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.

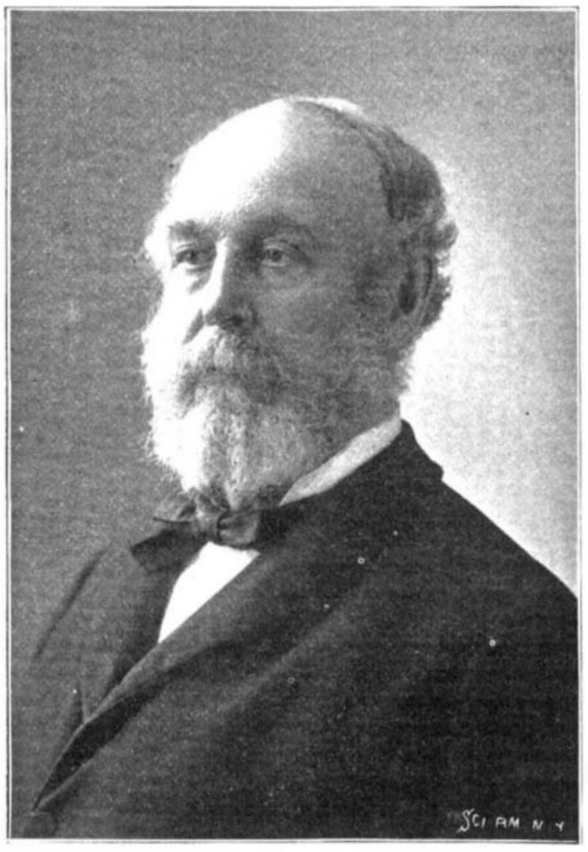
The exercises of the last day of the session consisted of papers and discussion on the education of an electrical engineer, by Messrs. Steinmetz, Sheldon, Owens, Esty, Buck and Raymond.

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.

Expedition to the Sahara.

Mr. Edward Dodson, a British explorer, has succeeded in traversing the Hinterland of Tripoli, which has hitherto been forbidden country. His expedition was sent out by the Natural History Museum of Edinburgh. Although little enough was gathered that was of any interest from the standpoint of the natural scientist, Mr. Dodson nevertheless succeeded in gaining valuable knowledge of this unknown land and in mapping out parts that have been hitherto but ill-defined on our charts. The journey was accomplished not without hardship. Eight camels, three horses and nine Arab servants entered the great desert eight days after leaving the city of Tripoli. Heat and blinding sandstorms, as well as a lack of water, were but a few of the troubles experienced. Water could be obtained only at intervals of from ten to twelve hours. Two weeks after leaving Tripoli, the town of Sofejin was reached, about 120 miles to the southeast. A detour was made in order to reach an old Roman reservoir where it was expected that a supply of water might be found. Mr. Dodson found this reservoir a most wonderful piece of masonry. The cement had not been in the least impaired, and the reservoir was still perfectly water-tight. On the journey to the reservoir dried beds of torrential streams containing great beds of brilliantly colored flowers were discovered. An examination of these flowery patches showed that the plants were of the "everlasting flower" kind. They had been completely dried by the heat and drought.

After their water bottles had been replenished from the old Roman reservoir, the men struck out for the Bonjem oasis, on the desert road to Sokna. Mr. Dodson had hoped to acquire fresh supplies of food at the oasis. He was disappointed. Those who lived in the oasis were almost starving and were compelled to depend on snails and date-palm juice for their sustenance The miserable huts built by modern Arabs stood out in strong contrast to the splendid buildings erected during the Roman occupation. Like the old reservoir these Roman buildings were in an excellent state of preservation. One of them covered an area of 3,600 square yards and had a gateway 12 feet thick. After four days' intense suffering, the party reached Sokna. For a day and a night they had traveled through an uninhabited desert without water. From Sokna the journey was continued to Murzuk, about 300 miles from the Sahara. On this part of the journey, the Jibil Soda, or Black Mountains, were crossed and the great petrified forest traversed. The Black Mountains were found to consist of large slabs of perfectly black stone. In traversing the petrified forest ten hours were consumed. The fallen trees varied in circumference from 2 inches to 7 feet. That the region was at one time submerged by the sea, was proven by the finding of marine shells. Returning from Murzuk the expedition again passed through Sokna and finally returned to the coast.

A New Type of Steamer.

A working model of a new and novel type of steamship, the invention of Herr J. Brohan, an engineer of Hamburg, has been on view in the Hall of Civil Engineers, Rue Blanche, Paris. The principal feature of this craft is that it is equipped with four propellers, one forward, another just before the rudder, and two at the stern. The vessel is flat-bottomed, but there is a short keel in the center and two false keels forward, to keep the hull off the bottom in case of grounding, and between which the forward screw revolves. The inventor estimates that with a steamer 300 feet long, built according to his design, he could make the passage from Havre to New York in four days.

PNEUMATIC TOOLS IN SHIP YARDS.

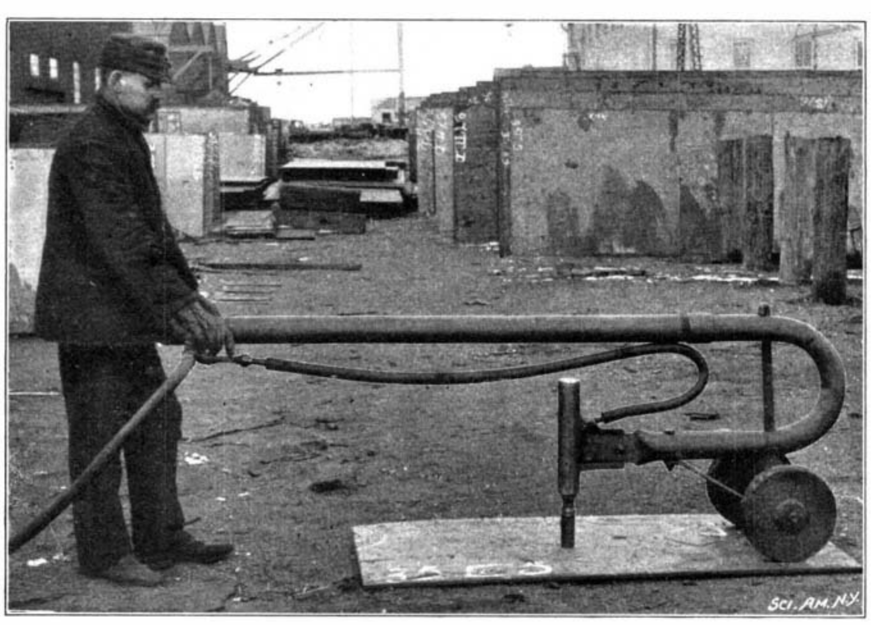
BY WALDON FAWCETT.

Within the past half decade a system of power riveting has been developed in American ship yards to a point beyond that previously attained anywhere in the world. The attempt was first made to use pneumatic compression riveters similar to those used in many bridge shops, but a limited experience sufficed to show that their great weight for the large gaps which are necessary in shipbuilding made it impossible to handle them in a ship on the stocks with either facility or economy.

RIVETER AT WORK ON SIDE FRAMING.

However, the possibilities of a pneumatic hammer consisting of a piston rapidly reciprocating inside of a cylinder and striking the end of a chisel were well known as far as its usefulness for chipping and calking were concerned, and consequently there were inaugurated at the plant of a shipbuilding firm of South Chicago, a series of experiments designed to test its capabilities for driving rivets. This effort was crowned with complete success, and was continued until it was made possible to drive every rivet in a ship with machines which are very light, short enough to go between frames and of small diameter, rendering them portable in the highest degree.

The shell rivets, which, prior to the introduction of these machines, had never been successfully driven by power, are now closed up with the greatest ease and facility, and the work is done both better and cheaper than would be possible by hand. This is a particularly advantageous advance for the reason that the increase in size of ships has rendered the plating so heavy, that to draw it up requires a rivet too large to be properly driven by hand. As indicative of the economy of time secured by the use of these devices, it may be noted that in deck and tank topwork three men and a heater boy will drive from eight hundred to one thousand rivets in a day. The whole operation of driving a rivet is completed much more quickly than by hand and before the rivet has lost its heat, the resulting contraction as the rivet gets cold drawing everything firmly together.



DECK RIVETER IN POSITION.

From careful computations made at the principal ship yards on the Great Lakes, and extending over a considerable period of time, it would appear that the economy of machine riveting, adding the cost of air, repairs, etc., effects a saving of from one to two cents per rivet over piecework prices for hand riveting, the degree of economy depending upon the location in the ship and averaging about 1¼ cents. In an ordinary lake steamer of 4000 tons the saving is from $4000 to $5000 over hand work. A record of 450 ⅞-inch rivets driven in a single day by one yoke machine is nothing unusual. At the regular rate for hand riveting, the placing of this number of rivets would cost $15.75, whereas with the machine the cost is $5 for the operatives and 50 cents for power.

Almost all the various kinds of pneumatic machines for ship yard use are characterized by great simplicity of design. Take, for instance, the yoke riveter as applied to bottom work. It consists of a pneumatic hammer mounted in gimbals on the end of a piece of pipe about eight or nine feet long, which pipe is hung by its center to a trolley running inside of another piece of pipe which is bolted to the bottom of the ship. This allows the hammer to be brought to any point in a considerable space of the ship's bottom without shifting. The mounting of the hammer in gimbals allows it to be swung in any direction, so as to get at the rivet from all sides exactly as in hand riveting. A small cylinder connected with the air pipe is provided to hold the machine steady when required, the piston rod being jammed up against the bottom of the ship, and carrying a piece of rubber on its top end to prevent slipping. There is also a radial frame or carriage to facilitate bilge work.

An important class of pneumatic tools is that comprising the chipping, calking and bending hammers. These machines range in weight from 7 to 11 pounds; have a stroke of from 1 to 4 inches at speeds varying from 3400 to 2200 strokes a minute, according to the size. All hammers of this kind require an air pressure of from 70 to 80 pounds, and must be supplied with 20 feet of free air per minute. The heavy chipping hammers weigh 15 pounds and make a 7-inch stroke at a speed of 1200 strokes a minute. Of all the various kinds of pneumatic hammers now in use in ship yards, it is claimed that the 9-inch stroke riveting hammer, weighing 20 pounds and having a speed of 900 strokes a minute, is the most powerful. In many yards a pneumatic holder-on is used instead of the ordinary bar for holding up the head of the rivet. It can be readily put into position, and presses the rivet against the sheet with a force of 1200 pounds with an air pressure of 100 pounds.

Of the air drills, a fairly representative type, such as is in general use in ship yards, is of 35 pounds weight and will drill in cast iron up to 2 inches, or in steel up to 1⅝ inches, the limit for reaming and tapping being 1½ inches. These drills require about 25 feet of free air per minute at 80 pounds pressure. The pneumatic painting machines of the 10-gallon size are now being extensively used in marine work; and side-light cutters, deck-boring machines and other appliances all have a place in the complete shipbuilding equipment. Every tool has afforded economic advantages in greater or less degree. Often this is intensified by the variety of uses to which the pneumatic tools may be put. For instance, the flat piston type of drill now in use at the Chicago ship yard, which is capable of drilling 3-inch holes in a solid sternpost, can also drill the side of the ship, ream on deck and drill and ream ship plates.

At each of the larger American ship yards several hundred pneumatic tools are now in use. At the plant of a shipbuilding company, whose yards are located in Camden, N. J., there are now in use about four hundred portable riveters, calkers, drills, etc. An air pressure of 110 pounds is carried, supplied by an air compressor capable of delivering 5000 cubic feet of air a minute.

Last Wire of the New East River Bridge Cable Strung.

Shortly before 11 A. M. on Friday, June 27, the last wire of the new East River Bridge was unreeled and carried across the river. It has taken over six months to string the wires, the work having been begun in December last. Each cable is composed of 7696 wires of No. 6 gage. The next step in the formation of the cable will be the process of squeezing the wires into a solid mass of about 18¾ inches diameter, when they will be banded and encased. Each wire is about 3000 feet in length and has an estimated strength of 200,000 pounds per square inch.

SHELL RIVETER WORKING ON THE BOTTOM.