power required to propel the trains was to measure by means of a dynamometer car the draw-bar pull of various trains. The braking effort per ton is not so high on certain types of locomotives as it is on coaches, due to the fact that not all wheels on the locomotive are always braked, and those that are braked cannot be set to the skidding point with a fully loaded tender, for if they were they would then skid with a slightly loaded tender.

Mr. Arnold recommends instead of the ten or twelve different types of locomotives now used electric motors weighing about 65 tons each, which for heavy work can be coupled. He stated that if given the opportunity he would make the necessary changes and install the new system within six months. The third rail is recommended for the tunnel, and the overhead system for the yards.

Of twelve different plans considered, the first, theoretically the most economical, provides for a direct-current power station at center of line and contiguous to tracks, 600-volt working conductors, no batteries, but this is impracticable because it would locate the power house in the residential portion of Park Avenue.

The twelfth plan therefore was the one recommended, namely, combined alternate-current and direct-current power station at Harlem River near outer end of line, one sub-station near other end. Batteries in power station and sub-station. Alternate-current transmission, 11,000 volts, direct-current conductors 600 volts.

While Mr. Arnold believes the alternating-current railway motor to be the most efficient, all things considered, for long-distance railway work, it has not yet demonstrated its ability to start under load as efficiently nor to accelerate a train as rapidly as the direct-current motor. The latter have also become standardized, and are the only type readily procurable from manufacturers in the United States; hence they are recommended for this terminal traction work.

Although the question of economy is relatively unimportant, safety and comfort being first to be considered, yet there is a slight economy also in the substitution of electricity for steam, as shown by the following table:

	Steam.	Electricity.
Operating expenses per mile exclusive of fixed charges, but including water, labor, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23.05	15.80
Fixed charges per locomotive mile, assuming that it now requires 40 locomotives to perform the present service and that 33 electric locomotives could perform the same service	1.13	7.83
	24.18	23.63

Perhaps the most important incident of the entire meeting was the announcement by Mr. Arnold, in closing the discussion of this paper, that he had invented a new system of electric traction whereby he utilizes waste forces and regulates and stores up force without depending on regulation from the power house. This is effected by applying surplus force to the compression of air, which as necessity requires, is released and adds the force needed to meet extra demands. Thus the motor can climb a grade as rapidly as it can descend; it can climb steep grades; by using its reserve it can traverse gaps in the line over private right of way, or onto spurs, sidings, etc.; so that ultimately power need only be transmitted along the main line, and also a great saving can be effected in buildings for conversion, etc. President Steinmetz commended the invention as one of great importance.

The third day was occupied with papers and discussions on various topics, lightning arresters, photometers, a curve-tracing instrument, loss of energy in transmitting power, electrostatic wattmeter, predetermination of alternator characteristics, by Messrs. Thomas, Matthews, Owens, Skinner, Walker and Herdt respectively.

The feature of the day, however, was the report of the committee on standardization by Dr. A. E. Kennelly and the ensuing discussion.

Much satisfaction was expressed that the government has now established a bureau of standards which is conducted in harmony with electricians. The report was adopted except that two sections were referred back to the committee with power of revision and of final settlement. One important matter which the Institute thus leads off in establishing without awaiting governmental or other sanction, but confident that its action will meet general approval and command universal acquiescence, is the fixing of a standard for candle power. After full discussion the recommendation of the committee was approved; and the standard, as far as the Institute can fix it, makes the Hefner = 0.88 British candle, as the ratio of horizontal intensities. The Hefner-Alteneck amyl-acetate lamp is—says the report—in spite of its unsuitable color, the standard luminous source generally used in accurate photometric measurements.

Prof. Owens presented the invitation of McGill University to hold the next meeting of the Institute at Montreal. A similar invitation has already been sent to the British Institution of Electricians. The Institute adopted a resolution inviting the British Institution to hold a joint meeting; but owing to the belief that probably 1904 would be preferred on account of the St. Louis Exposition, date and place were left undetermined.

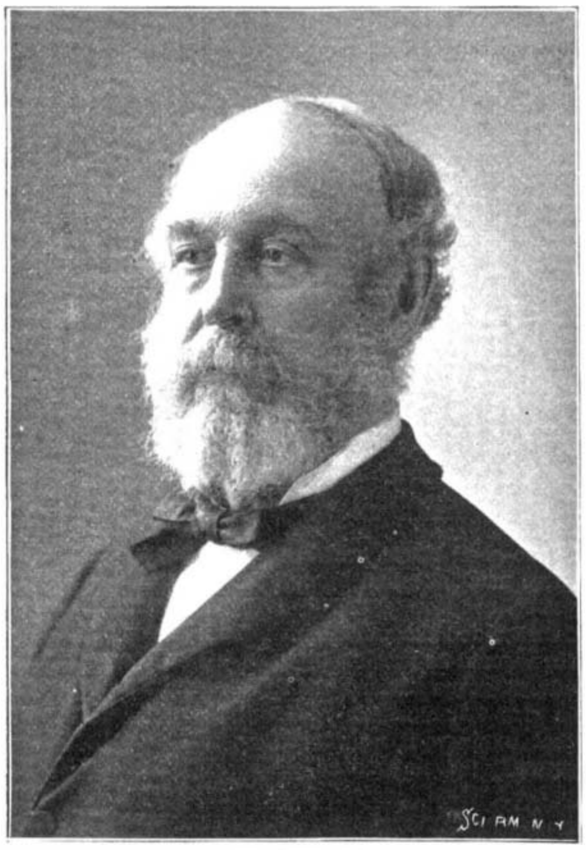
The exercises of the last day of the session consisted of papers and discussion on the education of an electrical engineer, by Messrs. Steinmetz, Sheldon, Owens, Esty, Buck and Raymond.

ASAPH HALL.

BY MARCUS BENJAMIN, PH.D.

The American Association for the Advancement of Science has two characteristic features. It meets in a new place and inaugurates a new president each year. In 1901 it met under the shadow of the Rocky Mountains in Denver, and this year it meets in the great industrial center of Pittsburg. The eminent naturalist, Prof. Charles S. Minot, who presided so gracefully in the West, yields the chair to an equally distinguished representative of the physical sciences.

Asaph Hall was born in Goshen, Conn., on October 15, 1829, and received a common school education in his native town. For a time he worked on a farm, but when he was sixteen years old he took up carpentry and followed that trade for many years. Meanwhile a thirst for knowledge that would not down came to him, and in his twenty-fifth year he began the study of geometry and algebra in the Norfolk Academy. Later he went to Wisconsin, and still later to Ohio, in both of which States he taught school, from the earnings of which he was able for a single term to study at the University of Michigan.



ASAPH HALL.

In 1857 he entered the observatory at Harvard as a student, but his abilities were so manifest that he was almost immediately assigned to the working staff with the rank of assistant, remaining in that capacity until August, 1862, when he was appointed an aid in the United States Naval Observatory in Washington. A year later he was made Professor of Mathematics in the United States Navy, and remained as such until 1891, when he was retired with the relative rank of captain. It is with the United States Naval Observatory that his name will be associated always for the brilliant discoveries that were made by him and which have gained for him such eminence among the astronomers of the world.

In addition to the usual routine work required at the Naval Observatory, he was from time to time assigned to important astronomical expeditions. These have included the parties sent to observe the solar eclipse from Bering Sea, and from Sicily, Italy, in 1870. He had charge of the American party sent to Vladivostok, Siberia, to observe the transit of Venus in 1874, and was chief astronomer of the expedition stationed at San Antonio, Texas, at the later transit in 1882.

His most famous contribution to astronomy was the discovery of the moons of Mars. Exact calculations were made of their orbits, and Prof. Hall gave to them the names of Deimos and Phobos (Wrath and Fear), from the passage in Homer's "Iliad" where these two divinities are mentioned as the attendants of the god of war.

His subsequent work has included important observations of double stars, an account of which he published in 1880. He also devoted much attention to Oberon and Titania, the outer satellites of Uranus, publishing in 1886 the results of observations made by him during 1875-76 and 1881-84 with the large telescope of the Naval Observatory. In the same year he gave to the world the results of similar observations on the satellite of Neptune and on that of Saturn.

On his retirement from the service of his government, he settled in Cambridge, Mass., and renewed the experiences of his early manhood with valuable work in the Harvard Observatory. Recently he returned to the home of his boyhood in South Norwalk, Conn.

In 1878 the Lalande prize of the French Academy of Sciences was awarded him for his discovery of the moons of Mars, and in 1879 he received the gold medal of the Royal Astronomical Society, "for his discovery and observations of the satellites of Mars, and for his determination of their orbits," as "the highest mark of esteem in the gift" of that Society, while in 1895 he received the Arago medal of the French Academy of Sciences.

In further recognition of his contributions to his chosen science, Hamilton conferred upon him the degree of Ph.D. in 1878, and that of LL.D. was given him by Yale in 1879, and by Harvard in 1886.

Prof. Hall has been elected to numerous scientific societies both in this country and abroad, including the French Academy. In 1875 he was chosen to the National Academy of Sciences, of which in 1883 he became home secretary, and in 1897, on the death of Gen. Francis A. Walker, he was chosen vice-president.

His connection with the American Association has been a long and honorable one. He joined that organization in 1876 and a year later was made a fellow. In 1880 he presided over Section A, delivering a retiring address at the Boston meeting on "The Advances in Astronomy," in which he said that "the great value of astronomy is that it is really a science, and that it has broken the path and led the way through which all branches of science must pass if they ever become scientific."

TIMBER RAILWAY BRIDGES IN AUSTRALIA.

In Australia, when the first railroads were constructed, the bridges were almost entirely built of timber, and even now this type of bridge is often erected in lieu of steel structure, as the native woods —seventeen varieties are available—are specially adapted to the work, owing to their great strength. The life of such bridges varies from thirty-five to fifty-five years, according to their location and other circumstances. In Queensland a large timber bridge has recently been completed. It is 320 feet long and 18 feet 6 inches wide. It spans a creek 10 feet deep at high-water mark, and which also has 20 feet of black mud below the bed. In flood times the water rises 25 feet above the level of ordinary high-water mark. The supporting piles are of iron bark timber well creosoted. The cost of driving the piles complete, including materials, labor, plant, etc., was $1.80 per lineal foot. The decking and its members are of spotted gum, and the cost was $19.80 per square, including all material and labor. The total weight of all the timber in the bridge as fixed is about 200 tons, while the weight of the iron work fixed is 4½ tons. The total cost of the structure, including a small portion of the approach roadway, was $9,500. The principal and most durable kinds of timber suitable for bridges are ironbark, spotted gum, blue gum, bloodwood, blackbutt, box, mahogany, karri and swamp mahogany. Ironbark, mahogany, blue gum, bloodwood, swamp mahogany, turpentine or peppermint, tea, she-pine and cypress pine are very durable when constantly immersed in water or wet ground, and are, therefore, well adapted for piles, etc., for the foundations.

The various methods of seasoning at present in vogue consist either in evaporating the sap by air-drying, or in dissolving it in water and afterward sun-drying the timber. Artificial drying is rarely resorted to with timber for engineering purposes. The greatest trouble against which the engineers have to contend are the ravages of the teredo, white ant, and other similar insects, and various means of protecting the wood against these pests are resorted to, the most general being the sheathing of the wood in copper. But even copper sheathing is not permanently effectual in resisting the attacks of the teredo. Creosoting properly carried out is the most successful of any process yet known. The various means of preserving the timber consist of painting, charring, creosoting and impregnation with metallic salts. The latter method, however, has not in all cases given satisfactory results.