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THE TECHNIC.

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NOTICE TO SUBSCRIBERS.

Hereafter we shall follow the general rule regarding subscriptions, and shall continue sending THE TECHNIC to subscribers until notified to discontinue.

WITH this number the ROSE TECHNIC enters upon the ninth year of its existence. From the time of its first appearance till the present it has improved with each number and this improvement has been most marked within the last two years. Circumstances have been most inductive to this growth, and the management with its natural ability, has grasped every opportunity afforded, has taken advantage of the prosperity so wide-spread and general, and has presented to the engineering public and those interested in college journals, two volumes replete with articles of real merit and intrinsic value. From time to time changes have been made as circumstances demanded. Each change has served its purpose. In pursuance of this policy, which is the one that shall guide our efforts thro the year, and which we believe to be the proper course, the present staff has decided, after much thought and deliberation, to carry out the plan suggested last year and to omit the department previously known as "College Notes and Clippings," as such, and to substitute in its place a page or so of clippings and points of interest gleaned from a careful review of our exchanges and contemporaries. According to the present arrangements this department will be edited by the editor-in-chief, who thus assumes the duties previously imposed upon the exchange editor, in addition to his other troubles, which are numerous. It is believed that this plan will be more beneficial to the readers of the TECHNIC than the former policy of commenting upon the various publications and their merits.

NEVER before in the history of the Institute have the prospects for a brilliant school year been so bright as they are at present. Thro the influence of the Student Council many of the organizations which heretofore have eked out a miserable existence, have been placed upon a sound financial basis and a more general interest in school affairs has been aroused among the students. The Telegraph Company has been enabled to put up new wire throughout its line and students are urged to join and participate in a pastime which is most interesting and instructive. The Scientific Society has once more been revived and from the interest displayed in the meetings so far it appears as tho it had gained enough momentum to carry it thro the year. The hours for meeting as now arranged are much more agreeable than formerly and the students will find it advantageous to attend as often as possible. The Y. M. C. A. has secured new quarters and is in a flourishing condition. The Athletic Association is no longer financially embarrassed and the Camera Club is prospering.

All that is now lacking is a musical organization. From all reports there is plenty of material for an orchestra or glee club, or perhaps both.

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FROM time to time numerous changes have been made in the school ciriculum in order to economize time as much as possible and to make the life of the students as agreeable as possible while engaged in their daily work at the Institute. This year the period from 11 to 12, Saturday is vacant in all the schedules and during this time the meetings of the various student organizations are held. The Scientific Society meets every other Saturday at this time and meetings of the Council and other organizations have been arranged so as not to conflict.

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THAT there is good in all things can not be denied and we are pleased to note that one of the Terre Haute dailies, which is sometimes prone to exaggerate certain innocent recreations of the students, is optimistic enough to see and to acknoweldge. The following is clipped from a paper of recent date:

It is to be said for the Rose Polytechnic in regard to the hazing pranks of the students that perhaps in no other institution for higher education are they required to devote as many hours to actual school work, so that something of the so-called playfulness can be overlooked.

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IN the near future THE TECHNIC expects to be able to publish an article by Dr. Edwin S. Johonnott, Ph. D., on the history, development, advantages and disadvantages of the different types of galvanometers. Since his graduation from Rose in '93 Dr. Johonnott has made a special study of the galvanometer in all its types and forms, and we can safely say that he is an authority on this subject. It is with pleasure that we produce in this issue a short discussion on a new form of sensitive galvanometer which Dr. Johonnott has designed.

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MANY pleasing responses have been received to the circulars sent to the Alumni requesting their subscriptions for Vol. IX of THE TECHNIC. One of the most encouraging comes from Guy Pierson, Spencer, Ind. It reads as follows: "Of course I want THE TECHNIC. Couldn't exist without it. The reason that I don't send the dollar now is because I can't get to the postoffice to get an order before mail time, and I haven't a dollar bill in my pocket, and I am afraid I will miss the first issue if I delay this matter."

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WE are much amused by an article which appeared in a recent number of the *Student*, I. U., Bloomington. After quoting in full an article published in the June TECHNIC in reference to state athletics, the *Student* has "something to say." We don't think that little say amounts to much. The idea of putting Notre Dame, Purdue and I. U. in a class by themselves is preposterous. Self-assurance is a good thing, but should be used judiciously.

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UNSOLICITED.

FAIRCHILD & NORTH-EASTERN RAILWAY COMPANY
GREENWOOD, WIS., Sept. 28, 1899.

To the Rose Technic:

My best regards and a dollar bill to pay my subscription for the coming year.

W. R. SANBORN,
Ch. Engr. F. & N. E. Ry.

The management of THE TECHNIC most sincerely wishes that more of the Alumni would follow Mr. Sanborn's example and subscribe for Vol. IX. The Alumni need THE TECHNIC and THE TECHNIC needs the support of the Alumni.

A New Form of Sensitive Galvanometer.

DR. E. S. JOHONNOTT, PH.D.

A METHOD for measuring small angular rotations by means of the interference of light waves was suggested some years ago by Prof. Michelson. The application of this method to the sensitive galvanometer was first undertaken by Prof. Wadsworth. He encountered three principal difficulties which were to a certain extent, overcome. These were:

(1) In the application to the Thomson astatic galvanometer to obtain a mirror system of sufficiently small moment of inertia.

(2) To obtain an instrument of the D'Arsonval type sufficiently sensitive.

(3) Third, and by no means the least, to obtain a sufficiently steady suspended system to keep the fringes in the field.

At Prof. Michelson's suggestion the attempt was renewed last year in the Ryerson Physical Laboratory. The form of the interferometer for measuring the angular deflections was identical with that used by Prof. Wadsworth. * The suspended mirrors were 1 centimeter square and mounted on the suspended system of the galvanometer. The distance between their centers was 4 cms. Some idea of the relative sensitiveness of interferometer method for measuring the angular deflection and that of the ordinary telescope and scale method may be obtained from the following: The angular deflection of the mirror to produce one millimeter deflection on the scale divided in millimeters and placed at a meter's distance from the mirror is $\frac{1}{2000}$ radians. With the interferometer system above when the center of one mirror approaches one-quarter of a wave length and the other recedes a like distance the relative change in the two optical paths of the interferometer system is one wave length. This will produce just one fringe deflection. But the corresponding angular deflection of the system is $\frac{1}{16000}$ radians.

Considerable difficulty was experienced in obtaining a suspended system sufficiently free from vibration, and particularly air currents, to allow accurate readings of the deflection in fringes. Among several forms of galvanometers to which the mirrors were attached a small D'Arsonval gave the best results. In the final instrument, which was placed on a stone floating in a mercury trough, and the whole suspended by a system of spiral springs, the fringes were usually so steady that at times it was difficult to distinguish their appearance from those for a rigid system.

With a small D'Arsonval, by shunting the galvanometer so that only about 2.5% of the current went through the instrument it was possible to make the swing aperiodic and slow enough to count the fringes deflection. In the new form never less than 70% of the current was shunted through the instrument, even with currents which produced a deflection of 400 or 500 fringes deflection.

The galvanometer was a modified form of one suggested by Prof. Mees and designed by Prof. Gray and himself. Two thin cylindrical coils were mounted at the ends of a ⊥ shaped frame of glass fiber, with their axes one decimeter apart. As the system rotates each coil moves nearly axially in its own electromagnetic field, whose direction is that of the radius of the coil. Each electromagnetic system consists of an inner core of Swedish wrought iron, which has a central portion of much larger diameter. Two magnetizing coils, with their currents running in opposite directions, slip on the ends of the core. The yokes consist of two cup shaped pieces of the same metal which meet at the center of the electromagnet. The coil swings in the annular space

*Physical Review, 1897, Vol. IV, p. 480.

between the raised portion of the core and the inner face of the cups.

Each suspended coil has 1,000 turns of No. 40 copper wire. The suspension wires were rolled copper wire of the same diameter.

The period of the suspended system under the torsion wire alone was at one time about 30 seconds. In throwing on the field this was reduced to 20 seconds, indicating that the magnetic control due to the induced magnetism in the coils was over three times the torsion control. Also, when the current through the suspended coils was put on, the deflections, when large, were unequal on opposite sides of the zero. For a range of several centimeters deflection, by the telescope and scale method, there was a wide divergence from a linear relation between the current and the deflection. It was found possible by altering the position of the suspended coils in the magnetic field to change the sensibility. Using longer suspension-wires it was found possible to increase the period under the torsion control alone to 70 seconds. Then by altering the position of the coils the period was increased from 15 to 35 seconds under the torsion and magnetic control.

The first in the following sets was taken when the period was 25 and the second 29.6 seconds.

The resistance used was in the neighborhood of 490 megohms, and had been previously determined by direct deflection method, using a sensitive Thomson instrument and also by the discharge of condensers method. In order to show the relation of the current to the deflection five Clark cells were used for the E. M. F. The fringes deflection were counted using respectively 1, 2—5 cells. In order to avoid error due to drifting of the zero, the count was continued back to the zero after the current was broken.

The galvanometer whose resistance was 841 ohms was shunted with 1400 in order to facilitate counting the fringes.

Set I. The instrument was adjusted to a period of 25 seconds.

The magnetizing current was 1.10 amperes.

Current.	Deflection in Fringes.		No. Cells in Series.	D Fringes per Micro-ampere.
On	34	33	1	11,000
Off	66			
On	71	70	2	11,800
Off	140			
On	107	107	3	12,100
Off	214			
On	147	148	4	12,600
Off	297			
On	190	190	5	13,000
Off	189			

II. This set of readings was taken several days later under the same conditions with the exception that the zero was altered by adjusting the tripod screws and throwing the coils in a new position in the magnetic field and making the period 29.6 seconds.

Current.	Deflection in Fringes.		No. Cells in Series.	D Fringes per Micro-ampere.
On	45	46	1	15,600
Off	92			
On	93	94	2	16,000
Off	188			
On	146	145	3	16,400
Off	289			
On	196	197	4	16,800
Off	389			
On	241	245	5	16,600
Off	490			

The values for D in both sets is the sensibility of the galvanometer shunted. To obtain the sensibility when not shunted the values of D should be multiplied by 1.6. This would give a sensibility ranging from D=15000 to 25000. The fringes, however, could be counted for only those currents giving a deflection below 10 or 12 fringes.

BALLISTIC SENSIBILITY.

Perhaps the most interesting and valuable feature of the galvanometer is its sensibility ballistically. In the August number of the *Philosophical Magazine*, 1899, p. 204, a new form of ballistic galvanometer is suggested by Mr. Davies. The instruments described above embodies the essential features of the proposed form.

The calculation of the relative sensibilities of the two coil form of D'Arsonval and the form prescribed by Ayrton & Mather in order to obtain the greatest current moment for the least moment of inertia shows the superiority of the two coil form even for ballistic purposes. The horizontal cross section of the single coil should be two tangent circles. Assume the field strength the same in both forms; and the area of cross section and effective volume of coil the same in both forms, then

$$\frac{M_1}{M_2} = 16.2 \qquad \frac{I_1}{I_2} = 191$$

Where M and I are the current moment and moment of inertia of the double coil respectively and M_2 I_2 the same for the single coil.

Hence the ratio of the sensibilities for ballistic use would be

$$\frac{S_1}{S_2} = \frac{M_1}{M_2} \quad \frac{I_2}{I_1} = 1.17$$

Thus the sensibility of the double coil is 1.17 times as great as the single coil, while for steady currents it is 16.2 times as great.

Below are indicated some of the results of discharging a microfarad charged to a small difference of potential at its terminals with a Clark cell. No shunt was used:

Deflections. Right.	Left.	Microfarad.	E M F	S Sensibility.
9	13	1	.00198	4500
5				

These readings were taken with the same adjustment, that is a period of 25 seconds, as Set I for steady currents. The readings taken with the same adjustment as Set II (period 29.5 secs.) were as follows:

Right.	Left.	Microfarads	E M F	S
7.5	11			
3.0		1	.001	7500

There would thus appear to be a discrepancy in comparing the results for steady currents with those ballistically. The ratio between the sensibilities should be $\frac{S}{D} = \frac{2\pi}{T}$. Thus it would appear that S is too high, particularly as the figures are given without allowing for damping. The above relatiou however, would only hold when the control is due to the earth's field alone.

A very complete account of what has been done recently on the sensitive galvanometer appeared in the November number of the *Philosophical Magazine*, 1898, by Profs. Ayrton and Mather. The most sensitive instrument there listed is one designed by Paschen, which gave D=135000. The most sensitive D'Arsonval to current, one by Nalder which gave D=760. The ballistic sensibilities given are calculated from those of D without considering the damping. The highest value for S with the D'Arsonval type is 5600. This was a narrow coil instrument designed by Ayrton and Mather.

The most sensitive instrument to currents of which any record has been found was one used by Langley which gave D=800000.

Many other interesting features, some of which have not been explained, will be delayed for a future occasion. There are also possibilities that the sensibilities given above may be multiplied many times.

Meeting of the American Association for the Advancement of Science.

DR. C. L. MEES, PH.D.

THE 48th meeting of the American Association for the Advancement of Science at Columbus, Ohio, from Aug. 21 to Aug. 26, was in many ways one of the most successful meetings held. The Association may be said to have had its origin in the American Association of Geologists and Naturalists, organized in 1840 in Philadelphia, and having for its object the bringing together of the comparatively few workers in science then in the United States. The men then constituting the association were scattered through what are now denominated the Eastern States, and few were to be found west of the Alleghenеys. They appreciated the advantages of closer intercourse for the purpose of mutual encouragement in their pioneer's work and the necessity of dissemination of the scientific knowledge, and the creation of public interest in it, in order that the healthiest and most rapid growth should come to this new country. In those days it was not an uncommon thing for a member of the association to spend a week, either on horseback or on a canal boat traveling to attend one of the annual meetings to gain new inspiration for his work. In 1848 the society was reorganized on broader lines under the present title, with the object set forth in the first paragraph of the constitution—"The objects of the association are by periodical and migratory meetings to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research and to procure for the labors of scientific men increased facilities and a wider usefulness." This proposed work of the association has been well carried out and the results of its activity have been felt in all parts of the country. The organization of many of the institutions of learning in the central and middle western states may be traced directly to the influence of this association. During the fifty years of its work it has accomodated itself more or less to the changed condition of the times and is now assuming rather the form of a congress of associations and societies, each one devoting its time and energies to one special branch of science or of scientific advancement Thus the association has been divided into sections, each having its own officers and operating under the coordinating rules of the association. Nine such sections have already been organized and held meetings in Columbus.

Section A—Devoted to Mathematics and Astronomy.

Section B—Physics.

Section C—Chemistry.

Section D—Mechanical Science.

Section E—Geology and Geography.

Section F—Zoology.

Section G—Botany.

Section H—Anthropology.

Section I—Social and Economic Science

Before each of these sections a Vice-Presidential address was read by the presiding officer, and all had full programmes of valuable papers.

In connection with these meetings a number of affiliated societies having the same object met just before the meeting of the general association. This year there met the Society for the Promotion of Engineering Education, the American Chemical Society, the American Mathematical Society, the American Society of Entomologists, and others. Thus within the period of two weeks there were brought together scientists and workers in all

departments of knowledge, and the aggregate reports of proceedings will probably be equal to a volume of over one thousand pages, abstracting hundreds of papers and reviewing the contributions to science during the year. To the readers of THE TECHNIC the proceedings of the Society for the Promotion of Engineering Education, the proceedings of Sections B and D, are perhaps the most interesting.

The Society for the Promotion of Engineering Education was presided over by Dr. T. C. Mendenhall. The subject of his Presidential address was Metrological Reform. In this address the deplorable condition of our systems of measurement is set forth. In the introductory paragraphs reference is made to the desirability of some concerted action on part of engineering schools to better the existing conditions and educate students and people alike to appreciate the necessity of reform. The author pays his compliments in a humorous way to the daily papers and popular journals, as means of education, drawing some rich material for such illustration from the journals of our own state. In further commenting upon the deplorable lack of knowledge on matters metrical among men of higher education, our own state again furnishes rich material to him in the well known attempt to establish the ratio between the circumference and diameter of a circle as 3⅓ by legislative action. Continuing, he points out that at present each state has practically its own standards of measurements, commercial and others, to the infinite confusion of all concerned. He then makes a plea for the abandoning of prejudice and the adoption of the metric system as the most logical and best established. The arguments against such change are all reviewed and it may be said fully disposed of.

This address should be read by every student, manufacturer and intelligent business man, and it is to be hoped that the suggestions therein contained will be vigorously supported. The address is printed in full in *Science* for August 18, 1899.

The program in full was as follows:

1. Address by the President,
   THOMAS C. MENDENHALL,
   President, Worcester Polytechnic Institute.
2. "The Essentials of a Technical Education,"
   A. L. RICE,
   Professor of Steam Engineering and Electricity, Pratt Institute.
3. "The Engineering Educational Value of a Refrigerating Plant,"
   WM. T. MAGRUDER,
   Professor of Mechanical Engineering, Ohio State University.
4. "The Place of Correspondence Schools in Engineering Education,"
   EDGAR MARBURG,
   Professor of Civil Engineering, University of Pennsylvania.
5. "Advanced Algebra in Engineering and Other College Courses,"
   F. L. EMORY,
   Professor of Mechanics and Applied Mathematics, University of West Virginia.
6. "Hydrocarbon Engine Testing Plant of the Ohio State University,"
   WM. T. MAGRUDER,
   Professor of Mechanical Engineering, Ohio State University.
7. "Teaching Force Assigned per Student in the Several Divisions of a Technical College,"
   J. P. JACKSON,
   Professor of Electrical Engineering, Pennsylvania State College.
8. "Methods of Teaching: by Text-book, by Lectures, by Laboratory, by Design, by Memoir,"
   C. F. ALLEN,
   Professor of Railroad Engineering, Massachusetts Institute of Technology.
9. "A Catalogue and Clipping Case,"
   WM. T. MAGRUDER,
   Professor of Mechanical Engineering, Ohio State University.
10. "Engineering Education and 'Expansion.'"
    W. S. ALDRICH,
    Professor of Electrical Engineering, University of Illinois.
11. "A Convenient Laboratory Equipment for the Study of Direct Current Dynamos and Motors,"
    H. B. SMITH,
    Professor of Electrical Engineering, Worcester Polytechnic Institute.
12. "A Comparative Study of the Electrical Engineering Courses Given in Different Institutions,"
    F. C. CALDWELL,

Associate Professor of Electrical Engineering, Ohio State University.

13. "An Apprentice System in College Shops,"
O. P. Hood,
Professor of Mechanical and Electrical Engineering Michigan College of Mines.

14. "Drawing, Mechanical Laboratory Practice and Shopwork in Engineering Colleges,"
H. E. Smith,
Assistant Professor of Mechanical Engineering, University of Minnesota.

15. "The Desirability of Uniformity in the Use of Mathematical Symbols and Terms."
A. E. Haynes,
Professor of Mathematics, University of Minnesota.

16. "The Use of Graphical Methods in the Solution of Problems in Mechanics,"
C. M. Woodward,
Professor of Applied Mechanics, Washington University.

17. "On the Nature of Entropy,"
Albert Kingsbury,
Professor of Mechanical Engineering, New Hampshire College.

The paper by Mr. Rice was a strong plea for making technical education primarily a thorough drill in principles underlying applications, drawing the examples from the daily surroundings of students in shops and laboratories.

Prof. Magruder's paper was mainly descriptive, showing how the ice plant in the dairy of the O. S. U. was utilized for instructive purposes.

Prof. Marburg presented an excellent sketch of the work done by correspondence schools, giving statistics and results. The conclusion seemed to be that they filled a certain want and probably accomplished some good, but could not be regarded as institutions capable of giving a real, substantial education in engineering at all comparable with the work done by schools giving class room and laboratory instruction.

Prof. Emory's paper deals with the question of the place for higher algebra in the engineering course. He contends that much of the higher algebra is taught too early in the course. His idea is to give thorough drill in the more elementary portions first and then take it up again later in the course.

The next two papers were mainly descriptive and statistical.

Prof. Allen's paper was an excellent summary of the various means to be employed, the manner of employment and the relative proportions of time to be allotted in giving the best results in teaching engineering. He points out and discusses the failure of the lecture method pure and simple the inadequacy of text book, when used alone, the erroneous direction of much of the laboratory work. He indicates how a judicious combination of all these means lead to the best results.

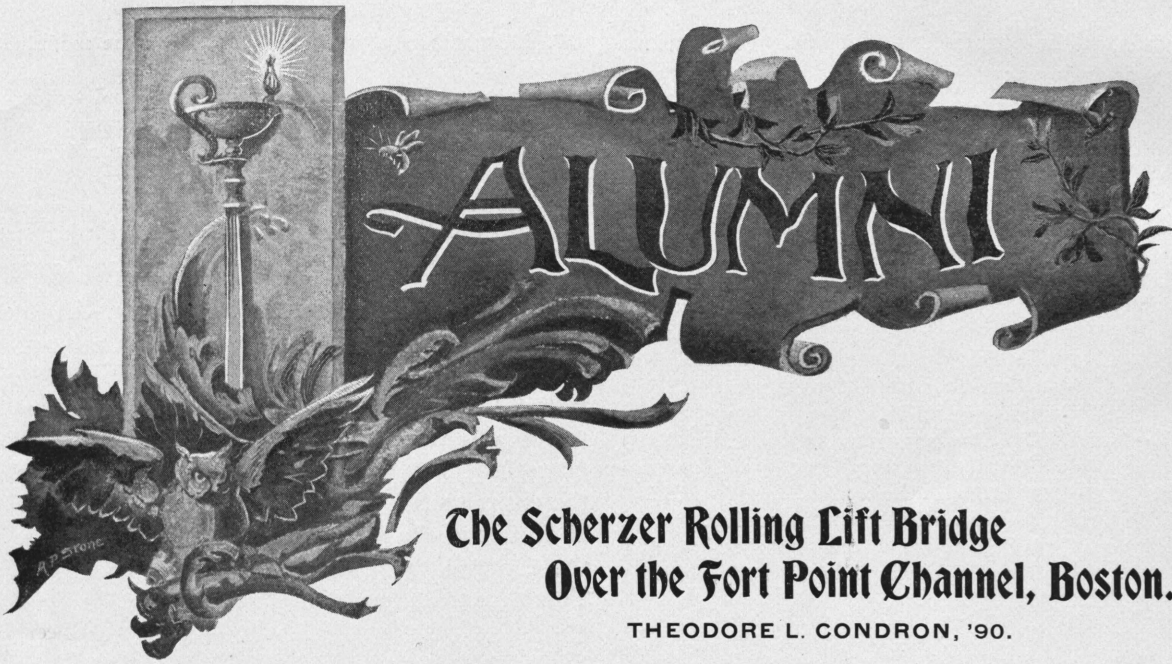
Prof. Aldrich's paper points out that engineers must look upon material expansion as opening out a new field for them, demanding special preparation for the wider usefulness abroad.

Prof. Caldwell, in his paper, arrives at the conclusion that excellent results have been attained in the education of engineers by widely different courses, but thinks that a unification in courses might be desirable to facilitate the intercourse between different schools and bring more nearly together the different engineering courses.

Prof. Hood related his experience with an apprentice system in connection with the operation of the shops of the Kansas State University. From six to eight apprentices were taken in the school shops and their time and work utilized in manufacture. Prof. Hood's experience seems to have been very satisfactory and he commends the system for further trial.

The remaining papers were of less interest and importance and need not be abstracted.

The discussions of the several papers were of great interest and form an important portion of the proceeding. These will all be published in full in the volume of proceedings, which can be purchased from the secretary when published.



The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston.*

THEODORE L. CONDRON, '90.

IN the R. R. Gazette of Aug. 4 last, was presented a general description of the main features of the Scherzer rolling lift bridge, recently completed over the Fort Point Channel, Boston, carrying the six adjacent tracks of the Plymouth and Midland divisions of the New York, New Haven & Hartford Railroad where they enter the yard of the new Southern Terminal Station. Accompanying that description were engravings showing the general plan and elevation of the structure, which are also shown herewith in Figs. 2 and 3, together with the arrangement of the locking device at the outer ends of the spans. Two views of the spans as erected were also shown. We here describe some of the details peculiar to this particular bridge, believing that there is enough novelty in the design to engage the attention of those interested in the designing and building of draw bridges.

For the benefit of those who may not have read the general description referred to above it may be stated that the bridge is composed of three independent, double track, skew spans, exact duplicates of each other and placed beside and parallel to one another, as clearly shown in the engravings, Figs. 1 and 2. The second span is about 33 ft. in advance of the first, and the third an equal distance in advance of the second. Each span has one long and one short truss, respectively 113 ft. 10 in. and 83 ft. 8 in. long, and spaced 27 ft. 2 in. center to center. The short truss of one span is adjacent to the long truss of the next and 28 in. center to center. The total width of the entire structure, carrying the six tracks, is 87 ft. 8 in. and the portion of the bridge crossing the channel proper is composed of three riveted truss spans, each weighing approximately 500 tons. The approach spans at both ends of the draw are deck plate girders; those back of the draw span, nine in number, really form part of the draw, as three of these spans support the tracks on which the draw spans roll, and three carry the machinery towers.

The substructure consists of two masonry abutments and four masonry piers. The latter are very long and narrow, being 150 ft. x 8 ft. The piers are all parallel and inclined 42 degrees to the axis of the spans. The clear opening of the channel, between fender piers, when the bridge is raised is 42 ft., measured at right angles to the piers, the distance center to center of pieces at right angles being 56 ft. 6 in.

The accompanying engravings, Figs. 4 and 5, are the strain sheets for the long and short

* We are indebted to the *Railroad Gazette* for the cuts which illustrate this description.—EDITOR.

trusses. The conditions for the calculations were as follows:

1. Live load, two 131-ton locomotives followed by a train of 4,000 lb. per lineal foot.

2. Dead load for truss "A." long arm, exclusive of member 17, 196,600 lbs.; center of gravity at K. This weight includes the weight of the floor and bracing carried by truss "A." Dead load for the short arm 93,400 lbs., including member 17; center of gravity at L. Counterweight 554,000 lbs; center of gravity at M. Truss "A" bears at Points A, G and I before being loaded.

3. Dead load for truss "B," long arm, exclusive of member 17, 157,400 lbs.; center of gravity at K. This weight includes the weight of the floor and bracing carried by truss "B." Dead load for the short arm 87,900 lbs, including member 17; center of gravity at L. Counterweight 254,000 lbs., with the center of gravity at M.

5. No bearing moves vertically during loading.

6. Truss "A" is held at one of the three bearings and slides on the other two bearings horizontally, without friction during loading.

7. All members of truss "A" have the same modulus of elasticity.

8. In computing the stresses for live load and temperature, the length and sectional area of all members of truss "A" are taken and not a uniform moment of inertia assumed.

9. The temperature stresses are computed on the assumption that the top chord becomes heated 50 degrees F. hotter than the lower parts of the bridge.

As the point G of truss "A" comes directly over the oblique channel pier, a support was provided for this point by means of an adjustable pedestal. This support at G made it necessary to compute the truss "A" as a continuous girder over three supports. The center of gravity of the entire span is shown to be a little less than 26 ft. above the roller track and 6½ in. back of the center line of the main post of the span. This theoretical position can of course be fixed

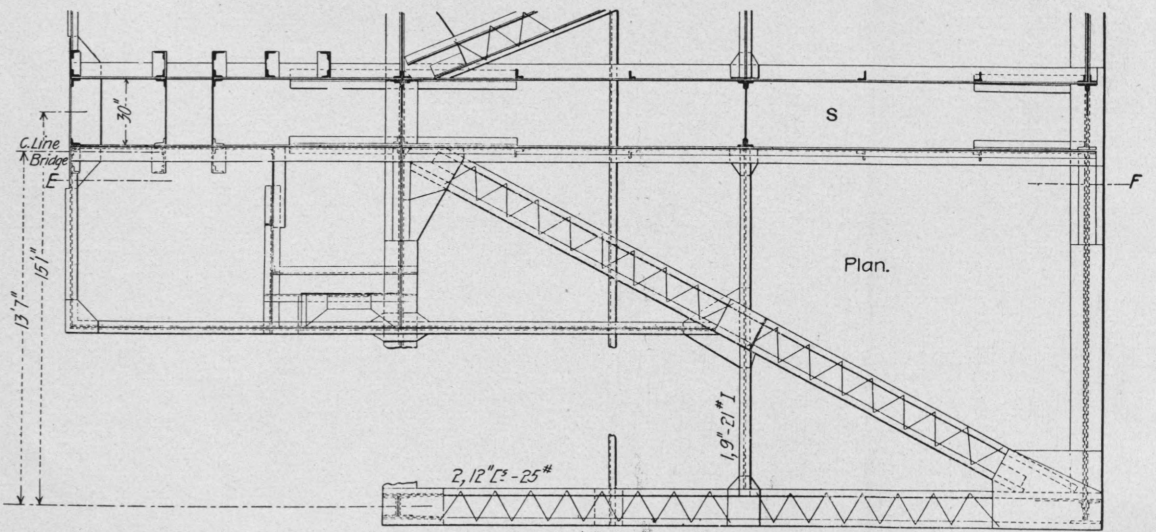


FIG. 9.—Machinery Floor of the Scherzer Bridge.

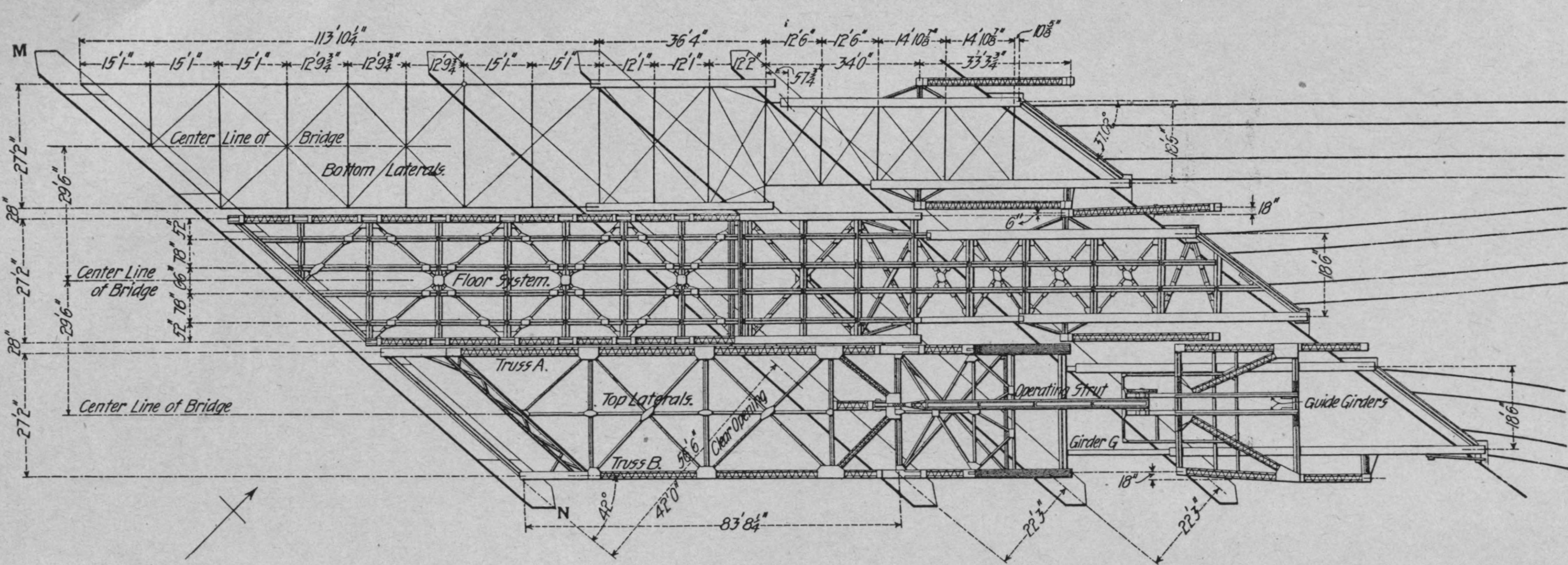


Fig. 2.—Plans of the Three Lifts of the Scherzer Bridge—Boston.

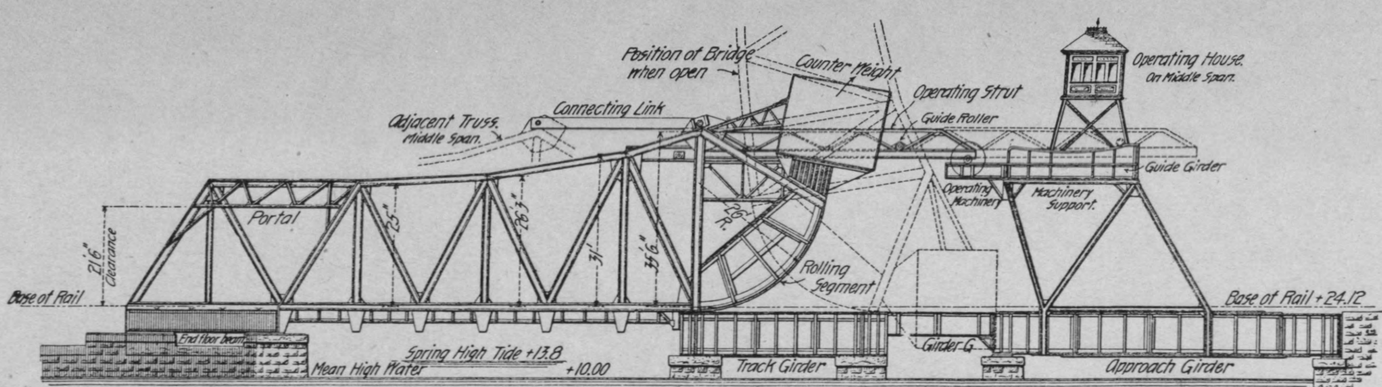


Fig. 3.—Elevation of Scherzer Lift Bridge, Showing Operating House.

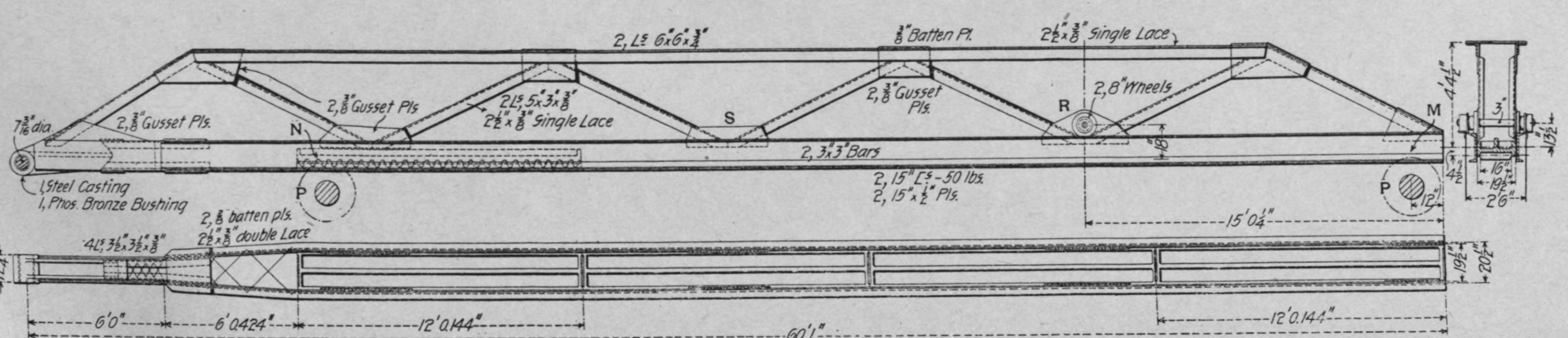


Fig. 6.—Operating Strut of the Scherzer Rolling Lift Bridge.

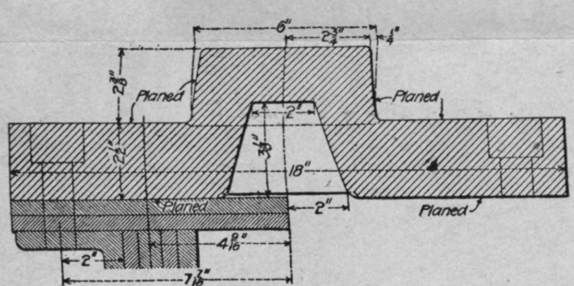


Fig. 11.—Section Through Tooth.

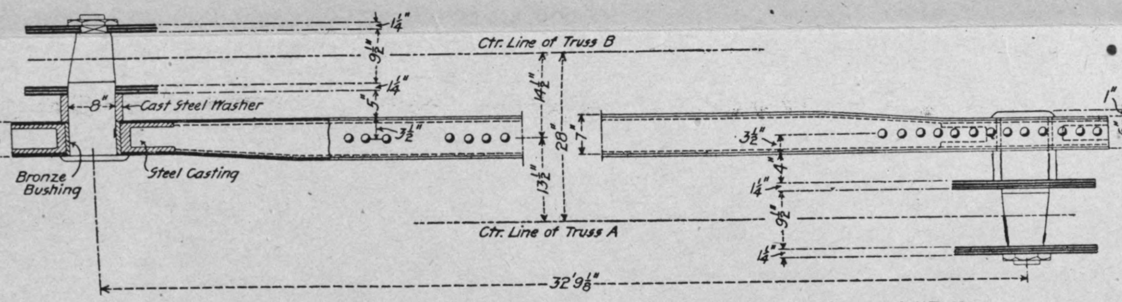
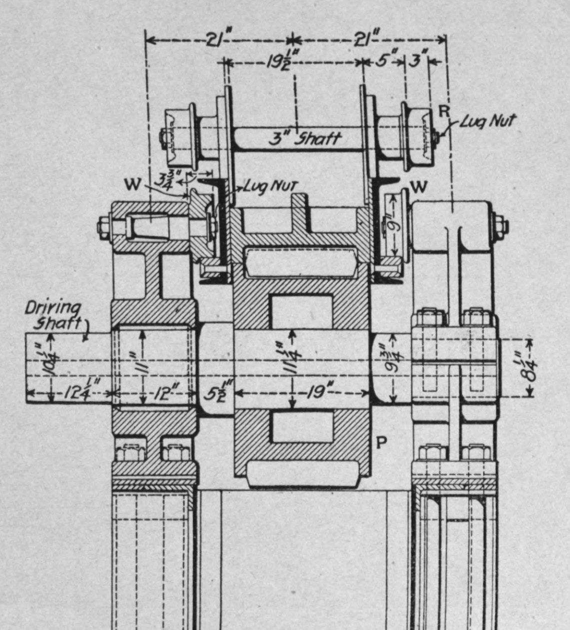
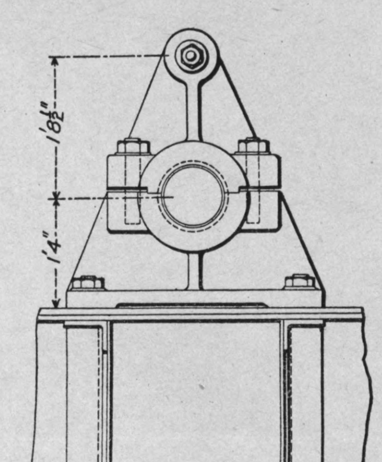


Fig. 10.—Details of Connecting Link Between Trusses "A" and "B."





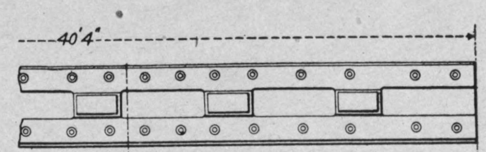


Fig. 12.—Section of Track Girder.

Fig. 8.—Mounting of Driving Gear.

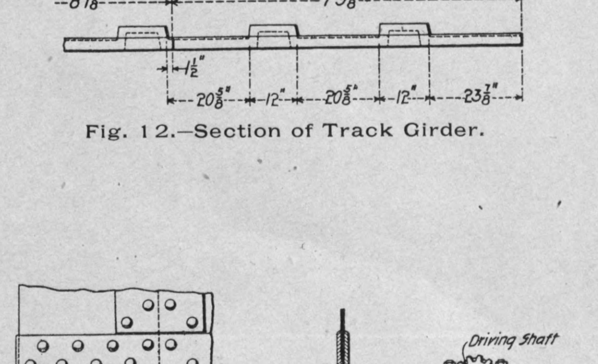


Fig. 13.—Locking Device.

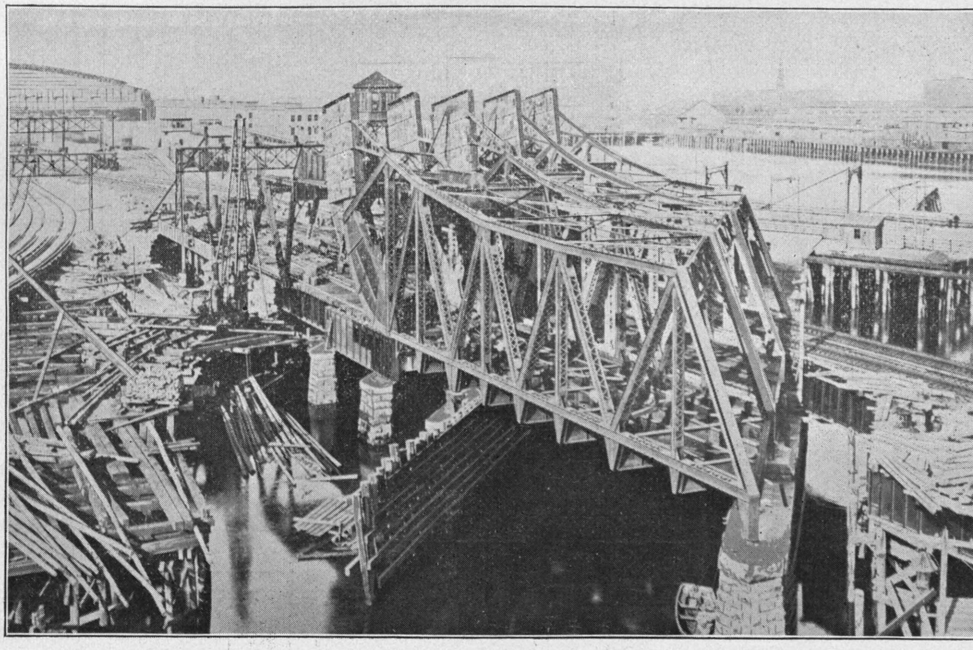


FIG. 1.—Scherzer Rolling Lift Bridge—Fort Point Channel, Boston.

the driving pinion and directly above the pinion. These rollers bear upon steel tracks riveted to the sides of the bottom chord of the strut and resist the upward reaction at this point. Near the shore end of the operating strut another pair of guide rollers, R, Fig. 8, are mounted. These rollers (also shown in Fig. 3) come into play during the last half of the opening movement of the span, when they bear upon the curved flanges of the guide girder, Fig. 10, and take a part of the weight of the strut off the bearing faces of the shrouds of the operating pinion and rack. The point, m, of the strut, S, Fig. 6, is over the pinion, P, when the span is closed, and with the span open the strut has moved back until the pinion is under the point, n. As the pin end of the strut describes an irregular curve during the opening of the span and the rack is straight, into which the pinion whose bearing is fixed engages, it follows that the shore end of the strut must also travel in an irregular curve ; hence the bearing face of the guide girder, Fig. 9, on which the rollers, R, bear, is curved as shown. The roller wheels, R, are 8 in. in diameter and are mounted on a 3 in. shaft passing transversely through the strut. The details of all these parts are clearly shown in Fig. 8, which is a view of the mounting of the operating pinion, a sectional view of the pinion and rack, and shows the relative position of the rollers, R and W, to these parts. As previously stated, each span is independently controlled by its own operating machinery, but as it will usually be necessary to open and close the three spans simultaneously, they are connected together by links of box section as shown, in Fig. 10. These links connect the top points of the main posts of adjacent trusses to which they are attached by steel pins 8 in. in diameter. These links are made of such strength that in case the operating machinery of one span is out of order the span can be raised and lowered by means of the operating machinery of one of the other spans, the necessary power being transmitted through the connecting link. These links also insure a uniform action of the three separate spans, when operated as a single structure.

The segmental bearings on which the span revolves are circular arcs of 80 degrees, with radii of 26 ft. and face lengths of 36 ft. 3⅝ in. On their faces are segmental cast steel tracks having

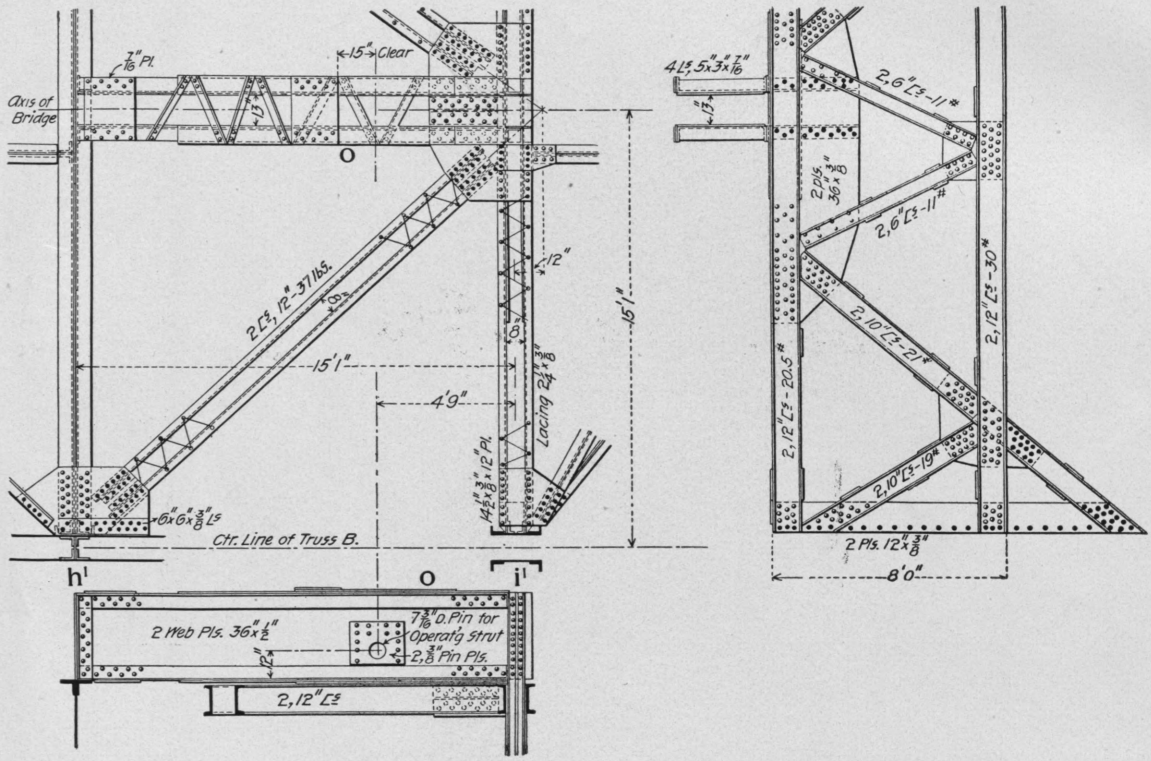


FIG. 7.—Part of Span Showing Operating Strut Connections on Box Girder.

practically by modifying the counter-weighting. The object in locating the center of gravity back of the point of support, as shown, is to have the span open or close by gravity to an angle of 40 degrees when the locking devices are released. This leaves the work done by the operating machinery in opening the bridge that necessary to roll it through the last 40 degrees of the arc, the entire movement being 80 degrees. Likewise, if released when open, it will fall by gravity from the wide open position to that of half closed, the operating machinery revolving it through the remaining 40 degrees of arc. Each of the spans can be opened and closed independently, but the three spans are normally coupled together so as to be operated as a single structure. In the following description only one span is referred to, as all three of the spans are alike.

The opening and closing of a span is accomplished by means of a trussed operating strut, S. Fig. 6, which is also shown in Fig. 3. This is 60 ft. long and 5 ft. deep and pivoted by a $7\frac{3}{16}$ in. diameter pin to the box girder, O, in the axis of the span, between the portal and the first cross frame, as shown in Fig. 7. The strut is designed to transmit a tension or compression stress of 126,000 lbs. Riveted to the bottom chord of the strut is a cast steel rack into which a cast steel pinion, 30 in. in diameter, engages; shrouds on the rack and pinion take the bearing and allow a free motion of the teeth. The pinion is driven by a 60 h. p. Westinghouse railroad type motor, to which it is geared. The gearing is so arranged as to operate the bridge at either one of two speeds; the fast speed opening the bridge in 30 seconds, while the slow speed, to be used during high winds, requires 90 seconds. A brake wheel, 4 ft. in diameter, on which are two band brakes controlled by 150 lb. and 50 lb. solonoids, is provided with which to regulate the movement of the span. By reference to Fig. 8, it will be seen that a pair of guide rollers, W, are mounted on the bearing block of

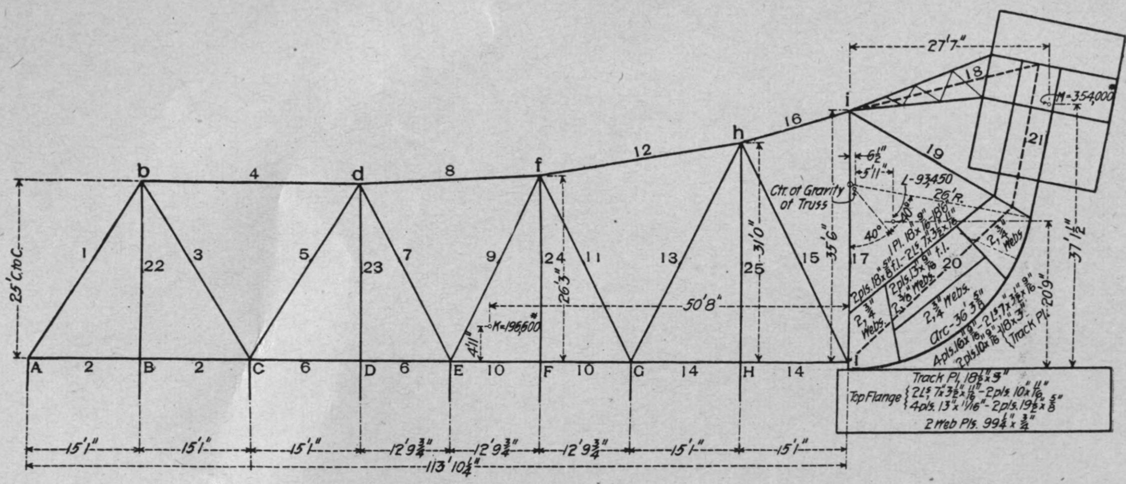


Fig. 4.—Strain Sheet for Truss "A."

STRESSES IN THE 114 FT. 3¼ IN. TRUSS ON THREE SUPPORTS "A."

Member.	Dead Load.	Live load, plus 12.5 per cent. for impact.		Stresses for excess in top chord.*	Maximum Stresses.		Unit Stresses.	Area. Net.	Area. Gross.	Sections.
1	+ 11,000	—151,500		— 32,600	—173,100	+ 11,000	7,300	23.7	26.4	2 pls 15 + ⅜ 1 pl 18 × ⅜ 4 ang's 3x3x⅜
2	— 5,400	+ 80,000		+ 17,000	+ 91,600	— 5,400	8,740	10.5	19.65	2 " 15 " ⅜ 4 " 3x3x⅜
3	— 48,400	+123,000	— 32,000	+ 32,600	+107,200	— 80,400	5,630	19.0	22.75	2 " 15 " ⅜ 4 " 4x3x7/16
4	+ 31,000	—146,500		— 34,200	—149,700	+ 31,000	7,280	20.6	22.25	2 " 15 " ⅜ 4 " 3x3x½
5	+ 69,600	+ 77,500	— 65,000	— 32,600	+147,100	— 28,000	8,150	18.0	20.97	2 " 15 " ⅜ 4 " 3x3x7/16
6	— 66,900	+138,000		+ 50,800	+121,900	— 66,900	6,530	18.7	22.25	2 " 15 " ⅜ 4 " 3x3x½
7	— 97,300	—138,000	+ 27,000	+ 27,600	—235,300		7,350	32.0	33:24	2 " 20 " ½ 4 " 5x3x7/16
8	+110,800	— 94,500		— 63,500	+110,800	— 47,200	7,080	15.7	19.65	2 " 15 " ⅜ 4 " 3x3x⅜
9	+115,900	+193,000	— 11,500	— 27,600	+308,900		9,000	34.3	39.44	2 " 21 " ½ 4 " 5x3x⅝
10	—161,000	+ 28,500	— 8,800	+ 75,200	—169,800		7,850	21.6	21.6	2 " 15 " 7/16 4 " 3x3x⅜
11	—118,100	—246,500	+ 1,100	+ 16,000	—364,600		7,300	49.9	53.1	2 " 22 " ¾ 4 " 5x3x11/16
12	+217,100	+ 85,500	— 3,950	— 83,500	+302,600		9,000	33.6	40.9	2 " 15 " ¾ 4 " 5x3x⅝
13	+138,400	—162,000		+101,000	+239,400	— 23,600	8,560	28.0	33.5	2 " 18 " ⅝ 4 " 3x3x½
14	—273,400	— 39,500	+ 31,500	+ 37,800	—312,900		7,800	40.1	40.9	2 " 15 " ¾ 4 " 5x3x⅝
15	—108,000	— 86,500	— 7,100	— 85,500	—287,100		7,070	40.6	43.44	2 " 20 " ⅝ 4 " 5x3x⅝
16	+335,200				+335,200		9,000	37.2	42.6	2 " 15 " ¾ 4 " 5x3x11/16

LIVE LOAD, PLUS 30 PER CENT. FOR IMPACT.

22	+ 9,500	+ 78,000			+ 87,500		9,000	9.7	11.76	2 10 inch channels, 2 pounds.
23	+ 17,600	+135,000			+152,600		9,000	16.9	19.8	2 15 " " 33 "
24	+ 16,200	+130,000			+146,200		9,000	16.3	19.8	2 15 " " 33 "
25	+ 18,900	+140,000			+158,900		9,000	17.7	20.58	2 15 " " 35 "

TAIL END PORTION OF TRUSS—STRESSES.

Member	Closed.	Half Open.	All Open.		Maximum Stresses.		Unit Stresses	Area. Net.	Area. Gross,	Sections.
16	+335,200	+198,000	+ 18,000		+335,200					
17	—184,500	— 35,000	+215,000		+215,000	—184,500	5,130	41.9	50.1	2 plates 20 × ¾ 4 ang's 5x3x11/16
18	+102,400	+228,000	+257,000		+257,000		9,000	29.8	33.7	4 " 6x6x¾
19	+249,700	+ 28,000	—260,000		—260,000	+249,700	4,250	61.2	64.12	4 plates 22 × ½ 4 " 5x3x11/16
21	—418,500	—278,000	—128,000		—418,500					Made to suit counterweight support.

NOTE: + for tension; — for compression.
* Temperature, 50° Fahr.

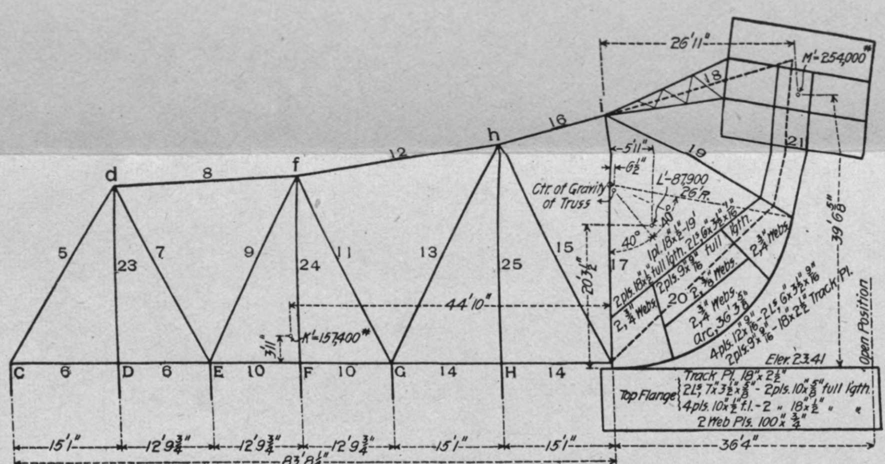


Fig. 5.—Strain Sheet for Truss "B."

STRESSES IN THE 83 FT. 8¾ IN. TRUSS "B."

Member.	Dead Load.	Live load, plus 12.5 per cent. for impact.		Maximum Stresses.		Unit Stresses.	Area. Net.	Area. Gross.	Sections.
5	+ 18,800	—236,000		—217,200	+ 18,800	7,280	29.8	31.4	2 plates 15 × ⅜ 1 plate 18 × ⅜ 4 angles 3x3x⅝
6	— 9,400	+124,000		+114,100	— 9,400	8,630	13.2	19.65	2 " 15 × ⅜ 4 " 3x3x⅜
7	— 48,700	+140,000	— 17,000	+ 91,300	— 65,700	5,770	15.8	19.65	2 " 15 × ⅜ 4 " 3x3x⅜
8	+ 31,200	—168,000		—136,800	+ 31,200	7,450	18.4	21.0	2 " 15 × ⅜ 4 " 3x3x7/16
9	+ 70,000	— 86,000	+ 57,500	+127,500	— 16,000	8,440	15.1	19.65	2 " 15 × ⅜ 4 " 3x3x⅜
10	— 60,900	+179,000		+118,100	— 60,900	6,680	17.7	21.0	2 " 15 × ⅜ 4 " 3x3x7/16
11	— 93,100	—114,000	+ 29,300	—207,100		7,280	28.4	29.0	2 " 18 × ½ 4 " 3x3x½
12	+102,500	—126,000		+102,500	— 23,500	7,980	12.9	19.65	2 " 15 × ⅜ 4 " 3x3x⅜
13	+113,700	+178,000	— 7,200	+296,700		9,000	33.0	39.2	2 " 20 × 9/16 4 " 5x3x9/16
14	—151,200	+ 88,000		—151,200		7,780	19.4	19.65	2 " 15 × ⅜ 4 " 3x3x⅜
15	—106,900	—225,000		—331,900		7,000	47.4	48.5	2 " 20 × ¾ 4 " 5x3x⅝
16	+206,200			+206,200		9,000	22.9	26.0	2 " 15 × ½ 4 " 3x3x½

LIVE LOAD, PLUS 30 PER CENT. FOR IMPACT.

23	+ 19,500	+135,000		+154,500		9,000	17.17	19.8	2 15 inch channels, 33 pounds.
24	+ 18,000	+130 000		+148,000		9,000	16.5	19.8	2 15 " " 33 "
25	+ 21,000	+140,000		+161,000		9,000	17.9	20.28	2 15 " " 35 "

TAIL END PORTION OF TRUSS.

Member.	Closed.	Half Open.	All Open.	Maximum Stresses.		Unit Stresses.	Area. Net.	Area. Gross.	Sections.
16	+207,500	+110,000		+207,500					
17	—118,700	+ 40,000	+155,000	+155,000	—118,700	5,550	27.9	32.24	2 plates 20 × ½ 4 angles, 5x3 x7/16
18	+ 62,500	+148,000	+176,000	+176,000		9,000	19.6	23.4	4 " 6x3½x11/16
19	+162,500	— 38,000	—192,000	—192,000	+162,500	4,720	40.7	43.4	2 plates 20 × ⅝ 4 " 5x3 x⅝
21	—262,500	—182,000	— 88,000	—262,500					Made to suit counterweight support.

rectangular pockets into which mesh the teeth of the horizontal track thus guiding the motion of the span and preventing any tendency to slip during the opening and closing. These teeth are of great strength, being 12 in. long by 6 in. wide, as shown in cross section, Fig. 11. Fig. 12 is a partial plan and elevation of the horizontal base track.

A detail of the end locking mechanism is shown in Fig. 13. The general arrangement of the locking device at the outer ends of the spans was shown in our issue of Aug. 4 last. The wedge-ended square bolts are thrown into position by pinions attached to the shaft running the full length of the abutment. It will be noticed (see Fig. 13) that these wedge ends will draw the end of the span down to its proper closed position, once the bolts have entered the sockets on the bottom of the end floor beam. There are six of these locks, two for each span, and all six work together, the driving shaft being connected by a worm gear to a 5 h. p. electric motor on the abutment. In case one span is not in use, it is left standing open and its locks operate idly with the others. The locking mechanism, as well as all of the other operations of the three spans, is controlled by one man in the tower house built above the machinery floor of the middle span.

The spans were erected in the open or raised position, thus avoiding any obstruction of the channel.

ALUMNI NOTES.

Clinton B. Kidder, '88, is now manager of the Terre Haute Electric Co.

Brent Wiley, '98, is with the Carniegie Steel Co., Limited, Homestead, Pa.

Abe Balsley,'91, was married Oct, 3rd to Miss Zillah Jane Neal, of Indianapolis.

H. W. Craver, '95, is chemist for the Duquesne Reduction Co., Pittsburgh, Pa.

J. Briggs Haney, '97, is constructing engineer for the Harbison-Walker Co., Pittsburgh.

J. R. McTaggart, '95, is first assistant chemist for the Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Harry J. McDargh,'96, became a benedict last June. Miss Belle O. Lowes, of Dayton, Ohio, was the cause.

F. A. Whitten, '98, has been promoted to the drafting room of the Henry R. Worthington Works, Brooklyn, N. Y.

J. T. Montgomery, Jr., '98, is located in Chicago, as the western representative of the Roebling Construction Company.

E. L. Shaneberger, '95, is in the department of maintenance of way, Pennsylvania Railway, with headquarters at Terre Haute.

S. D. Collett, '90, with the Elevator Supply and Repair Co., of New York City, paid the Institute a visit last week.

M. B. Stewart, '98, P. G., '99, is in the employ of the Southern Indiana Railroad company, construction department.

L. S. Rose, '92, has been appointed acting engineer of maintenance of way of the Cincinnati-Sandusky division of the Big Four.

J. David Ingle, '97, having completed a course in mining engineering at Columbia University, is now engaged in the mining industry near Oakland City, Ind.

Clarence Tucker, '97, has recently been promoted to the position of chief draughtsman at the ordnance department of the Driggs-Seabury Gun and Ammunition Company, Derby, Conn.

W. R. Sanborn, '96, recently returned from the Klondike with an abundance of experience and enough gold dust to pay his expenses. He is located at Greenwood, Wis., as chief engineer of the I. & N. E. Ry.

THE CLASS OF 1899.

N. P. Burt, is taking a post graduate course at Worcester Polytechnic Institute.

W. G. Davis, C. Howell and C. B. Keyes, are employed in the testing department of the General Electric works at Schenectady, N. Y.

N. C. Butler, is employed in the works of the Worthington Steam Pump company, Brooklyn, N. Y.

Jas. J. McLellan and Arthur D. Kidder are in the employ of the American Zinc, Lead and Smelting Co., of Boston Mass., at Webb City, Mo.

Chas. F. Trumbo is constructing engineer for Trumbo & Son, Muir, Ky.

Arthur P. Stone is with the Wheeling Corrugating Co., Wheeling, W. Va.

Arthur C. Thompson is with M. E. Thompson, electrical engineer, at Ridgeway, Pa.

Edward P. Edwards is with the National Steel Co., at Youngstown, O.

F. H. Froelich is with Edward Ford, constructor, Toledo, O.

Jno. F. Schwed is in the construction department of the Chicago & Northwestern Railway.

Jesse E. Holliger is drafting in the office of the Vandalia Line, Terre Haute, Ind.

Cubitt B. Smyth is engaged in mill construction at Breckenridge, Colo.

Geo. H. Likert is with the Union Pacific Railway at North Platte, Neb.

J. Milton Platts is with the Western Electric Co., of Chicago.

Frank J. Jumper is with the Terre Haute Car and Manufacturing Co., Terre Haute, Ind.

Walter D. Crebs is attending the Commercial College at Dayton, Ohio.

Harry C. Schwable is with his father in the hotel business at Greenville, Ohio.

Harvey G. Kittredge is interested in the manufacture of oils and painting materials at Dayton, Ohio.

Editor Technic:

The change from Terre Haute and the Polytechnic to Lawrence and the University came to us so suddenly that I have been half expecting to awake and find it all a dream. The arrival of rent day and of coal bills, coal five dollars a ton, has served to dispel such fancies. A Freshman class of sixty-one in the College of Engineering has helped to the same end.

We have found life in the Sunflower State very pleasant thus far. There are many noticeable differences between our situation here and the former one in Hoosierdom. Some few of these may prove of interest in the telling.

Perhaps the most striking feature of the University at first sight, especially to a Rose man, is its situation. The town of Lawrence lies on the north bank of the Kansas or Kaw River. The greater part of it is in the level valley, but on the southwestern edge the streets run up to a peculiar hill or projection from the bluffs. This rises quite abruptly to a height of something like three hundred feet. At the summit there is a fairly level space of some twenty acres. This is the campus of the University.

In the center, upon the very highest point, stands Frazer Hall, the main building. It is very similar in plan and size to the main building at Rose, but is built of stone. Grouped about it at distances of fifty to two hundred yards are the Physics Building, Library, Natural History Building, and Shops. These are all large structures, built of stone in modern design. A new Chemistry Building is just now up to the top of the foundation.

As might be expected from such a site, the view of the surrounding country from any point on the campus is truly magnificent. The fertile valley of the Kansas, here from twenty to twenty-five miles wide, lies spread out like a map. Standing on University Hill we are almost in the center of it. The silvery blue of the river sparkles here and there through its fringe of green as it winds its way to the Big Muddy. Here and there the checkerboard of fields and orchards with the dotting farmhouses and barns is

broken by an abrupt knoll or mound similar to the one on which we stand. A particularly prominent hill called Blue Mound rises high enough to cut the horizon some six or seven miles to the southeast. This I am told was the spot where watch fires were kindled during the troublous times of '61–'65, warning the people of the village to flee from the dreaded border raiders.

The country hereabouts fairly bristles with history. On a small map of a part of the country there may be counted the sites of twelve towns long since defunct. Their names are sacred to the memory of various booms "before the war." While out with a wheeling party a few days ago we passed through what was once one of the largest and most promising of these villages. Now not a building of any kind remains to mark the spot. The children of Lawrence study United States history and the geography of the town at one and the same time. The principal thoroughfare is named Massachusetts street. The parallel streets to the east are named for the original thirteen States and to the west for the states in the order of their admission into the Union. The cross streets are named for Revolutionary heroes, the historical basis for whose order being as yet a lesson to me unlearned. The town was a hotbed of anti-slavery sentiment during the civil war and suffered much from various raids. In 1863 almost the entire town was burned by raiders under Quantrell. Old citizens have some interesting tales to relate of these times.

The daily round of life and work at the University presents some novel ideas to one accustomed for seven years to Polytechnic ways. The chapel exercises every morning have proved very enjoyable. My private room is right against the chapel wall and I find it convenient to step in for the exercises of twenty minutes. The call sounded at 8:50 is a selection upon the splendid pipe organ by Prof. Penny Dean of the School of Fine Arts. This organ, the crowning feature of the department of Music, is of interest from both a musical and technical standpoint. Its action is entirely electrical, the manuals being contained in a small cabinet movable about the auditorium and connected with the seat of melody by a fifty foot flexible cable. Some one has said that there is an inspiration in the music of a great pipe organ touched by a master hand. It is at least a very pleasant privilege to be able to listen for a few minutes every morning to the strains of such an instrument. On the opening morning the students filled the chapel to overflowing and listened to an eloquent address on the "Development of Christian Liberty," by Governor Stanley, the chief executive of Kansas.

The Fowler Shops, where my work in mechanical and hydraulic laboratory is done, is a pretty building of rough native stone very appropriate for its setting in the grove of young trees. The building is brand new, as is also much of the equipment. Everything about it is as clean and neat as a new dollar. Just now it rivals the Museum in Snow Hall as a showpiece for visitors.

The various forms of outdoor sport receive hearty support from the students and faculty. McCook Field, a gift to the University for the purpose, is the scene of the baseball and football games. Here on last Saturday the Varsity team played the Indians from Haskell Institute. This is the government school for the Indian boys and girls located two miles south of Lawrence. The grounds of the Golf Club are located conveniently near to the University. A faculty tennis tournament is in progress this week on the two courts notched out of the hillside. A conspicuous object in the corridor of Fraser Hall is a large map of the vicinity of Lawrence, published by the University Country Club. This club is organized for the promotion of driving, riding, walking and wheeling into the country. They issue reduced copies of their map, pocket size, which are very useful and interesting. The map shows all roads, with the valuable landmarks of schoolhouses and churches, and also shows many historic spots.

The scenery hereabouts is admirable for outdoor sketching. Its natural beauties are particularly fine and there is no lack of picturesque

buildings of various sorts. On the top of a knoll only a short way from the University there stands a fine specimen of the old Dutch windmill, full size, and in good preservation. It was used until within a few years as a grist mill. A half day jaunt over that way with a sketch book and camera is on my program for the near future.

A sad incident of the opening weeks of the term was the death, on last Sunday, October 1st, of Mrs. Marvin, wife of Professor F. O. Marvin. Professor Marvin is the Dean of the College of Engineering and Professor of Civil Engineering.

And now, Mr. Editor, I have taken quite enough of your valuable space. Don't fail to mail us THE TECHNIC promptly on the 15th of each month. While striving earnestly to become worthy Jayhawkers, we still have a lively interest in all Polytechnic affairs.

O. E. McMEANS.

UNIVERSITY OF KANSAS, Oct. 5, 1899.

The Edison, or Three-Wire, System.

HARRY S. RICHARDSON, '00.

Read before the Scientific Society, September 30th, 1899.

IN electric lighting there is perhaps no greater factor than the expense of the copper necessary for the distribution of the current over the lines, and naturally the object has been to devise some means of distribution whereby the amount of copper could be reduced.

If lamps could be made that would burn at high voltage and at the same time be durable, the problem would be easily solved, for the higher the voltage the smaller is the amount of copper necessary to carry a given current with the same line loss. The trouble here is that of making a suitable lamp. Many attempts have been made to make lamps of higher candlepower that would burn at higher voltage, but all have practically failed to present a lamp of such a nature with a good, substantial filament—a reliable, hardy, commercial lamp. All trials and attempts gradually centered into the almost universal agreement that a 16 c. p. lamp which will burn at about 100 volts, is about as good a lamp in all respects as can be manufactured for commercial purposes. Such lamps could be used in series on high voltages, but then a whole series would have to be burning or none at all, which would be extremely inconvenient at times, and then, if one lamp should happen to go out or be broken the rest of the series would be useless. And then, too, if high voltages were used, much greater care would have to be exercised in the wiring of buildings.

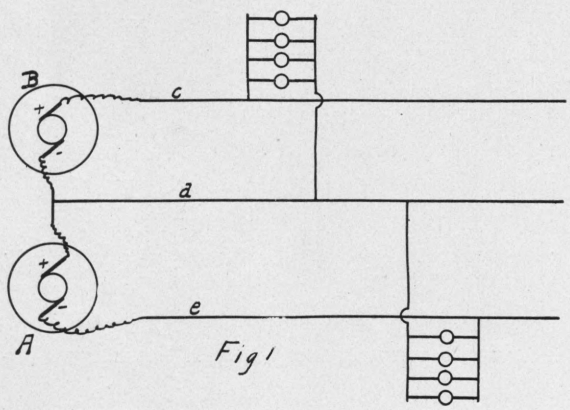
The problem then sifted down to how to so distribute the current at a low potential as to reduce the necessary amount of copper.

This problem comes up only in direct-current systems, for in alternate-current systems the

power is transmitted at extremely high voltages and reduced by means of transformers.

The result of this question was the development of the Edison, or three wire, system. Although it bears the name of our American inventor, it seems that it was first used and patented by Dr. J. Hopkinson in 1882. However, shortly after its introduction in Europe by Hopkinson, it appeared in America under Edison's name and there has been much dispute as to who the originator of the idea was.

For the operation of this system two dynamos having the same voltage are connected in series, thus affecting a difference of potential between the terminals, which is twice that affected by one dynamo.



Let A and B represent two dynamos having the same voltage, say 110 volts. Then there is a difference of potential between c and e of 220 volts and the wire necessary to carry a given current with that voltage keeping the heating effect and per cent. of loss constant, would be only ¼ of that required if the voltage were 110.

This follows from a few of the fundamental equations:

Let R=total resistance of line wire.
l=length of line wire.
S=specific resistance of line wire.
A=area of cross-section of line wire.
C=current.
E=difference of potential at the dynamo.
p=drop in volts.

Then $R=\frac{lS}{A}$ and $p=CR$.

$\therefore p=\frac{lSC}{A}$, whence $A=\frac{lSC}{p}$ (1).

Also the watts=EC=q.

Now when the voltage is doubled $E_1=2E$, and let C_1 be the current, p_1 the drop in volts, and A, the area of cross-section.

Then $A_1=\frac{lSC}{p_1}$.

Since q is constant $\therefore E_1C_1=q=2EC_1=EC$ $\therefore C_1=\frac{C}{2}$

Also the % drop being the same and $E_1=2E$ $\therefore p_1=2p$.

$\therefore A_1=\frac{lSC}{4p}$ (2).

Dividing (2) by (1): $\frac{A_1}{A}=\frac{\frac{lSC}{4p}}{\frac{lSC}{p}}=\frac{1}{4}$ $\therefore A_1=\frac{1}{4}A$.

This, of course, effects a great saving of copper, but either 220 volt lamps or 110 volt lamps in series would have to be used, and this is avoided by running a third, called the neutral, wire, d, which is connected as shown in the diagram.

Suppose no lamps to be burning except a circuit between c and d. Then B will be the only dynamo doing work which will be accomplished through c and d.

Let a circuit requiring an equal current be turned on between e and d. B will tend to send a current out through c and back through d, while A will tend to send an equal current out through d and back through e. The result of these tendencies is a neutralization in d and the current flows out through c and returns through e, leaving d entirely neutral. The lamps are then working in series on a 220 volt circuit, but if for any reason all or part of the lights on one side should go out, those on the other side will not be burned out by a sudden increase in voltage, but will continue to work as a simple multiple system with the neutral wire.

The aim is naturally, to so arrange the loads that, as near as possible, a balance may be obtained so that the dynamos will be doing equal work, and so that the size of the neutral wire may be reduced to a minimum, for it has only to carry the excess of one side over the other.

As was stated, the system without the neutral

wire would be working at 220 volts, and the necessary wire would be only ¼ of that required if it were working at 110 volts. Now, the neutral wire in nearly all cases, can be made much smaller than the other two, but even though it were made the same size the copper would be increased 50% and the total would only be ⅜ of that required with the ordinary 110 volt multiple system. If the neutral wire were made ¼ of the other two, then the total amount of copper would be $\frac{9}{32}$ of that required with the other voltage.

Edison proposed to still further reduce the size of the neutral by providing each consumer with a switch which could be set to either main, his idea being that the consumer will set his switch to the main giving the highest pressure. Thus they would mutually aid each other in getting the standard pressure and would relieve the neutral.

Prof. Forbes also proposed to make the switch automatic in its action.

While there is certainly no doubt as to the merits of this system, its progress into universal use has been retarded by the fact that it is controlled as a patent, and then for long distance lines high potential-alternate-transformer systems have come into general use, the dangers of the high voltages being subordinate to the financial considerations.

Below is a comparison of three systems for two imaginary plants:

PLANT WITH FIVE CIRCUITS.

Total number of lights=3,000.

Total number of lights, per circuit=600.

Length of each circuit=1 mile.

2 Wire System, 110 Volts, Direct Current.

Drop in line=10%=11 volts.

Then for one circuit, where l = length, S = specific resistance, and A=area of cross section of wire:

$$\text{Resistance of wire}=R=\frac{lS}{A}=\frac{2\times5280\times2.54\times1.57}{10^6A}$$

The line loss is represented by the product of C and R, or, CR=11.

Substituting here, 300 amp. for C and the above expression for R:

$$300\frac{2\times5280\times2.54\times1.57}{10^6A}=11. \therefore A=13.2 \text{ sq. cm.}$$

=2.1 sq. in.

The area equivalent=12—No.0000 B and S guage wires.

1 ft. No. 0000 weighs .64 lbs.

∴Weight required=2×12×5280×.64=81100 ℔

Cost of copper=16c per ℔.

∴Total cost of copper for distribution=5×81100×.16=$44,880.

Cost of 175 kilowatt generator=$2,500.

Total cost=$47,380.

3 Wire System, 220 Volts, Direct Current.

The load for 3,000 lamps becomes 750 amp. and the drop=22 volts.

∴ the copper necessary for the outer mains=¼ of that in the two wire system, or A=.525 sq.in.

The equivalent = 4 — No. 000 B and S guage wires.

1 ft. No. 000 weighs .50 ℔s.

∴ weight required=2×4×5280×.5=21120℔s

I mile No.000 for neutral=5280×.5=2640 ℔s.

∴ total weight for one circuit=23760 ℔s.

∴ cost for 5 circuits=23760×5×.16=$19,008.

Cost of two 90 K. W. generators=$3,000.

∴ Total cost=$22,008.

2 Wire System, 2,000 Volts, Alternating Current.

For one circuit the amount of copper necessary would be too small to be practical in other ways and the smallest practical size wire would be used which may be taken as No. 10, B. and S. guage.

For this system the number of transformers per circuit, which, of course, depends upon the number of consumers, must be assumed. Letting, then, the number of transformers per circuit be 2, the total number=10.

No. 10 wire weighs .031. ℔s per foot.

∴ weight required for one circuit=2×5280×.031=328 ℔s.

∴ Cost for 5 circuits=5×328×.16=$262.

Cost for 175 K. W. generator=$2,500.

Cost for 10 transformers, 300 lights, 60 cycles =$1,800.

∴Total cost=$4,562.

Thus it appears that the two wire system at 110 volts would be almost absurd while the 3-wire system would mean a saving of \$25,372. The alternating system shows a saving over the 3-wire system of \$17,446, but it is apt to be misleading, for, (if the consumers were small and consequently a larger number of them), the cost of the transformers would be greatly increased. However, in the case as actually taken there would be no doubt as to the alternating current system being the best.

LINE FROM STATION TO DISTRIBUTING BOARD.

Length of line=1500 feet.

Number of lamps=1,000.

2 Wire System, 110 Volts, Direct Current.

Drop=10%=11 volts=CR.

C=500 amp.

$$\text{As before, } R=\frac{ls}{A}=\frac{3,000\times 12\times 2.54\times 1.57}{10^6 A}$$

$$\therefore 500\,\frac{3,000\times 12\times 2.54\times 1.57}{10^6 A}=11.\ \therefore A=652\text{sq.cm}$$
$$=1.01\text{sq.in.}$$

Equivalent=6—No. 0000 B and S guage wires

∴ Weight required=3,000×6×.64=11520 lbs.

∴ Cost=11520×.16=\$1,843.

Cost of 125 K. W. generator=\$1,800.

∴ Total cost=\$3,643.

3 Wire System, 220 Volts, Direct Current.

Load=250 amp. Drop=22 volts.

Making the three wires all the same size, the weight required would be 3/8 of that in the other system, or the weight required=4320 lbs.

∴ Cost of wire=4320×.16=\$691.

Cost of 2–60 K. W. generators=\$2,200.

∴ Total cost=\$2,891.

2 Wire System, 2,000 Volts, Alternating Current.

No. 10 wire weighs .031 lbs. per foot.

∴ Weight required=3,000×.031=93 lbs.

Cost of wire=93×.16=\$14.88, or \$15.

Cost of 125 K. W. generator=\$1,800.

Cost cf 2 600 light transformers, @\$3.60,=\$720.

∴ Total cost=\$2,535.

Thus in this case the 3-wire system saves \$752 over the 2-wire, 110 volt system, while the 3-wire and alternating current systems cost nearly the same.

Each of the systems has its own peculiar advantages and as the conditions vary so, it would be necessary to make the comparison for every particular case. However, the general statement may be made that the 3-wire system always has the advantage over the 2-wire, low potential system except in small installations, where the difference between the costs of two half-size generators for the 3-wire system and one full-size generator for the 2-wire system would exceed the amount saved on the copper by the 3-wire system.

For long-distance transmission, a high-potential, alternate current system would be the only practical system, and it would continue to be so until the cost of the transformers exceeded the amount saved on the copper by using the high voltage by an amount equal to the difference between the costs of two one-half size generators and one full-size generator; or, in other words, until the cost of the transformers minus the difference between the costs of the generators equaled the amount saved on the copper.

In regard to the mechanical power necessary to operate the two machines for the 3-wire system as compared with that required for the one machine for the 2-wire system, there would be scarcely any difference, as the two machines would be run by one engine, and the belts being smaller would probably compensate for the additional friction of two machines. At least the difference, if any, would be negligible in comparison with the other differences.

The 3-wire system has been applied to street railways in the following manner:

The trolley wires of a double track road are used for the outer mains and the track forms the neutral. If the loads could be fairly well balanced this system would be an advantage, for the current through the track would be slight and many of the bothersome factors would be eliminated. But in practical installations it has been found difficult to preserve the system fairly well bal-

anced, since the loads on various branches are necessarily very unequal at times.

A plan has been devised to remedy this, and consists of crossing over the trolley wires of the different tracks at necessary points, so that some of the motors on one track will be coupled between the positive main and the neutral while others will be coupled between the negative main and the neutral, and likewise for the other track. In this way the load on either track may be balanced up, as circumstances require, between the different branches of the system, instead of balancing the load of one track against that of the other, as has been customary.

The following diagram will serve to illustrate:

A and B are the trolley wires which are connected to the positive and negative terminals of a pair of generators G and G^1; C and C^1 are the two sets of tracks which are connected to the neutral; 1, 2, 3 and 4 represent motors going in directions indicated by the arrows. The trolley wires are divided by section-insulators as at D and the wires are connected across as shown, section *a* of wire A and section *b* of wire B forming one branch, and section *b* of wire A and section *a* of wire B forming the other. Then 1 and 2 are on the same circuit and 3 and 4 on the other. When any of the motors pass from one section of the trolley wire to another, they pass at the same time from one branch of the system to the other.

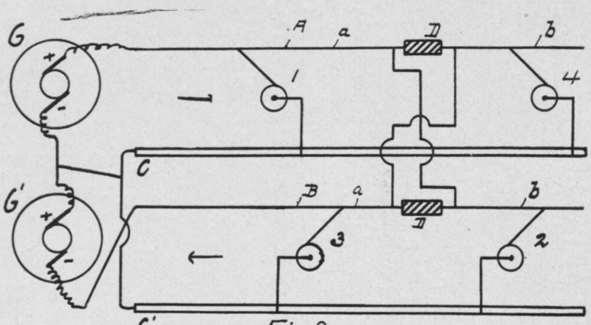
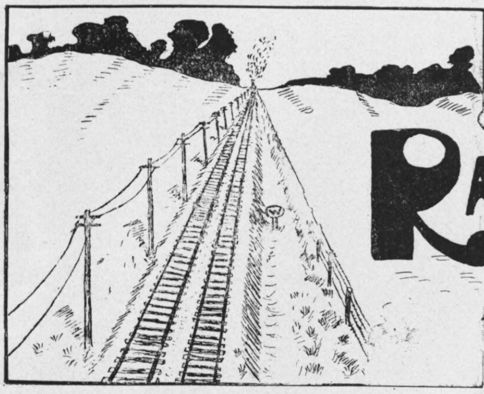


Fig 2.

THE CAMERA CLUB.

The Camera Club begins its new year's work in a more prosperous condition than ever. The Council having voted some money for its use, the club will be able to carry out some plans which it has had for some time. The dark room will be thoroughly cleaned and fitted. A good lantern using gas will be put in and other improvements made. The club hopes to make such arrangements that the dark room may be open Saturday afternoon and evening. The club also hopes to have a series of open meetings similar to those of the Scientific Society, at which papers will be read on photographic subjects by some one familiar with the subject under discussion. Last June Mr. Schwartz was elected President, and at the first meeting this year Mr. Clay was elected Vice President and Mr. Pfleging Secretary and Treasurer. All Freshmen feeling an interest in photography are urged to join the club. Also such other students as are amateur photographers and are not yet members. Those desiring to join should apply to the Secretary, who in common with the other officers of the club will be happy to give any further information desired.



RAILROAD SURVEY.

JOHN T. DICKERSON, '01.

THE '01 Civils went into camp at Forest Park June 16, 1899. Mr. McCormick was in charge of the party, which, with the Sophomore assistants and several men taking special work, numbered nineteen. Quarters were fitted up in the two cottages utilized by the party of '98, but the camp equipment was far ahead of those of previous years. Portable tables, chests, an ice box, the absence of tin eating utensils, and a wall tent for the safe housing of wheels, were features that went to make the '99 camp a decided improvement over its predecessors.

That execrable task, the carrying of water, was, in great part, obviated by damming the small brook at the bottom of the deep ravine just back of the camp, and, with the aid of a force pump and line of pipe, lifting the water thus collected, to a point near the cottages, where it was stored in large metal tubs.

The survey started at station 29+75 on the preliminary line run by the '00 Civils the year previous. For the benefit of those members of that survey who do not remember the precise location of station 29+75, we will say that it is just back of "the old negro's cabin across the gulley."

The ostensible purpose of the survey was to secure a route from some point on the '98 line to a point on the Big Four, by which the heavy grade encountered just after leaving the Big Four on the former line, might be dispensed with.

From the starting point at 29+75, the preliminary was run a short distance north, where an angle approximating 90° was turned to the right. This course passed just back of the camp, where a stop was ordered, and a rapid reconnoissance in which the stadia was used to great advantage, was made towards the south and east, around the thick woods and deep ravines lying to the east of the proposed course.

The results of the reconnoissance seeming to justify it, the original course was adhered to, and after passing through some very rough and heavily wooded country, the line emerged into the open, where little or no difficulty was experienced. Shortly after leaving the woods, the line turned to the east and was prolonged to the section line, where it turned and ran almost due north to the Big Four.

The level and topographical parties followed close after the transit, and in this way the different parts of the survey were kept about even.

The method used in taking topography, I believe, had never been employed in former Rose Tech surveys. As a diligent search through the various hand-books upon railway surveying has failed to reveal this method, a short description of the scheme may not be amiss.

A topographical party was made up of three men. The accessories used were a leveling board and rod, a light board about 36″ x 12″, and several sheets of cross-section paper, approximating 24″x8″, or, if the nature of the ground seemed to warrant it, a larger sheet of paper was used. A center line running the long way of the paper

represented the line of survey, and the various stations were laid off thereon, the scale used being the same as that of the proposed map. This center line was also taken as the edge of a vertical plane containing the line of survey. The elevations of the various stations were set down in pencil, and the horizontal lines of the paper represented parallel planes perpendicular to the vertical plane mentioned above, and at such a distance apart as the proposed system of contours made necessary. Five foot contours were employed on this survey, and, to facilitate plotting, the horizontal planes were taken as one foot apart.

The scale of the proposed map was 100 feet to the inch, and the stations on the center line of the cross-section paper were laid off one inch apart. Of course the same scale would be used in measuring out from the side of the line of survey.

The *modus operandi* was as follows: Starting at one of the line stakes, two of the men, using the leveling board and rod, measured out perpendicular to the line, calling off as they progressed, the distance out and the rise or fall of the ground. The third member of the party, using the piece of board as a support for the section paper, plotted the various points called off to him by the assistants. The same operations were gone through with upon the other side of the line, and in this way a cross-section was secured.

The points at which the cross-section cut the five foot horizontal planes were then projected vertically up into the horizontal plane passing through the stake, thus giving the horizontal distance from the stake out to the various contours. Succeeding stakes were treated in the same manner, and corresponding points thus obtained were connected, giving contour lines in their true positions.

After a party had caught "the hang of the thing," the rapidity with which they worked was really surprising. By means of carbon paper, the contours were easily transferred to the map.

Two weeks were occupied in making the survey, and every minute of that time was spent in hard work. Slope stakes were set over the whole length of the line, and transition curves were run in, the curve used being Nagles. One or two men were left in the office every day, and were engaged upon the maps, profiles, and in making observations. All field parties started for work at seven o'clock in the morning and worked until six in the evening, taking an hour for dinner.

The maximum grade on the located line was one of 1.6% and the sharpest curve was one of 5°. It will be seen that the ostensible purpose of the survey was not realized, but the real object, namely, that of affording the students in civil engineering a certain amount of practical work in railway surveying, was accomplished.

FACULTY CHANGES.

The Institute starts in this year with a slightly altered faculty. Mr. Arthur Kendrick, who was associate professor of physics, has been given a year's vacation for European travel, while Mr. Orange E. McMeans, who was instructor in drawing, has taken a position of more importance in the University of Kansas at Lawrence.

Dr. Edwin S. Johonnott, who is now associate professor of physics, was graduated from the Rose Polytechnic Institute in 1893. In 1894 he was professor of mathematics in Drury College in Springfield, Mo. Late in the same year he became a post-graduate student in Johns-Hopkins University. Here he took special work in physics under Dr. Rowland and Dr. Ames, as well as some special mathematical work.

In '95–'96 he was fellow in Chicago University and assistant to Dr. Michelson.

During this time he was engaged largely in research. Among the problems attacked by him was the measurement of the viscosity of water with original apparatus; the measurement of the thickness of the black spot in soap films gave

material for the degree of Doctor of Philosophy, which was granted him last year at the University of Chicago. Other investigations were in progress and will be continued here. Even in the short time Dr. Johonnott has been in the school he has given evidence of his ability as a teacher, which compares most favorably with his known success in investigation.

During his stay in Chicago, in 1897, he submitted a thesis to the faculty of Rose, and was granted the degree of M. S.

Mr. Geo. W. Mitchell, of the Miller School of Applied Science, of Virginia, now occupies the position of Instructor in Drawing. Mr. Mitchell subsequently to having taken a two year's graduate course at the University of Virginia, held the position of Instructor of Drawing under Prof. Palmer, now of the State University of Virginia. The position which Mr. Mitchell has filled since the 2d of October was filled up to that time by Mr. W. H. Insley, '00, whom the boys thoroughly appreciated. So early as this is written no judgment of Mr. Mitchell's success can be made, but he comes highly recommended and will doubtless prove a very competent instructor.

STUDENT ORGANIZATIONS.

SENIOR CLASS.

President, Jesse H. Loofbourow.
Vice-President, Curtis A. Mees.
Secretary-Treasurer, Robert York.
Athletic Directors, David Meriwether, Jr., Sidney J. Kidder.

JUNIOR CLASS.

President, Walter F. Huthsteiner.
Vice-President, Leslie L. Helmer.
Secretary-Treasurer, R. Roy Warfel.
Athletic Directors, Wm. Hadley, John T. Dickerson.

SOPHOMORE CLASS.

President, Edgar L. Flory.
Vice-President, Frank A. Kattman.
Secretary-Treasurer, Reginald P. Dryer.
Athletic Directors, R. P. Dryer, Fred Fishback.

FRESHMAN CLASS.

M. W. Blair, Representative.

STUDENT COUNCIL.

President, Jesse H. Loofbourow.
Vice-President, William H. Insley.
Treasurer, Harry S. Richardson.
Clerk, Harry A. Schwartz.
Secretary, Edgar L. Flory.
Councilors, Sidney J. Kidder, Jesse I Brewer, Walter F. Huthsteiner, R. K. Rochester.

ATHLETIC ASSOCIATION.

President, Sidney J. Kidder.
Treasurer, John T. Dickerson.
Secretary, Reginald P. Dryer.

CAMERA CLUB.

President, Harry A. Schwartz.
Vice-President, Harry G. Clay.
Secretary-Treasurer, Frank W. Pfleging.

Y. M. C. A.

President, William H. Insley.
Vice-President, A. L. Kittredge.
Secretary-Treasurer, C. J. Larson.

TELEGRAPH ASSOCIATION.

President, Harry S. Richardson.
Secretary-Treasurer, Robert K. Rochester.
Superintendent, Mr. W. Courtney Appleton.
Assistant Superintendent, Victor A. Hommel.

SCIENTIFIC SOCIETY.

President, Jesse I. Brewer.
Secretary-Treasurer, Hugh E. Perkins.
Senior-Councilman, William H. Insley.
Junior-Councilman, Robert N. Miller.

Following is a list of the new students at the Rose Polytechnic Institute:

FRESHMAN CLASS

Robert B. Arnold, Terre Haute.
Seth F. Arnold, Westminster, Vt.
Alfred N. Austin, Terre Haute.
Marion W. Blair, Terre Haute.
Wallace Bowie, Gallup, N. M.
George T. Boyce, Lenther, Mo.
Harry S. Braman, Terre Haute.
Otto L. Brettner, Mt. Vernon.
J. Sims Brosius, Terre Haute.
Eugene Burt, Leavenworth, Kas.
Howard N. Clugston, Ashland, O.
Clarence A. Cohn, Salt Lake City.
Irving J. Cox, Terre Haute.
N. Hadley Cox, Terre Haute.
Graham Davies, Louisville, Ky.
Merton L Dodge, Harbour Creek, Pa.
Leo F. Dorn, Louisville, Ky.
Phillip R. Eaglesfield, Grand Rapids, Mich.
James E. Fitzpatrick, Terre Haute.
Henry C. Gilbert, Terre Haute.

John A. Grimes, Portsmouth, O.
Raymond N. Harwood, Shelbyville, Ill.
Roy Hughes, Terre Haute.
J. Boudinot Hunley, Jr , Terre Haute.
Warren Ijams, Terre Haute.
Frank R. Ingle, Evansville
William D Ingle, Oakland City, Ind.
Brent C. Jacob, Louisville, Ky.
Brown Katzenbach, Terre Haute.
Henry S. Kellogg, Evansville.
Carl J. Kiefer, Cincinnati, O.
Edward C. Kirby, Muncie, Ind
Robert J. Koffend, Appleton, Wis.
Gustave Koopman, Cullman, Ala.
Albert A. Grieger, Louisville, Ky.
Sol Levi, Cincinnati, O.
George B. Lindenberger, Louisville, Ky.
Earl C. Metzer, Terre Haute.
Arthur D. Michel, Marion, Ind.
Howard E. Miller, Portsmouth, O.
Merwin B. Miller, Afton, Ia.
Richard A. Oglesby, Salt Lake City, Utah.
Harry W. Palmer, Brockport, N. Y.
William A. Peddle, Washington, D. C.
Harvey B. Petitt, Owensboro, Ky.
B. Albert Pine, Cincinnati, O.
Chester L. Post, Gordon, O.
Charles E. Price, Paola, Kas.
Fred N. Rumbley, Terre Haute.
Robert J. Schefferly, Detroit, Mich.
Harry Smith, Terre Haute.
Singleton Y. Sweeney, Owensboro, Ky.

GRADUATE STUDENTS.

O. Morton Diall, DePauw University.
Collingwood R. Duroe, Iowa State Agricultural College.
James R. Riggs, Central University of Kentucky.

SPECIAL STUDENTS RANKING JUNIORS.

Everett E King, Warren, Ind., Indiana State University.
Ira Marshall, Alma, Ill., Austin college

RETURNED AFTER WITHDRAWAL.

R. R. Warfel, Junior class.
Gilbert Crawford, Junior class.
R. P. Dryer, Sophomore.

THE Y. M. C. A.

The Rose Tech Y. M. C. A. have again shown how much they have the welfare of our boys at heart in an unselfish way by establishing a reading room on the third floor, where one may read such periodicals as are not found in the library. Amongst others there are on the table *Munsey's*, *McClure's*, *Cosmopolitan*, *Outing*, *The Literary Digest*, *Review of Reviews*, dailies, etc.

These rooms are open to all students, and those who have already enjoyed the luxury of fifteen minutes of fiction or history of the day in easy rocking chairs or lolling on a comfortable couch will not need to be urged to come again.

The Pipe Rush.

As has been the custom in previous years the Sophomores challenged the Freshmen to a game of base ball to be played Saturday, September 16. Underneath the challenge were written the words, "No pipes allowed."

The challenge was immediately accepted by the Freshmen, who also said they *would have pipes*.

Accordingly at 2:30, on Saturday afternoon, the game was called by Prof. McCormick. The day was very warm and was an ideal one for those having cameras. However, it was very uncomfortable for those who participated in the Rush; for most of them had donned football suits and sweaters. The game was devoid of interest for the spectators who had really come to see the rush and not the game. Some of the older students, however, watched the Freshmen players very intently, to discover any good base ball material for the team next spring. They were disappointed in this respect however, as but few of the men showed exceptional skill.

At the close of the fifth inning the Freshmen displayed corn cob pipes, which their Junior friends had bought for them at five cents per dozen.

The positions of the men on the respective teams were as follows:

'03		'02
Bowie	C	Nicholson
Braman	P	Hills
S Arnold	1B	Fishback
Oglesby	2B	Peker
Arnold	3B	Shaley
Pine	SS	Crebs
Fitzpatrick	CF	Brentano
Eaglesfield	RF	Hommel
Michel	LF	Dryer

Umpire, Prof. McCormick.

Score { Freshmen, 1. Sophomores, 7.

The Rush was carried on according to the rulings of last year's Council, namely, that it shall be refereed by a member of the Senior class, chosen by the Council, and consist of two parts, the first part being the struggle for possession of the small pipes; the second part, for the class ownership of the large pipe. Each part to be limited to fifteen minutes. This arrangement proved a great success, in that it brought the contest to an agreeable end, for when the referee, David Meriwether, blew his whistle all struggle ceased and both classes quietly left the field.

The Sophomores were outnumbered, but taken as a whole, they were much larger than the Freshmen, and before the Rush it was very doubtful as to who would be victorious. During

the struggle for the small pipes the Sophomores showed up very well and by the end of the fifteen minutes they had gained possession of a number of Freshman pipes.

The referee now had the two classes line up on opposite sides of the base ball diamond. The large pipe was then placed in the center of the diamond and at a pre-arranged signal both classes made a rush for the pipe. Arnold, '03, by means of his sprinting qualities, got the pipe and it remained in the possession of the Freshmen throughout the entire fifteen minutes. It was therefore awarded to the class of '03.

I. U. 17., R. P. I. 0.

The foot ball season of '99 opened as far as Rose is concerned, last Saturday at Bloomington, where she met Indiana University in one of the hardest fought games any team of Rose Polytechnic has experienced in years. The wonderful strength which I. U. developed last year precluded anything but a severe drubbing. The only hope Rose had was to make the game interesting for her opponents. The manner in which she did this won the admiration of every one that witnessed the game.

The overwhelming odds, against which she had to contend, make the score of 17 to 0, although an apparent I. U. victory, virtually a victory for the home team. When I. U.'s superior weight, training, and experience, are taken into consideration and the fact that her team consists of almost the same men that played last year, while Rose has many new men in her line up, Saturday's game portends a brilliant record for Rose on the gridiron this fall. The team should receive the undivided support of the student body which it so nobly represented.

I. U. won the toss-up and chose the south goal with a strong wind to her back. Hadley kicked off for Rose to I. U's 30 yd. line. By steady gains the ball was returned to the center of the field, where I. U. was forced to punt. The ball unfortunately did not stay in Rose's hands long. After securing the ball again it was an easy matter for I. U. to push up the field for a touch down. Hubbard failed at goal. Score, 5—0.

Hadley again kicked off, this time to I. U's 15 yard line. By good interference the ball was returned by I. U. to Rose's 45 yard line. Rose here rallied and secured the ball on downs, but was forced to give it up in a similar manner. Hubbard, realizing the strength of his team, then sent the pig-skin whirling through the air for 25 yards. On a fumble by Rose, I. U. secured the ball again on the former's 45 yard line. The ball was advanced by steady gains to Rose's 10 yard line. Here she was caught napping and allowed I. U. to work a revolving wedge for a touch down. Hubbard kicked goal. Score, 11—0.

Hadley kicked off for Rose to I. U's 10 yard line. By rapid gains I. U. returned the ball to the center of the field. Rose's light line was absolutely unable to withstand the fierce onslaughts of I. U's guard back plays, and she was gradually advancing the ball toward the goal for another touch down when time was called for the first half.

Notwithstanding the fact that several changes were made in the I. U. line up for the second half, Rose showed up much better and held her opponents down to one touch down.

Hubbard kicked off 35 yards for I. U. By a 10 yard run and a 25 yard punt the ball was returned to the center of the field, but lost to I. U. After securing the ball, I. U. rallied and worked back by steady gains for a touch down. Hubbard kicked goal. Score, 17—0.

Hadley kicked off to I. U's 35 yard line. She succeeded in returning the ball to her 40 yard line, but there lost it on downs. Rose now took a brace and succeeded in advancing the ball to within 25 yards of scoring, but lost it on a fumble. Hubbard was then given the ball for I. U. and succeeded in making 15 yards. By two more gains of five yards and a nice run of 20 yards, I. U. was able to place the ball on Rose's 25 yard line, but lost it on downs. It did not remain long in Rose's possession. By three runs

of 5 yards, the ball was carried by I. U. to Rose's 10 yard line. Here she lost it again on downs. Rose succeeded in returning the ball to her 15 yard line, but then was forced to give it up. I. U. from this point rapidly pushed up the field for the goal line, but was robbed of it by time being called when within five yards of scoring.

Score for the game, 17—0.

The line-up:

I. U.	POSITION.	ROSE POLY.
Hurley	Center	Appleton
Pike	Right guard	Peker
Johnson	Left guard	Hadley
Ray	Right tackle	Bowie
Niezer	Left tackle	Talmadge
Aydelotte	Right end	Dickerson
Honger	Left end	Arnold
Foster	Quarter back	Lindenberger
Hawley	Right half	Huthsteiner
McGovney	Left half	Kidder
Hubbard	Full back	Meriwether

A SCRUB GAME.

The team made its first appearance on the gridiron against a team from the city, September 30. The team from the city was called the "High School Team," but it consisted principally of men who once attended the school, but do not at present. Five minutes after the kick off there was no doubt as to what the final result of the game would be. Although the Rose team did a great deal of fumbling, which was their greatest weakness, they outplayed the other team at every point. The game was rather slow and was without any special feature, unless it was bad fumbling done by Rose, which was the only way in which they lost the ball. Had it not been for this the score would undoubtedly have been much larger.

Meriwether won the toss and chose the south goal. The High School kicked off to Talmadge, who fumbled. The High School team got the ball, but were held for downs. Rose then carried the ball down the field by a succession of end runs and line plays, until Kidder was sent through the line for a touch-down. Hadley failed to kick goal, making the score 5 to 0. The ball was then kicked off to Meriwether, who advanced ten yards before being downed. After a few plays near the center of the field time was called.

In the second half Hadley kicked off to Whitlock, who was downed without a gain. The ball was in the High School's territory during the entire half, and it was fumbling alone which kept Rose from making another touch-down.

THE ELEVEN.

The team will be composed mostly of new men who have had little, if any, experience in the game. Meriwether, who is captain of the team, will play in his old position of full back. Appleton, Peker, Talmadge and Huthsteiner will very likely play their old positions at center, guard, tackle and half back respectively. Kidder has been doing good work at half back and will very likely play that position. Our line will be very light, but we hope to make up in speed what we lack in weight. The new men working for the line, who are receiving most attention at present are Hadley, Bowie, King, Pfleging and Uhl. Dickerson and Arnold at the ends have been showing up very well. Lindenberger and Jumper are trying for quarter back. Both of these men have had some experience. There are a number of others who have been doing excellent work and if they do not make the team this year will undoubtedly do so next year. The second team deserves great praise for coming out to practice regularly. The success of the first team will depend very much on the second team, for in practicing together the weak points of the team are brought out. The manager is trying to arrange a schedule of games for the second team.

The games scheduled for the first team to date are:

Oct. 7—Indiana University, at Bloomington.
Oct. 21—De Pauw University, at Terre Haute.
Nov. 4—Earlham University, at Terre Haute
Nov. 18—De Pauw University, at Greencastle.
Nov. 30—Earlham University, at Richmond.

The second eleven has five games scheduled, as follows: Two with Butler, two with Brazil High School and one with Vincennes High School.

DIFFERENTIALS

The entire lot of belting in the shops will be renewed this year.

King, in Senior Mechanics, tries to tell Dr. Gray that a vertical goes up.

Hills, '02, "Prof. Hathaway, I don't see how you get that 13.8675." General laugh.

Paige, '02, translating German in class, "And the angel winked at him with her hand."

Work on the Modulus, to be gotten out next spring by the Junior class, is coming on nicely.

We are glad to see that the tennis courts are again being used. Why not have class tournaments in the spring?

Welcome to you all who have cast your lot with us, and may your stay be profitable, not only to yourselves, but to us all.

Prof. "If I subtract 'p' from this equation what will I have left?"
A real bright Soph. "The remainder."

Koffend, '03, is reported to have spent considerable time in drawing off what he thought was condensed steam from a hot-water radiator.

Before the pipe rush the frightened Freshmen were, as usual, asking such timid questions as "Is that great big fellow that passes here so very strong?"

In a burst of class feeling the Seniors have adopted a class cap, to be of the regular golf pattern, dark blue, with '00 stitched on in a lighter shade.

Freshman, looking over the '98 Modulus, came across the following, "Thomas Gray, Ph. D. Director." "Why, I did not know that Gray was physical director."

The new hand-book published by the Y. M. C. A. for the use of the students is far superior to the one of last year, and we are sure very much appreciated by all

The Athletic Association has just made an acquisition of new suits, nose guards, shin guards, etc., for the football season, Dirty them up in making good plays for Rose, boys.

In a discussion between two Juniors as to which was the larger, Prof. Hathaway suggested that the average cross-section ought to be considered along with height and weight.

The Freshman class comes from rather more widely distributed states than usual. There was even a suspicion that some of them might get homesick on seeing the Wild West show and enlist as cowboys.

The center of student population seems every year to move north a little. The change this year is marked. A few, however, have done their best to change the tide in the opposite direction.

Work will be begun this year on the first of a series of metal working lathes, to replace some of those now in the shop. It has been found that the lathes constructed by our own shops are more convenient for the uses to which we must put them.

The Freshmen have been forbidden to join any fraternities until after the first term. This measure protects the fraternities in that it will lessen the chances of any mistakes, and though they can pledge members it will give them an opportunity to become better acquainted with them before permitting them to ride the goat.

Mr. McCormick is still assisting Professor Howe in the Civil Department. Under his supervision the Sophomores are making a topographical survey of the east gravel pits of the Vandalia railroad.

Senior President Loofbourow, in an announcement before the student body—"The Y. M. C. A. of Rose will tonight receive for the Freshmen, light refreshments will be served. The purpose of the refreshments—" Deafening applause.

The next paper, to be read before the Scientific Society on the 14th of October, will be a review of the work on the Chicago Drainage Canal, an enterprise which, completed, solves a difficult sanitary problem after a manner unprecedented as to the magnitude of operations.

The Institute has been improved in several ways since last June, but the greatest and most noticeable of all is Prof. Hathaway's "New Lu Mi Num." The "Ice Wagon" is saved for rainy days and after about ten years more of use it will be put on exhibition in the Museum as a relic of by-gone days.

A comparatively large class has been enrolled for '03, there being 52 in the class. There have also been entered on our lists the names of two students taking special post-graduate work, two taking the regular Junior course as post-graduate work, three taking regular Junior, and one taking regular Sophomore work. This places the number of students at 121.

The Camera Club has in course of construction a dark room in the basement of the Institute, which will be fitted out with a lantern with doors at the sides for printing velox paper, print washers, negative washers, and a good sink, besides lockers for members in which to keep their trays and chemicals. The key to this dark room will be given to any student on request by any official of the club. Every one owning a camera of any description is urged to join the club.

That fever of rush peculiar to the climate of Chicago has been caught by Prof. Hathaway and while there this summer he actually purchased himself a new wheel, and a beauty it is. However, a word of warning! It has been whispered that north end policemen are looking for a scorcher. Pray be careful, Professor, for we can not spare you for even long enough to explain to the Judge that that bicycle runs all by itself and you are kept busy back-pedaling.

Madison—Looking through a telescope in the the physical laboratory—

"Now, Prof., does that thing hang down or up?"

The reception of the Rose Tech Y. M. C. A. to the Freshmen was enjoyed thoroughly by all those present and the object in view—to present an opportunity to the newcomers to become acquainted with the veteran students—was certainly gained. The affair being quite informal, and the students and in fact every one wearing visiting cards conspicuously hung to the view of all interested, made formal introductions quite unnecessary, and very daintily served cakes and ices, paradoxical as it may seem, thawed out our strangers wonderfully.

The Poly Telegraph Association is in a flourishing condition, its membership already being eighteen. Their batteries have been removed to the Institute, where a room has been provided for setting them up. They have sixty batteries newly charged. The work of rewiring the line has been begun and new wire will be used and a new route taken in many places, thus cutting out several dead loops. Thus they are in a position to connect with any one living within limits of their line, and there will be many to whom it will be a profitable as well as an enjoyable experience. Any one desiring instruments will please notify the Superintendent, Mr. W. C. Appleton, from whom copies of the "Student's Manual for Telegraphers" may also be obtained free of charge upon application.

At a recent meeting of the student body football was the topic of interest, and after some deliberation a call for volunteers for the organization of a second eleven was made, and though there might have been more men who could give

up their time and lend their muscle and brain to such a good cause, it is thought that a very fair team could be obtained. It is true that it is not easy for one to rush through his noonday meal and then take such heavy exercise only to go to the class room heated up and tired However, remember that the interests of the whole school are necessarily centered in the individual exertions of a few who are by nature better fitted to endure such exertions and let the thought of the honor of representation overbalance all the somewhat selfish considerations for personal comfort. It is true that the men, more especially of '03, average as comparatively of light weight, however, although weight is very desirable, agility and sound headwork count for more, and this many can acquire or develop through conscientious training. Now—to use an expression familiar to all who rather unwillingly joined into a game of hide and seek or hare and hounds—"Don't be coaxed," but come out and play, for you certainly will derive a personal benefit, for exercise is most essential for the health of those who by their studies are necessarily confined to their rooms for the greater part of the day, and remember the verse of Jurenal, "Irandum est utisit meus sana in corparl sano."

We are glad to welcome back to our fold Mr. Warfel, formerly '00, who dropped one year to go West for his health, and now continues as a member of the class of '01, and Mr. Dryer, first of '01 and now taking work with '02.

One of the Freshmen, after the usual exhortation of Dr. Mees, worded something after this fashion, "We are here to work, to work good and hard, and if you are not ready to do this, you may as well stop right here," was honest enough to admit that he had come to satisfy his pleasure-loving nature, rather than subdue it, and since he was convinced that he could not do this at Rose, he would search for a place better suited to his purposes.

Insley, "This space is three-quarters of an inch in width, and it is to be divided into twelve spaces."

Sophomore, "That would make each space one-sixteenth of an inch in width, would it not?"

Insley, "No, I want it divided into twelve spaces."

"Prof. McCormick, how many moons do you see up there?" asked Talmadge, at civil camp, one evening.

"I see one moon," was the answer and he looked at Talmadge as though something might be the matter.

"I don't, I only see a half moon," and Mr. McCormick walked silently away.

Uhl, '02, "Prof. Hathaway, when do you stop dividing?"

Prof. "Why! When you get through."

Scene—Hathaway's room.

"Clink. Clink."

A scuffling of feet is heard like a drove of cattle going over a bridge. Above the noise the calm voice, with accents pure and sweet of Prof. Hathaway is heard.

"That is an example of a scramble after the almighty dollar "

The "almighty dollar" happened to be a beer check.

From the Engineering Press.

* * * The education received at any institution can only be regarded as a preparation for the practical side which must come later, and should be regarded as only a preparation in any case. Practice is continually changing, but fundamental principles can never change, and that education best fits a man for success in life which grounds him thoroughly in those principles which are at the bottom of all applied science and art, while at the same time it impresses upon him that what he is learning is only a foundation upon which he must erect the superstructure himself. Too often the successful cramming which has enabled a student to pass an examination with flying colors has really unfitted him altogether for subsequent success in life, not only because it has failed to teach him the things which he must know in order to attain success, but because it frequently leads him to believe that the mere passing of an examination in itself constitutes success. Examinations are all very well in their way, but the student himself should be his own strictest examiner, and his examination paper should not be that set before him by his teachers, but that which his own ambitions for the future may set before him.—*Engineering*.

A London magazine says: The craze for automobile riding is on the increase in this country. Manufacturers either here or in France cannot turn them out fast enough, and leading English firms are overwhelmed with orders. ''Motoring'' will be as great a craze next season in England as it is in France now. Most of the cycle makers of Coventry and Birmingham are experimenting with motors. Petroleum as the motive power is used in every case, electricity being rejected owing to the necessity for charging stations.

The acetylene gas plant of the Logansport and Wabash Valley Gas Co., at Wabash, Ind., exploded August 7, with destructive effect. This is the first plant installed in this country on so large a scale, and has been in use about a year in lighting the city. The accident, which does not appear to have been satisfactorily explained, will cause a renewal of distrust of this gas.—*American Engineer and Railroad Journal*.

German engineers are pursuing improvement in steam engine efficiency by the use of superheated steam, and one direction which their progress is taking is the use of poppet valves, to avoid the earlier difficulties of cutting and tearing valves, valve stems and seats. There is so much to be gained by superheating steam that it is well worth while experimenting, even at considerable expense, in order to overcome the difficulties.—*American Engineer and Railroad Journal*.

Within a few days two additional turbines will be in operation in the power house of the Niagara Falls Hydraulic Power and Manufacturing Co. Each of these wheels has a capacity of 2500 h. p., and each will be direct connected to two generators. It will be recalled that the wheels in the station of the Niagara Falls Hydraulic Power and Manufacturing Co. are operated under a head of over 200 ft.—*Electrical World and Engineer*.

The Century Number of the Modulus.

The Modulus.

THE Junior Class of the Rose Polytechnic Institute announce that on May 1st, 1900, the fourth MODULUS will appear. "The Modulus 1901" will be a special edition, commemorating the year of its publication, 1900.

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