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Rose Technic Staff
Rose-Hulman Institute of Technology

······# THE ROSE TECHNIC.

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THE ROSE TECHNIC.

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THE Poly's loyalty to the fair sex, if nothing else, infuses within him an interest in the Inter-state oratorical contest, to be held at Minneapolis May 4th. Indiana's representative is to be a young lady, and should she win, congratulations from R. P. I. will be forthcoming with as much enthusiasm as those from even DePauw herself. It is no insignificant distinction for her to have won in the Indiana contest, and should her unquestioned ability secure for her the victory in this greater contest, the honor, indeed the fame, will be banking capital for an entire lifetime. Success to Miss Nelson! Success through her to Indiana!

* * *

RECENTLY drawings have been received by the drawing department from a number of sources, which have added materially to the collection. Professor Ames requests the announcement that donations of this kind will be highly appreciated. Blue prints, photographs, trade catalogues, etc., are also solicited.

UPON March 11th a hopeful delegation went to Indianapolis to secure for Rose those rights in the various state college organizations to which in equity she is entitled. An entire revision of the athletic constitution was one of the questions to be considered, base ball and foot ball schedules were to be made out, field day was to be assigned, and a college press association was to be formed. It is almost needless to ask with what success the efforts of this delegation were attended. Every hope was realized. Every reasonable request was acceded. Indeed, from beginning to end, the deliberations of the several bodies were characterized by a spirit of mutual consideration and courtesy, which betokens good omen for intercollegiate affairs in every direction. The delegates were thorough gentlemen, good feeling constantly prevailed, and favors were distributed with an equality which permits no college to boast of advantage. Plainly, the day of college antagonism in Indiana is rapidly drawing to a close. The reason for this lies wholly in the fact that the students of the several institutions are beginning to learn that the gentlemen are not, by any means, concentrated in one city. Acquaintance has developed the truth that all college men have an interest in common, and the prediction is ventured that during the coming year this tendency to inter mingle will rapidly grow. In consequence, on next "Oratorial Day" the state association will meet on a basis broader and better than ever before.

* * *

GENERAL assemblies of the students are of such infrequent occurrence that a call for one is interpreted to be the announcement of important business. In consequence, much was expected of the assembly on Thursday evening last. Anticipations were fully realized, in that much progress in the preparation for state field day was made public, sufficient, it may be added, to indicate that the events of May 27 will be managed

with an excellence of system subsequent years will be slow to improve upon. The condition of affairs gives rise to feelings of great satisfaction. When the state convention of athletic delegates gave the field day to Rose it was with the understanding and upon the promise that the athletic meet would be made the best the state has ever known, amateur or professional. Present preparations give full promise that no misrepresentations were then made. They further give promise that visiting delegations may expect every courtesy within the power of the students of Rose to extend. All this will be in keeping with the tendency toward warmer inter-colegiate social relationship, which has manifested itself in all intercollegiate affairs of the present year. Certainly, it is hoped that every college man who comes to Terre Haute on May 27th may leave entertaining higher regard for the Polytechnic and her students than ever before.

* * *

SUCH full announcement of the Institute Souvenir, to be issued by the Senior class, has been made through other channels, that it is unnecessary to enter into detailed mention of the project here. Suffice it to say that the volume will be one all the students will have an interest and a part in, and their support is one of the factors which will determine its excellence. The Seniors have assumed the responsibility of the publication, and the appearance of the book is promised for the first week in June.

* * *

IN all the leading educational institutions of the country, active steps are being taken preparatory to sending full and carefully arranged exhibits to the Columbian Exposition. There seems to be a general desire that the great centers of learning in America shall win their share of praise from the hundreds of thousands of foreigners who will visit the great display. Coupled with this is the further desire for prestige each institution naturally holds, which will have the inevitable tendency of creating rivalry, and thus aiding in the improvement of the exhibits. In this connection it is pleasing to again note that Rose will not be found in the rear rank when the fair opens. Just how comprehensive our exhibit will be it would now be premature to say, as the board of trustees have not taken action on the report submitted by the committee of the faculty. Of this much, however, assurance can be given, that a good exhibit will be made, or none at all. The Institute has a reputation of which all who have any connection with it are proud, and this will not be placed in jeopardy by sending to Chicago a collection of work which will suffer in comparison with that shown by others.

* * *

BY courtesy of the faculty THE TECHNIC has been granted the use of one of the vacant rooms on the third floor of the main building for office purposes. This concession is made in recognition of the great disadvantage under which the board of editors has worked up to the present time in being unable to exchange assistance among the members in the duties of the several departments. The exactions of the institute course, as all students know, are very severe, and it is necessary that each member of the board should use as little time as possible in doing his editorial work. It is that time may be economised, in other words, that has led to the new arrangement. The condition has been stipulated that the room shall be used strictly by the members of the board for doing their work, and to this end the rule has been made, to which THE TECHNIC has acquiesced, that no one outside the editorial board shall be admitted. It is confidently believed that the arrangement will prove beneficial all around.

* * *

PRESIDENT Eliot, of Harvard, occupies a position which justifies those not familiar with his public record in presuming him to be a man of preëminent good sense, as well as learning. Unfortunately, this is but another instance of expectations doomed to disappointment. No one can read his recent public utterances, placing the Mormons on a plane with the Puritans, without

serious misgivings as to his sanity. Suspicions were aroused when he found occasion to publicly extol the eastern college and decry the western, but leniency was shown him on the belief that his eyes suffered from "Eastern complaint" in the clear, bracing atmosphere of the west. Now, these suspicions are confirmed. A man whose native modesty has been so far stunted in its development as to permit him to stand upon the lecture platform of a great western university and openly proclaim the comparative perfection of the institution under his charge, might be expected to so pervert history as to see in the Mormons the grand characteristics of the Puritans. President Eliot may be a good president of Harvard; he may be a great man in the eyes of the east, but here in the wild, uncultured west a suspicion is entertained that he is a dangerous man, occupying a position, the responsibility of which is beyond his calibre.

TEMPERING.

BY PROFESSOR C. S. BROWN.

Tempering is that process by which varying degrees of hardness may be imparted to some metals. The ability to take this physical change is the most valuable property of steel and its most distinguished peculiarity. Other metals possess this quality to a more or less marked degree, but none compare with steel in the wide range of tempers or degrees of hardness which may be imparted to it, or the facility with which the temper may be obtained suited to any required purpose.

Nearly all metals are hardened or tempered by being hammered, rolled or subjected to great pressure, on account of the increased density produced in the metal by such processes. Iron, brass and copper may be made quite hard by being drawn into wire or rolled into rods. The tempering of steel, however, is best accomplished by suddenly cooling from a high heat, while a slow cooling anneals or softens the metal so that it can be easily worked. Tempering properly consists of three distinct operations. First, heating to the proper temperature, next, "hardening" by dropping in some bath to accomplish sudden cooling, and last, "drawing," or letting down the temper to the proper degree of hardness required. While these operations may appear simple and easily performed, they require, at the same time, a good deal of care in manipulation, and much of the success of the operation depends upon the judgment of the operator.

Much care must be exercised in heating that the steel may not be overheated or "burnt," as burnt steel cannot by any method be restored to its original quality. For proper heating a very hot fire is unnecessary, as the piece to be hardened should be heated slowly and evenly so that all parts may be brought as nearly as possible to the same temperature. Rapid or uneven heating may cause the piece to warp or twist out of shape while in the furnace, and result in serious injury or ruin to the article heated. Steels high in carbon will harden at a very low red, and are easily injured by a much higher heat. The most successful tempering can be done by dipping the metal at the lowest possible temperature at which it will harden, the popular conception of the "cherry red," commonly mentioned as the proper heat for hardening being much higher than necessary for most of our American high carbon steels and entirely too high for some

For a cooling bath water is the most efficient of all fluids, on account of its high specific heat and great capacity for absorbing heat while changing temperature or vaporizing. The quicker steel is cooled the harder it becomes, consequently, for articles which it is desirable should be very hard, a

fine spray of water under considerable pressure makes the most efficient cooling bath; or a stream of flowing water serves better for this purpose than still water, as in the latter a film of steam envelopes the article and prevents rapid absorption of heat. A strong brine made of common salt and pure water is sometimes used when it is desirable to make a tool "glass hard." Acidulated water is also used for this purpose. Pure water is, however, the most satisfactory bath for hardening tools the temper of which is to be drawn, and if the bath is kept clear of oil or grease the longer it is used the better it appears to act. Steel properly hardened has a distinctive color which cannot well be mistaken, and does not require to be tested by the file to demonstrate its hardness. It should come from the bath showing a grayish white or mottled gray color, and if hardened at the proper heat will without drawing be quite tough and resist considerable hammering without breaking. If heated hotter than the low red necessary for hardening, it will be found quite brittle and quickly fly to pieces under the hammer.

An excellent method of showing the bad effects of high heating in hardening steel is to take a small bar of square steel, and mark off on one end of it eight or ten equal lengths about $\frac{1}{2}''$ long by "nicking" with a cold chisel. This end can then be heated in the forge fire for the distance covered by the pieces marked off, the heat being graduated from a white or melting heat at the very end to a temperature below the red at the last peice marked off. If this heated end be then suddenly cooled in water and the pieces marked off be broken at the "nicks" the various specimens broken off will show by their texture the effects of the temperature to which they have been subjected. The end specimen, which was heated white hot, will be coarse grained, yellowish in color and have a distinct lustre. It will also be very hard, cut glass easily, but prove as brittle as glass under the hammer. The next specimen will be a little less yellow in color and open in grain, but will have the "fiery" lustre which shows it to be over heated. These characteristics will gradually grow less marked in the succeeding specimens till, in those heated to a low or dull red, they will be succeeded by a fine, close, silk-like grain which is quite homeogeneous throughout the bar. This specimen will be found very tough under the hammer, and quite hard enough for almost all purposes. The next specimen will likely show a less close grain except on the edges and corners, the center being less hard and more in texture like the original bar. Another specimen will likely show no change whatever from the original bar.

A few practical illustrations of this sort will do much towards impressing the learner with the proper color for heating when tempering, and be of great value in impressing him with the great importance of a low heat in working, and particularly in tempering steel. American steels were for years unpopular and considered unreliable, for no greater reason than that they would not stand the temperature at which our blacksmiths and steel workers had been accustomed to forge and temper imported steels. It is doubtless true that our own steels would have been more popular years ago had greater attention been paid to the education of the native blacksmith in the manipulation of the material.

"Drawing the temper" is the technical name for the process by which the hardness of the article being tempered is decreased while its strength and toughness are at the same time increased. It It is plain that the cutting quality of a tool would not be improved by softening it were it tough enough to hold an edge. But hardened steel is brittle, and a keen knife or chisel edge would not stand if not tempered by drawing. It is desirable, therefore, to retain this hardness as far as possible, only drawing it down sufficient to obtain the requisite strength and toughness to make the edge stand without chipping or nicking.

A valuable peculiarity of steel is that on heating, its surface becomes coated with a thin film of oxide, the color of which indicates the temperature to which the steel has been raised. Drawing the temper consists in heating the hardened piece of steel to a temperature sufficient to "draw down" some portion of its hardness and make it tough and strong enough for the purpose required. The amount of this "drawing" can be regulated by the color of the oxide film which

first coats the polished surface of the steel with a light straw color, gradually growing darker till it becomes brown, then dark brown to purple blue and green, when shortly it begins to show red heat and the steel returns to the same condition as before hardening. Repeated tests have demonstrated the temper indicated by the oxide color best suited for a particular tool, and when after proper hardening different pieces of steel are drawn to this partiular color they will be found to have approximately the same hardness and toughness, varying, of course, with the different qualities of steel used. The time used in drawing also makes some little difference in the temper, as a piece drawn quickly to a certain color will be somewhat softer than a similar piece drawn slowly, as it takes some little time for the oxide to form on the surface of the metal. Slow drawing is preferable in all cases, as while the hardness is decreased but little the toughness of the specimen is very much increased if considerable time is allowed for this process. A convenient arrangement for drawing the temper of small tools, such as taps, dies, reamers, milling cutters, etc., is a heavy cast iron plate from one to two inches thick, which can be set over the forge fire and heated to a low heat. On this the articles to be drawn are placed after having their plane and cylindrical surfaces well polished in order to better show the color of the oxide film. The pieces should be heated slowly, meanwhile being turned over occasionally in order that they may heat evenly and be of the same temper throughout. When the proper color is reached the article should be cooled by dipping in cold water, or better, be laid aside to cool slowly, in which case they become tougher than if cooled suddenly. A better method of drawing the temper of small articles, or of articles having both thin and heavy sections, and particularly of tools having teeth, such as taps, reamers, cutters, etc., is by a sand bath, a shallow box of cast iron filled with sand heated to the proper temperature for drawing.

For all tools a charcoal fire is far better than either hard or soft coal, on account of the bad effect on steel of sulphur usually contained in greater or less quantities in all coal. Coke makes an excellent substitute for charcoal, and is used largely for tempering purposes. Where common smithing or soft coal is used, it is best to cover the fire well with coal, wetting down the outside which should be heaped up in a small mound over the fire, and vent made in the side for the escape of smoke and gases and the insertion of tools, etc., for heating. The fire soon burns a dome-shaped cavity in the mound, filled with flame and heated gases, in which pieces can be heated very evenly. Before the articles are inserted for heating the fire should be allowed to burn till no more smoke escapes from the opening. In this condition the coal will have been well coked and the sulphur contained in it drawn off, leaving the cavity of the mound in the best possible condition for proper heating. At this point the blast should be shut off leaving only sufficient to keep the fire burning well, and permit the pieces to be hardened to heat slowly and evenly. Frequent turning of the article in the fire will facilitate even heating and prevent the burning of small points, such as the teeth of taps, cutters, etc.

In tempering taps, reamers and other articles of considerable length in proportion to their diameter, much care must be exercised in heating and dipping. Uneven heating will cause springing, so pieces of this sort should be continually rotated while heating. If cooled quicker on one side than on the other they will be likely to spring, so it is necessary to dip the piece with its axis perpendicular to the surface of the bath. As most taps and reamers are hardened only on the portions covered by the teeth—the shanks being left soft—they should be heated but little above the toothed portion, and when dipped should be moved up and down, and at the same time given a slow rotary motion about the bath in order to stir the cooling mixture and accomplish rapid cooling. This vertical movement prevents too sharp a line being drawn between the hard portion covered by the teeth and the soft material of the shank, and the consequent likelihood for a crack or break to occur at such a point. Taps, reamers and milling cutters should be heated to

an almost impreceptible red. This causes sufficient hardness in the teeth, while the body of the tool is scarcely hardened at all and retains all the toughness and strength of the unhardened metal. After polishing they should be drawn to a dark straw color, and allowed to cool slowly without dipping. Milling cutters, before heating, should have the mandrel hole filled with clay in order to prevent sudden cooling and a consequent possible bursting of the cutter. This treatment leaves the teeth hard and the center somewhat softer, which effect can be further increased by drawing the temper with a hot mandrel run through the hole in the cutter. By this means, with judicious cooling of the teeth with water the center can be drawn to a dark blue while the teeth remain at the desired temper indicated by the dark straw color. A cutter tempered in this manner will be much tougher and less liable to break than if drawn to the same color throughout.

[To be concluded in May number.]

THE FACULTY--1891-92.

In this issue it is the pleasure of THE TECHNIC to present a frontispiece group of the faculty, giving excellent likenesses of each member. In connection the following brief biographical sketches will be of interest:

Henry T. Eddy, President, was born at Stoughton, Mass., June 9th, 1844. He was fitted for college at North Bridgewater (now Brocton), Mass. In 1867 he received the degree of A. B. from Yale; in 1868 that of Ph. B. from the Sheffield Scientific school; in 1870 that of A. M., from Yale; in 1870, also, that of C. E. and in 1872 Ph. D., both from Cornell University. He has taught as instructor in field practice in the Sheffield Scientific school, 1868; instructor in Mathematics and Latin, University of Tennessee, Knoxville, 1868–69; asssistant professor of Mathematics and Civil Engineering, Cornell University 1869–73; associate professor of Mathematics, Princeton College of New Jersey, 1873–74; professor of Mathematics, Astronomy and Civil Engineering, University of Cincinnati, 1874–90, where he was Dean of the Academic Faculty, 1874–77 and 1884–90. He was president-elect of the University of Cincinnati in 1890, and became President of Rose Polytechnic Instititute in 1891. Spent the year 1879–80 in study abroad—one semester at Berlin, under Kirchhoff in Mathematical Physics, and under Helmholz in Physical Laboratory, the other semester attended lectures at the Sorbonne, at Paris. Vice-President American Association for the Advancement of Science for Section A. (Mathematics and Astronomy) at the Philadelphia meeting, 1884. Member of the Am. Phil. Soc. Author of "Analytical Geometry," Philadelphia, 1874; "Researches in Graphical Statics," New York, 1878; "Neue Constructionen aus der Graphischen Statik," Leipzig, 1880; "Thermodynamics," New York, 1879; Maximum Stresses under Concentrated Loads, New York, 1890, and of many published papers in scientific and technical journals.

William L. Ames, Professor of Drawing, was born at Kingston, Mass., in 1855, and received his preparatory training in the public schools of that place. From 1873–76, he was with the Macon Locomotive Works, Taunton, Mass., and from 1876–79, with the Old Colony Rivet Works, Kingston, Mass. From 1879–82, he was a student of the Worcester Polytechnic Institute, receiving the degree of B. S. on graduation. During the year 1882–83, he was a student in the School of Design, Cincinnati, O. Since March, 1883, he has been connected, in his present capacity, with Rose Polytechnic.

J. A. Wickersham, Professor of Language, born 1851, near Wilmington, Ohio, received early training in the public schools of Herper, Iowa,

and in the preparatory department of the University of Kansas. Graduated from the University of Kansas in 1876, with the degree of B. S., having done special work in Greek. From '76 to '78, was instructor of Greek and Latin in that University, took the degree of Arts in 1878, and was elected to the chair of Greek. He did not, however, undertake the duties of that position, but resigned, and from '78 to '81 was a student of philosophy at Leipsig, Berlin and Tübingen. In 1881, was, for a short time, principal of the schools of Franklin Falls, N. H., published "Poems," and "Aliso and Achne," N. Y., and entered Rose Polytechnic Institute in 1883.

William A. Noyes, Professor of Chemistry, was born in 1857, on a farm, near Independence, Iowa. He graduated from Iowa College, Grinnell, Iowa, in 1879, taking degrees in both Arts and Science, the latter degree being given chiefly for work in chemistry during the last two years of the course. During the fall of '80 he had charge of the Chemical Department of Iowa College during the absence of the Professor. In January 1881, went to Johns Hopkins University, and took the degree of Ph. D. there, in 1882. During 1882–83 he was instructor in Chemistry in the University of Minnesota, and during the three years 1883–1886 was professor of Chemistry in the University of Tennessee, at Knoxville. In the summer of 1886 he came to the Rose Polytechnic. During the winter and spring of 1889 had a leave of absence which was spent in work with Professor v. Breyer, in Munich. He has published a number of scientific articles, chiefly in the American Chemical *Journal* especially a series "On the Oxidation of Benzene Derivatives with Potassium Ferricyanide," and on the "Atomic Weight of Oxygen." Has also written a book on Qualitative Analysis, published by Henry Holt & Co.

Malverd A. Howe, Professor of Civil Engineering, born in 1863, received the degree of B. S. from Norwich University in Vermont in 1882, that of M. S. from the same university in 1888; in 1886 he received the degree of C. E. from the Thayer School of Civil Engineering, Hanover, N. H. He taught during the year 1882–83 as second master in the Vermont Episcopal Institute of Burlington; during the year 1886–87 in Lawrence Scientific School at Harvard University, and in 1887 entered Rose.

Professor Howe is a member of the Engineers' Club of St. Louis, and an associate member of the American Society of Civil Engineers. He is the author of the following books and pamphlets:

The Sabula Draw by Graphics.
Retaining Walls for Earth.
The Continuous Girder.
Tables and Formulas used in the application of the method of Least Squares.
Diagrams, Formulas and Tables for Bridge Engineers and Architects.
Some experiments to determine the strength of Vitrified Sewer Pipe.

Carl Leo Mees, Professor of Physics, was born in Columbus, Ohio, May 20, 1853, was graduated at Ohio University and at Starling Medical College in 1875, meanwhile, in 1870–5, holding the office of Assistant Chemist of the Ohio Geological Survey. He was then called to the Professorship of Chemistry and Physics in the Louisville, Ky., schools where he remained until 1880, after which he spent some time in study at the Imperial Institute, Berlin. In 1882 he became Professor of Physical Science in Ohio University and in 1887 was called to the chair of Physics in Rose Polytechnic Institute. Dr. Mees is a member of scientific societies and in 1887 was secretary of the physical section of the American Society for the Advancement of Science, of which he has been a fellow since 1876.

Thomas Gray, Professor of Dynamic Engineering, was born in Scotland in 1850, and was educated in the public schools, the Watt Institution Edinburg and the University of Glasgow. He was graduated from the latter institution as B. S. and C. E. For three years, 1878–81, he taught electrical engineering in the Imperial College of Engineering, Tokio, Japan. From 1881 to 1888 he was assistant to Sir William Thomson and Prof. Jenkin. While with them he was their chief representative as engineer in the construction and laying of the Commercial Cable Company's system of trans-atlantic and other cables. In 1888 he came to America to assume his present duties in R. P. I. The following is a list of orig-

inal papers contributed by Prof. Gray to the Royal Societies of London and Edinburgh, the Geological Society of London, the *Philosophical Magazine*, the Seismological Society of Japan, British and American Associations for the Advancement of Science, the American Society of Mechanical Engineers, the Indiana Academy of Sciences, &c.:

On the Determination of Magnetic Moments in Absolute Measure.
On the Specific Heats of Saline Solutions.
On the Specific Resistance and Specific Inductive Capacity of Glass.
On the Effect of Permanent Elongation on the Specific Resistance of Metals.
On a Seismometer and Torsion Pendulum Seismograph.
On Steady Points for Earthquake Measurements.
On Instruments for Recording Earthquake Motions.
On the Best Arrangement of the Wheatstone's Bridge for the Measurement of any particular Resistance.
On a Seismograph for Registering Vertical Motion.
On Recent Earthquake Investigations.
On a Seismograph for Large Motions.
On a Method of Compensating a Pendulum so as to make it Astatic.
On the Variation of the Specific Resistance of Glass with Density, Temperature and Chemical Composition.
On the Graduation of Galvanometers for the Measurement of Currents and Electromotive Forces in Absolute Measure.
On Gray and Milne's Seismographic Apparatus.
On the Size of Conductors for the Distribution of Electric Energy.
On the Measurement of the Horizontal Component of the Earth's Magnetic Field.
On a New Standard Sine-Galvanometer.
On the Electrolysis of Silver, and of Copper, and the Application of Electrolysis to the Standardizing of Electric Current and Potential Meters.
On Silk and Wire Suspensions in Galvanometers, and on the Rigidity of Silk Fibres.
On an Improved Form of Seismograph.
On Electrical Measurements.
On Practical Electrical Testing.
On a New Reflecting Galvanometer of Great Sensibility and on New Forms of Astatic Galvanometers.
On the Relation between the Electrical Qualities and the Chemical Composition of Glass and Allied Substances.
Relative Merits of Dynamometric and Magnetic Methods of Obtaining Absolute Measurements of Electric Currents.
Autographic Apparatus for Testing Materials.
Dynamometers for Power Measurements.
On the Resistance of Metals to Cutting and Boring.
On a Machine for Testing Torsional Strength and Stiffness of Materials.
Earthquake Observations and Experiments in Japan.
On the Strength and Elasticity Constants of Certain Rocks.
Seismic Experiments.
The Function of the Laboratory in Technical Schools.
Problems in Mechanical Science (Vice President, Address Section D, A. A. A. S.).
On Expansion Calorimeters.
Telegraphy (Encyclopedia Brit).
Telephony (Encyclopedia Brit).
Seismology (British Admiralty Manual of Scientific Enquiry).

Charles S. Brown, Professor of Machine Design and Superintendent of the Mechanical Department, was born in Connecticut, August 1860. He was graduated from the Sheffield Scientific School of Yale in the mechanical engeering course with degree of Ph. B. in 1883. He was constructing engineer for the Blake Crusher Co., New Haven, Conn., until 1887, doing mining mill work, fine crushing and concentration of ores. During 1887–88 he was assistant engineer for the Metropolitan Street Railway Co. of Kansas City, Mo., in the construction of cable railways. He became connected with Rose Polytechnic Institute in September, 1888.

A. S. Hathaway, Professor of Mathematics, is a graduate of Cornell University of '79. During his undergraduate course in that institution he contributed a number of articles on mathematics to the *Analyst*, and was sent by Cornell as its representative to the Inter-collegiate contests at New York City where he won the first prize in his favorite study. After graduation he became a teacher in mathematics in the Friends' High School, Baltimore, for a time. He then turned his attention to business pursuits, but at the request of Professor Sylvester, who was then at the head of Johns Hopkins, gave up a profitable employment to take a fellowship there. This continued two years, 1882–84. In '84 he reported Sir Wm. Thompson's lectures for Johns Hopkins and the Electrical Conference for the United States government. In 1885 he was elected instructor of mathematics at Cornell and later an assistant professor, which position he held at the time of his appointment here. He has been a writer of frequent articles on mathematical subjects in recent years, and several of his articles on the Theory of Numbers have appeared in the *American Journal of Mathematics* and in the Johns Hopkins circulars.

W. H. Kirchner, B. S., Junior Professor of Drawing and Librarian, was born at Otter River, Mass., Oct. 24, 1868. He received his preparatory training in the Templeton High School, after which he entered the Worcester Polytechnic Institute, graduating in 1887, having made a speccialty of drawing and design. Professor Kirchner became Instructor of drawing in Rose Polytechnic Institute in 1887. In 1889 he was promoted to

the position of junior professor in that department, and in 1891 was elected Librarian.

Edwin Place, B. M. E., Instructor in Physical and Engineering Laboratories, took the degree of B. M. E. at Cornell University in 1883. After two years service with the Sperry Electric Light, Motor and Car Brake Company, of Chicago, returned to the University and spent a year there in graduate studies pertaining to electrical engineering. In July, 1886, entered the employ of Glover, Davis & Co., wiring contractors for the Westinghouse Electric Company, and after three months service was given the position of superintendent of the Westinghouse Illuminating Company of Schenectady, N. Y., which he held for a year. The year following he was in charge of construction work for the Western Engineering Company of Lincoln, Neb., a firm of electrical and mechanical engineers. January 1, 1888, entered the engineering department of the Edison United Manufacturing Company, of New York City, but at the end of two months accepted the situation of foreman with the Tucker Electrical Construction Company, of New York, with whom he remained till appointed instructor in the Rose Polytechnic Institute, January, 1890.

Robert L. McCormick, B. S., Instructor in Mathematics and German, born 1867, graduate of Rose Polytechnic Institute in 1881; received honorable mention in Sophomore and Senior years, took the one hundred dollar prize for best work of Junior year, and won the Heminway gold medal for best work throughout the course. Before entering Rose, he was a special student of mathematics at Indiana University for one year. He entered Sophomore class of R. P. I. in 1888 and became Instructor in the Institute in 1891.

THE TECHNIC is indebted to Messrs. Wright & Holloway and Mr. H. T. Biel for photographs furnished in arranging the illustration presented.

THE VOLTAIC ARC.

BY EDWARD S. ALLEN, formerly of '92.

There is probably no branch in the electrical science, since the time of Volta, Ampere, Jablochkoff, Sir Humphrey Davy and others, that has undergone such vast improvements, and which has so nearly reached perfection as has the voltaic arc lamp. Since its first commercial introduction, (in a crude way) during the winter of 1884 at the Place de la Concorde, Paris, the arc lamp has been greatly improved upon and to-day affords invaluable benefits to the mariner, the merchant, and the pedestrian. We are indebted to Sir Humphrey Davy for the first arc light, used commercially, which he obtained by the use of a series of powerful galvanic batteries comprising some two thousand cells, arranged in porcelain cups. The liquid used was a solution of water, sulphuric and nitric acids, the plates being zinc and copper. Davy graphically describes his discovery as follows:

"When pieces of charcoal about an inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch) a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and by withdrawing the points from each other a constant discharge took place through the heated air in a space equal at least to four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle."

Davy had no means by which the distance between the carbons could be regulated, therefore the light was of short duration, and practically

useless. This discovery was made in 1808, and not until thirty-six years later did it come into practical utility, being during these years simply an experiment for the laboratory. The main difficulties were the wasting of the charcoal, and the absence of a device by which the electrodes or carbon (charcoal) points could be automatically adjusted to produce the required steady arc.

Closely following the first introduction of the voltaic arc for commercial purposes, inventors brought forward many new devices for feeding the carbon rods. However, at that time the tendency was toward a clock-work feed, leaving a solenoidal or magnetic feed entirely out of the question, probably owing to their limited knowledge of the science. Strange to say, to-day the clockwork feed is still used in some instances, especially in lighthouses where a constant, invariable feed is required, one which can be free from moisture, and atmospheric changes.

It may seem strange to some that the arc is not produced directly from electricity, but it is however true as will be seen. Two rods of carbon being first placed in contact, the current seemingly flows or passes through the rods without resistance. Upon the separation of these carbons a spark is produced by a current set up in the lamp itself, commonly termed self induction, due to the difference of potential at the moment of separation. This small spark is capable of heating a small portion of the air space between the carbon rods, and also vaporizing a portion of the carbon at the points, so that the air space finally becomes filled with carbon, possibly in a gaseous state. Thus the arc is established, and maintained at incandescence. Although this carbon vapor conducts the current fairly well, it at the same time offers some resistance and becomes white-hot. The temperature of the arc has been said to be 8700°, although no practical demonstration has as yet been brought forward.

It is not definitely known as to the exact nature of the arc, whether it is due to incandescence of the particles or the oxidation of the carbon, although some writers contend that owing to its power of burning under liquids, in oils, and in vacuum, it is due to incandescence. The ark itself is an extremely interesting study, and by the aid of a smoked glass one can readily see most of the phenomena connected with it. I had occasion to test a new form of arc lamp depending on a novel principle for its feed, and at the same time made some observations on the nature of the arc. A pressure of 50 volts was used, and the light produced was quite brilliant. The lamp being placed near the floor for testing, a good view of the "crater" in the upper carbon could be obtained. Through smoked glass the crater seemed to be a boiling, molten fluid, and bubbles were seen traveling around the edge now in one direction and now in the other. This agitation of the molten particles was probably due to the particles of carbon being torn from the upper carbon and deposited below. The air was filled with finely divided particles of carbon, which were extremely disagreeable to the eyes, and necessitated a protection of screened glasses. The crater in the upper carbon acts as a reflector and projects the light over a great area as compared with the light itself. If the lamp is hung so that the current shall enter at the under carbon the reversal of the above condition will occur, the light being thrown upwards and the deposition of carbon particles being above instead of below. Lamps burning under these conditions are said to be burning "above."

Arcs are classed as follows: The "steady" arc, or that which burns with little agitation, no flickering, and noiseless. This point varies in different lamps, but the average arc for best efficiency and full candle power is from $\frac{1}{16}$ inch to $\frac{3}{32}$ inch. The "hissing" arc, or that caused by the carbons being fed too close together, the resistance being thus decreased appreciably and causing a hissing sound as of escaping steam. Third, the "flaming" arc, or that due to the separation of the carbons beyond their limit of arc, thus causing a great waste of carbon surface, and a very poor light, as is also the case with the "hissing" arc.

Arc lamps may be divided into several groups, viz: Clockwork lamps, depending on a clockwork mechanism for their feed; Solenoidal lamps, fed by the introduction of helices or coils of coarse wire having hollow cores into which a soft iron magnet is drawn, producing the required separa-

tion, and a shunt coil of fine wire having high resistance and causing the rods to approach each other at the moment the resistance at the arc becomes too great; Clutch lamps, depending on a clutch mechanism for their feed together with the aid of gravity to assist the downward vertical movement, and solenoids to produce the separation, at the moment the current is established; Differential lamps, depending on a compound wound solenoid which governs the feed of the upper carbon.

A new lamp which is novel and original came under my personal observation recently. It embodies quite a number of new ideas as to its feed, and a description will doubtless prove of some value to the reader. The lamp, although not as yet manufactured for the trade, was patented some ten years ago by Mr. Alex. E. Brown, Vice President of the Brown Hoisting and Conveying Mach. Co., of this city. The lamp is designed for a pressure of from 40 to 50 volts, with a current of 5 to 10 amperes. Two solenoidal coils are situated upon a framework, preferably of iron. These coils have within their hollow cores, soft iron magnets which are free to move in a vertical direction. Attached to these magnet cores is a bar or armature which serves two purposes—that of joining the magnets and at the same time serving to lift the lever upon which is hung the valve governing the upper carbon. A shunt coil of fine wire, having a resistance of about 400 ohms, and designed to take 1% of the total flow, is also fitted to the upper frame. This coil has an internal magnetic core capable of drawing up vertically. Attached to this core is a rigid rod of brass, upon the lower end of which is a plunger, which fits accurately in a valve. The valve itself is governed by the two main circuit coils above mentioned. The valve with, with its plunger, is fitted inside a brass tube accurately reamed internally to permit free and easy movement of the valve. Into this tube is poured glycerine, which prevents the escape of air under the valve, at the same time allowing the carbon to feed down slowly when required. The brass tube which contains the valve and plunger is entirely covered by a larger protecting tube screwed to under side of upper lamp frame. The action which takes place upon the establishing of the current is as follows: The current passing around the main circuit solenoids tends to draw up their cores, and thus lift the valve and tube by which the upper carbon is adjusted. To facilitate an even feed of upper carbon, the shunt coil which draws its magnet up at the instant the arc becomes too widely separated, also lifts the small plunger in the valve and allows the glycerine to flow through small channels in the valve, consequently lowering the carbon until the proper arc is reached. This feed to my mind is the only feed theoretically perfect, that has so far been designed, it being constant, steady and non-intermittent. The lamp has not been put into commercial use, but it will doubtless meet with success, upon its introduction for lighting purposes. The manufacturing of arc carbons has become one of the electrical features of to-day, but a discussion of this must be deferred. Suffice it to say that the standard diameters now used are $\frac{1}{2}$ inch, and $\frac{7}{16}$ inch. The majority of lamps being designed for $\frac{1}{2}$ inch carbons.

The arc lamp has proven invaluable in railroading, marine navigation, street lighting, in commerce, and in fact all branches where an intense steady light is required, and to deprive us of this grand gift, which is but one of the many resources of electricity, would be equal to the extinguishing of our sun.

CLEVELAND, Ohio.

GRAPHIC SOLUTION OF EQUATIONS.

BY PROFESSOR A. S. HATHAWAY.

II.

The following constructions are given as illustrations of my article in the last number of THE TECHNIC. The following errors occur in that article: Page 139; 1st column, 14th line from bottom, and 2d column 2d line from top, $A'\ B : O\ A$ should be $A'\ A : O\ A$. In the 2d column 16th line from the bottom, $A'\ B : m\ O\ A$ should be $A'\ A : m\ O\ A$.

Roots of $2x^2+4x+1$ [FIG. I.]

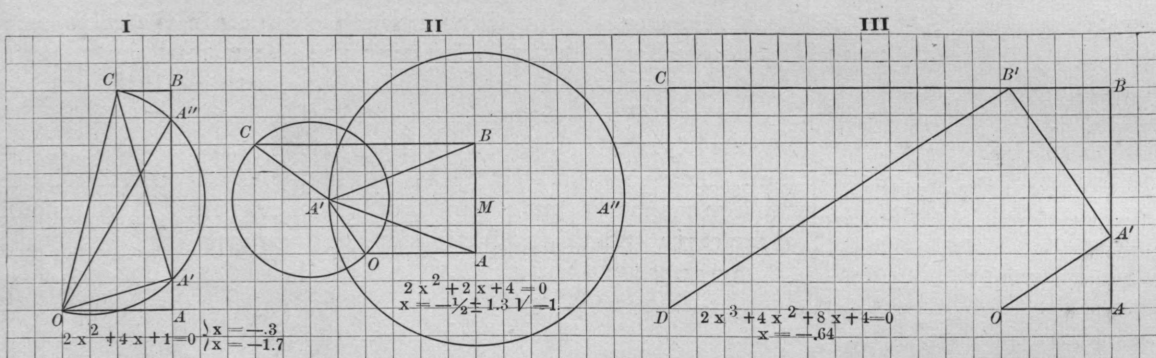
As the coefficients are all real it is preferable, and for real roots necessary, to transform the equation by putting $x=\frac{z}{m}$, $m=(1, 90°)$. The equation becomes $2\,z^2+4\,m\,z+m^2=O$, and $O\ A=2$, $A\ B=4m$, $B\ C=m^2=-1$. If $A'\ A : O\ A$ is a root of this equation then, dividing by m, we find $A'\ A : m\ O\ A$ as a root of the original equation. If this is real A' must lie on $A\ B$, produced if necessary. Remember that A' is such that $O\ A'\ A$, $A'\ C\ B$ are similar triangles and we see that the angle $O\ A'\ C$ is a right angle when A' lies on $A\ B$. Hence the circle on $O\ C$ as diameter cuts $A\ B$ in the sought points A', A''. From the figure the roots $A'\ A : m\ O\ A$, $A''\ A : m\ O\ A$ are approximately $-.3$ and -1.7.

Roots of $2\,x^2+2\times+4=o$. [FIG. II.]

Here $O\ A=2$, $A\ B=2m$, $B\ C=4m^2=-4$. The circle on $O\ C$ as diameter does not cut $A\ B$ and the roots are imaginary. Since $O\ A'\ A$, $A'\ C\ B$ are similar, therefore A' is equally distant from A and B, and that distance is mean proportional between $O\ A$ and $C\ B$. A circle with this mean proportional as radius and center at A or B will therefore cut the perpendicular erected at the middle point (M) of $A\ B$ in the sought points A', A''. The circle with center at M and cutting the circle on $O\ C$ as diameter at right angles also passes through these points. Conceiving $m.\ O\ A$ drawn from A' we see that $M\ A$ and $A'\ M$, $A''\ M$ are the real and imaginary components of the roots. The roots given by A' and A'' are by the figure $-\frac{1}{2}-1.3m$ and $-\frac{1}{2}+1.3m$.

Real root of $2\,x^3+4\,x^2+8\,x+4=o$.

We have $O\ A=2$, $A\ C=4m$, $B\ C=8\,m^2=-8$, $C\ D=4\,m^3=-4m$. The circuit $O\ A'\ B'\ D$ was drawn by aid of transparent paper turned round a pin with cross section paper underneath, after the manner of Lill's wooden and ground glass discs.



The root, $A'\ A : m\ O\ A = \tan A'\ O\ A$, may be read off from the cross section paper to several decimal places. It is here $-.64$....

Referring back to the previous article observe that $O\ A'$, $A'\ B'$, $B'\ C'$ are equi-multiples of $O\ A$, $A'\ B$, $B'\ C$, the coefficients of the quotient of $a\,x^3+b\,x^2+c\,x+d$ by $x-r$ where $r=A'\ A : O\ A$. This follows from the similar triangles $O\ A'\ A$, $A'\ B'\ B$, $B'\ C'\ C$ which give $O\ A' : O\ A = A'B' : A'\ B = B'\ C' : B'\ C$ both as to tensor and angle parts. Hence the circuit $O\ A'\ B'\ C'$ represents the quotients on the new scale in which $O\ A'$ instead of $O\ A$ represents the first coefficient a. In the present example, therefore, $O\ A'\ B'\ D$ is the circuit for the quadratic equation having for its roots the remaining pair of roots of the cubic. The circle on $O\ D$ as diameter will not cut $A'\ B'$ so that these two roots of the cubic are imaginary.

ALUMNI DEPARTMENT.

AN ELECTRIC RAILWAY POWER STATION.

BY C. B. KIDDER, '88.

In designing a street railway plant, two ideas must be kept constantly in view. First, the purpose of the plant, i. e. the transportation of passengers in the most satisfactory manner. Second, the accomplishment of this purpose at the least possible cost. In other words, the situation must be considered both from the point of view of the patron of the road and the stockholder. Neither of them cares particularly how the desired results are obtained. They only care for results.

The power station is the heart of the entire system and demands careful consideration. It must be reliable and economical in operation. With many of the early electric railways a satisfactory station would consist of boilers capable of withstanding a steam pressure of about 90 pounds, an iron stack 60 or 80 feet high, hand-fired furnaces, and either small, high speed engines, each belted direct to one or two small dynamos; or a slow speed corliss engine belted to a counter shaft carrying friction clutches and friction pulleys which would carry belts driving a number of small dynamos. The electric lighting plants of the day were copied almost in every detail. The business of these roads increased rapidly, throwing heavier loads on the power stations than they were designed or able to carry. More engines and dynamos were added, until many of the stations became an aggregation of small units. There are numerous stations in this country having in one room a long row of comparatively small, high-speed single-expansion engines, usually each one belted direct to one or two generators. If such stations are supplied with plenty of steam, oil, numerous attendants, etc., they will usually run quite satisfactorily, but not economically.

What may be considered good practice in a small station may not be considered as such in a larger one. Good practice consists in arranging every detail to best suit the conditions of the case at hand. The compounding of engines under certain conditions is known to result in a saving of fuel. One of the conditions for best economy is full load, or nearly so. The load on a railway plant is varying constantly; on a small road it may vary from zero up to more than the rated capacity of the machinery, many times a day. Under such conditions the extra cost of compounding may outweigh the benefits derived from it. If the number of cars run is increased, the load will become steadier, so that in large stations the size of the engines may be arranged with such reference to the load that more engines may be started as more power is required; thus each engine, while in operation, will be working under nearly full load. Formerly compounding was limited to large corliss and slow-speed engines almost entirely. It is now applied to the high speed class of from 50 to 250 horse power.

It is important to always have plenty of reserve power to meet the demands of the heavier travel towards evening every day, and on special days. In striving to obtain the very highest economy, some engineers have followed marine engineering practice in adapting triple and even quadruple expansion engines to station work, and also in employing very high steam pressure for the generation of which special boilers have been built. Of course their use is limited to large stations, where the saving effected by their use would be most apparent. A power station should be designed to make the different units as nearly independent of each other as possible. This is readily accomplished with high-speed engines belted direct, or if the room is large enough to allow sufficient distance between centers, slow-speed engines may be belted in the same manner. Where the engines are belted to countershafting, however, the dynamos are more or less mutually dependent on it and the friction devices it usually carries. Within the last two years, but more particularly within the last year, a great change has been made in dynamo building. Instead of the ordinary bi-polar type, multipolar machines ranging in size from 100 horse-power to 700 horse-power have been brought out. That they have proven satisfactory in operation is shown by the large number which have been built, and the constant increase in size. It is now stated that one large company has closed contract to furnish five

generators of one thousand horse power each, to run at eighty revolutions per minute and to be coupled direct to Corliss engines. These large generators, as a rule, have self-oiling bearings, run with little or no sparking, and require very little attention. A station of very large capacity, with an equipment of this kind may run with fewer attendants, less oil, for both generators and engines, and certainly better fuel economy than a station of equal capacity but with smaller units either belted direct or from countershaft.

It is sometimes urged that generators should have sight-feed oil cups instead of self-oiling bearings, in order to compel the engineer to keep a continual supply of fresh oil going to the bearings, whereas with the self oiling bearings he might allow the same oil to remain so long in the bearing as to become unfit for use. It seems to me that if I could trust an engineer to run a valuable plant at all, I could trust him to run it if all the bearings were self oiling. Most of these large machines are driven by belt, as in ordinary practice, but in some cases engine and dynamo have been mounted on one base and their shafts coupled together.

In designing a power station at present, we may have a great variety of apparatus from which to choose. This is fully true of the boilers now on the market, many varieties of the water-tube type being presented to compete with the old reliable horizontal return tubular. In connection with the latter type the question of mud-drum or no mud-drum presents itself. It is a question which has been discussed thoroughly but not settled by unanimous consent, especially in this part of the country, where they are in quite general use. Those who use them will think you are crazy if you do not use them; their opponents will think you are crazy if you do use them. It is certain, however, that they do sometimes give considerable trouble, and that boilers may be run very satisfactorily without them. Mechanical stoking and careful attention to furnace building may assist in producing more perfect combustion than is usually obtained. A good exhaust steam feed water heater should be used. Open heaters under the right conditions give good results, and their first cost is usually less than the closed type, but they possess certain defects which can be overcome only by the latter.

A description of the plant of the Terre Haute Street Railway Company may, perhaps, be of interest to some of the readers of THE TECHNIC. The three boilers are of the horizontal return tubular type, 54 inch diameter, 16 feet long, each having thirty-six 4 inch tubes. They are equipped with the Roney Mechanical Stoker, operated by a small standard Westinghouse engine. Aside from the question of saving fuel, the stokers have proven very satisfactory. When operated properly, under normal conditions, there is no smoke. As the power station is in the center part of the city and between the business and residence portions, this is a very important item. As there are no fire doors to be opened, the boilers are not subjected to frequent blasts of cold air. The furnaces and boilers are all independent of one another, and the latter may be used separately or in any desired combination. The three boilers were originally equipped with mud-drums, but one has been removed with satifactory results. The smoke stack is of brick, 113 feet high, octagonal in section, with a core 90 feet hight, lined with fire brick 50 feet. There is an air space of two inches between the two walls. The boilers are fed by two duplex steam pumps, used separately. The exhaust steam from the engines and pumps passes through a Stilwell and Bierce heater of the open type. The boilers deliver steam through separate connections to a 10 inch main, which extends from the first boiler to the last engine. The steam, in passing from the 10 inch pipe to each engine goes through a separator, which extracts the water entrained in the steam, and also that which has condensed in the pipe. This water is carried back to the boilers by a "steam loop," which operates continuously and without attention, and is, of course, hot when it reaches the boiler.

All live steam pipes are covered with magnesia sectional covering. The three engines are arranged in a row and are belted directly to the three generators. They are all Westinghouse compounds, two having high pressure cylinders 12″ diam., low pressure 20″, and a stroke of 12″, running 300 revolutions per minute and rated at 100

horse power with 100 pounds steam pressure. The third one has a high pressure cylinder 18″ diam., low pressure 30″ diam. and 16″ stroke, runs 250 revolutions per minute and is rated at 250 horse-power with 100 pounds steam pressure. The two small engines are belted direct to 100 horse-power generators of the vertical U. S. type, which run at 350 revolutions per minute. The large engine is belted to a 250 horse-power Multipolar (4 pole) generator. These generators can all run at least 25 per cent. above their rated capacities without danger. They are all compound wound, for 500 volts, and are run either alone or in parallel.

The most interesting instruments on the switch-board are the lightning arrestors and circuit breakers. The novel feature in the former is the method employed for breaking the arc formed by the dynamo current which follows the lightning. The arc is formed inside an air chamber and expands the air sufficiently to expel with considerable force two curved carbons between which the arc was formed. These carbons are carried on swinging arms, one being connected to the trolley wire and the other to the ground. As they swing apart of course the arc is broken. The circuit breaker is simply a double break jaw switch, opened automatically by the action of the current. When the current becomes excessive it lifts the armature of an electromagnet and releases a spring, which opens the switch. It may be adjusted to open with any desired current by changing the weights on the armature. To prevent burning the brass points of the switch, the current is broken on carbon. They are very quick and satisfactory in operation, and much neater than fuses.

For convenience in handling the generators, a track has been suspended from the ceiling. A four wheeled truck, carrying chain blocks of 12,000 pounds capacity, runs on this track, and both truck and blocks are operated from the floor. Any part of the generator can be lifted, carried along and lowered as desired. Rails, answering the same purpose, are also provided over the engines. They greatly facilitate the work of taking engine and generators apart for inspection and repairs.

NOTES.

Mr. R. F. Thompson is again practicing electrical engineering in Marysville, Montana.

Mr. J. A. Austermiller, '90, is now connected with Mr. Allen in a machine shop on 13th street in this city.

Mr. Wm. McKeen, '89, who has recently been in Germany is now working for the Pan Handle R. R. at Columbus, O.

Mr. Frank W. Hurlbert, '91, is still with the Detroit Works, who have replaced Mr. Rae by Mr. Gilbert Wilkes, recently chief engineer of the Edison Works.

Mr. F. J. Buckley, '91, has left the Westinghouse Co. of Pittsburg and has gone into partnership with his brother in the manufacture of dynamos at his home in Kalamazoo, Mich.

Mr. Taro Tsuji, '90, who has been with Mr. J. A. L. Waddell, Consulting Engineer, Kansas City, has left some drawings with Prof. Howe making application for the degree of Master of Science.

Mr. Edwin C. Thurston, '90, is with W. A. Fulwider & Co., Lumber Dealers, Bloomington. His work is principally with the machinery. He asks us to give the Y. M. C. A. all the help that we can.

Mr. Allen Moore, '88, with Thomson-Houston Co. Germany, promises us an article for a future number of The Technic. He has been in Russia for a time. His address is 32 Hollman Strasse, Berlin, Germany.

Mr. V. J. Gillett, '91, has left the Detroit Electrical Works and is now in the employ of Mr. Frank B. Rae, recently electrical engineer for the same works, but now located in the same city as a consulting electrical engineer.

Mr. W. H. Elder, '90, who has been enjoying a short rest, has received an offer to take a hand at the level on a short preliminary survey for the G. R. & I. R. R. near his home in Kalamazoo, Mich. If the road is built he will obtain a summer's job. He has been sick since undertaking this work and was obliged to return home for nearly a week.

ATHLETIC DEPARTMENT.

THE I. I. A. A. CONVENTION.

The regular annual convention of the Indiana Inter-collegiate Athletic Association occurred on Friday, March 11, and was one of the most important which the association has yet had. Eight colleges were represented: DePauw University, Wabash College, Indiana University, Purdue University, Rose Polytechnic Institute, Butler University, Hanover College and Earlham College, the two latter being voted in as the first action of this meeting.

The convention first took up the matter of revising the constitution, and a form presented by J. W. Noel, of Purdue, was discussed and finally adopted, with the numerous amendments agreed upon by the convention.

The constitution being adopted the meeting then proceeded to make out the base-ball and foot-ball schedules and to decide upon the place of holding the annual Field Day. The base-ball schedule is as follows:

April 16, Butler at Purdue.
April 16, Wabash at Rose.
April 23, Purdue at DePauw.
April 23, I. U. at Hanover.
April 23, Butler at Wabash.
April 29, Hanover at Wabash.
April 30, Hanover at Rose.
April 30, Purdue at I. U.
May 2, Hanover at DePauw.
May 7, Purdue at Hanover.
May 9, DePauw at Butler.
May 14, Rose at Purdue.
May 14, Wabash at DePauw.
May 14, Hanover at Butler.
May 21, DePauw at Rose.
May 21, I. U. at Butler.
May 28, Wabash at Purdue.
May 28, Rose at Butler.
May 30, DePauw at I. U.
June 4, I. U. at Wabash.
May 7, I. U. at Rose.

By this it is seen that we have four games at home and two away; that our hardest games come toward the last of the season, and that we have now two weeks to get ready for the game with Hanover.

Only two invitations for the Field Day were presented to the association—one from Wabash and our own. After hearing the statements in favor of Crawfordsville and Terre Haute the latter place was decided upon, and we again have the labor of arranging for Field Day and the pleasure of entertaining our friends from the other colleges. It was decided by the convention to strike out the tug-of-war from the program and insert the running hop, step and jump and the quarter-mile safety bicycle. Friday, May 27, is the date fixed on for holding the Field Day. The list of events is as follows:

100 yards dash.
220 yards dash.
¼ mile run.
1-mile run.
120 yards hurdle race.
Standing broad jump.
Running broad jump.
Standing high jump.
Running high jump.
Hop, step and jump.
Putting 16-pound shot.
Throwing 16-pound hammer.
¼-mile safety bicycle.
¼-mile ordinary bicycle.
1-mile safety bicycle.
2-mile ordinary bicycle.
1-mile walk.
High kick.
Pole Vaults.
Throwing base ball.
Tennis singles.
Tennis doubles.

PAST FIELD DAY RECORDS.

It will be of interest to all now engaged in training for field day, or who are at all concerned in the matter, to know what has been done on former field days. Accordingly, complete lists of the winners and the records made in the previous field days are given here. In considering the records made last year due allowance must be made for heavy track and muddy grounds.

FIELD DAY, SATURDAY, MAY 31, 1890.

EVENTS.	WINNER.	COLLEGE.	RECORD.
100 yards dash	F. C. Brewer	Wabash	10½ Sec.
⅕ mile bicycle (ordinary)	Hulman	R. P. I.	38 Sec.
Standing broad jump	Thomas	DeP. U.	9 feet 10 inch.
Putting 16 lb. shot	Hulman	R. P. I.	27 feet 7 in.
220 yards dash	Stover	Wabash	26 seconds.
One mile run	Rudy	DePauw	5 Min. 44½ Sec.
Running broad jump	Hanson	R. P. I.	18 feet 9 in.
One-fifth mile run	Stover	Wabash.	
Standing high jump	Layman	R. P. I	4 feet 5 in.
Throwing hammer	Martin	Wabash	51 feet 8 in.
2 mile bicycle	Wilhite	Wabash	7 Min. 2½ Sec.
Running high jump	Layman	R. P. I.	5 feet 2 in.
120 yards hurdle	Stieg	R. P. I	16½ seconds.
1 mile walk	Mills	R. P. I	8 min. 15 sec.
One-half mile run	Zaring	DePauw	2 min. 28 sec.
High kick	Mount	Wabash	8 feet 6½ in.
Throwing base ball	Herring	DePauw	326 feet.
Three legged race	Moth & Gibson	R. P. I.	13 seconds.
Tug of War		R. P. I.	
Tennis, singles	Seaton	Wabash.	
Tennis, doubles	Gibson & Jones	R. P. I.	

FIELD DAY, SATURDAY, JUNE 6, 1891.

EVENT.	WINNER.	COLLEGE.	RECORD.
100 yards dash	Layman	R. P. I.	10⅗ seconds,
Putting 16 pound shot	Hulman	R. P. I.	32 feet 4 in.
Standing broad jump	Studebaker	Purdue	9 feet.
Running high jump	Layman	R. P. I.	5 feet 3 inches.
Throwing 16 lb hammer	Hampson	R. P. I.	69 feet 11 in.
One mile walk	Erickson	Wabash	8 min. 8⅗ sec.
120 yards hurdle race	Martin	Wabash	19⅗ seconds.
¼ mile bicycle (ord.)	Jernegan	Wabash.	
220 yards dash	Crowell	Purdue	24½ seconds.
High kick	Hildreth	R. P. I.	8 feet 5 inches.
One fourth mile run	Oglesby	R. P. I.	58⅘ seconds.
Running broad jump	Zaring	DePauw	17 feet 7 in.
One mile bicycle (safety)	Wetherbee	R. P. I.	3 min. 54 sec.
Standing high jump	Layman	R. P. I	4 feet 6 in.
Throwing base ball	Zaring	DePauw	342.2 feet.
One mile run	Butts	R. P. I.	5 min. 18⅘ sec.
Pole vault	Gibson	R. P. I.	7 feet 6 in.
Tug of War		R. P. I.	
Tennis, doubles	Gibson & Jones	R. P. I.	

No. 1 WON.

Victory, the watch-word of last year, was the cry last Saturday when our team played and won from Wabash. The day opened bright enough but clouded up in the afternoon, and a cold wind blowing made anything but a good baseball day. A good crowd witnessed the game

however, and divided the honors of applause equally between the home and visiting teams. The umpiring was most satisfactory, the fairness of Erickson, the Wabash man, being quite a surprise to our boys. But few close points came up during the game and they were decided almost without objection from either side. The Wabash team showed by their playing throughout the game that they had had little practice—that they were not ready for the game. Their batting was weak, fielding generally uncertain, and especially so in center-field and at third. Duckett pitched a slow, easy ball and was hit freely; Martin's catching was only fair. On our side Hedden's work in the box and Rock's behind the bat were as good as they were unexpected; it was the first game for both and both did remarkably well. Wenzel on first, and Lash in left-field, also playing in a championship game for the first time, did very well. The official score given here will explain the points of the game.

POLYTECHNIC.

	AB.	R.	1B.	SB.	PO.	A.	E.
Tinsley, r.	5	2	0	2	0	0	0
Layman, 2.	2	3	1	3	0	1	1
Boyles, 3.	3	1	0	0	0	1	1
Hedden, p.	4	0	2	2	4	6	0
Bailey, s.	4	2	0	0	4	2	3
Lash, l.	5	0	2	0	2	0	0
Wenzel, 1.	4	0	2	2	9	0	2
Rock, c.	5	0	2	1	7	0	1
Anders'n m	4	2	2	0	1	0	0
Total	36	10	11	10	27	10	8

WABASH.

	AB.	R.	1B.	SB.	PO.	A.	E.
McClure, 1.	5	1	2	3	9	1	0
Green, l.	5	2	0	2	3	2	0
Duckett, p.	5	1	0	0	0	5	1
Martin, c.	5	1	2	1	4	2	1
Johns, 3.	4	2	1	2	4	0	3
Hutchi gs 2.	3	0	0	0	4	2	1
Wood, m.	4	0	0	2	1	0	1
Becker, s.	4	0	1	0	0	1	1
Adams, r.	4	0	1	1	2	1	1
Total	30	7	7	10	27	14	9

SCORE BY INNINGS.

	1	2	3	4	5	6	7	8	9	
Polytechnic	1	0	3	1	1	3	0	0	1	—10
Wabash	0	0	0	0	0	4	0	1	2	— 7

Double plays—Wabash, 3.
Bases on balls—Hedden, 2; Duckett, 7.
Bases given for hitting man with ball—Duckett, 1
Struck out—Hedden, 6; Duckett, 1.
Passed balls—Rock, 1; Martin, 4.
Wild pitches—Duckett, 1.
Time of game—1 hour 58 minutes.
Umpires—Smith and Erickson.

Although there were some good points to the game and some of the new men did play better than was expected in the first game, it would be folly in the face of the above score to persuade ourselves that we played a strong game. Comparing Saturday's game with the DePauw and Purdue games of last year or the game with I. U. the year before we may feel thankful that it was not our fortune to meet one of those teams for our first game this year. For the first five innings the game was played well on our side, but in the sixth with a score of 9 to 0 in our favor, and everything pointing to a shut-out for Wabash, the team went to pieces and let in four runs. The base running also was very bad, giving chances for doubles and easy put-outs at every turn. What does it all mean? It means that resting in security for the past month and trusting to last year's fame to win this year's games are no go. It means that no more time is to be lost; that the next two weeks must be spent in constant hard practice; and that any member of the team who misses a single practice hour should have his name taken from the list at once. If the team looking beyond the mere fact of a victory and not deceived by the empty flattery of so-called personal friends, can see its own weakness stamped on every feature of the game, and take up at once the only remedy, all will yet be well. The lesson is ours—learn it.

PURDUE, 14—BUTLER, 9.

LAFAYETTE, April 16.—The base ball season opened here to-day in a game with Butler, played in our new athletic park. The day was perfect and the attendance about eight hundred Game was called at 3:45, with Butler at the bat. Batting order as follows:

BUTLER.	PURDUE.
Baker, 3b.	Aldrich, ss.
Cullom, c., Capt.	Fulkerson, rf. & 3b.
Williams, rf.	Kintner, 3b. & c.
Davidson, 1b.	Olin, 2b., Capt.
Nichols, lf.	Olds, 1b.
Bennett, p.	Evans, c. & mf.
Lauter, ss.	Moore, mf. and rf.
Cameron, mf.	Bronson, p.
Grayston, 2b.	Witt, lf.

And the score by innings:

	1	2	3	4	5	6	7	8	9	
Butler	0	0	3	0	4	2	0	0	0	— 9
Purdue	1	1	0	3	6	0	3	0	*	—14

E. F. NORTON.

NOTES.

In order to correct a wrong impression in the minds of our Wabash friends, and at the same time to subtantiate a statement made by one of our representatives at the I. I. A. A. convention, we wish to call attention to the relative standing of the several colleges at the Inter-collegiate field day of 1890. The statement was made before the convention by the Wabash delegate, that Wabash

had tied the R. P. I. for first place, in all save the tug-of-war; that no other college but the R. P. I. had a tug-of-war team on the grounds and that we were allowed to pull the tug between two of our own teams and, of course, winning it, thus getting the championship, implying that it was decided in our favor by unfair means. Our delegate immediately denied that we had won by any such scratch, and stated that were ahead of any other college by at least two, and he thought three points. It is in support of this assertion that we call up the matter here. The statement of the Wabash delegate in regard to the manner of pulling the tug is correct, with the addition that other teams had entered but failed to appear, and why the tug should not be awarded to us under the circumstances, does not appear. But we did not need it. Complete records of that field day are given in another column and by referring to them it will be seen that R. P. I. held ten firsts, Wabash seven, and DePauw two, so that we were three ahead of any other college.

The success of the committee on guarantee fund in raising the amount needed to guarantee the state field day shows us two important things: First, that the business men of Terre Haute are interested in athletics, that they are in full sympathy with our efforts and that they have confidence in our business ability and integrity. Second, that our committees still have their accustomed energy and that there will be no lack of push to send the field day through with a whirl.

A meeting of the executive committee of the I. I. A. A. will be held to-day in Indianapolis when the status of certain college men who have become professionals by accepting pay for their services in base ball or other departments of athletics and who now wish to be considered as amateurs, will be decided. The constitution is iron-clad on this point, and only by a two-thirds vote of the executive committee can a man be reinstated. Fortunately we have none such.

CURRENT AFFAIRS.

THE NEW CATALOGUE.

In the new catalogue, now in the hands of the printer, the several courses, Mechanical, Electrical and Civil Engineering and Chemistry will each be given complete, and by itself; and each subject will be marked with the time allotted to it per week. Several rearrangements and changes have been made which render the courses somewhat more independent. Especially is this the case with the Electrical, which now appears for the first time entirely separated from the Mechanical. Heretofore these courses have been coincident, except that in the Electrical part of the time scheduled for shop practice was devoted to electrical work in the laboratory.

Among the changes which may be noted in detail, are the following, which will take effect with the present Freshman class:

The shop practice of the third term of the Freshman year is to be in the machine shop, blacksmith shop and foundry instead of in the wood room. At the beginning of the second term in the Sophomore year, the two courses will separate and those selecting the Electrical course will take, as heretofore, seven hours per week shop and three hours practice in the Electrical laboratory. In the Junior year all students will have four recitations per week under Prof. Mees throughout the whole year. First term, Electricity; second term, Heat; and third term, Sound and Light. Those taking the Electrical course will spend two hours in the laboratory and eight hours in the shop per week, during the first and second terms. During the third term they will omit shop work and in its place take two recitations per week in Electricity under Prof.

Gray and four hours in the Electrical laboratory. The mechanical engineers will have ten hours of shop practice throughout the year. In the Senior year the electrical engineers will have two recitations in electricity under Prof. Gray and six hours of laboratory work per week. As heretofore they will devote part of the time set down for the Physical and Mechanical laboratory to work in the Electrical laboratory. In place of the two recitations in electricity the mechanical engineer will have six hours per week of Steam Engineering during Senior year.

Analytical Mechanics, together with Calculus, will hereafter be taught by Prof. Hathaway. There will be six recitations a week throughout the entire junior year, four in Mathematics and two in Mechanics

The Seniors will hereafter spend their entire shop time of the third term in the pattern shop.

BRIDGES AND BRIDGE DESIGNING.

On April 11th, J. A. L. Waddell, C. E., a consulting engineer of Kansas City, Mo , and western agent for the Phœnix Bridge Co., delivered two lectures before the students of the Senior and Junior classes. It is hoped by those who heard the lectures, that others of a similar character will be delivered and by practical men of wide experience, who, like Mr. Waddell, are abreast of the most approved methods of scientific engineering. While the lectures pertained more particularly to bridge engineering and were of especial value to students of the civil course, they were not lacking in interest or ideas for students of the other courses. During the morning lecture, the proposed designs for several bridges were presented, several important features of each structure were considered, and questions concerning certain details not clearly understood by the students were answered. The designs considered were as follows: *First*, A competitive design for a five-span draw-bridge across Darling Harbor, New South Wales. *Second*, Proposed lift bridge across the Ship Canal, Duluth, Minn.; Mr. Waddell having been retained by the City of Duluth as engineer of construction. *Third*, A pull-back cantilever, proposed as an alternative for the lift bridge. *Fourth*, A proposed design for train shed, for the new Union Depot at St. Louis. Designs of the above together with several other designs of bridges proposed and in course of construction, will soon be in the possession of the Institute. The lecture during the afternoon, from two o'clock until four, was on " Bridge Designing."

SEALS AND THE SEAL ISLANDS.

On the evening of April 8, Dr. T. C. Mendenhall favored the people of Terre Haute with an instructive and entertaining lecture on the above subject. He spoke for nearly two hours to an appreciative audience which completely filled Normal hall. Through the courtesy of Dr. Mees, the lecture was illustrated by stereoscopic views of photographs taken at the Seal Islands and vicinity. Dr. Mendenhall spoke briefly of the discovery of the Seal Islands, of the purchase of Alaska by the United States Government a quarter of a century ago, and reviewed the most important points of the present international dispute. By the aid of a map he showed the location of the Alaskan Possessions, Behring Sea, and the North Pacific. He then gave a description of the trip which he, together with the other three members of the Investigating Commission, made to the Seal Islands in the United States steamer Albatross, nearly a year ago. A description of the islands and the seal-skin industry was given in that entertaining manner, which, to those who have heard the Doctor, needs no explanation.

Y. M. C. A. NOTES.

The new officers have taken their places and a term of good work is expected.

A convention of the college associations was held in Bloomington on the 15th and 16th inst. A report of the meeting will be given next month. President Edw. Reidel was sent as a delegate.

Some of our active members are not as regular in their attendance as they might be. Every member should be present at the regular weekly meeting.

A cordial invitation is extended to every student to attend the meetings. They will help you and you will help them.

THE GEOLOGY LECTURES.

Prof. E. N. Claypole, of Buchtel College, Akron, Ohio, delivered the following course of lectures last month, before the Senior and Junior classes: 1. Coal—Anthracite. 2. Coal—Bituminous. 3. Volcanicity. 4. Geology of Fresh Water. 5. Earthquakes. 6. Geology of Iron and its Ores. 7. Tin and Tin Mining. 8. Architecture of Mountains. 9. Petroleum. 10. The Geological Engineer. 11. Formation of Lake Erie. Before the arrival of Prof. Claypole the general opinion in the two upper classes was that the whole affair was something which had to be endured. Long before the close of the first lecture there were few men in the room who had not changed their minds, and a more contented set of fellows appeared at the second lecture. Throughout the entire course Prof. Claypole held the attention of his hearers and succeeded in making many wish that they could know more of the subjects. The last lecture in the course was open to the public and was delivered before a good audience in Normal Hall.

THE TELEGRAPH ASSOCIATION.

At the last monthly meeting of R. P. T. A., held April 11, officers for the present term were elected as follows: President, Rice, '93; Secretary, Wenzel, '93; Treasurer, Johonnott, '93. Rock, '92, and Holt, '94, were selected superintendents for the ensuing month. With the exception of a few brief interruptions the line has been in excellent order since the first of the year. A change of superintendents each month and a distribution of the work of the Association, whereby each member has a possibility of distinguishing himself, gives assurance for the continued success of this convenient feature of the School.

THE STATE PRESS ASSOCIATION.

The newest state college organization is the Indiana Inter-collegiate Press Association formed at Indianapolis, March 11th, with the Purdue *Exponent*, the DePauw *Bema*, the Indiana University *Student*, the Butler *Collegian*, the *Wabash*, of Wabash, the *Earlhamite*, of Earlham, the Moore's Hill *Collegian* and THE TECHNIC comprising the charter membership. The objects of the association, which are many, may be classed under two heads: First, the improvement of the college papers of the state; second, the advancement of inter-collegiate relations. Limited space in the present issue prevents that elaboration upon the subject which its importance calls for. Suffice it to say that prospects are very bright, and undoubtedly the association will accomplish much work. The offices were distributed as follows: Presidency, *Bema;* vice-presidency, *Earlhamite;* secretaryship, *Student;* executive-committeeship, *Bema*, TECHNIC and *Exponent*.

THE ORCHESTRA CONCERT.

The Orchestral Club gave its third annual concert at the Congregational Church on the night of the 18th of March. Musically considered it was a great success, every number on the program being well rendered. The orchestral work was much better than the club has ever done before. The vocal solos by Miss Harriet Paige and Miss Edith Castle were, of course, well rendered and were well applauded by the audience. Among the instrumental solos, the cornet solo by Mr. Johannesen and the violin solo by Mr. Hesser were especially worthy of praise. Mr. Johannesen's playing is fully equal to that of many men who style themselves professionals. The audience was very small, owing to the great number of attractions during the same week.

SENIOR ENTERTAINMENT.

A large audience greeted Nye and Burbank at the Normal hall on March 22d. This was the second entertainment under the auspices of the Senior Class, and was a complete success, although had the weather been more favorable a larger audience would have listened to the wit and eloquence of the evening. Mr. Nye's droll appearance and delivery together with his humorous stories had the same effect on this as on all other American audiences, that of pleasing them. Although suffering from an attack of la grippe, Mr. Burbank completely captivated his hearers. Mr. Burbank's dramatic monologue of the prison scene in "A Tale of Two Cities" certainly gave scope to his histrionic ability, while the humorous selections afforded great amusement.

LOCALISMS.

The Juniors have taken up the subject of "Heat."

Wanted—An instructor for the Freshmen, to teach them the school yell.

The long promised daily newspapers have actually appeared in the reading room.

Sophomores have taken up the study of Calculus, a treatise by Greenhill being used.

Mr. Ben Grosvenor has been promoted to assistant instructor in the machine shop.

The Dale brothers were called home last month to attend the funeral of their grandfather.

Two members of the Freshman class, Hebb and McTaggart, have chosen the chemical course.

Should the number of monkey wrenches controlled by each "Thesis monarch" be regulated by law?

Lamb, ex-president of the class of '95, anticipates entering the Institute next September with the incoming class.

The Juniors have completed their French. Sophomores take a final examination in "Conic Sections" April 20.

Robinson, '94, has given up the agency of Hunter's Steam Laundry, and Mory, '94, has assumed charge of affairs in his stead.

Scientific German has been taken up by the Juniors. It is intended that part of the work will be in the German scientific journals.

Ogelsby and Sperry have completed their thesis experiments at the Terre Haute House and are now ready to put their results in shape.

The sympathy of the school is with Holderman, '95, who was called home during the last week of March by the sudden death of his sister.

A Freshman about to leave the main building, slips, and strikes the floor in a manner that attracts the attention of all present. A professor endeavors to relieve the young man's embarrassment by the question, "Did you fall?" and is astounded at the ungrateful reply, "No! I tumbled."

On the hour plan as arranged at present the Junior class has two extra hours of practice, the Sophomores have four and the Freshmen six.

Schultz, '94, who was called home two weeks before vacation, owing to the illness of his father, has decided to discontinue his course at the "Poly."

Becker, '93, visited friends at Bloomington during vacation and reported an activity in athletics at the State University which R. P. I. needs to imitate.

Will the Alumni inform us whether they consider it added honor to have undergraduates write for consent to act as "proxy" in certain social matters?

Andrews, '94, will assist Prof. Howe in the civil engineering department. His principal duty in the recently assumed position will be instructing the Freshmen.

Prof. Brown has kindly granted the request of the Juniors to allow them to report for shop work at 1:15 p. m. Thursday instead of at 1 as called for on the schedule.

Dr. Mees passed the vacation at Columbus, O. Mr. McCormick visited friends in Sellersburg and Greenfield, Ind. Other members of the Faculty remained in Terre Haute.

The Sophomore class in civil engineering commenced field work April 12. Level lines are being run between the Institute and city water works through Elm street and also through Third avenue.

O. E. Taylor, the photographer of '94, has been obliged to withdraw on account of the failure of his eyes. He has accepted a position in a hardware store at his home. Those who knew him were all sorry to see him leave.

Tinsley and Rose, the Senior civils, have about completed their apparatus for reading bridge deflections, but unless the Wabash goes down soon they will be somewhat hampered in their experiments, the water at present being some two feet above the part of the shore upon which their apparatus is to be placed.

Mr. James Dale is perfecting a tenis racket, for the success of which there is much assurance. One of the novel features about it is the material used, which is Aluminum.

The Orchestra has had its picture taken. Prints were presented, by the club, to Miss Harriett Paige and Miss Edith Castle. Miss Paige is an honorary member of the organization.

Several members of the Sophomore class remained in the city during vacation, the thought uppermost in their minds being the preparation for final examination in analytical geometry.

As every student now has the advantage of a half hour for training and exercise on the campus it is hoped that conflicts between Sophomores and Freshmen in the main building will in future be avoided.

It is reported that W. H. Hampson, formerly of the class of '93, and at present a student at L. S. Jr. U., will return to Indiana during the early summer for the purpose of becoming a benedict.

The many friends of J. P. Butts will be interested to know that he has left the employ of the Kenwood Bridge Co., and is at present in the engineer's corps of the Chicago, Milwaukee & St. Paul Railroad Co.

The average "Poly" is now thoroughly aroused to the fact that we are on the "home-stretch" of the school year and that to realize a satisfactory termination of the years' work means extra effort during the remaining two months.

A letter of recent date was received by Prof. Ames from Mr. Duff Green, formerly a member of '92. Mr. Green is Vice-President, Treasurer and Manager of the Manley Machine Co. of Dalton, Ga., and reports the business in which he is engaged as being in a prosperous condition. He has recently invented a display rack for the exhibition of canes, umbrellas, etc.

Folsom, with the assistance of several of the Seniors, has been able to complete his test of the Westinghouse engine. The larger part of the work on the thesis, that of working out the indicator cards, is yet to be done.

E. K. Hood, '95, who left the Institute on account of ill-health, is visiting his brother, O. P. Hood, '85, in Manhattan, Kan., where he will remain until Christmas. He is at present doing some work for the Agricultural College.

The following Freshmen have chosen the course in civil engineering: Crockwell, Daniels, Holderman, H. C. Smith, Sandford, Shaneberger and Wiggins. They will go into training at once and may develop as contestants for the mile walk on approaching Field Day.

The long promised and wished for cement floor has been put down in the blacksmith shop and foundry. It cannot be learned whether there is a patent on the composition or not. It consists of a bed of brick bats laid on edge and covered with about a quarter of an inch of cement.

The *Spectator*, published at Capital University, Columbus, O., says the following of Dr. Mees' recent lecture in that city: "The C. U. Lecture Association gave its fifth regular entertainment on 1st inst. Dr. C. Leo Mees, of the Polytechnic Institute, Terre Haute, Ind., had been secured as lecturer for the evening by the executive committee, and it proved to be a most fortunate and valuable arrangement to have the doctor in our midst. The subject of the discourse was "Music and its Physical Explanation." By means of crayon diagrams and a number of various mechanisms the lecture was amply illustrated. Rapt attention was given the speaker from the beginning to the end, as was meet, since the doctor presented his subject in a clear, attractive and in every respect exemplary manner. He is a fine speaker and knows how to handle his subject and audience. The Orchestra was present to give a few well rendered selections."