consequently the same work, and the same coefficient. The four segments behave like cubes, and, if the material is homogeneous, give results that are sensibly equal.

This second series of tests has the great advantage of permitting all the operations to be effected upon the same solid. One can thus study the relations that may exist between the various coefficients that result therefrom. The precision of the apparatus, in fact, permits not only of verifying the coefficients of quality required by the conditions of a contract for supplies, but also of effecting true scientific researches. Through this apparatus Mr. Nivet has been able to indicate a few laws of the resistance of materials called non-elastic. A study of such work would exceed the limits of this article. We shall add that the tests upon traction and shearing give figures proportional to the sections upon which we operate, while the tests upon crushing give more complex results. In this latter case the coefficient is proportional to the section when the height of the solid tested is equal or superior to the side of the base; but it increases as soon as the ratio of the height to the side of the base diminishes, and becomes infinitely great when the height is very feeble with respect to the base—which is precisely the case with mortar joints. The tests upon crushing must, therefore, be made upon solids whose height is equal to or greater than the side of the base.—La Nature.

New Ocean Record for the American Line.

The American liner St. Louis on her last trip reduced the ocean record from Southampton to New York from 6 days 5 hours 22 minutes, which was the time of her sister ship, the St. Paul, to 6 days 2 hours and 22 minutes. Her average speed was 20·86 knots an hour, which is slightly better than that of the St. Paul, which was 20·82. It is probable that to one of these fine ships will fall the distinction of being the first to bring the time of crossing below six days.

TRIAL OF THE COMPRESSED AIR MOTOR BY THE THIRD AVENUE RAILROAD COMPANY, NEW YORK.

The compressed air motor is a device which is suffering from the prejudice engendered by many years of costly but comparatively fruitless experiment. Invention and capital, seeing its promising possibilities, have frequently joined hands in the effort to produce an efficient motor, but beyond learning some valuable lessons as to the chief sources of loss, and the direction in which improvement must be sought, they have failed to produce an effective machine.

At the present writing, interest in the compressed air motor has been revived by rumors of its adoption by two large corporations: the Metropolitan Traction Company and the Third Avenue Railroad Company, both of New York City; the former making use of the Hoadley motor, and the latter adopting the system invented by Mr. R. Hardie.

The trouble with the earlier systems has been of a two-fold nature. When air was compressed into the storage reservoir, a certain portion of the power was expended in raising the temperature of the air (according to the well known law), and this heat, which was subsequently lost by radation, represented a dead loss of power. Moreover, when the air was expanded in the cylinders, there was a corresponding reduction of temperature, which was often so great as to cause freezing and choking up of the exhaust passages.

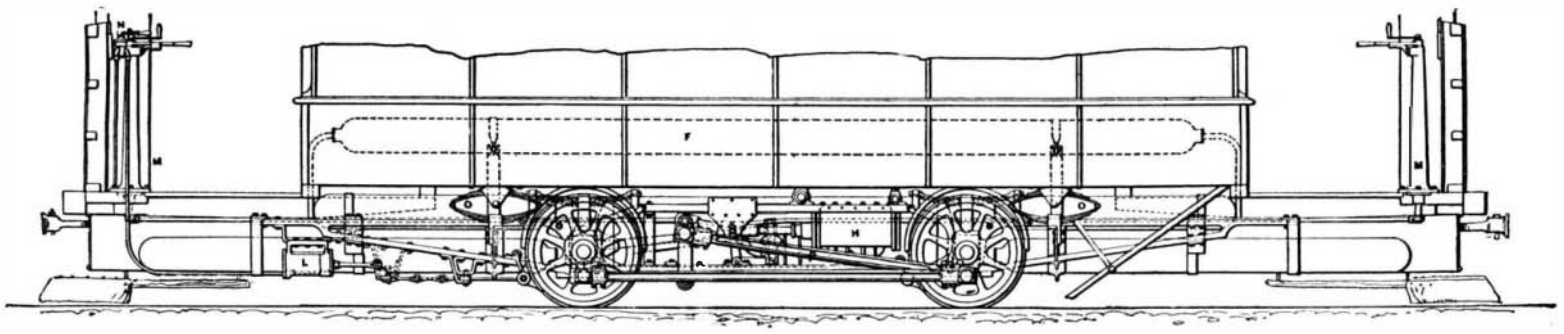
In the Hardie system it is sought to prevent the first loss by compressing the air in three stages, and recovering the heat of compression by passing the air through tubes around which cold water is circulating. The cooling water is fed to the boilers and the heat which it has withdrawn from the compressed air is thus recovered. After passing the third stage of compression and cooling, the air is forced at a pressure of 2,000 pounds to the square inch into a reservoir consisting of a stack of rolled steel flasks, 9 inches in diameter and 20 feet long.

The cars, one of which is shown in the accompanying illustration, are similar in their general appearance to an ordinary street car; but they are provided with a truck whose construction is suggestive of the bar frame of a locomotive, the truck, moreover, being suspended by springs from the axle boxes, and the cars being similarly suspended from the truck. Underneath the seats and beneath the floor of the car are sixteen air reservoirs, similar to those in the power house. In the center of the car and also beneath the floor is placed a hot water tank, by means of which the air is heated before it enters the cylinders, and the difficulty of frozen exhaust passages is overcome. It is 18 inches in diameter and 7 feet long, and is filled with 500 pounds of water.

Before the car starts on its run, its air reservoirs are charged with cold air at 2,000 pounds pressure by means of a flexible tube connecting with the power house supply, and steam is admitted to the heater until its contents are raised to a temperature of 350 degrees. It takes a little over half a minute to charge the reservoirs.

In operating the car, the air is first expanded by a reducing valve to a pressure of 150 pounds, and passed into a receiving cylinder, whose capacity is one cubic foot. It is then admitted to the heater, where its action is thus described by General Herman Haupt, the consulting engineer of the company: "When the air passes into the tank of water heated to 350 degrees, each 50 cubic feet of air absorbs and carries over an amount of water in the shape of steam equivalent to 26 cubic feet of air. This adds 50 per cent to the volume; and, as the air is itself expanded 50 per cent by the increase of temperature, the total gain of volume as the air and steam pass from the heater is 100 per cent. The condensation of the steam in the cylinders and pipes liberates the latent heat and maintains the temperature at such a point as to render freezing impossible."

General Haupt informs us that the efficiency of the



SIDE VIEW OF ENGINES AND AIR BRAKE, HARDIE COMPRESSED AIR MOTOR.

THE HARDIE COMPRESSED AIR MOTOR CAR.

heater was tested on a couple of experimental runs, on the first of which, with the heater in use, 308 cubic feet of air were used. The heater was then emptied, and the same run was made with cold air, when more than double the amount, or 661 cubic feet, were required.

The two cylinders of the motor, 7 inches diameter by 14 inches stroke, are built into the frame on each side of the car, and lie inside the wheels. A short connecting rod from the cross head operates a vertical rocking lever, from which a connecting rod transmits the motion to a crank on the outside of the driving wheels. The two wheels on each side are connected by a coupling rod, so that the whole weight of the car is available for adhesion.

The valve gear is of the ordinary Stephenson link type, with an additional valve on the back of the main valve to regulate the cut-off.

The controller and "reverse lever" are situated as in an electric car on the front platform. The throttle valve is operated by a crank handle, and the reversing and cut-off are effected by the lever. There is another lever for working the air brake, by means of which also an auxiliary supply of air can be admitted to the cylinders at starting.

The reciprocating parts are counterbalanced, and this work appears to have been judiciously done, as there is no perceptible oscillation due to this motion. The general appearance of the car is pleasing, the moving parts being hidden from view by letting down the slat apron, which is shown in the illustration hinged back against the side of the car.

Science Notes.

The meteorological and magnetic observatory of the University of Odessa has for its function not only the reading of the numerous instruments with which it is equipped, and the discussion of the results observed and registered, but it is intended also to serve as a high school where students of the faculty of physics and mathematics can be trained in the work of meteorology and physical geography. Schools in meteorology are so few, says Nature, that the development of the curriculum of the Imperial University at Odessa will be welcomed by all who think that trained investigators and experimental work are needed for the advancement of the science.

A paper on "The Application of the Formula of Clapyron to the Melting Point of Benzine" has been printed in the Comptes Rendus by M. R. Demerliac. It records an experimental study of the lowering of the melting point of benzine by pressure. The pressure gage used had been calibrated against a mercury column directly, and the alterations in temperature were measured to 0·001° by the changes in resistance of an iron wire forming an arm of a Wheatstone's bridge. The alteration in melting point for an additional pressure of one atmosphere calculated from Clapyron's formula is 0·02936°; the experimental figure is 0·0294, the difference being less than the errors of observation.

Punctuality in woman has been attained under hypnotic suggestion, in a remarkable set of experiments recently reported to the Society for Psychical Research. A young person of nineteen, who had never shown any capacity for calculation, and who was in good health at the time, though her nerves had been unstrung for a year before, was hypnotized and directed to do certain simple things at specified times, writing down the time when she thought she did them. The intervals suggested varied from a few hundred to over 20,000 minutes, and sometimes as many as six suggestions, starting at different hours, were working on her at once. The experiments read like the painful examples in the mental arithmetics. At 4 o'clock one day she was asked to do something in 10,080 minutes, beginning at 10 the day before. In fifty-five experiments there were only two failures. On awakening, the subject had no recollection of the suggestions made to her.

On the glass of a Crookes tube, which has been used for some time, being heated in the blowpipe, it assumes a dead or dull appearance, which, observed M. Gouy to the Paris Academy of Science, at first leads to the supposition that it has become devitrified. The alteration is, however, limited to the internal surface of the tube, being so much more marked as the glass has received a more intense cathodic radiation, and being absent in the portions not so exposed. The microscope shows that this dull surface is chiefly constituted by a vast number of gaseous bubbles in the substance of the glass, but near its surface. On the heating being continued, these bubbles unite and increase in volume, so that at length they become visible through the magnifying glass, and sometimes even to the naked eye. Glass, therefore, which has been exposed to intense cathodic rays, gives out numerous gas bubbles when softened by heat, a phenomenon which occurs in no other case; and it would seem that the cathodic rays cause the gases of the tube to penetrate into the substance of the glass, afterward remaining occluded until set free by the softening of the glass. The experiments which gave rise to these observations were made with four glass tubes slightly differing one from another, but only one of them showed a considerable number of bubbles in the portions most exposed to the cathodic rays.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

This society is one of those affiliated with the American Association for the Advancement of Science, and will hold its meeting, as usual, a few days before that of the A. A. A. S., namely, from August 20 till August 22, at Buffalo.

The annual address by the president, Prof. Mansfield Merriman, of Lehigh University, will be on "Some Modern Tendencies in Engineering Education."

Dr. Merriman has been an educator for nearly twenty years, beginning at the Sheffield Scientific School of Yale University, soon after his completion of an advanced course of study. He was graduated from the school as bachelor of philosophy in 1871, as civil engineer in 1872, and as doctor of philosophy in 1876, and began teaching in 1877. In 1884 he removed to his present station at Lehigh University, where he is professor of civil engineering. He has been identified with the American Association for the Advancement of Science since 1883, having been elected fellow in 1885, and vice president of the Mechanical Section for the Brooklyn meeting in 1894. His address before that section on "The Resistance of Materials under Impact" is published in the volume of proceedings for that meeting. He has been a prolific writer of text books and essays in his department of science, his latest work having been a volume on higher mathematics, issued during the present month of August, in which Prof. R. S. Woodward was associated with him.

Dr. Merriman was one of the founders of the Society for the Promotion of Engineering Education, which was launched in connection with the memorable mechanical exhibition at the World's Fair in Chicago, so that the society is only three years old.

Its proceedings from year to year have attracted increased attention, and are regarded by engineers as valuable contributions to technical literature. A large number of papers will be read at the approaching session, the interest of the meeting being greatly stimulated by the fact of meeting so near to the wonderfully expanded industrial enterprises which have taken root at Niagara. A great increase in the number of topics presented to the mechanical section of the A. A. A. S. is also promised for the same reason.

MANSFIELD MERRIMAN,

PROFESSOR OF CIVIL ENGINEERING, LEHIGH UNIVERSITY; PRESIDENT OF THE SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION.

Saturday, August 22, will be given up to an excursion to Niagara Falls, under the direction of Mr. George E. Mann, president of the Engineers' Society of Western New York, and every afternoon other excursions will be made.

The programme so far as yet made up includes the following papers to be read on different days: President's address, "Past and Present Tendencies in Modern Engineering Education," Mansfield Merriman; Report of Committee on "Uniformity of Symbols for Engineering Text Books," I. O. Baker, chairman; "Agreement on Definition of Engineering Terms," Thomas Gray; "Seminary Methods as Applied to Engineering Subjects," F. P. Spalding; "An Experiment on the Conduct of Field Practice," F. O. Marvin; "A Quarter Century Progress in Engineering Education," Robert Fletcher; "The Method of Teaching Perspective to Engineering Students," H. S. Jacoby; "The Study of Modern Languages in Engineering Courses," T. M. Drown; "A Course of Study in Naval Architecture," C. H. Peabody; "The Elective System in Engineering Colleges," M. E. Wadsworth; "The Desirability of Lectures to Undergraduates on the Ethics of Engineering," C. C. Brown; "Quantity versus Quality in Smaller Colleges," Albert Kingsbury; "Biology for Civil Engineers," G. C. Whipple; "The Conservation of Government Energy in Promoting Education and Research," C. W. Hall; "The Hale Engineering Experiment Station Bill," W. S. Aldrich; "How to Divide Subjects for Original Investigation among Different Colleges," C. H. Banjamin; Report of Committee on "Entrance Requirements for Engineering Colleges," F. O. Marvin, chairman; "Credit for Shop Experience in Entrance Examinations," W. T. Magruder; "A Course of Study in Municipal and Sanitary Engineering," A. N. Talbot; "Engineering Education in Japan," J. A. L. Waddell; "Modeling as an Aid to Teaching Machine Design," G. W. Bissell; "A Course of Study in Mechanical Railroad Engineering," H. W. Hibbard.

The meeting of the society will be held at the room of the Engineers' Society of Western New York, in the Library building, Buffalo, August 20-22.

Cycle Notes.

For comfort the front tire should be considerably softer than the rear one.

District telegraph boys in New York City have been provided with bicycles.

The bicycle has reached the Soudan; at last accounts there were two in use there.

A room for checking bicycles has been provided at the Metropolitan Museum of Art in New York city.

The Argentine Republic has passed a law forbidding women to ride bicycles in public. The law was framed to protect the interests of the owners of public vehicles.

Riders should never allow the adjusting cone of the head of the wheel to become loose, as continued jolting will thus weaken that part of the wheel, which bears the greatest strain.

A pneumatic grip is one of the latest contrivances to make the trip more enjoyable. Grips provided with a ball joint are also being introduced.

Even to the farthest eastern part of the world the bicycle has found its way. A bicycle club has been formed at Vladivostok, which is the end station of the great Siberian railway, 10,643 kilometers east of St. Petersburg.

A London bicyclist, Mr. Jefferson, who has undertaken to ride to Irkutusk in Siberia, reached Moscow by a roundabout journey of 2,500 miles from Rotterdam in six weeks. He went by way of Hamburg, Dantzig, Riga, St. Petersburg, and Novgorod, and had bad weather, snow storms, and bad roads in March and April.

Bicycle manufacturers are making a large draught on the supply of elmwood. Most of the wood used in the rims of bicycle wheels are now made of rock elm. During this year 3,000,000 rims will be required for the trade. It takes about 2½ feet of wood for a rim, so that the 3,000,000 rims will call for 7,500,000 feet of wood. As only the finest wood can be used in rims, amounting to only a fifth of the bulk of rock elm, these rims will call for the cutting and handling of nearly 40,000,000 feet of this wood.

An inventor of Switzerland has designed a bicycle which he thinks will effect a revolution in the shape and mode of propulsion of the wheel. He proposes to utilize the strength in the back as an aid to the legs in propelling the wheel. The pedals are on a line with the bottom of the seat, and are placed in the front part of the frame. There is a back to the seat which affords a brace for the rider's back, enabling him to exert much more power than in the present model. The steering bar consists of a long handle similar to that of children's tricycles.

It is not surprising that some of the leading features of bicycle construction should be traced back for centuries. The invention of the pedals has been attributed equally to a Frenchman, Michaux, to a Scotchman, and to a German, according to one's nationality, but it seems that none of them can have the honor of priority to this method of propulsion, for according to a book published in 1694, under the title of "Recreations Mathematiques et Physiques," the inventor was a doctor named Elie Richard, living at Saintonge. It appears that in 1690 he constructed a carriage which was driven from behind by a footman, "who worked it with two feet by means of two little wheels concealed in a box, and attached to the axle."

Wooden handle-bars are considerably in vogue just now and promise to gain rapidly in favor. Indeed, the prediction is ventured that in a year or two they will displace the metallic ones as completely as wooden rims have ousted those of steel. Some riders have long wanted wooden handle-bars, but could not buy them. Now several manufacturers offer them for sale, although the dealers do not seem to have a large supply on hand. The price is $2.50 to $5 apiece. The chief advantage of them is that they absorb vibration. Wheelmen often complain of a numbness of the hands and wrists after long rides, and even after short ones over cobblestones. The wood is springy, and prevents this after effect, as well as adding to the pleasure during the ride. Then, too, there is a saving in weight. A wooden handle-bar was found to weigh 17½ ounces, against 25½ ounces for the steel one which it replaced. This, however, is only a secondary consideration. There is, perhaps, little choice in strength between the two kinds. It is confidently asserted that any accident which would break a bar of elm or hickory would do serious damage to one of hollow steel, such as is in general use. The new handle-bars are covered with cork where they are grasped by the hand.