Spring 5-1911

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Rose Technic Staff
Rose-Hulman Institute of Technology

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THE TECHNIC

TERMS

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AT a recent meeting of the Technic Staff held on May 3rd, the staff for the ensuing year 1911-12, was duly elected. The following men comprise the new board:

Carl J. Krieger, '12, Editor-in-Chief.
Richard D. Madison, '13, Asst. Editor.
William W. Reddie, '12, Reviews.
William R. Bell, '12, Alumni.
Richard Fishback, '12, Athletics.
Joseph A. Hepp, '12, Senior Locals.
Smith N. Crowe, '13, Junior Locals.
Walker Henry, '14, Sophomore Locals.
Wallace L. Lewis, '14, Artist.
Ferdinand E. Meyer, '12, Business Manager.
Camille C. Baines, '13, Asst. Bus. Manager.

The newly elected staff will assume its responsibilities with the publication of the June issue.

We feel the highest degree of confidence concerning the abilities and enthusiasm of the individual men comprising the new staff, and hence, unreservedly predict a large measure of success for the 1911-12 Technic. Gentlemen, our very best wishes will follow you in your endeavors.

In concluding our brief term of service we wish to extend our sincere thanks to the members of the Rose Faculty, to the Alumni and Student body, and especially to the Associate Editors and members of the Executive Department of the present staff for their enthusiastic and efficient support, without which we would unquestionably have succumbed to the deadening effects of editorial trouble-itis.

———ooo———

WE have before us a copy of the DePauw Daily, the *Official Student Publication* of DePauw University, edited by one Mark P. Haines. This particular issue of aforesaid paper contains an editorial with the enlightening caption: "Where do we get off?"

For the benefit of our readers we will say that the essence of this literary gem is: *Let us (DePauw) sever all athletic relations with Rose Poly!* And why? We present some verbatim extracts which will throw some light on the situation:—"What have we ever gained by playing Rose Poly? True the game is a cheap one——." "Again let us ask—what have we gained by playing Rose Poly, other than furnishing a cheap and mediocre attraction. It is doubtless true that much of the unsavory reputation which Rose Poly enjoys——." "Now DePauw does not need Rose on her schedule. Indeed, Rose has been lucky to stay on as long as she has, but the time has come to let her drop for a time until she has had an opportunity to eliminate some of her 'rough neck' and provincial athletic methods."

Whether Mr. Haines wrote this insulting article himself matters little; as editor-in-chief of the publication, he becomes personally responsible for the entire contents of each issue.

It is entirely unnecessary for us to comment on this puerile outburst of a 'lime-light seeking' young hopeful. We have letters before us signed by Mr. Eldie Troxell, DePauw's football manager, wherein is stated that "no one connected with athletics at DePauw approves of the contents of that editorial," and—"I trust the Poly student body will not take the editorial as an expression of the way DePauw students in general feel about our relations. I am, for my part, sorry that we *could not arrange* a game."

The only thing which strikes us as demanding an explanation is this: Why is it that articles of such a character as the one referred to can and do appear in an *Official Student Publication.* In justice to individuals or other schools which may thereby be slandered, how can the authorities at DePauw refuse to take cognizance of such palpably false and misleading statements and neglect to make an *official* denial or compel the offending editor to eat humble pie and publicly say—peccavi! Have the DePauw authorities lost the power of control over their *Official Student Publication,* or is it merely a matter of convenience to overlook a breach of etiquette and decency when perpetrated by the student editor at the expense of a neighboring institution? We ask you—is it fair?

THE regular meeting of the Student Council was held May 1, 1911. Meeting opened at 7:45 by President Garst. On Roll Call C. E. Hoffner was absent; Walter Voss and O. P. Heppner were late. Minutes of previous meeting read and approved.

W. R. Bell gave the following report:

Balance in Bank on May 1st, 1911: ..			$1049.85
Amt. Credited to Organizations on May 1, 1911:			
Y. M. C. A.	$120.25		
Camera Club	24.80		
Gen. Fund	608.13		
Technic	46.80		
Ath. Ass'n.	203.54		
Scientific So.	16.65	$1020.17	
Overdrawn Accounts:			
Symphony Club ...	$ 68.02	$ 68.02	
		$ 952.15	
Am't. Disbursed by Organizations since Apr. 4th, 1911:			
Y. M. C. A.	$ 7.70		
Camera Club	1.00		
Symphony Club ...	39.00		
Technic	50.00		
		$ 97.70	
Bal. in Bank on May 1, 1911: ...		$ 952.15	$1049.85

W. R. BELL, Treasurer.

Moved by O. B. Heppner that report be accepted, seconded by D. J. Johnson; carried.

President Garst reported concerning petition for bona-fide unexcused absences, telling of his conversation with Dr. Mees. It was shown that the matter was much more complicated than was thought at first, and it was decided that no definite action could be taken until after further investigation.

Moved by E. A. Mees that report of challenge rush committee be taken from table and discussed, seconded by Kauffman; carried. After considerable discussion, D. J. Johnson, upon the suggestions of other members of the Council, made the following motion:

Time of Rush—8 o'clock P. M., to take place under torch light.

Place—In an inclosure of the foot-ball field;

size of enclosure to be forty (40) yards square, duly fenced off.

The rush to be controlled by upper classmen.

The challenge or banner shall be mounted upon a telephone pole not exceeding twenty-five (25) feet in height.

The rush shall be duly advertised in the papers, an admission of about fifteen (15) cents be charged, and proceeds go to the Students Fund.

The expenses, such as telephone pole, lights, etc., shall come out of gate receipts. Presidents of Sophomore and Junior classes of the previous year are empowered to manage as to expenses of this rush.

This motion was seconded by E. A. Mees; carried.

President Garst then reported as to the proposed revision of the Constitution. It was decided that the report be tabled until a printed form be handed to each counsellor.

Heppner reported that the Symphony Club concert would be held on Wednesday night, May 3.

Walter Voss then presented the case of the Symphony Club as to the work that was expected of it, and it's financial situation. Gillum moved that a certain amount be appropriated from the General Fund to cover the deficit of the Symphony Club, seconded by Kauffman; carried.

Moved by D. J. Johnson, seconded by W. R. Bell, that the bill of one hundred ($100.00) dollars for base ball suits be paid; carried.

Moved by Beauchamp that a committee be appointed to confer with Faculty as to a date for an informal meeting, seconded by Gillum; carried. Kauffman, Bell and Beauchamp were appointed.

Moved by Heppner that the Symphony Club be allowed to continue their regular rehearsals and that Council assume the financial responsibility, seconded by Gillum; carried.

Moved by O. B. Heppner that meeting be adjourned until Thursday at 4 o'clock P. M., seconded by Bell; carried.

Adjourned meeting opened Thursday at 4 o'clock P. M. by President Garst.

A Constitution and By-Laws were provisionally adopted by the Council. These will be handed, in printed pamphlet form, to each student in the Institution.

An auditing committee, to audit treasurer's books, was appointed. The committee is Kauffman, Garst and Beauchamp.

Motion to adjourn by Johnson, seconded by H. M. Kauffman; carried.

Meeting adjourned at 5:15 P. M.

J. M. Beauchamp, Secy.

HARMONICS IN ELECTRICAL ENGINEERING

By PROF. CLARENCE C. KNIPMEYER, B. S.

THE beginner in the study of Mechanics needs hardly to be reminded that bodies without weight and motion without resistance are impossible, for no fact in everyday life is more conspicuously true. Neglecting weight and friction, he may study the laws of Mechanics and apply them to certain conditions obtain desired results and then predict with more or less exactness what the effects of weight and friction will be. In this he is aided by his everyday experiences since childhood.

The beginner in the study of Electrical Engineering first considers all alternating currents and electromotive forces as being pure sine waves. Indeed he may never be told that they are likely to be otherwise. He cannot hear, see, feel, taste or smell them. Neither will childhood experiences help him out. He can, and usually does, master the laws of sine waves and learn to apply them in studying the action of electrical apparatus. But he should not stop at this stage, for true simple sine waves seldom exist, and he should therefore know what to expect of a complex wave.

An electromotive force wave may approximate the sine shape very closely yet ripples will be found in it which, under conditions not unlikely to occur, will be magnified in the resultant current wave so that it has no resemblance to sine shape. An alternating current generator may have its armature coils so distributed and its field poles so shaped that the e.m.f. wave is sinusoidal at no load, but it cannot then give a sine wave under load. A transformer may have a sinusoidal e.m.f. impressed upon it, but then it will not take a sinusoidal current. Usually there is much more inductance than capacity in a circuit, yet the capacity, acted upon by the faint ripples in the e.m.f. wave, will cause much larger ripples in the current wave, and resonance between the inductance and capacity in series may occur with the ripples of higher frequency. Sine waves are often treated vectorially. Non-sinusoidal waves do not lend themselves to such treatment, and the many attempts to use them so result in unexplained discrepancies and paradoxes.

Alternators may have windings and air gap flux so distributed as to approximate sine form in the e.m.f. wave at no load. But even then there will be ripples because of pulsing of flux with change of magnetic reluctance due to change of tooth and slot positions under a pole. With 2n slots per pole the ripples will have frequencies 2n-1 and 2n+1 times the fundamental frequency. When load is put upon the machine the local magnetic reaction produced by the alternating currents in the armature cause pulsations in the field magnetism which cause ripples of frequencies 2m-1 and 2m+ 1 times the fundamental, m being the number of phases. Finally the armature reactance, varying with double the fundamental frequency because the reactance for an armature coil is a minimum when under a pole and a maximum when between poles, will cause the reactance drop in the armature to vary and, with it, the terminal e.m.f. This can produce only a triple frequency ripple, but this may be, and usually is, a large one.

Wave distortion in synchronous motors and synchronous converters may be produced much as in alternators, and will further complicate the generator wave. Inductive apparatus, such as transformers and induction motors take currents which, particularly at light loads and at no load, are badly distorted because of the varying permeability of the iron with the varying flux. The triple frequency ripple or harmonic in the exciting current of a transformer may have a maximum value more than half as large as that of the fundamental.

Every periodic single valued function is, by Fourier's theorem, composed of a constant term and a sum of sine and cosine functions and may be expressed as

$$y = A_0 + A_1 \sin\theta + A_2 \sin 2\theta + A_3 \sin 3\theta + \ldots\ldots$$
$$+ B_1 \cos\theta + B_2 \cos 2\theta + B_3 \cos 3\theta + \ldots\ldots$$

Each pair of sine and cosine terms ocnstitutes a ripple or harmonic.

By choosing as X axis a line making the areas on the two sides equal, the constant term will drop out. Also, by drawing roughly a few component sine waves and their resultants, it can readily be seen that for the two half-waves to be symmetrical with reference to the starting point, no even harmonic can be present. This is shown in Fig. 1, where the fundamental and

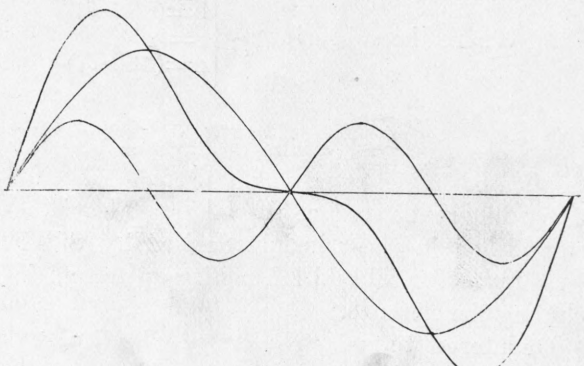


Fig. 1.

second harmonic combine to form a wave the two halves of which are not symmetrical with reference to their starting points, the first half being much steeper at starting than the second half. Fig. 2 shows a fundamental and an odd harmonic, the third. Here the two half waves are perfectly symmetrical. The two components are shown starting in phase but, if they did not start in phase, the symmetry with re-

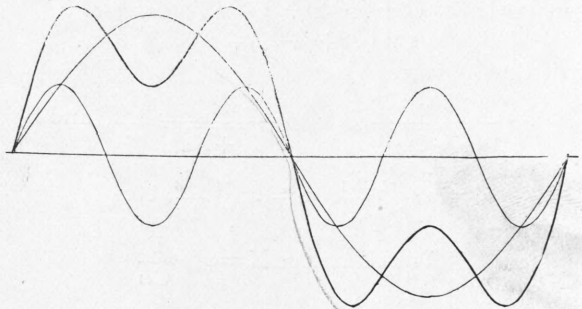


Fig. 2.

spect to the starting point of the two halves of the resultant wave would still be had.

A symmetrical complex wave may then be expressed as

$$y = A_1 \sin\theta + A_3 \sin 3\theta + A_5 \sin 5\theta + \ldots\ldots$$
$$+ B_1 \cos\theta + B_3 \cos 3\theta + B_5 \cos 5\theta + \ldots\ldots$$

A more workable form and the one generally used because it expresses maximum values and phase relations directly is

$$y = R_1 \sin(\theta + \Phi_1) + R_3 \sin(3\theta + \Phi_3) + R_5 \sin(5\theta + \Phi_5) + \ldots$$

where $R_1 = \sqrt{A_1^2 + B_1^2}$, $R_3 = \sqrt{A_3^2 + B_3^2}$ etc., and

$$\tan\Phi_1 = \frac{B_1}{A_1}, \quad \tan\Phi_3 = \frac{B_3}{A_3}, \text{etc.}$$

Clearly R_1 is the maximum value of the fundamental, ϕ_1 is its phase relation with the complex wave, R_3 is the maximum value of the third harmonic and ϕ_3 its phase relation with the complex wave, etc.

Alternator windings are always symmetrical and so also are the field poles, and hence must generate symmetrical waves without even harmonics.

With either winding or field unsymmetrical, even harmonics cannot be produced. With both unsymmetrical the even harmonics are barely possible. It seems safe to say that only in telephonic circuits and in short circuit surges or other transient conditions are even harmonics present.

If an electromotive force

$$e = E_1 \sin(\theta+\phi_1) + E_3 \sin(3\theta+\phi_3) + E_5 \sin(\theta+\phi_5) + \ \ldots..$$

is impressed upon a closed circuit a current

$$i = I_1 \sin(\theta+\phi_1-\alpha_1) + I_3 \sin(3\theta+\phi_3-\alpha_3) + I_5 \sin(5\theta+\phi_5-\alpha_5) + \ldots\ldots$$

will flow. Here

$$I_1 = \frac{E_1}{\sqrt{R^2+X_1^2}}, \quad I_3 = \frac{E_3}{\sqrt{R^2+X_3^2}} \text{ etc., and}$$

$$\alpha_1 = \tan^{-1}\frac{X_1}{R}, \quad \alpha_3 = \tan^{-1}\frac{X_3}{R}, \text{ etc.}$$

The reactance $X = \omega L - \frac{I}{C\omega}$

is, of course, different for each harmonic, because the angular velocity, ω, is different, being three times as great for the third harmonic as for the fundamental, five times as great for the fifth, etc.

The effective or root-mean-square value of any periodic e.m.f. is

$$E_0 = \sqrt{\frac{1}{\pi}\int_0^\pi e^2 d\theta}$$

Hence the effective value of the complex e.m.f. is

$$E_0 = \sqrt{\frac{E_1^2+E_3^2+E_5^2+\ldots.}{2}}$$

and of the complex current

$$I_0 = \sqrt{\frac{I_1^2+I_3^2+I_5^2+\ldots\ldots}{2}}$$

The general expression for average power is

$$P = \frac{1}{\pi}\int_0^\pi e\, i\, d\theta$$

where e and i are instantaneous values of e.m.f. and current. This gives for the complex waves

$$P = E_0 I_0 \cos\alpha_0 = \frac{E_1 I_1}{2}\cos\alpha_1 + \frac{E_3 I_3}{2}\cos\alpha_3 + \frac{E_5 I_5}{2}\cos\alpha_5 + \ldots.$$

The equivalent sine waves which would have the same effective values and give the same power are

$$e = \sqrt{2}\, E_0 \sin\theta \text{ and } i = \sqrt{2}\, I_0 \sin(\theta-\alpha_0),$$

the maximum value of a sine wave being $\sqrt{2}$ times the effective value.

To obtain the true shape of a wave, instantaneous values must be recorded. This may be accomplished by an oscillograph or by an instantaneous contact device capable of adjustments to give values at various points on the wave. A contact-maker having a point fixed to alternator shaft to revolve synchronously with it, and a brush adjustable to any angle for making the contact is easily made.

Having determined the wave form, to find the values of, say, the first three odd harmonics we must find the six unknowns A_1, A_3, A_5, B_1, B_3 and B_5 and measure six ordinates each of the form

$$y_a = A_1 \sin\theta + A_3 \sin 3\theta + A_5 \sin 5\theta + B_1 \cos\theta + B_3 \cos 5\theta + B_5 \cos 5\theta$$

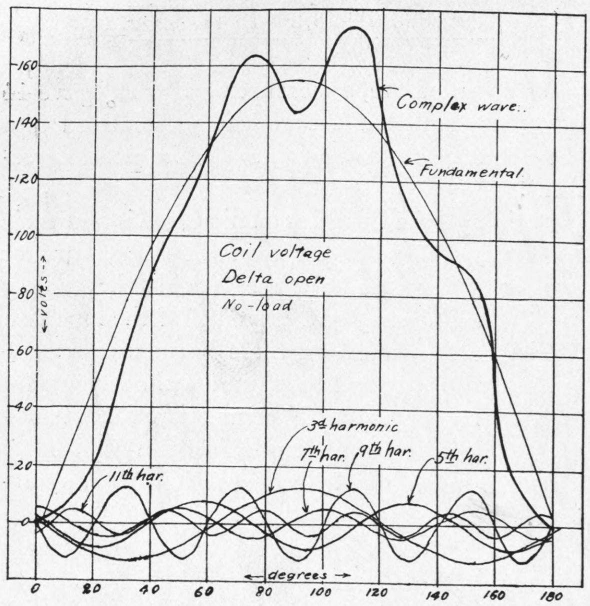
The solution of the six simultaneous equations is simplified by reason of the fact that $\sin\theta = \sin(180°-\theta)$ and that $\cos\theta = -\cos(180°-\theta)$. If we add ordinate y_b to ordinate y_a all the cosine terms must drop out and all the sine terms be doubled. Substracting them, the sine terms drop out and the cosine terms are doubled. Thus we have

$$S_1 = y_c + y_d = 2(A_1 \sin\theta_1 + A_3 \sin 3\theta_1 + A_5 \sin 5\theta) \text{ and}$$
$$d_1 = y_c - y_d = 2(B_1 \cos\theta_1 + B_3 \cos 3\theta_1 + B_5 \cos 5\theta)$$

Where the subscript $\begin{cases} a=\theta \\ b=(180-\theta) \\ c=\theta_1 \\ d=(180-\theta_1) \end{cases}$

Since sine and cosine values are so often duplicated in the equations, systematic elimination will greatly reduce the labor. This is accomplished in the schedule devised by S. P. Thompson for all odd harmonics up to and including the eleventh.

Of interest to many readers of The Rose Technic will be the true character of the waves furnished by the 12-pole forked-field Stilz alternator of the electrical laboratory. This machine has 72 armature slots, hence has 6 slots per pole giving rise to the 11th harmonic and possibly a 13th. As a 3-phase machine it has but 2 slots per pole per phase—a not very thorough distribution of the windings. Fig. 3 shows the no-load e.m.f. wave, with its com-

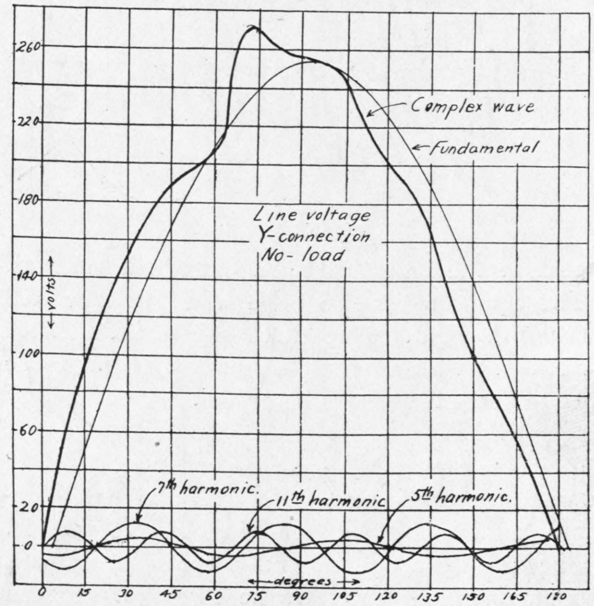


$$e = 154.2\sin(\theta - 2°11') + 12.2\sin(3\theta + 71°32') + 8.2\sin(5\theta + 159°54') + 5.2\sin(7\theta + 97°32') + 12.2\sin(9\theta + 172°42') + 4.3\sin(11\theta - 67°2').$$

Fig. 3

ponent harmonics, of one of the three coils when disconnected from the others. The harmonics are produced largely because neither winding nor flux is well distributed. The air gap is short and uniform and the edges of the poles are sharp, making the entrance of a coil into flux very abrupt. The 11th harmonic is due to the reluctance varying with a frequency 2n-1 = 11 since there are 6 slots per pole. The 13th may exist, and if it does, then, being ignored in the analysis, it has influenced slightly the values obtained for the others. Under load the 5th and 7th harmonics might well be expected to increase because of armature reaction which exists only when the machine is loaded. Using a single coil per pole, that is, with a concentrated winding, the 5th harmonic increased from about 5 per cent. to 20 per cent. of the fundamental, all because of the bunching of the winding, while the 11th, not being dependent upon the winding distribution, suffered no change.

With load, the 3d and 9th harmonics would become greater because of the reactance drop. The armature reactance would vary less if the pole arc were greater, and so the 3d and 9th harmonics would be smaller. This method of reducing these harmonics need not be applied, for in the *Y* connection of the armature coils they must drop out. Fig. 4 gives the wave form



$$e = 253\sin(\theta - 4°15') + 2.7\sin(3\theta + 237°) + 4.9\sin(5\theta - 73°12') + 13.0\sin(7\theta + 229°) + 0.9\sin(9\theta + 154°) + 8.1\sin(11\theta - 15°42').$$

Fig. 4.

for the line e.m.f. at no-load when the coils are *Y* connected. It will be noted that the 3d and 9th harmonics appear negligibly small. In fact they do not exist, but appear to only because of inaccuracy in the wave measurements and because higher harmonics than the 11th are ignored.

Fig. 5 shows that, the three fundamentals being 120° apart in the 3-phase alternator, the three harmonics will be 3 times 120° apart, that is, they will be in phase. Hence in the Y connection all simultaneously try to send current out from the middle of the *Y* or into it. This not being possible if the neutral of the *Y* is isolated or disconnected, they exactly neutralize each other. The same is true of all odd multiples of 3.

In the delta connection the 3rd harmonic e.m.f.s, being in phase, cause a triple frequency current to circulate in the delta and do not appear in the line. Likewise the 9th harmonics. The equation for the wave with delta closed bears this out. The three coil e.m.f.'s were measured with a voltmeter and all found to be 110 volts effective. The coils being accurately spaced, the three voltages should add up to zero, for three vectors of equal magnitude and 120° apart add up to zero. But the waves are complex, and cannot be treated as simple vectors. The delta was opened and a voltmeter showed the unbalanced e.m.f. to be 44 volts. Closed again through an ammeter the current was found to be 12.2 amperes, a value so large as to seriously reduce the capacity and efficiency of the machine.

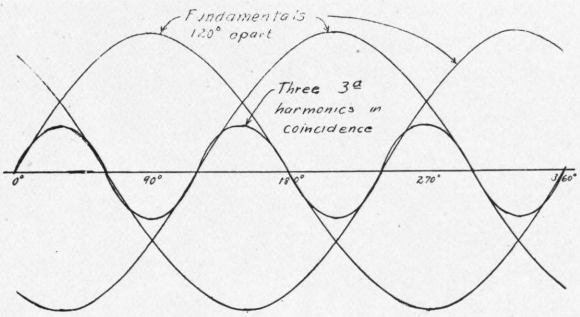


Fig. 5

In the delta the three 3d harmonics are exactly in phase. Also the three 9th harmonics. The 5ths are 24°, the 7ths are 17° and the 11ths are 11° apart. Since these harmonics are pure sine waves they may be added vectorially. Then, calculating from the single coil expression for e.m.f., the maximum values of the component harmonic e.m.f.'s tending to produce current in the delta are

$$E_3 = 12.2 \times 3 = 36.6$$
$$E_9 = 12.2 \times 3 = 36.6$$
$$E_5 = 8.2 + 2 \times 8.2 \cos 24° = 23.2$$
$$E_7 = 5.2 + 2 \times 5.2 \cos 17° = 15.1$$
$$E_{11} = 4.2 + 2 \times 4.2 \cos 11° = 12.4$$

Combining these to give the total effective e.m.f. tending to produce current in the delta we get

$$E_o = \sqrt{\frac{36.6^2 + 36.6^2 + 23.2^2 + 15.1^2 + 12.4^2}{2}} = 42 \text{ volts}$$

As noted before, a measurement of E_o gave 44 volts, so that the theoretically calculated and the actually observed values are in close agreement.

Although the third harmonic e.m.f.'s and their multiples, being consumed in the delta, do not appear in the line to cause trouble there, they lower the efficiency and capacity of the machine. With the *Y* connection these harmonics are effectually suppressed also, and without harmful currents. Hence the *Y* connection for generators is much to be preferred, in fact, good practice does not allow delta connection in an armature.

With *Y* connected generator, transformers connected *Y* or delta may be used. If transformer primaries are *Y* and secondaries are delta connected, and both generator and transformer neutrals are grounded, as shown in Fig 6, the

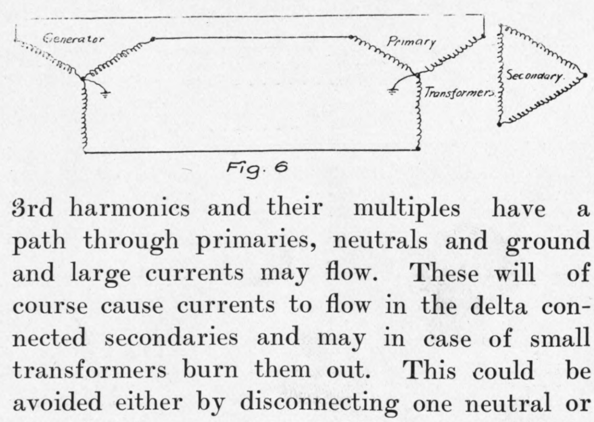


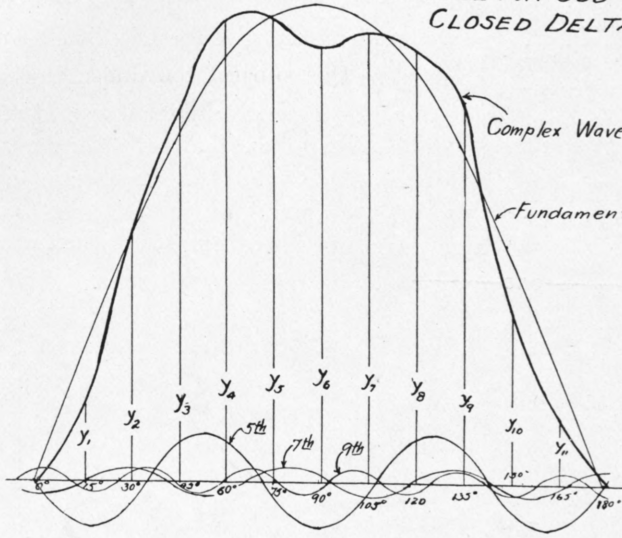
Fig. 6

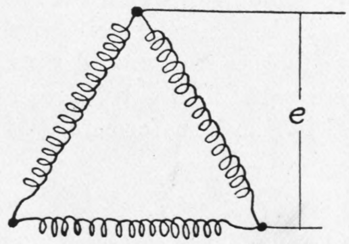
3rd harmonics and their multiples have a path through primaries, neutrals and ground and large currents may flow. These will of course cause currents to flow in the delta connected secondaries and may in case of small transformers burn them out. This could be avoided either by disconnecting one neutral or changing the secondary to a *Y* connection. The latter would prove effective because no triple frequency current could flow in the *Y* secondary without a neutral and a harmonic that does not exist in the secondary cannot exist in the primary, excepting, of course, the exciting current. If the *Y* secondary were used with a neutral, the 3d harmonic currents would exist in

E.M.F. CURVE OF STILZ ALTERNATOR.

ANALYSIS BY S.P. THOMPSON'S SCHEDULE FOR ODD HARMONICS UP TO THE ELEVENTH.

CLOSED DELTA.





	$y_1 = 24$ $y_{11} = 21$	$y_2 = 80$ $y_{10} = 55$	$y_3 = 117$ $y_9 = 121$	$y_4 = 146$ $y_8 = 137$	$y_5 = 148$ $y_7 = 143$	$y_6 = 138$
Sum	45	135	238	283	291	138
Diff.	3	25	-4	9	5	

$S_1 + S_3 - S_5 = r_1$: 45 + 238 + 283 − 291 = −8 = r_1

$S_2 - S_6 = r_2$: 135 − 138 = −3 = r_2

$d_1 - d_3 - d_5 = e_1$: 3 − (−4) = 7; 7 − 5 = 2 = e_1

Above values entered in table below after being multiplied by sine in left hand column.

Angle	Sine terms: 1st and 11th harmonics		3d and 9th harmonics		5th and 7th harmonics		Cosine terms: 1st and 11th harmonics		3d and 9th harmonics		5th and 7th harmonics	
sin 15° = 0.262	$S_1 = 11.8$				$S_5 = 76.2$			$d_5 = 1.3$				$d_1 = 0.78$
sin 30° = 0.500		$S_2 = 67.5$				$S_2 = 67.5$	$d_4 = 4.5$				$d_4 = 4.5$	
sin 45° = 0.707	$S_3 = 168.2$		$r_1 = -5.66$		$-S_3 = -168.2$			$d_3 = -2.8$		$e_1 = 1.414$		$-d_3 = 2.8$
sin 60° = 0.866		$S_4 = 245.0$				$-S_4 = -245.0$	$d_2 = 21.6$				$-d_2 = -21.6$	
sin 75° = 0.966	$S_5 = 281.0$				$S_1 = 43.5$			$d_1 = 2.9$				$d_5 = 4.8$
sin 90° = 1.000		$S_6 = 138.0$		$r_2 = -3.0$		$S_6 = 138.0$			$-d_4 = -9$			
Total 1st column	461.0		-5.66		-48.5		26.1		-9.0		-17.1	
Total 2d column	450.5		-3.0		-39.5		1.4		1.4		8.4	
Sum	911.5 = $6A_1$		-8.66 = $6A_3$		-88.0 = $6A_5$		27.5 = $6B_1$		-7.6 = $6B_3$		-8.7 = $6B_5$	
Difference	10.5 = $6A_{11}$		-2.66 = $6A_9$		-9.0 = $6A_7$		24.7 = $6B_{11}$		-10.4 = $6B_9$		-25.5 = $6B_7$	
	$A_1 = 151.9$ $A_{11} = 1.8$		$A_3 = -1.4$ $A_9 = -0.4$		$A_5 = -14.7$ $A_7 = -1.5$		$B_1 = 4.6$ $B_{11} = 4.1$		$B_3 = -1.3$ $B_9 = -1.7$		$B_5 = -1.7$ $B_7 = -4.3$	

$E_1 = \sqrt{151.9^2 + 4.6^2} = 152.0$ $\quad \tan\phi_1 = \frac{4.6}{151.9} = .0303 \quad \phi_1 = 1°44'$

$E_3 = \sqrt{2.1^2 + 1.3^2} = 1.9$ negligible

$E_5 = \sqrt{14.7^2 + 1.7^2} = 14.8$ $\quad \tan\phi_5 = \frac{-1.7}{-14.7} = .0865 \quad \phi_5 = 184°58'$

$E_7 = \sqrt{1.5^2 + 4.3^2} = 4.5$ $\quad \tan\phi_7 = \frac{-4.3}{-1.5} = 2.860 \quad \phi_7 = 250°44'$

$E_9 = \sqrt{0.4^2 + 1.7^2} = 1.7$ negligible

$E_{11} = \sqrt{1.8^2 + 4.1^2} = 4.5$ $\quad \tan\phi_{11} = \frac{4.1}{1.8} = 2.280 \quad \phi_{11} = 66°20'$

$$e = 152 \sin(\theta + 1°44') + 14.8 \sin(5\theta + 184°58') + 4.5 \sin(7\theta + 250°44') + 4.5 \sin(11\theta + 66°20').$$

all parts of the system, for nothing would prevent their flow. In this case the ground connection of generator neutral or transformer primary neutral would have to be broken. But then a slightly unbalanced *Y* connected load would very greatly unbalance the three secondary line voltages for the reason that without a neutral the primary coil currents must be equal and hence the secondary coil currents must be equal and an unbalanced load cannot be supplied by the transformers.

The above is presented with the hope that it may awaken interest within the minds of students in a subject which is, because of its practical importance, given too little attention. Even were this subject too difficult, which it is not, for the undergraduate, it would still seem desirable to call his attention to the errors, often absurdly large, and the troubles which may arise from assuming all waves to be sine waves. Sine waves are ideal things, complex waves real.

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The Symphony Club concert which was given on May 3, at the Conservatory Hall by the Orchestra, Mandolin and Glee Clubs, was indeed a musical treat. A large audience was in attendance and showed its appreciation by liberally applauding the splendid work of the vocal and instrumental artists.

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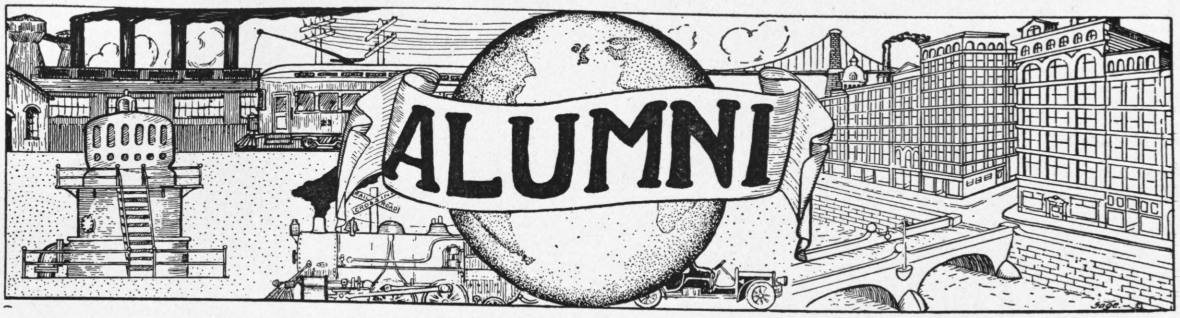
AT last an itemized statement of all the business transacted in publishing the 1911 Modulus is available, and we take pleasure in presenting it to our readers. Considering the fact that the amount of money involved in the production of this volume exceeded $1,500, and that the loss due to what is commonly called "bad accounts," was quite large, this report is certainly very satisfactory, the actual deficit amounting to a trifle over eight dollars.

Much credit is due the business manager, Mr. H. W. Ker, for this fine showing, and it would appear to be a rather uncharitable thing—to express it mildly—for any Senior to try to pick out flaws and make adverse criticisms concerning the management of the 1911 Modulus. To those who are willing to shoulder heavy responsibilities at least a semblance of fraternal consideration is due. Mr. Ker's final statement is as follows:

Printing	$ 647.40	
Engraving	396.33	
R. R. & Carfare	16.10	
Stamps	18.53	
Rent Phoenix Club	67.50	
Music for Dances	18.00	
Express Charges	22.95	
Paints for Posters	9.50	
Photos and Supplies	47.86	
Miscel, Stationary, Etc.	30.66	
Part Loan and Interest	218.60	
Cash Paid H. Kauffman	.85	
Prin. due R. P. I.	27.77	
Interest to June 6th, 1911	.56	
Balance from Class June 1909		$ 3.50
Receipts from Dances		114.00
Class Dues		57.70
1911 Modulus Sales		726.00
Postage Scales, Expressage, Etc		4.20
From Organizations		41.05
One 1909 Modulus		1.50
Cuts sold to '13 Class		8.55
Loan from R. P. I.		240.00
Junior Prom. Loan		19.15
Interest for One Year		1.15
Class Assessment to Cover Deficit		8.03
	$1541.76	$1541.76

—H. W. Ker, Business Manager.



ELEVENTH HOUR NOTES ON THE DEVELOPMENT OF WATER POWER

By Curtis A. Mees, C. E.

IN a very able address before the American Institute of Electrical Engineers on Dec. 16, 1909, Mr. Henry L. Doherty, than whom there are few men more intimately acquainted with this business, stated that "there is probably no other class of securities which deserves so well the support of the public as those issued by companies owning and operating successful water power properties and having a permanent and relatively non-competitive market." He then quotes a banker friend as follows: "We will not consider a water power project unless after doubling the cost, cutting the available power in two and reducing the market price by 40 per cent. it will still show interest on the bonds necessary to be issued."

Isn't the opinion of that moneyed pessimist flattering to us who so vigorously attack those who would compel us to be licensed by the Government so that we would become liable for malpractice.

But he is not so far wrong, for, as a matter of fact, a pitiably large percentage of the developed water powers are failures.

The effect has been impressed on us; to the cause we have perhaps given little thought. A great many factors enter into the perfectly successful development of a water power proposition and negligence in regard to careful consideration of any one of these may wreck the enterprise.

The promoter of the scheme may be at fault; the engineer in his purely technical capacity may be at fault, or the manager of the property may be at fault—or, as it more generally happens, all three of them are to blame.

The causes may be any or all of the following:

(a) Inadequate control of the undeveloped property.

(b) Inordinately high cost of the undeveloped property.

(c) Underestimated cost of development.

(d) Overestimated power capacity.

(e) Impracticable development scheme.

(f) Uneconomical details of design.

(g) Ruinous selling costs.

(h) Inability to market the power.

(i) Mismanagement or inefficiency in operation.

(j) Fancy financeering.

These items we will enlarge upon to get a fuller understanding of their especial significance.

(a) The first step in making a development embraces the control of the property.

The property may be owned in fee or one may hold options on it covering either the entire properties involved or water rights alone. In either case every acre of land that is necessary should be taken care of before construction is undertaken else the high cost of parts of the property growing out of damage suits or plain hold-ups may make development prohibitive.

In some states laws have been enacted wherein the right of eminent domain is granted for development as well as transmission of power and in these states the project is safeguarded to a considerable extent, for, curiously, a jury ordinarily makes an award for such damages below the figure originally offered. Of course it is never wise to have recourse to such action except in perhaps a few isolated cases, because the good will of the community may perhaps be easily assessed as an asset more valuable than the difference between the open purchase price and the price paid for condemned property.

(b) The price paid for ownership or control of the property may be much more than it is really worth—perhaps because it is a very difficult matter to arrive at a true value for it. If the proposition embraces considerable storage one can form some idea of what area is worth, but where storage amounts to little one does not buy land but rather a condition and it is quite surprising that land which one couldn't sell for $25.00 an acre for farming purposes couldn't be bought for $100.00 an acre for power development.

For the last few years much ado has been made about "power monopolies" and a great many erroneous newspaper and magazine articles, picturesquely worded to satisfy the desire of the reader for something startling, have lent color to the belief that any water power project must of necessity be an enormous money maker and that the ownership of such a site is equal to that of holding a gold mine. As a matter of fact, there is an analogy, for many of both are absolutely worthless; some might possibly pay dividends under careful management, while a very few are really money makers. But at that, the mine has the advantage, for its ores have intrinsic value, whilst water has merely a potential value.

It seems advisable therefore to control the property for a tentative development by options only, until a thorough study of the complete details of the undertaking will justify its purchase at any price.

(c) Underestimation may be due to false assumptions as to either costs, quantity or nature of the work. In any event it may be actually ascribed to either lack of thoroughness or ignorance.

Few engineers or architects have the opportunity of forming any adequate first-hand notions as to labor costs, costs of handling or storing materials, or any of the other numerous items that enter into an Estimate, except perhaps the delivered costs of the materials or the machinery itself.

That, however, should be all the more reason for studying such details and for devising files for recording all available information, for ready reference. If the Engineer were required to accept his Estimate as a Contract Price there would undoubtedly be more time and thought spent on its preparation.

It suggests itself as being perfectly feasible that an Estimate of Cost should be backed up with a tentative bid by a responsible Contractor, and even then certain overhead charges should be kept in mind, such as Executive Supervision, Promotion, Publicity and Organization Expenses, Accounting and Official Expenses, Interest on the Money Spent During the Construction Period, and a fair Contingency Fund to cover damages, accidents and other unforseen expenses.

Where errors have been made as to quality or nature of the work this generally presages inadequate preliminary investigation. It is true that frequently such preliminary work is not carried out as thoroughly as it should be because of the great expense involved. "Penny wise and pound foolish" certainly.

While we admit that this is an expensive proceeding, we see no reason why it should not be made a progressive investigation such that the client will have an opportunity for withdrawing at certain stages with the assurance that the investigation up to that point has proven the inadvisability of proceeding. We propose toward the end of these notes to suggest a schedule for procedure along these lines.

Such unforseen expenses as may be found necessary after the most thorough investigation found practicable should be amply covered by the Contingency Fund.

Engineers are of necessity Optimists but it is well to measure ones Estimate by the rule of the Pessimistic Financeer. And it is comforting to remember that if one builds within one's Estimate one is a good Engineer, whereas——.

(d) While it is true that records of rainfall or stream flow may be rather meagre for some particular locality, one may fortunately find such records covering fairly long periods for nearly every proposed power site. Records for stream flow have been gathered for a number of years and rainfall records cover very much longer periods. While the latter are only infrequently used, we believe that their importance warrants more careful consideration in connection with the more convenient and more accurate stream flow measurements.

When it is remembered that a daily load curve will show that the bulk of power is used for from, say 10 to 12 hours during the day, the necessity for storing up the energy of the water that flows during the remaining hours is apparent. Under certain circumstances, of course, the storage of water to equalize the discharge of a stream, for not alone low days but even low weeks or low months, increases the value of the property greatly. It is well therefore to consider the effect of storage toward increasing the natural minimum flow of a stream.

In considering a storage proposition, however, it is wise to bear in mind the fact that silting up of the resorvoir is bound to take place, and while authorities may quarrel one with another as to whether or not deforestation of our mountain slopes may have increased or decreased rainfall or run-off, we do know that this denudation has facilitated the stripping of the mountain slopes of its top soil and this comes down to us in greater quantities each year filling up our reservoirs with remarkable rapidity. It is to be hoped that more research work will be done to determine the amount of this sedimentation so that in the development of a water power its effect may be taken into careful consideration.

On account of regulation in stream flow through very great storage capacity the operation of a number of plants, or a united system as it has been called, is always preferable to that of a single station and it is always wise, if at all possible, to examine carefully the possibilities of controlling a stream for its entire length down to the fall line.

The establishment, with some accuracy of the minimum regulated stream flow is, however, only one of many considerations in the study of Power Capacity. Others of importance are the determination of minimum capacity for flood conditions with resultant reduction of head by back water; the accurate determination of net head as compared to the gross head more frequently considered—(and right here it is well to note that it is not always advisable to make the attempt to get every drop of water or every inch of head out of a development, even though there are those who criticise because they say one may not have developed to the greatest possible extent and may not therefore have the conserved the natural resources to the extent that the advocates of conservation would urge, still there is an economic limit to development and this should not be over-stepped), and the determination of the efficiency of the plant from prime mover to the customer's meter.

All these elements enter into determination of the Production Capacity, but this quantity should not be confused with Selling Capacity for it is manifestly impossible to secure a loading which will take the output of the plant with unvarying regularity from one end of the year to the other. First among the details to be considered in establishing the Selling Capacity are what may be called Business Losses—due to holidays, shut-downs, or the like. Then, because water is a very inflexible source of power and the range between efficient low capacity and overload capacity of a water wheel is restricted to narrow limits, unless auxiliary capacity, ample storage reservoirs or the like are used a certain margin of the Production Capacity must be held in reserve to meet peak load requirements. Any daily load curve will show certain intervals during which a greater amount of power is used than the average required throughout that day, or these daily load curves will show characteristic differences depending on the day of the week or season. For instance, the starting of a mill or shop always requires more power than is required to keep it going; particularly is this true of Monday morning starting because then all joints are particularly stiff. Then again, at certain seasons a lighting load will lap an industrial load for an appreciable length of time.

These periods of peak load may by careful management in selling power be kept reasonably low but they always occur to a certain extent, and within certain limits, by minimum charges and by restriction of peak load requirements, some power must be held in reserve.

So much for minimum power capacity, but there is generally a possibility of generating a considerable amount of additional power, due to fluctuations in stream flow and a fair proportion of this may be produced to advantage.

On this account it is customary to sell several classes of power, depending upon the period during which this power must be delivered—that which one may be called upon to deliver at any and all times being generally known as Primary power, and that which one may be called upon to deliver for certain periods only being generally known as Secondary power and being further designated by the period as 8-month, 9-months or 10-months Secondary power.

We believe that it is impracticable to sell any but one class of power, and that Primary power. While it is very true that for, say six months in the year one may find available twice as much water for the generation of power as one may find for say 355 days in the year, still we believe that this deficiency should be made up by an auxiliary plant and that as far as the customer is concerned only one class of power is available for him. Of course there might be conditions under which it would be preferable to provide for Primary plus Secondary generating capacity, without auxiliary capacity, but in this event if at all possible such shorter period power, or spare power, should be used only under direct control of the generating company.

While it is true that storage enters to a greater or lesser extent into most developments, it is wise to consider auxiliary capacity even beyond this for practically every such development of the single station for here it is used not alone to bring up the average in Selling Capacity, both by introducing a certain amount of flexibility and by making up for water deficiency, but it insures continuity of service as well—a valuable consideration in selling.

(e) By impracticable development we mean to cover both faults in Layout and in Methods. It is well to consider in sufficient detail to permit of close estimating all possible layouts that might suggest themselves and then judgment as to the best scheme can be based on dollars and cents, which is the final criterion in any event.

This embraces so much detail that we will not enter more fully into a discussion of them except to point out by the crudest example what we mean.

A given development may be made either by building a low diverting dam and a canal, or by building a high dam at a lower site and thereby doing away with the canal entirely.

I have known of just such cases and I have seen a long canal built when that was by far the worst scheme of development. In laying out a plant it is well always to do as little work on artificial channels as possible, whether this be for intake canal, flume, pressure pipe or tail race, because these invariably mean great expense at first cost and maintenance as well.

As to the methods employed in development—this refers to construction methods. These are of lesser importance when the work is done wholly under contract but when it is either wholly or in part done by administration they become serious considerations. Again this item covers so many details that it would be impossible to consider them individually so we will only mention several examples.

For a given development there are required a high masonry dam and in extension of the same the Power House.

Work should not be begun until the transportation facilities are as perfect as they are expected to be made.

All approaches, roads, railroads, tracks, etc., should be from below the proposed dam so that they will not be cut off.

Inasmuch as the dam will probably be the more expensive part of the work it should be the last finished, it being of course ideal to have the Power House, with its equipment completely installed, and the dam finished at the same time. Otherwise a great deal of interest will be lost on moneys spent for work lying idle while a few men putter around the power house doing a lot of wiring, drying out and testing. And besides, if the progress on the dam is much greated than that at the power house the latter will be exposed to floods where they may cause more damage than anywhere else.

On the whole, it may be well to keep in mind that haste reduces interest losses.

In doing such work by contract bonuses might profitably be offered to effect this saving.

(f) Economies may be affected in Design both through details in Plans and in Specifications so numerous that only casual mention is possible.

For any particular site the plans and specifications should be drawn up to utilize to the fullest possible every natural advantage that may be offered and the proposed methods of construction should be studied so that they may be adapted one to the other.

While we thoroughly believe in combining to the greatest extent possible Architectural Beauty and Scenic Beauty, there are ways and ways of doing this and with the exercise of thought and care in these details the creation of harmonious effects will be found to be inexpensive rather than otherwise, and up to a certain point, expenditures to accomplish this purpose will actually yield dividends, for environment tells, and the operators in a station where every detail is neat, complete and pleasing will strive for records of equal characteristics, to the benefit of their employer.

A number of Details of Design which affect directly the economical or efficient operation of a plant should be considered more thoroughly than it now seems to be common practice.

These embrace a movable controllable weir crest for the spillway where nowadays flash boards are used; a movable weir crest in the tailrace so that for full load discharges this crest may be lowered beyond the level required to seal the draft tubes under no load conditions, preventing thereby loss of head due to gorging of the channel. For horizontal turbines the use of such devices may be considered as the "Fall Increaser," lately patented by Mr. Clemens Herschel, or a similar devise patented by the

French Engineer, M. Saugey, by which devices it is proposed to use flood waters for the creation of a draft head to equalize losses caused by back water at such times.

For vertical turbines an additional runner may be conveniently installed to keep up speed and capacity under similar conditions.

The use of reinforced concrete for dams and power house details by which great economies are effected, commends itself providing, however, that one is satisfied that the structure is in itself of sufficient strength to withstand for a reasonably long period the ravages of time and the elements under such severe conditions.

There is no doubt whatever that the stability of such a structure can economically be made much greater than that of the gravity type of dam in solid masonry. Few failures of reinforced concrete used in a manner which can be compared with this are chronicled and most authorities state that reinforced concrete under such circumstances will not deteriorate in strength, but we have as yet no long time records to go by.

In any event, it is well to caution that a design be selected whereby as much concrete as possible comes into compressive stress and it is also well to provide for the strictest possible supervision so that poor workmanship and misplaced reinforcement may be avoided.

While European practice has sometime since brought out a spiral casing for water wheels, by the use of which the efficiency of the same has been brought up several per cent., it is only within the last few years that Americans have also adopted this design. While the higher efficiency of wheels with these casings generally just does justify the greater expense of this design at the present prices obtained for power, we believe that here conservation certainly does justify the expense. We believe that in the future this general shape will be utilized even for vertical turbines in pairs and with three runners on a shaft, where now it is being used only with single runners, as this shape may be molded in the concrete and does not necessarily have to be a steel casing at all, or at most only a short casing immediately around the guide buckets.

A very recent innovation in transmission line practice seems to be economical and practicable. I refer to the use of supporting towers between anchorage towers or strain towers. Inasmuch as it was necessary to put comparatively heavy towers at intervals along the line, and particularly at turns, in any event, there is no reason why the intermediate towers should not be used alone for supporting the conductors at the desired height.

Outdoor equipment for switching and transformation should also tend toward economy.

Many other details might be brought to the reader's attention, such as Head Gates and Hoisting Equipment, Provision for Disposing of Trash and Floating Debris, and a thousand and one others, but space forbids.

(g) This item is intended to cover the distribution or transmission costs.

While it is very true that it is exceedingly difficult in laying out a transmission line to provide for anticipated business, still that is only a particular reason why this matter should be studied as thoroughly as it is possible to do so, because it must be remembered that an uneconomical distribution system may wreck the whole project, because, whatever the production cost may be, an excessively high selling cost may prove prohibitory to development. In localities where the margin between the cost of power as generated by the manufacturer himself and that for which a central station could afford to deliver it to him is very small, favorable contracts (for the consumer) for furnishing power are frequently entered into before development of a plant, in fact, in order to finance the undertaking because it seems to be generally believed that a few contracts must be closed at any cost just to establish the practicability of the enterprise, and just such contracts generally prove a loss to the generating company and should actually prove the enterprise to be impracticable. We believe that it is possible to make certain conditional contracts for the sale of power preceding development based, not on what will prove ruinous prices but rather on the merits of peculiar advantages for the consumer or manufacturer to be derived from using that kind of power as generated by himself.

In many cases we believe that it would be advisable to build the auxiliary power station in anticipation of the construction of the main generating station, thus building up the market, and the transmission system as well, to meet the actual needs. By this means, too, customers could be familiarized with the advantages of buying power from a central station and the closing of the conditional contracts above referred to would naturally follow.

(h) We presume under this item that the fault does not lie in managerial ability but in actual insufficiency of demand. There are many localities which, though blest with wonderful water power sites, do not offer an attractive market for power. While such sites will in the natural course of events some day become valuable for development, there are some expedients by which a market could be created even nowadays. These embrace the stimulation of manufactures—the electrification of existing steam trunk lines, the building of electrical interurban lines, the pumping of water for irrigation, the production of nitrogen compounds by fixation of the atmospheric nitrogen, the electric smelting of ores, and even the application of electrical energy for lumbering and paper industries where the advantages of plant flexibility and reduction of fire hazard may overcome competitive advantages due to cheapness of waste material as fuel.

(i) The question of mismanagement or inefficiency in operation we will not enter into specifically, because this is the important factor of success in any established industry and it is a study in itself.

(j) Fancy Financeering should really not be considered at all, because if this is resorted to the project can hardly be considered a legitimate one anyway, and such alone are worth spending thought on, other than those of avoidance.

As stated above, we now submit a schedule of procedure in investigation of the feasibility of development of a water power such that by graduation of the considerable expense of such investigation the promoter may be encouraged to have this work done step by step in the most thorough manner and with as little risk of loss as possible, and with the final assurance that his securities will represent face value.

The first step will include:

Conception of the scheme.

Preliminary study of the power possibilities.

Preliminary surveys and designs.

Preliminary estimates of cost.

If this preliminary work is done by one who is familiar with all the details of water power development there is no reason why it should not at a very reasonable cost prove whether or not it is advisable to look further into details.

If warranted by this work the next step will embrace:

The taking of options on the property, or on water rights.

The making of accurate surveys.

Exhaustive studies as to the power possibilities of the development.

The study of the market and transmission.

Determination of the cost of competitive power and preparation of a schedule of selling prices for the water power.

Preparation of tentative plans.

Preparation of approximate estimates of cost.

The study of the market should embrace a thorough canvas not alone as to quantity but as to character of the requirements as well, because both of these factors influence earning capacity.

The cost of competitive power should be established by actual certified tests made under operating conditions on typical plants such as those to which it is proposed to sell the power, and these tests should be made on small plants and large plants alike to determine the range of power production costs. From these tests it will be possible to get up the proposed schedule of prices.

If warranted by this work there will then follow:

The taking of options on transmission right of way.

The taking of conditional contracts for power.

The preparation of working plans and accurate estimates.

The procuring of tentative bids for construction, and

The launching of the project financially.

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ALUMNI NOTES

On April 17th, Dr. Mees received a letter telling of the death of Mr. T. L. Camp, '97, which occurred on January 27th, at Chicago. Mr. Camp was on a Western trip, and was stricken with appendicitis. An operation was necessary, but Mr. Camp was unable to rally.

Rector Lawrence, '10, visited Terre Haute on May 10. He reported having been transferred to the Cincinnati office of the Wagner Electric Co., and also having received a promotion recently.

Mr. V. K. Hendricks, '89, office engineer for the Frisco System, has moved his office from St. Louis to Springfield, Mo.

Announcement has been received of the marriage of Mr. Lucien Ira Blake and Miss Mary Beroset Meten, of Trinidad, Colorado. Prof. Blake was the first professor of physics at Rose and was appointed by Pres. C. O. Thompson.

At a meeting of the Rose Technic Club of Pittsburgh on May 16th, the vacancy of the office of Vice-President, caused by the resignation of Mr. J. Sims Brosius, '03, was filled by the election of I. R. Ralston, '09.

Chas. E. Washburn, '10, was in Terre Haute recently, enroute to Detroit, Mich., where he will take a position with the Trussed Concrete Steel Co.

ROSE LEAVES

TABRIZ

By Vahan Shah Boudakhiantz, '14.

TABRIZ, the capital of the State of Azarbijan, two days carriage ride from the Russian frontier, besides being the center of commercial and social life, is the home of the crown prince of Persia, making it an important city of great political influence.

The name "Tabriz" means "fever" in Persian, though in reality the city has an excellent climate ,as is well known to every traveler.

On several occasions the city has been destroyed by earthquakes, but it has always been rebuilt, and is now larger than ever. Owing to the absence of a census, the population cannot be exactly stated, but it is estimated to be from 230,000 to 240,000—the second largest city in Persia.

The inhabitants consist of some six thousand Armenians, one hundred to one hundred and fifty thousand Syrians, and about as many Europeans, with about forty or fifty Americans. The rest are Tartars, or "Ajams," as they are called, the most fanatical Mohammedans of Persia.

It is singular that in a large city like Tabriz, the Persian language should be altogether a secondary one; it is only used about the court houses of the crown prince, and other official places, while the population speaks Turkish, which, although understood by the Turks, is nevertheless quite different from the Constantinople dialect. As Armenians represent the principal commercial element, their language is largely used in the business district.

The city covers an unusually vast area; gardens full of fruit trees, houses with large yards (likewise full of trees) are numerous; but the high walls are what make the city picturesque. The houses, never over two or three stories high—high structures being against the religion—are built of brick and stone, making a fire department not only unnecessary, but unknown. The thickness and length of the walls, together with the size of the street door—which is all that can be seen from the street—are the only means of distinguishing between rich and poor. As a rule, the Mohammedans occupy more than one house; one for the men, the other for the women—for the reason that "women should not be seen by men."

The streets have no names nor numbers; with few exceptions, besides being unfit for vehicles, they are ziz-zag in shape, and quite a few of them do not terminate into another street, so if a person chooses one by mistake, he will probably return to his starting point, after wandering for many blocks. It seems that the ziz-zag streets have taught the people to walk in ziz-zag ways; there is no such thing as "keep to the right"—they keep to the right or the left, as they please. An address is given by including the name of some one who is well known in that particular street, thus—"—— in the street where Mrs. X lives—two doors below the shoemaker—the house with the big red door and brass hammer." (Hammers are attached to the doors, and are used instead of bells.) Sidewalks are scarce, and when they do exist, they are not always preferable to the middle of the street, and are used by animals as well as people. These animals are the asses or donkeys—the express and delivery wagons of Tabriz. Add to these some horses, camels, and a few carriages, and some idea of the general transportation and traffic scheme of Tabriz can be gathered.

Of all places of interest, the "Bazar" or business district should be named first; it is not only interesting to travelers, but to natives as well; there one can see crowds of men from neighboring towns and villages, with all sorts of merchandise. On account of the irregularity of walking, it is often impassible; for this reason the rich people are led thru the crowds by servants. The noise, confusion, horses, caravans of camels, combine to cause such a mixture, that one is fortune to make his purchase without being trampled upon. After sunset another rush starts—one which resembles the flight of a defeated army.

The religion, as already stated, is Mohammedanism, which in a nutshell is that "God is God and Mohammed is his prophet." There are many rules to be observed, such as praying so many times a day, visiting sacred cities where their early prophets died, keeping fast a whole month from early morning until sunset, etc. They are supposed to wash themselves every day from the top of their head to their toes, but baths not being always available, they will wet their right hand, rub the top of their head, (which is usually shaven) and rub their right foot, thus carrying out the order.

Christians are considered unclean, but "civility" and the amiable attitude of the government make it possible for them to get along fairly well under the existing circumstances. It should be said as a credit to Persian government that a Christian's life or property is not subject to the caprice of a fanatical mob, as used to be the case in Turkey.

The people are very superstitious, and have a strong belief in the "evil eye," to which are credited all minor accidents. An owl seen on some one's roof is fatal; it is "good-bye" for that house—it won't last long. If a cat mews at the moon, some disaster will surely arrive. Number "13" is unlucky, and is never mentioned while counting without accompanying it by the words "it is not"; for example, "ten, eleven, twelve, 'it is not' thirteen, fourteen," etc. Such a state of ignorance can be explained by the absence of schools—that is, schools where something more than religion is taught, and at that, a religion which has proven itself to be a bad conductor of civilization.

Mohammedans, having no private buildings for instruction, have their children taught in mosques, under the clergy. They are taught from the Koran, which the priests themselves are often not able to understand; quite often, the students learn their lesson by heart, without being able to point to the right place in the book.

The city has no play houses or shows where people could seek enjoyment; they either gather in "cafes," where tea is served and opium smoked, or they assemble here and there to hear the so-called "professionals" tell stories, which are told according to the tastes of the curious listeners. The heroes of such stories are generally persons of extraordinary physical strength, and their foes devils with dozens of heads and hundreds of legs; these stories seemed to have inspired the artists who draw pictures so meaningless to Westerners. A few acrobats, an occasional snake or monkey trainer, furnish the only other amusements. The Oriental dances so much magnified by show managers or "special" correspondents do not exist at all in public places, and wherever they do exist take place in private houses.

After 10 p. m. no one is supposed to be seen on the streets, and if seen, one should know the countersign. This countersign—which may be anything—is given out by "police" before dark, and holds good for one night only. Its chief object is to keep suspicious characters off the streets; very seldom is one arrested for not knowing the countersign—it can be bought with the "price of a smoke," or even by a promise—because there being no night courts, the officer certainly would not lock up a suspicious character in his house, hence, he lets him go—"let George do it," is the rule generally followed in such cases.

The conversation of the inhabitants is exceedingly polite—so much so, that they are often called the "Frenchmen of the Orient." The language used, whether Persian or Turkish, is full of poetic and polite phrases. It is hard to believe that profane language can exist among them, but it must be admitted that under the right "temperature and pressure" the slang used is—well, say expressive.

Some of their extremes of politeness have their disadvantages. For example: If you pass by Mr. X's house, said gentleman's politeness obliges him to invite you in for dinner or supper, as the case may be, even if he—Mr. X—had just had his meal, or if nobody were at home. Again, if you remark to Mr. X, "What a pretty horse, carpet, etc., you have," Mr. X's politeness obliges him to say: "It is a present to you, sir." However, if you accept the "present," it is understood that you are going to "make it good" by offering him a price for it. Presents are bought in Persia, not given away.

At the social gatherings—which are generally "eats"—ladies are the guests of the hostess, and gentlemen the guests of the host. Before entering the room, all guests remove their shoes—hats are removed only when they retire, and upon no other occasion. Salutations are made by bowing. They sit on the floor, which is covered with rugs or carpets; before the eating starts, a servant enters, bearing a vessel full of water, and an empty wash bowl; he helps the guests to wash their hands, while seated. Knife and fork even at present are rarely used—they use their fingers. After the meal, "Kallian"—a water pipe known in Turkey as "Nar Keeley"—is produced, which is used by ladies as well as gentlemen; often in order to give it a good start, a servant in charge smokes it first, after which it is passed around to the guests, and finally to the servants. If the company is large, more than one pipe is used.

The Christians, who are mostly Armenians, are often called the "Swiss of the Orient," because of their skill as tradesmen. They are settled in two different parts of the city, and live close to each other, which is always the case in Mohammedan countries. Unlike that of their neighbors in general, the part of town occupied by them seems to be a little oasis in the desert; the silly harem life—"women should not be seen"—does not exist among them, and moreover, many of the ladies are dressed like Europeans. They have four excellent schools, accommodating from eight to nine hundred boys and girls; co-education was introduced a few years ago. They have theatres, lectures, and many societies for helping out this or that public spirited enterprise, all of which are vigorously supported by both men and women. The Armenians have two very good schools, one for each sex, which are patronized by all nationalities. But, their chief object being to convert the inhabitants to Christianity, more energy is consumed, and less good is accomplished, by giving too much instruction in the Bible. Of course, this is done with good intentions, but this much is certain: the money spent in attempting to convert a semi-civilized and fanatical community, such as these Mohammedans, if not wasted, represents a miracle. For these Mohammedans always did, do, and will need three things before they can become true Christians, viz: 1st, Education, 2nd, Education, and 3d *Education*. After they have these, if there being Christians still be doubtful, then, and only then, is the field open for missionaries, whose good work always will be appreciated.

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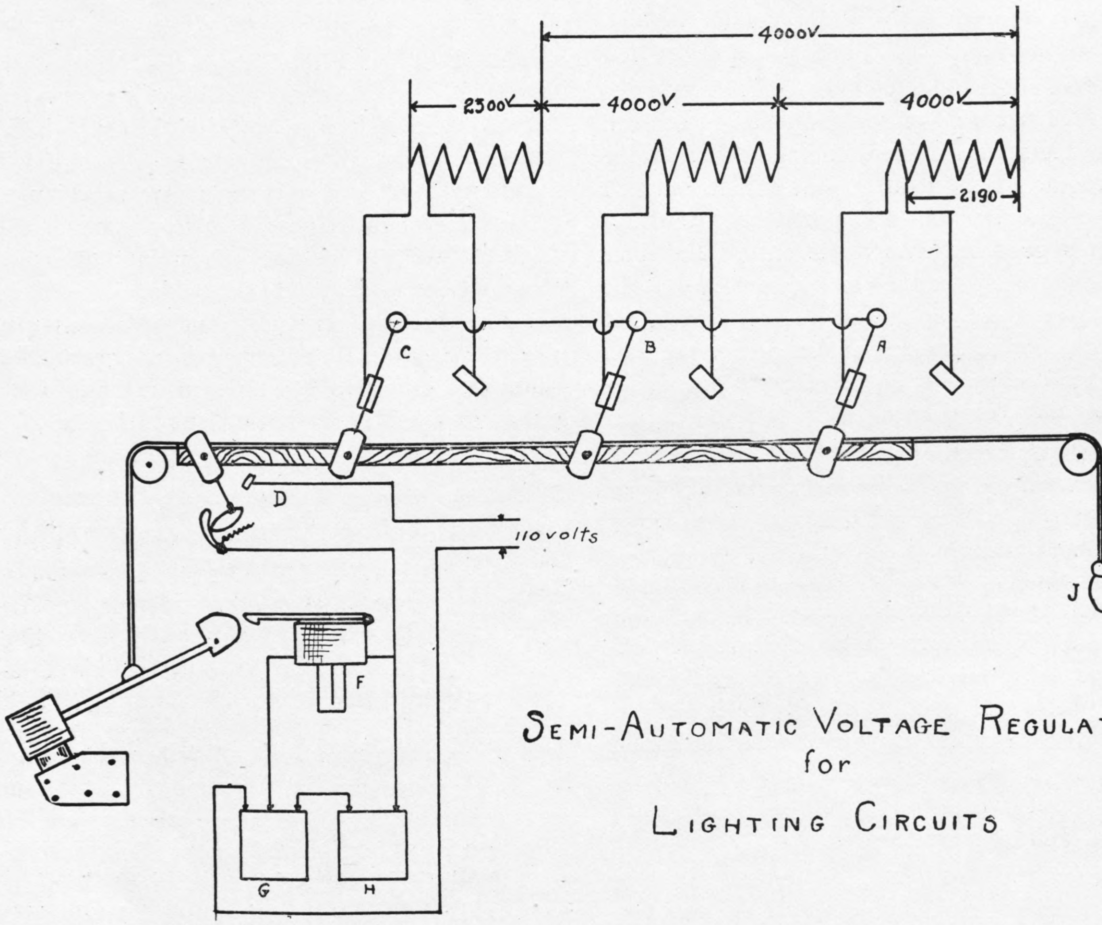

Semi-Automatic Voltage Regulator for Lighting Circuits

SEMI-AUTOMATIC VOLTAGE REGULATOR FOR LIGHTING CIRCUITS.

By C. B. Cook, '05.

In electric installations in Industrial Plants where the lighting transformers are supplied with current from the same circuit furnishing that to motor transformers, some difficulty has been experienced in maintaining constant voltage on lamps. This is occasioned by motors being thrown on and off the circuits with the consequent fall and rise of transformer primary voltage. This trouble is more noticeable when a great number of motors are stopped at one time, as at noon and evening each day.

In the plant of the Willy-Overland Automobile Company, a device has been installed for taking care of this trouble.

The incandescent lighting is on the 115 Volt normal secondary circuits of three 100 K. V. A. 4000-115 Volt, single phase, 25 cycle star-delta connected transformers. Each of these transformers is provided with 5 per cent. taps. These taps are brought out to one pole of a single pole double throw sliding contact switch. The end of the primary winding nearest this 5 per cent. tap, is brought out to the other pole of the corresponding switch. In this installation the fixed or pivot ends of the three switches are connected together forming the neutral for the star connection. (See diagram).

Normally when the motors are thrown onto the secondary circuit of their transformers, power and lighting banks being separate, the primary voltage is pulled down to approximately 3800 volts which would give about 110 volts on the lighting transformer secondaries, if the entire primary winding of the lighting transformers was in circuit. However, since 113 Volt Carbon Filament Lamps are used, a voltage of 110 is too low when the distribution loss is taken into consideration, consequently the 5 per cent. taps are utilized by means of switching mechanism to raise the secondary voltage. This makes it possible to impress 3800 volts on 95 per cent. of the primary winding, giving approximately 115 volts on the secondaries.

After motors have all been stopped the voltage comes back to normal and with lighting transformers, as connected, an excessive voltage would be impressed on secondaries so that a contact making voltmeter is utilized to change transformer connections at a predetermined pressure of 118 1-2 volts corresponding to 3,900 volts on transformer primaries.

(Refer to diagram). When the switches (A), (B) and (C) are thrown to the right by means of the rope with handle at (J) the weight (E) is lifted; at the same time this makes a cir-meter (G), (H) being resistance for voltmeter. This voltmeter at a set higher voltage will allow to be energized the solonoid (F) which trips and allows to fall the weighted arm (E). This throws the switches to the left and cuts in the whole of the primary winding thus not allowing the secondary voltage to become excessive, and giving the proper protection to lamps, and at the same time breaks voltmeter circuit and lengthens life of meter and solenoid.

A maple stick connects the switching handles and for the flexible member an ordinary sash cord runs over the pulleys. The weight (E) drops onto a rubber buffer.

It is only necessary for the attendant to throw switches to the right when the load comes on, the automatic feature taking care of the change when the load goes off.

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The last of the series of class entertainments given by the Ladies of the Faculty, took place on May 6, at the Heminway Home. The Sophomores, class of 1913, were the guests. The evening was spent in conversation, games, dancing and the disposal of all sorts of "goodies." Everybody reports having had a splendid time.

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On May 5th, the V. Q. V. Fraternity gave it's annual frat dance at the Pythian Temple. The decorations were very elaborate and harmonious. Streamers of purple and white tissue paper radiating from a central post formed a canopy over the entire floor. The favors were huge bouquets of fresh violets and each lady was presented with a handsome V. Q. V. bar pin. A program of eighteen dances was carried out. The chaperones were: Prof. and Mrs. Hathaway, Prof. and Mrs. Kelso, Mrs. Malverd Howe, Mr. and Mrs. Newhart and Mr. Le Forge.

Locals

Y. M. C. A.

THE officers of the Y. M. C. A. for the ensuing year were elected at the regular meeting on April 14. The following men were recommended for nomination by the nominating committee and elected as a whole:

President—Henry L. Yingling.

Vice-Pres.—Harry C. Uhl.

Sec.—Smith M. Crowe.

Chairman Relig. Meetings Com.—James E. Spindle.

Chairman Membership Com.—Jerry H. Service, Jr.

Chairman Social Com.—Raymond Buck.

Chairman Bible Study Com.—August H. Albrecht.

Pianist—Ivan Kauffman.

The office of Treasurer is omitted on account of the change in the Student Council Constitution, which provides for a General Treasurer.

Boys—this is a department of the Polytechnic student body of no mean importance. A great deal of work is put into its hands to carry on for the benefit of the students as a whole. Being a department of school activities, the Y. M. C. A. is dependent upon school spirit for its best results equally with any branch, so get in behind these new men and give them 9 rah's for the coming year, and also your earnest support.

On the 14th of April the Rev. C. R. Parker, of the First Baptist Church, gave the second of a series of discussions of "Laws of the Kingdom" upon, Law of Sacrifice. The last of the series was given April 28 upon the Law of Love, presented in such a forceful manner that all who heard it declared it the strongest given during the year.

The Rev. E. W. Dunlavy favored us by a study of the Book of Romans on the 5th inst.

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Dr. Mees took his annual trip to Louisville on April 26.

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Morris Rypinski, ex-'11, is now located in Indianapolis.

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Chas. F. Werst, who has had a siege of typhoid fever, is reported convalescent.

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Floyd M. Weaver, '11, attended the Rose-DePauw game at Greencastle, April 25.

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D. G. Evans, J. M. Tilley and R. V. Buckner were in Hutsonville, Ills., recently in connection with their thesis work.

Wm. Wey, ex-'10, is now assistant chemist for the Diamond Match Co., at Arkon, O.

The Senior architects have drawn a magnificent perspective of the proposed library which is the subject of their thesis. It can be seen in the architect's room.

E. E. Black, '11, has accepted a position in Colorado with an engineering company. He will go to take up the work immediately after commencement.

From some cause or other the Thesis subject of Clore and Weaver was misquoted in the last issue of the Technic. It should read "A Sanitary Survey of the Water of Terre Haute."

Edward J. Ducey, '11, is on the eligible list of the Civil Service Commission, he having passed the examination for Engineering Student, Department of Agriculture, office of Public Roads. A few days ago he received his commission, and will report at Washington, D. C., after the commencement exercises.

The second annual "Love Feast" of the Beta Upsilon Chapter of the Sigma Nu Fraternity, was held Sunday night, May 7th, at their Chapter house.

The idea of this "Feast" originated with N. A. Bowers, of the class of 1910, and serves as a farewell to the seniors of the Fraternity and at the same time gives the members practice in making after-dinner talks.

W. R. Bell, of the Class of 1912, presided as Toastmaster, and called upon each member of the fraternity for a toast.

C. E. Bell, '11, who joined the ranks of the married men last summer, was presented with a set of silver spoons, R. C. Slocomb, '12, acting as spokesman.

The members of the local chapter of the Sigma Nu Fraternity, held their annual Spring dance at the chapter house in North Center St. Wednesday, April 28. This was a very enjoyable affair and was given in honor of the young lady friends of the chapter.

The four dancing rooms were decorated with the fraternity colors, while the large fraternity emblem, which was recently made by G. M. Derr, '13, was used to good advantage. This emblem has thirty-seven two candle power lamps imbedded in it.

The program covers were unique in design, consisting of a large R with which the Greek Letters Sigma Nu were interwoven. The entire cover was made of brass. Each young lady received with her program some white roses which is the Fraternity flower.

The Chaperones were: Mrs. O'Reilley and Mrs. O'Connor, of Indianapolis, and Dr. and Mrs. E. S. Johonnott.

The Press Club held its regular monthly meeting Friday, May 12, P. M., at the Heminway home.

After the regular order of business, A. F. Brennan presented a paper on "The Practical Applications of Descriptive Geometry." Mr. Brennan had the subject well in hand and gave some very interesting information.

The program of the I. I. P. A. Convention, which takes place at Crawfordsville, Ind., May 19 and 20, was given out at this meeting, and is as follows:

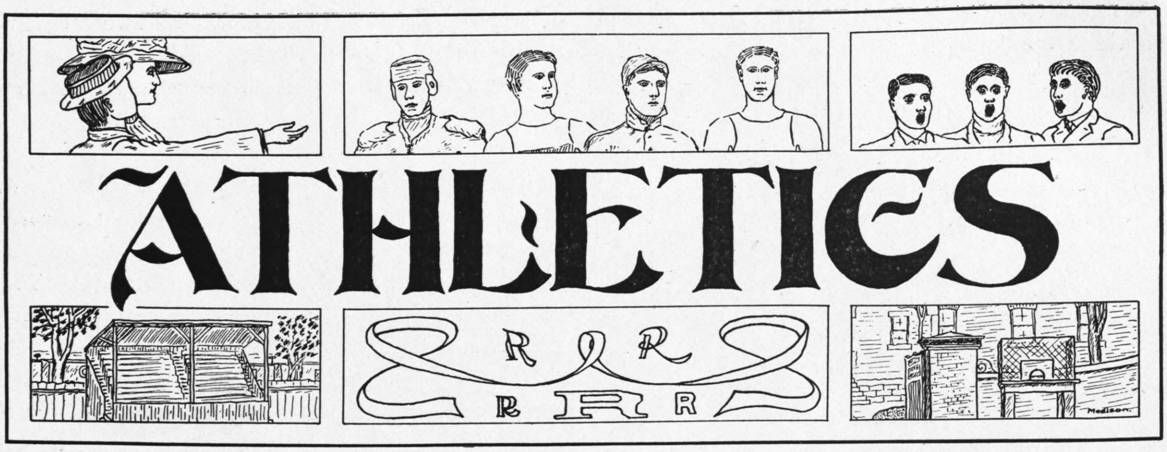
Friday, May 19, 4:00 P. M.—Baseball game between Wabash and Michigan "Aggies."

8:00 P. M.—Press Club dance in honor of visitors.

May 20, A. M.—Business session; State College Tennis Tournament.

Afternoon—I. C. A. L. Track Meet.

7:00 P. M.—Annual Press Club banquet at which the speakers will be Gov. Marshall, Louis Howland, editor of the Indianapolis News, and J. A. Green, editor of the Fort Wayne News.



THE Base Ball team has played eight games winning five of them. For some reason or other everyone seems to be hitting the ball hard and often, there being four men above the three hundred mark and others close to it. It is unusual to have a Poly team of heavy hitters, usually it is a one man team, the pitcher being the whole show. This year it is a nine-man team. Rose is fortunate as to pitchers. Starting back in the nineties there were Meriwether, Hills, Braman, Dailey, Douthett, Dennitt and Backman, all of whom were stars. Now in walks another one, this time a left hander, who will well be able to keep up the reputation. Nehf has pitched in five games for a total of thirty-four innings and allowed just six hits in the whole time, besides striking out fifty-five men. The other schools of the state are worrying to think that there will be three more years of him. Barrett is taking his regular turn in the box, having pitched thirty innings, allowing fifteen hits and striking out twenty-eight.

Nehf is leading in hitting with an average of .526, while Buckner is close second with .484. Kelley is third with .385, and Barrett with .313. The others will be found in the averages on the last page. The team average is .275, remarkably high for a college team.

Another week or so will tell how much they drop.

SMITH N. CROWE, of Webster, Indiana, was recently elected basket ball captain for 1911-1912 by the members of this year's team. "Pat" played his first college games this winter and made good at a guard position.

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INDIANA came first, but a combination of errors gave the game away as our men outhit their opponents. Tommy Barrett pitched a nice game, allowing only six hits and striking out seven. Rose walked away from Wabash in the first game, knocking two pitchers out of the box. Then came the best of all. Our friends from Greencastle attempted to humiliate us on their home grounds, but a certain Arthur Nehf and 8 sluggers gave the DePauw team and student body an eye opener. Martin was knocked out of the box in the fourth inning and Overman had his hands full for five innings. Here's hoping we duplicate when DePauw comes here. After DePauw came Hanover. Barrett held them safe for nine innings, while Poly scored four runs.

Then Normal—for six innings it lasted, the final result being thirteen to one. If rain hadn't come when it did they might have been scoring yet. Wabash gave us our second jolt. Nehf allowed only two hits but nine errors gave the game away.

Normal is getting an awful bad habit of winning games from Rose. Moore, who was given an awful drubbing in the first game, "came back," and it was through his pitching that Normal won the game. The Teachers can certainly play ball on their own grounds and vice-versa.

E. I. S. N. put up a nice game at Charleston and Rose was only able to win six to two. Shookie started to pitch but lack of practice told and in the fourth inning he decided he couldn't "come back" and retired in favor of Nehf who struck out thirteen of eighteen men who faced him.

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THE batting and fielding averages of the team will be found at the end of the department. They include the E. I. S. N. game.

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THE Track Team will hold three meets this year, having dual combats with Normal and Millikin University, and also the State meet at Crawfordsville. The men for this year's team are mostly unknown quantities as most of the candidates are members of the Freshman class. The Millikin meet which, comes first, will decide their ability. Millikin won the dual meet last year on Rose Campus and the meet this year will be held in Decatur. Normal, as usual, will not cause much trouble. The men have not been turning out for work-outs and as a consequence Captain Coffey has not a very large squad to work with. The following is a list of the men who have been working out: Captain Coffey, Gray, Spindle, H. Kelley, Johnson, Ransford, Moore, Coltrin, Deming, Meyers, Hallett, Uhl, Cox and Black.

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INDIANA 8—ROSE 1.

In the opening game of the season the team put up a poor fielding game and Barrett's good pitching went for naught. The team hit hard but Indiana's errorless fielding kept the score down:

Indiana	AB	R	H	PO	A	E
Cunningham, cf	4	0	3	2	0	0
Lewis, c	4	2	1	7	3	0
Berndt, 2b	4	1	1	3	3	0
Gill, ss	2	2	0	2	5	0
Hay, 3b	4	1	0	4	2	0
Howard, p	3	0	1	1	2	0
Librook, p	1	0	0	0	0	0
Dawruther, lf	2	1	0	0	1	0
Driscoll, rf	3	0	0	0	0	0
Martindale, rf	0	0	0	0	0	0
Burt, 1b	4	1	0	8	2	0
Totals	31	8	6	27	18	0

Rose	AB	R	H	PO	A	E
Lawler, c	4	1	1	9	3	0
Bradford, 2b	3	0	1	3	3	3
Wyeth, cf	4	0	0	1	0	0
Buckner, lf	3	0	2	0	0	0
Shook, 3b	4	0	1	0	1	2
Kelley, ss	3	0	2	0	3	1
Byers, rf	4	0	1	0	0	0
Denning, 1b	3	0	0	10	2	0
Barrett, p	3	0	2	1	2	2
Totals	31	1	10	24	14	8

By Innings:—

Indiana	3	1	1	0	2	1	0	0	*	—8
Rose	0	0	0	0	0	1	0	0	0	—1

Summary—Two-base hits: Cunningham, Barrett. Struck out: By Howard 6, by Barrett 7. Bases on balls: Offi Barrett 1, off Howard 1, off Librook 2.

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ROSE 8—WABASH 4.

This was the game when the fellows hit their stride. Not an error was chalked up in the error column, and thirteen hits gave us eight runs. Barrett started the game, but was wild and Nehf relieved him in the fourth inning. Buckner and Nehf were the hitting stars, Buckner getting a three-base hit and a single, while Nehf got a single and also a home run drive that went nearly to the main building. Wabash used three pitchers and every one of them was given a warm reception. Wabash made but one hit, off of Barrett, in the fourth inning. The score:

Rose	AB	R	H	PO	A	E
Lawler, c	4	1	1	14	2	0
Bradford, 2b	4	0	1	2	2	0
Wyeth, cf	3	1	1	1	0	0
Buckner, lf	4	1	2	1	0	0
Kelley, ss	3	1	2	0	0	0
Shook, 3b	3	1	2	1	1	0
Byers, 1b	4	1	2	6	0	0
Nehf, rf & p	4	1	2	0	0	0
Barrett, p & rf	3	1	0	2	0	0
Total	32	8	13	27	5	0

Wabash	AB	R	H	PO	A	E
Huffine, lf	2	1	0	0	0	0
H. Lambert, lf	2	0	0	0	0	0
W. Lambert, 3b	4	1	0	0	1	0
Herron, cf	1	0	0	1	0	1
Kutz, 1b	2	1	1	6	2	0
Starbuck, c	2	1	0	8	4	1
Glover, lf	4	0	0	1	0	0
Rich, ss	2	0	0	2	1	0
Williams, 2b	3	0	0	6	2	0
Puckett, p	3	0	0	1	1	1
Winnie, p	0	0	0	0	1	1
Myers, p	1	0	0	0	0	0
Total	26	4	1	24	12	4

By Innings:—

Rose ....1 1 0 1 0 3 2 0 *—8
Wabash ....1 0 0 2 1 0 0 0 0—4

Summary—Home run: Nehf. Three-base hit: Buckner. Two-base hits: Nehf, Kutz, Shook. Stolen Bases: Lawler, Wyeth, Shook, Huffine, Herron, Rich 2. Sacrifice hits: Shook, Rich. Struck out: By Barrett 6, by Nehf 7, by Puckett 5, by Winnie 1. Bases on balls: Off Barrett 7, off Nehf 2, off Puckett 2, off Winnie 2. Wild pitches: Barrett 2. Double play: Lambert to Kutz to Rich. Hit by pitcher: Herron, Kutz, Kelley, Wyeth.

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ROSE 7—DePAUW 0.

The Percys and Willies laid aside their ping pong rackets and dress suits long enough on this afternoon to don their base ball uniforms and gloves and play a game of base ball with their "rough neck" friends from Terre Haute. Notwithstanding the circumstances the Poly boys proceeded to knock the ball all over the lot to the great embarassment of the assembled crowd. To make it worse, Mr. Nehf made fourteen men fan the air. Martin started the game for the Methodists but retired in favor of Overman in the fourth inning. The score:

Rose	AB	R	H	PO	A	E
Lawler, c	3	1	1	13	0	1
Shook, 3b	4	1	2	0	0	0
Wyeth, cf	4	1	1	0	1	0
Buckner, lf	5	1	1	0	0	0
Kelley, ss	4	1	0	0	1	1
Byers, rf	5	0	1	0	0	0
Barrett, 2b	4	0	1	2	1	0
Nehf, p	3	1	2	1	5	0
Lammers, 1b	4	1	1	11	0	0
Total	36	7	10	27	8	2

DePauw	AB	R	H	PO	A	E
Schladerman, ss	4	0	0	1	1	2
Adams, 3b	4	0	0	1	1	1
Hardin, c	4	0	1	12	0	0
Patterson, rf	4	0	1	1	0	0
Johnson, 1b	4	0	0	12	0	0
Crouch, 2b	4	0	1	1	3	0
Thomas, cf	4	0	0	0	0	0
Clark, lf	3	0	0	0	0	0
Martin, p	1	0	0	0	0	0
Overman, p	2	0	0	0	3	0
Total	34	0	3	27	8	3

By Innings:—

Rose ....3 0 0 2 0 0 2 0 0—7
DePauw ....0 0 0 0 0 0 0 0 0—0

Summary—Two-base hits: Nehf, Shook. Bases on balls: Off Martin 2, off Overman 1, off Nehf 2. Struck out: By Nehf 14, by Martin 5, by Overman 6.

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ROSE 4—HANOVER 0.

Hanover wasn't even in the running and it was only a question of getting through with the game before it rained too hard. It was drizzling through the nine innings and the players lacked life. Tommy Barrett pitched a nice game, allowing only three hits and striking out nine batters. Dawson pitched a good game for the visitors and it was partly due to his smile that the game was not entirely devoid of interest. The score:

Rose	AB	R	H	PO	A	E
Lawler, c	3	1	1	10	1	0
Bradford, 2b	4	0	0	4	3	0
Shook, 3b	4	0	1	0	2	0
Buckner, lf	3	0	2	1	0	0
Kelley, ss	4	0	1	0	1	0
Byers, cf	3	0	0	1	0	0
Nehf, rf	3	2	2	0	0	0
Deming, 1b	3	0	0	11	0	0
Barrett, p	3	1	2	0	5	0
Total	30	4	9	27	12	0

Hanover	AB	R	H	PO	A	E
Dickey, c	4	0	1	2	1	0
Dawson, p	3	0	1	0	5	0
Hollenbach, 1b	4	0	0	9	0	0
Slawson, 2b	3	0	0	3	1	0
Drew, 3b	4	0	0	1	1	0
McLaughlin, ss	3	0	0	1	1	1
Scoggin, rf	3	0	0	2	0	0
Carlisle, cf	3	0	0	5	0	0
Keyle, lf	3	0	1	1	1	1
Total	30	0	3	24	10	2

By Innings:—

Rose	0	0	1	0	3	0	0	0	*	—4
Hanover	0	0	0	0	0	0	0	0	0	—0

Summary—Three-base hits: Lawler, Dawson. Two-base hits: Barrett, Kelley. Bases on balls: Off Barrett 4, off Dawson 1. Struck out: By Barrett 9, by Dawson 2. Hit by pitcher: Buckner, Slawson. Double play: Kelley to Bradford to Deming. Umpire—Lammers.

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ROSE 13—NORMAL 1.

Six innings was enough for poor old Normal. Eleven hits with five errors by Normal, four of which were attributed to Bird, caused the slaughter. Normal could get but one little hit, it being an infield scratch. Nehf struck out twelve men. Shook was a star with the bat, getting a three-base hit with the bases full. Buckner also got a three bagger. The crowd was nearly treated to a fight as Wilson, of the Normal team, got overheated in an argument with the umpire and proceeded to fight. The players quickly stopped the trouble. The score:

Rose	AB	R	H	PO	A	E
Lawler, c	4	0	0	11	1	0
Bradford, 2b	5	1	2	2	2	0
Wyeth, cf	3	3	1	0	0	0
Backner, lf	3	2	2	0	0	0
Kelley, ss	2	2	2	1	0	1
Shook, 3b	4	2	2	0	1	0
Byers, rf	2	3	1	0	0	0
Deming, 1b	3	1	0	5	0	0
Nehf, p	2	0	1	0	2	0
Total	28	13	11	*19	6	1

*One out when game was called.

Normal	AO	R	H	PO	A	E
Bird, 3b	3	0	0	2	1	4
Brown, 1b	2	0	0	4	0	0
Wilson, lf	2	0	0	2	0	0
Clarke, 2b	2	0	0	1	0	0
Mitchell, cf	2	0	0	0	0	0
Brill, ss	2	0	0	1	1	0
Hogue, rf	2	1	1	3	0	0
York, c	2	0	0	5	0	1
Moore, p	1	0	0	0	4	0
Frakes, p	1	0	0	0	1	0
Totals	19	1	1	18	7	5

By Innings:—

Rose	2	1	3	5	1	1	—13
Normal	0	0	0	0	0	1	— 1

Summary—Three-base hits: Shook, Buckner. Bases on balls: Off Moore 7. Struck out: By Nehf 12, by Moore 4, by Frakes 1. Passed ball: York. Hit by pitcher: Byers. Umpire: Pfirman.

———ooo———

WABASH 6—ROSE 4.

Errors lost another game here, as Wabash only made two hits off of Nehf who struck out ten men. Bunched hits in the first inning coupled with Wabash errors gave Poly three runs. Myers pitched a good game allowing only three hits although two of them were for extra bases. The score:

Wabash	AB	R	H	PO	A	E
Herron, cf	5	2	1	2	0	0
Lambert, 3b	3	0	0	3	2	1
Huffine, lf	3	0	1	0	0	0
Kirtz, 1b	4	0	0	11	0	1
Starbuck, c	4	0	0	5	0	1
Glover, rf	4	0	0	3	0	0
Rich, ss	3	1	0	1	5	0
Williams, 2b	4	1	0	1	2	1
Meyers, p	4	2	0	1	1	0
Total	32	6	2	27	10	4

Rose	AB	R	H	PO	A	E
Lawler, c	3	1	1	11	0	1
Bradford, 2b	4	1	0	2	1	1
Wyeth, cf	4	1	0	0	0	0
Buckner, lf	4	1	2	2	0	0
Kelley, ss	4	0	0	2	1	4
Shook, 3b	3	0	0	1	2	1
Byers, rf	4	0	0	2	0	0
Demning, 1b	3	0	0	4	2	1
Nehf, p	2	0	0	0	1	1
Total	31	4	3	24	7	9

By Innings:—

Wabash	0	0	2	4	0	0	0	0	*	—6
Rose	3	0	0	0	0	0	0	0	1	—4

Summary—Three-base hit: Lawler. Two-base hit: Buckner. Bases on balls: Off Meyers 2, off Nehf 3. Struck out: By Meyers 4, by Nehf 10. Stolen bases: Nehf, Herron 2, Huffine. Sacrifice fly: Shook. Umpire: Grimm.

NORMAL 5—ROSE 3.

Made confident by the steady pitching of Moore, Normal won a game from Poly. The Normal players seem to be able to play better on their home grounds, and as a result many spectacular stabs were made. Normal had four errors but the sensational plays that were made more than evened up matters. Asbury, in center field, and Brown at first base, were the worst offenders, and some of their "stunts" even surprised themselves. Asbury's catches of two of Shook's hits and one of Bradford's were mere accidents. Either one of the hits would have brought in runs as there were men on base all three times.

The Normal rooters caused a great deal of amusement by their truly unique rooting and "kidding" of the Poly students.

Buckner was a star, getting two hits out of three times up and stealing four bases. One of his hits went over the right field fence, but owing to ground rules was only good for two bases.

Poly scored in the first inning. Lawler walked but was put out at second on Bradford's attempted sacrifice, Bradford being safe at first. Brad stole second and Wyeth fanned. Buckner hit a fly to Mitchell who dropped it and Brad scored. Normal scored three runs in their half. With one down, Barrett hit Brown who took third on Wilson's hit. Wilson stole second. Clark him to Deming who threw Brown out at the plate on a close play. Mitchell hit a high one to left but Buckner couldn't see the ball on account of the sun, Wilson and Clark scoring, Mitchell going to second. Brill hit to Byers who missed the catch, Mitchell scoring. The next man struck out.

Poly tied the score in the fourth. Buckner singled and Kelley beat out a bunt, and both worked a double steal. Shook hit a long fly to right, Buckner scoring on the throw in and Kelley scoring when York let the ball get by him. Byers and Deming struck out.

Normal won out in the fifth. Two were out when Brown singled to right. Wilson hit to center and Wyeth let the ball get by him, Brown scoring and Wilson going to third from where Barrett's wild pitch let him come home. Poly made several desperate attempts to tie up the score in the innings that followed but the luck would not break right.

There is still a third game to be played and as far as any Rose man is concerned there is no doubt as to the outcome.

Normal	AB	R	H	PO	A	E
Bird, 3b	4	0	0	0	5	1
Brown, 1b	3	1	1	8	0	0
Wilson, lf	3	2	2	0	0	0
Clark, 2b	4	1	1	2	2	0
Mitchell, cf	2	1	1	0	0	1
Asbury, cf	2	0	0	2	0	0
Brill, ss	2	0	0	0	1	0
Hogue, rf	4	0	0	4	0	1
York, c	3	0	0	11	1	1
Moore, p	3	0	0	0	1	0
Tota	30	5	5	17	10	4

Rose	AB	R	H	PO	A	E
Lawler, c	4	0	0	7	1	0
Bradford, 2b	5	1	0	1	1	0
Wyeth, cf	4	0	0	2	0	1
Buckner, lf	3	1	2	3	0	0
Kelley, ss	3	1	2	1	2	0
Shook, 3b	3	0	0	1	1	1
Byers, rf & 1b	4	0	0	1	0	1
Deming, 1b	3	0	0	6	1	1
Nehf, rf	1	0	1	0	0	0
Barrett, p	3	0	0	2	3	0
Total	33	3	5	24	9	4

By Innings:—

Normal ....3 0 0 0 2 0 0 0 *—5
Rose ....1 0 0 2 0 0 0 0 0—3

Summary—Two-base hits: Buckner, Kelly, Mitchell. Stolen bases: Buckner 4, Bradford 2, Kelley, Wilson, Clark. Sacrifice hit: Shook. Struck out: By Barrett 3, by Moore 9. Bases on balls: Off Barrett 2, off Moore 4. Wild pitch: Barrett. Double plays: Kelly to Deming, Barrett to Byers. Hit by pitcher: Brown, Brill. Umpire: Thornton.

———ooo———

ROSE 6—E. I. S. N. 2.

There was very little trouble winning this game. Shook started to pitch, but about the third inning, when the Normalites began hitting him pretty freely, decided he couldn't "come back." Nehf took his place and of the eighteen men who faced him, thirteen struck out. Art also delivered another home run. The score:

Rose	AB	R	H	PO	A	E
Kelley, ss	3	2	1	0	0	1
Wyeth, cf	4	1	1	1	0	0
Shook, p & 3b	3	0	0	0	4	0
Buckner, lf	5	1	1	1	0	0
Nehf, 3b & p	4	1	2	0	1	2
Lawler, c	4	0	2	12	1	0
Byers, 1b	4	0	1	9	1	0
Bradford, 2b	4	0	1	4	2	0
Fishback, rf	4	1	1	0	0	0
Total	35	6	10	27	9	3

E. I. E. N.	AB	R	H	PO	A	E
Flaherty, ss	4	0	0	3	1	1
Schemkar, 2b	4	0	1	6	3	2
C. Hill, 3b	4	1	1	0	2	0
Stansberry, cf	4	1	2	3	1	0
S. Hill, c	3	0	0	3	3	0
G. Rankin, 1b	3	0	0	11	1	1
Harrison, lf	3	0	0	0	0	0
M. Rankin, rf	3	0	0	1	0	0
Sampson, p	3	0	0	0	5	0
Totals	31	2	4	27	16	4

By Innings:—

Rose	3	0	0	0	1	0	1	1	0	6
E. I. S. N.	1	0	0	1	0	0	0	0	0	2

Summary—Home run: Nehf. Bases on balls: Off Sampson 2. Struck out: By Nehf 12, by Sampson 3. Hit by pitcher: Wyeth, Shook. Stolen bases: C. Hill, Stansberry, Kelly.

The following are the batting averages:

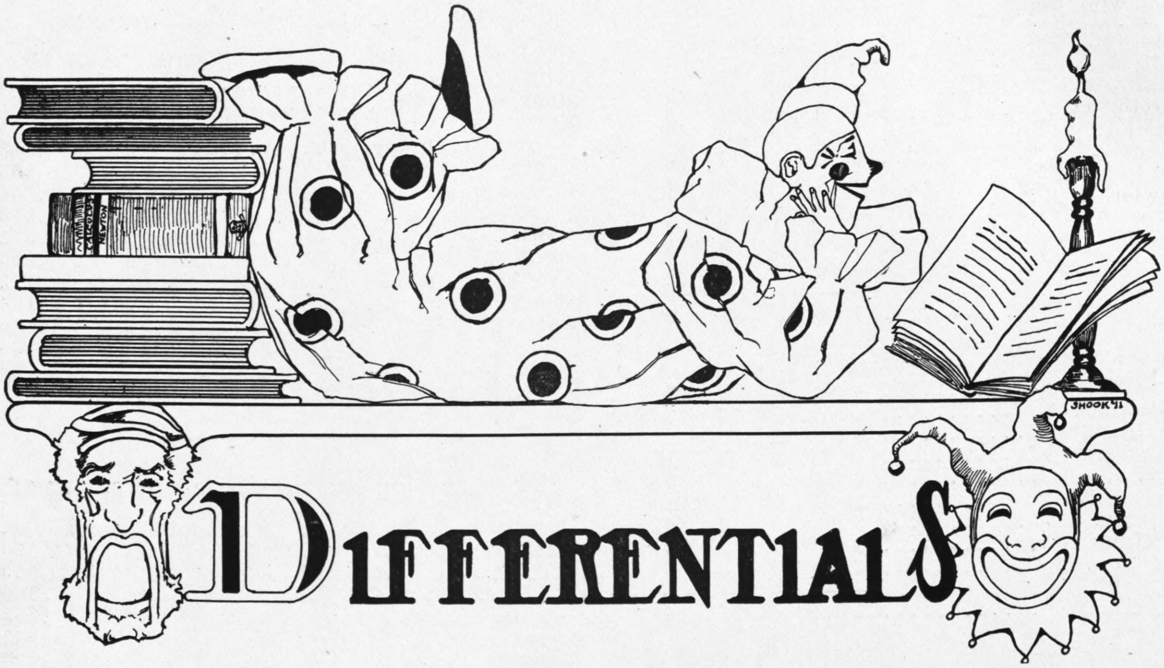
	AB	R	H	Pct.
Nehf, p & rf	19	5	10	.526
Buckner, lf	31	6	15	.484
Kelley, ss	26	7	10	.385
Barrett, p. 2b & rf	16	2	5	.313
Lammers, 1b	4	2	1	.250
Fishback, rf	4	1	1	.250
Shook, 3b & p	29	4	7	.242
Lawler, c	29	5	7	.242
Byers, 1b & rf	30	4	6	.200
Bradford, 2b	29	3	5	.172
Wyeth, cf	26	7	4	.154
Deming, 1b	15	1	0	.000
	258	47	71	

Team Average .275.

———ooo———

The following are the fielding percentages:

	PO	A	E	Total Chances	Pct.
Buckner	8	0	0	8	1.000
Lammers	11	0	0	11	1.000
Lawler	88	9	2	99	.980
Deming	36	5	2	43	.953
Byers	19	1	1	21	.952
Barrett	7	11	2	20	.900
Bradford	18	14	4	36	.889
Wyeth	5	1	1	7	.857
Shook	3	12	4	19	.789
Nehf	1	9	3	13	.769
Kelley	4	8	8	20	.600
Fishback	0	0	0	0	....



Jojo—"Symbolically how could that be said in words."

* * * *

Hath—The "C" in this equation is a constant.

Meyers—Say Prof., does that "C" vary?

* * * *

Citizen on Car—See that young man, he is a Civil Engineer.

Second Citizen—How did you guess it?

First—He just gave his seat to a young lady.

* * * *

Krieger—Have you heard the new theory, that the human body contains sulphur and that it appears in varying quantities.

Hepp—You don't say? Well, that accounts for the fact that some girls make better matches than others.

* * * *

Cootsey Lammers—Well, I guess I will leave at two, Professor.

Stephenson—Well, I guess you won't!

Nehf (In Chemistry)—Did you say that was profane, Professor?

* * * *

Rehm (Who had onions for dinner)—Say, Gil, did you ever hear the saying that if you eat an apple every day you will keep the physician away?

Gilbert—No, but I've heard that if you eat an onion every day you will keep every one away.

* * * *

Beech—Say Joe did you ever drink many toasts?

O'Connell (absently)—No, I usually eat mine.

* * * *

Doc. White—Mr. Hansen, can you tell me what makes seat water salty?

Hansen—You see, Dr., it was just like this. When you have an admixture of an excess of chloride of sodium with an aqueous fluid, such as water, the result is a solution whose taste reminds one of aslt.

Sibley—They say that a constant dripping of water will wear any object out.

Loehninger—Ugh! Just think what a whole glassful would do to my stomach.

* * * *

Reddie—What would happen if you gave a woman all the credit she asks for?

Reilly—All the men in the world would be in the poor house.

* * * *

Prof. Faurot (In Freshman German class)—Hansen, how about the feminine endings in German?

Hansen—Why there are four just the same—I mean one all alike.

* * * *

Prof. Faurot—Hoele means cave and helle means bright.

Gillum—I get hoele and helle mixed up.

Prof. Faurot—That's hell.

* * * *

Leforge (In English)—After the calf is dead they hold a post-mortem examination to see if it is in perfect health.

* * * *

Wickersham (Helping Schoonover pronounce French name in translating)—" 'S' is silent."

Schoonover—Sssisle and——.

* * * *

Stephenson (Seeing Scott climbing fence after forage for rolls)—You don't think that fence will last very long with you fellows climbing it so much, do you?

* * * *

Baines was passing the site of the new interurban station, when he was heard to remark to a friend, "Say, I thought I heard a frog jump."

* * * *

Hath—"Now I am talking to you as a son."

Voice in Rear—"You mean son-in-law, don't you, Professor?"

Did or did not Hath look at Levi?

* * * *

"Anybody that is above the room temperature is said to be dry."—Knippy.

In Prep. German—"You can get a copy of Heath's Dictionary for a dollar and a quarter."

Finkelstein—"A dollar and a quarter! Twenty-five beers! If I had twenty-five beers I wouldn't need a dictionary."

* * * *

In Sophomore Dynamics Denny referred to useful work and "waisted" work. Isn't "waisted" work useful?

* * * *

This might have been at Rose:—

College President, to Librarian—"I wonder where I can find the janitor."

Librarian—"I have found that the quickest way is to write him a postal card."—Success.

* * * *

Another gem from Prep. German:—

Clegg, translating "*Was den Helden unsrer Geschichte anbelangt*, ——" "What the hell has become of our story."

* * * *

Hath—"Now this curve doesn't belong in the family."

Brennan—"Let's call it Levi."

* * * *

Kelley, in Mineralogy, accidentally dropped his pipe, which fell on the floor and made an excursion down under the fatherly eye of the Doctor. From all appearances Doc White evidently heard some one remark that "it was stout enough to walk."

* * * *

Wischy, in Dynamics—"Now this is what is called a tare."

Donaldson—"Yes, we know what they are."

Wischy—"I know, but this is spelled differently."

* * * *

Keys (the blacksmith) entered the wash-room the other day in time to see Wood "heave" a cake of soap at Levi, and broke forth with "Hey! Quit your spontaneous monkeying."

* * * *

Cy—"Nibs, what's a crisis?"

Tommie—"Two out and the bases full."

A JOURNALISTIC COURTSHIP.

Said an ardent youth
To the Journalistic Miss,
"Let us shyly go to press
So that we may print a kiss."
An edition soon was out
He knew what he was about,
"Our success is fine," he said
"We must get some extras out."

* * * *

Some one said he saw Hath riding over toward West Terre Haute the afternoon the Bloomer Girls were there.

* * * *

A new integral has been proposed for Hath to verify. It is: The integral of beer and whisky from hand to mouth equals the change of one from sober to drunk, equals ten dollars.

* * * *

Knippy—"You could get this electricity if you spent half as much time trying to get acquainted with it as you do some girls."

* * * *

Knippy—"Mr. Kelley, what effect does a current have in a conductor."

Kelley—"It kills him."

* * * *

Said the bridge to the river,
"I'll fall on you."
Said the river to the bridge,
"I'll be dammed if you do."

* * * *

Queen—"You are the first man I ever permitted to kiss me."

Hoff—"And you are the first girl I ever kissed. Will you marry me?"

Queen—"I wouldn't marry a liar."

Hoff—"I would."

* * * *

Young Man—So Miss Ethel is the oldest. Who comes after her?

Kid Brother—Nobody ain't come yet, but pa says the first one that comes can get her.

Knippy—"If you would rupture a glass plate by an electric spark, what would happen to the plate?"

Levi—"In all probability, the plate would break."

* * * *

Brennan—"Whom did you take home from the party Saturday night, Levi?"

Levi—"Never mind, what were you doing up at Collett Park?"

* * * *

"Mary had two rosy cheeks
They set your blood to racin',
But when she washed her face at night
She left them in the basin."

* * * *

Denny (To Bill Royse at Normal game)—"Say, Bill, why don't you yell?"

Bill—"Be hanged if I root for Normal, and I am afraid to root for Poly."

* * * *

"Oh Mr. Hoffner, you have no idea how much it meant to me when you kissed me last night."

"Really! I won five dollars on it myself!"

* * * *

Dr. John—"Mr. Wilson, please mention an Oxide."

Joe—"Leather."

Dr. John—"And what is leather an oxide of?"

Joe—"Oxide of beef."

* * * *

To those who talk and talk
This proverb should appeal:
"The steam that blows the whistle,
Will never turn the wheel."

* * * *

Maud Muller on a summer's day
Raked the meadow sweet with hay.
The Judge came along in his motor car
And Maude deserted her rake right thar.

CAISSON DISEASE AND COMPRESSED AIR.

COMPRESSED air and its effects on men are familiar subjects to engineers in most of our large cities, where subways, railroad tunnels and deep foundations for buildings have involved a large amount of subaqueous construction. The danger which attends work of this character is great unless the lengths of shifts and the periods of decompression are intelligently regulated; but intelligent regulation must be based upon a thorough knowledge of how compressed air acts upon the human system, for it is only after such knowledge is acquired that adequate precautions can be taken to safeguard the lives of compressed air workers.

Dr. Leonard Hill, for the past fifteen years, has been among the most diligent investigators in this field, and the report of his experiments (page 362, Engineering Record, Vol. 63, April 1, 1911) merits the attention of all engineers engaged in compressed air work. His studies have involved extensive animal experimentation and, in order to determine the subjective effects of high pressures, he and Dr. Greenwood entered an experimental air chamber and withstood pressures as high as 92 lbs. Among the interesting features of Dr. Hill's work was the use of Oxygen to hasten decompression. It is well established that caisson disease is caused by the formation of bubbles of nitrogen which appear in the blood and interfere with circulation after decompression. Dr. Hill found that breathing oxygen helped to clear the nitrogen out of the system and he points out that by using oxygen and exercise in the air locks work might be done at a depth now considered dangerous. Oxygen should be used, however, only under expert medical advice. The conclusions as regards the use of oxygen are not final, and Dr. Hill is at present investigating this interesting point. Exercise during decompression is valuable in preventing cases of the bends, but as a matter of fact it is difficult to get men to exert themselves in the air locks after a hard six or eight hour shift in a tunnel or caisson if the uniform method of decompression is employed. In tunnels, however, it is an easy matter to put in more than one bulkhead and air lock, so that decompression will be accomplished in successive stages and the matter of exercise will be taken care of automatically by making the men walk from one lock to the next. This system was used with success in the Pennsylvania Railroad tunnels under the East River at New York, where work was done under a pressure as high as 40 pounds per square inch. In cassion work, unfortunately, the stage method of decompression is not so easy to apply.—*Engineering Record.*

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CONCRETE HIGHWAY BRIDGE OVER THE FRENCH BROAD RIVER.

THE Engineering Record of May 6, 1911, gives a description of the new reinforced concrete bridge across the French Broad River at Asheville, N. C.

The bridge has a length of 931 1-2 feet and contains nineteen spans of which the two principal ones are 145 ft. arch spans over the river. The remaining spans forming approaches to the arch spans are of the beam and girder type and vary in length from 21 to 59 feet. The deck is 34 ft. 10 in. wide in the clear, divided into a 30 ft. roadway, and one 4 ft. 10 in. sidewalk. The sidewalk, on the one side, and part of the roadway on the other, are carried on cantilever floor beams. The height of the floor above low water level is 50 feet.

The bridge was designed for two electric railway tracks, each carrying three 35-ton cars en train, and a 24 ton road roller, the the weight of which was assumed to be distributed through the paving and macadam over an area of 12 feet long and 10 feet wide. The rest of the roadway was designed to carry a load of 100 lbs. per sq. ft.

Each of the arches has a clear span of 145 feet, a rise of 42 feet, and consists of two fixed arch ribs carrying concrete spandrel columns which support a beam and slab deck system. The main arch ribs are spaced 23 ft. center to center and depth from 4 ft. at the crown to 7 ft. 9 in. at the springing line. The abutments of each rib are independent save for struts between them. The abutments, with one exception, as well as nearly all other foundations, rest upon rock, which was found from 3 to 8 ft. below the surface of the ground. The west abutment of one arch rib rests upon a wide grillage foundation made of 12x12 in. pine timbers placed side by side below the water line in two layers or tiers, and securely bolted together. The bed rock at this point was so far below the surface as to make the above type of foundation much cheaper than going to solid rock and the results have been perfectly satisfactory.

There are 13 girder spans at the eastern end of the bridge and 4 spans at the western end. The longest span, 59 ft., is over the main line of the Southern Ry., while a 43 ft. span bridges the side tracks of the same line. All the spans are of the same general type, consisting of square columns supporting longitudinal girders 23 ft. on centers, which in turn carry transverse floor beams, 6 ft. 6 in. center to center, and 6 in. floor salbs. All girders have knee braces at the columns, and the transverse beams are cantilevered to carry the sidewalk and part of the roadway.

The paving of the bridge consists of 15 in. of macadam, the top surface of which is bound by Standard Asphalt macadam binder applied hot at a rate of about 2 1-2 gal. per sq. yr.

The maximum compression stress was limited to 600 lbs. per sq. in., and the maximum tensile stress in the steel to 13,000 lbs. per sq. in. No tensile stress was allowed in the concrete.

The total cost of the bridge exclusive of right of way, legal and engineering fees, was $67,-799.34, an average of about $72.80 per lineal foot, or about $2.10 per square foot of clear floor space for roadway and sidewalk.

—*Engineering Record.*

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CLEARANCE CAR FOR THE PENNSLYVANIA RAILROAD.

A new clearance car has just been placed in service on the Pennsylvania Railroad. This car which is fully illustrated in the *Engineering Record*, Vol. 63, No. 13, April 1, 1911, was designed in the office of the Engineer of Maintenance of Way and built at the company's Altoona shops, and is being run over every division as rapidly as possible in order to secure correct measurements of the distances from the track to projecting portions of station building, tunnels, bridges and other objects. It is also designed to indicate automatically while moving on curves the elevation of the rails and the degree of curvature.

The car is 54 feet 8¾ inches long over all and 30 feet between truck centers, and is built entirely of steel. The main floor is 4 feet 5¼ inches above the top of rail and at the front end of the car, where the templets are located is a second floor at an elevation of 9 feet 8 inches above the top of rail.

All measurements are taken at the center of the wheel truck, from which clearances are computed. The main templet, which is erected directly over the center of the truck, has a width of 10 feet between elevations, 2 feet and 12 feet above top of rail, exclusive of the fingers or feelers attached to the sides. From an elevation of 12 feet above top of rail the templet recedes towards the middle of the car at an angle of 45 degrees reducing the width of the templet to 4 feet at the top at an elevation of 15 feet above top of rail.

Immediately in front of the main templet is constructed an auxiliary templet designed to measure overhead bridges, tunnels and other objects between elevations 17 feet and 20 feet above top of rail.

With all of the attachments working automatically it is possible to take clearance measurements while the car is running at a speed of four miles per hour.

Though two men can operate the new clearance car, one taking the readings of the scales and the other recording them, where clearances are close and irregular it requires the services of three men.—*Engineering Record.*

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RETAINING WALL FOR C. M. & ST. P. RAILROAD AT ELGIN, ILL.

THE Chicago, Milwaukee and St. Paul Ry. has just completed at Elgin, Ill., the construction of a large retaining wall of somewhat unusual design which is described in detail and fully illustrated by J. H. Prior, Asst. Engineer, C. M. & St. P. Ry., in the Railway Age Gazette of April 7th. The situation that confronted the railway company was to build a wall so as to keep the company's embankment and also the footing of the retaining wall itself within their right-of-way. The right-of-way at this station occupies a narrow strip of the west bank of the Fox River. The ground to the left of the right-of-way is occupied by a row of mills and factories which abut on the right-of way line and so the footing could not project to the left of that line. The wall could not be moved to the right in order to keep the footing from projecting beyond the right-of-way line, as it was necessary to maintain a certain distance of the side track from the right-of-way line, this distance being determined by the use made of the side track. Test pits showed the allowable bearing on foundation to be about two tons per square foot. Piles could not be driven as their driving would interrupt the use of the side track and disturb the foundations of the adjoining buildings.

To meet the above conditions five different types of walls were designed.

Type A.—Plain gravity wall with footing projecting on rear of wall.

Type B.—Reinforced retaining wall, cantilever type.

Type C.—Reinforced wall, buttress type.

Type D.—Cellular retaining wall filled with earth.

Type E.—A longitudinal wall supported on the outside by buttresses with slabs on top the whole forming a hollow retaining wall.

Each of the above walls was investigated for three conditions of loading, namely:

Cace I—Live load on side track only.

Cace II—Live load on main track only.

Case III—Live load on both tracks.

The type A has a maximum bearing on the toe of footing of 5,700 lbs. per sq. ft. and its cost per lineal foot of wall is $31.94. The maximum bearing of 5,700 lbs. on the toe was greater than the foundation would carry and hence was rejected.

Type B has a bearing of 5,470 lbs and cost $29 per lineal foot and was found unsuited for the same reason as type A; excessive bearing on the toe.

Type C is the ordinary buttressed retaining wall. The bearing on the toe of the wall was 5,-

970 lbs. per square foot, and the cost $29 per lineal foot. It was rejected for the same reason as the types before.

The type D, cellular wall filled with earth, is formed of two longitudinal curtain walls connected by transverse diaphragms. The vertical space between the parallel longitudinal walls and the transverse diaphragms is filled with earth. The maximum pressure on toe of footing for this type is 4,250 lbs. Its cost per foot is $42.15. The design was rejected on account of high pressure on toe.

The type E, which is a new type in reinforced concrete is an old type in stone masonry, having been illustrated in Benj. Bakers Actual Lateral Pressure of Earthwork, 30 years ago. The wall consists of a footing which supports longitudinal wall and the cross walls. The cross walls, which are spaced about 12 feet on centers, connect at one end to the longitudinal wall and at the other end support the girder which spans from one cross wall to another. Above the girder, the slabs are supported at one end by the girder and at the other by the longitudinal wall. The maximum pressure on the toe of the footing is only 2,580 lbs., which is only 61 per cent. of the next lowest and 43 per cent. of the highest. The cost is $42.75. This cost is greater than that of any other type, but as it was the only one suitable for the situation, namely, where the retaining wall must give full use of right-of-way and have low bearings on the toe of the footing it was adopted and built.—*Railway Age Gazette.*

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THE QUEBEC BRIDGE.

THE contract for the construction of the superstructure of the Quebec bridge has been awarded to the St. Lawrence Bridge Co., of Montreal, a Canadian concern, being a combination of two Canadian bridge companies, the Dominion Bridge Co., of Montreal, and the Canadian Bridge Co., of Walkerville, Ontario. The contract price is about $8,650,000.00, this sum and the contract price for the substructure make a total of about $12,000,000.00. It is expected the bridge will be finished by 1915. In addition to the St. Lawrence Bridge Co., three other firms tendered bids on this work, the Maschinenfabrik Augesburg-Nuonburg Aktien Gesellschaft, of Gustavsburg, Germany; British Empire Bridge Co., of Montreal, and the Pennsylvania Steel Co., of Steelton, Pa. Tenders were based on the plans and specifications prepared by the Board of Engineers in charge of the work, but contractors were granted the privilege of preparing plans of their own, if they should so desire, and submitting tenders thereon. Three of the above firms availed themselves of this privilege; the St. Lawrence Bridge Co. in fact, submitted seven different plans with tenders, in addition to tendering on the Boards plans.

The official plan upon which tenders were called was for a cantilever bridge with anchor arms and cantilever arms of the same length, and the erection was to be by cantilevering out the suspended span. Five modifications of this design were also prepared by the Board, a tender on any of the six propositions being considered a tender on the Board's design. Two of these schemes were based on erecting the suspended span by cantilevering out, while the remaining four were based on erecting the suspended span at an adjacent site and floating it into position.

The design approved by the majority of the Board as well as the additional experts appointed by the government, was one submitted by the successful contractors, it being the opinion of the engineers that this design contained several features, particularly in respect to erection, that rendered it preferable to the designs prepared by the Board.

The design is to have the K web-system in the cantilever and anchor arms, the suspended span being a modified Pratt. All members in the anchor arm and those immediately over the main pier, as well as the floor system, are carbon steel, the cantilever arms and suspended span being of nickel steel. The top chords are composed of built-up riveted members extending over one full truss panel or two floor panels.

The suspended span is 640 feet long, 110 feet deep at the center and 70 feet at each end. The cantilever arms are 580 feet long, 70 feet deep at the end and 310 feet high over the main post. The anchor arms are 515 feet long, as at present designed. The trusses are 88 feet apart and there is a clear head-room of 150 feet above extreme high water. The total length is about 3228 feet.

The bridge will be designed to accommodate two railway tracks and two sidewalks for foot passengers, the government having decided that no accommodation will be provided for highway traffic. The train load allowed on each track will be equivalent to two E 60 engines followed by a train load of 5000 lbs. per lineal foot of track.

The length of span has been slightly increased over that originally proposed by the Board, being now fixed at 1800 feet, being the same as the original span. This increase was brought about by a rearrangement in the manner of sinking the caissons, thus allowing the center line of the new bridge to remain coincident with that of the old bridge. The old main piers will not be used, but will be taken down to lower water level, the stone being reused in the new piers.

—*Engineering Record.*

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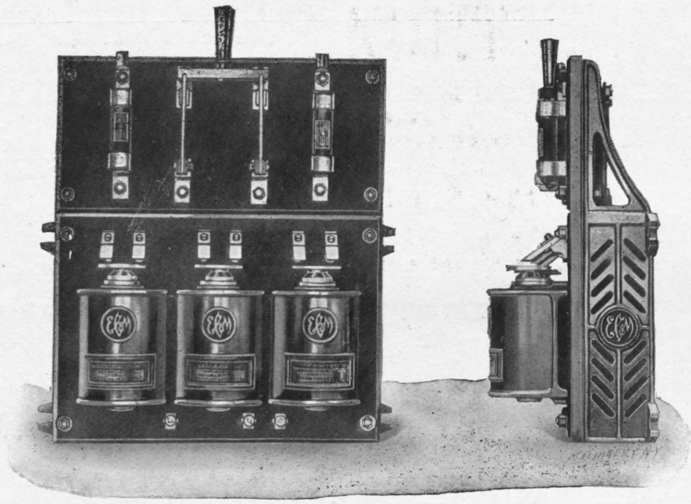

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