is putrefied in the lungs by inspired air." A confusion with the word "rotation" is of course responsible for the definition of the axis of the earth as "an imaginary line on which the earth is supposed to take its daily routine." Scientific teaching offers a large number of opportunities for such confusions when technical terms reach the mind through the ear only, and not also through the eye. Really, one cannot be hard on a child who tells us that food passes through the "elementary" canal, or that one of the brightest stars is called "Juniper."

When a word that is in common use has a special scientific meaning, it is always necessary for the teacher to take pains to avoid a misconception. Unless he is warned against the error, it is hard for a pupil to get out of his mind the idea that "shed" in "watershed" must point to some kind of a building. Thus we get such examination answers as these: "A watershed is a place where there is water and rocks overhead that form a shed." "A watershed is a house between two rivers, so that a drop of water falling on one side of a roof runs into one river, and a drop on the other side goes into the other river."

In a great many instances the root of the trouble is evidently an imperfect explanation of the fact or phenomenon described. When an examination candidate declares that "a parallel straight line is one which, when produced to meet itself, does not meet," how is it possible to escape the conviction that an attempt has been made to load the memory with a definition without the least endeavor to get hold of its meaning? Such an answer reflects far more seriously upon the teaching received than does the statement that "parallel straight lines, even if produced to all eternity, cannot expect to meet each other." In the latter case, in spite of the confusion between the words "infinity" and "eternity," there is at any rate a fairly substantial idea of what parallel lines are. Mere rotework teaching, again, would account for the declaration that "air usually has no weight, but when placed in a barometer it is found to weigh about fifteen pounds a square inch." Clearly, there can have been little laboratory teaching in the school from which came the answer that "if a small hole were bored in the top of a barometer tube, the mercury would shoot up in a column thirty feet high," though one cannot understand how any small boy with ordinary curiosity could have refrained from attempting to verify such a fascinating statement by independent experiment. The lazy mind, catching up vaguely something it has heard while escaping the least exertion of thought, is further illustrated in the startling proposition that "things which are equal to each other are equal to anything else."

A subtle danger, to which even the most efficient teacher is sometimes exposed, is that of making an unimportant feature so interesting that the really significant matter is overlooked. A specimen case is the answer that "gravity is chiefly noticeable in the autumn, when the apples are falling from the trees." Evidently the picturesque story related of Sir Isaac Newton had impressed the mind to the obscuring of the truth involved. And this child was by no means a mere repeating parrot, for he had reflection enough to reach, independently of his teacher's assistance, the conclusion that, if it is in falling apples that gravitation is chiefly illustrated, the autumn is the time of year when it must be most frequently visible.

Some of the funniest answers reported are, after all, better testimonies to the quality of the teaching than many replies which conform more nearly to the phraseology of the books. The following account of the law of gravitation is not quite a model of scientific expression, but it certainly shows that the examinee has been thinking the matter out for himself and not without success. "If the earth was to have no gravity, and if we climbed to the top of a hill and jumped a little above the top, we would stick fast in the air, and thus there would be an end to our existence; or if there was no gravity, then some of the furniture in our houses would be above the floor of the house, and thus if we let a thing fall it would not fall to the ground, but stick just in the place where it fell out of our hands." Here, too, is a piquant illustration of the law that liquids expand when heated: "If a kettle is placed on the fire with water in it, and all means of ventilation stopped up, the kettle would bounce off the fire from the great force which was made inside it which it wanted to let escape." Happily many instances might be given in disproof of the frequent accusation that present-day school teaching stifles originality. The mental activity with which a pupil, when at a loss for an answer, will construct one out of his own head is often such as gives promise of conspicuous distinction if once the habit of diligence could be formed. It is not mere adroit evasion to say that "the difference between water and air is that air can be made wetter, but water cannot." No less thoughtful was the lad who in an essay on "The Elements" said: "Air is the most necessary of all the elements; if there was no such thing as air, I would not be writing this essay now; also there would be no pneumatic tires, which would be a sad loss." A mind capable of detecting the subtlest analogies of nature must surely have been possessed by the boy who wrote: "Mushrooms always grow in damp places, and so they look like umbrellas." We may be sure that it was not from a San Francisco school that there came the assertion that "the probable cause of earthquakes may be attributed to bad drainage and neglect of sewage." At any rate, the zeal for sanitation shown thus early ought to guarantee a diligent career as health inspector. A particularly curious instance of independent but inaccurate observation is this answer to a question respecting the differences between steamers and sailing vessels: "A steamer cut or part the water aside; but with a sailing vessel it is not the case, for it sail up and down on the waves and billows." This answer, possibly, is due in some measure to the pictures—advertisements of steamship companies and the like—which represent steamers as aggressively cutting their way through the water, as compared with the quieter representations of the progress of sailing ships. Perhaps similarity with the domestic uses of electricity is accountable for the statement that "electricity and lightning are of the same nature, the only difference being that lightning is often several miles in length, while electricity is only a few inches."

SCIENCE NOTES.

The quantity of sulphuric acid in mine water varies according to the district and condition of the mine. Some mine water has been found to contain only a few grains, while the water in other workings often contains over 100 grains per gallon.

Some experiments have been recently carried out which appear to show that the sea water round the coast of Ireland possesses a richness in radium not hitherto expected. This result has been extended by measurements made on samples of water collected between Madeira and England, and also on water from the Arabian Sea. In a paper recently delivered it is shown that the deep-lying sediments of the ocean are exceptionally rich in radium. The materials dealt with were partly from the "Challenger," partly from the "Albatross" collections. Some globigerina ooze from the west coast of Ireland was also treated.

Dr. H. F. Schmidt, of Berlin, has completed an exhaustive study of the effect of Roentgen rays on the development of amphibia. Thirty-five axolotl eggs were placed in a shallow dish in water and exposed to the rays for half an hour. Thirty-one eggs from the same animal were simultaneously exposed to the air of the laboratory, in a similar dish of water, but shriveled from the Roentgen rays. The two batches of eggs were then kept in identical conditions and observed from time to time. When the larvæ appeared the effect of the rays was strikingly apparent, the larvæ from the eggs exposed to the Roentgen rays being much smaller than the others and curved in a peculiar manner. Only a small percentage of the exposed eggs hatched, and all the larvæ which came from them died within a few days. The thirty-one eggs which were not exposed to the rays produced as many larvæ, all of which were alive and very active after the death of the others. Microscopic examination of the larvæ killed by the rays showed that the membraneous envelope of the brain was almost destroyed and that the brain and spinal cord were seriously injured. Similar effects of radium rays on the eggs and larvæ of frogs have been observed by other experimenters.

THE CURRENT SUPPLEMENT.

A paper by Mr. William P. Durtnall entitled "The Generation and Electrical Transmission of Power for Marine Propulsion and Speed Regulation" opens the current SUPPLEMENT, No. 1703. The city of Gary, Ind., is installing a sewer system which presented unusual difficulties to the engineer because of quicksand. A novel method of draining the wet excavation instead of emptying it in the usual way is described by Mr. C. M. Ripley. Mr. R. B. Woodworth's paper on "New Shapes of Steel for New Uses" is concluded. An important development which will exercise a far-reaching influence upon the commercial prosperity of Egypt, and which would tend to increase the agricultural prosperity of the country, has been effected by the completion of the first section of the Libyan Desert railroad. The English correspondent of the SCIENTIFIC AMERICAN describes and illustrates the work in detail. "Darwin and After Darwin" is the title of a paper by Prof. Henry Edward Crampton in which the newer discoveries in biology are simply explained. The twenty-fourth installment of Prof. Watson's elements of electrical engineering deals with electrochemistry. In an article entitled "The Respiration of an Inland Lake," Prof. E. A. Birge describes the part played by the absorption and distribution of oxygen in small bodies of inland waters.