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THE ROSE TECHNIC.

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DEPAUW affords an amusing spectacle in her vain endeavors to vindicate her hasty action in withdrawing from the I. I. A. A.

Wildly catching at any visionary reason to support herself in her unfortunate attitude she angrily turns upon our athletic association and upon THE TECHNIC as though Rose were to blame for her unenviable position and responsible for the actions of the I. I. A. A.

So ludicrous is the attack upon us that it seems but childish chaffing to answer it, yet out of respect for the University which our contemporary represents and which is supposed to contain students other than pessimists and anarchists, we will make an effort to point out his error, hoping that all his reasoning faculties have not been carried away by the flights of his own oratory.

First, however, we should mention that we were laboring under a wrong impression at the time of writing our last editorial. Thinking the delegates were alone responsible for the surprising action we stated that "their action was pettish and unworthy of the institution which they represented." This we retract as we have done these gentlemen an injustice since we find they were but executing the orders of those who are highest in the management of DePauw's athletic affairs. But we do not transfer this mild censure to the DePauw athletic officials since it would be utterly inadequate to express our opinion of the course which they endeavored to pursue.

The DePauw Weekly opens this discussion with the peculiarly illogical statement that " * * * it surely needs no proof that Butler directly infringed the constitution when she played the game of last Thanksgiving." Right here we would beg leave to differ. It is true Butler played the game with the Light Artillery on Thanksgiving day, but it is absolutely absurd to say she directly infringed upon the constitution thereby, since the only words in the constitution which even remotely touch upon the case are the following:

"The Thanksgiving day game shall be played at Indianapolis between the two teams standing highest the year before. The net proceeds of the gate receipts to be equally divided between the contesting teams after 1892. * * *"

How DePauw construes this to mean that Butler, or any one else was prohibited from playing football in Indianapolis on Thanksgiving day is a mystery. Butler was censured for being inconsiderate, but she was not censured for having violated the constitution. Most preposterous was the demand which DePauw made, namely, that Butler be suspended from the association for the remainder of the year. Thus prohibiting her from base ball and track athletics but reinstating her in time for the next foot ball season. Indeed the DePauwite's idea of justice is wondrous strange, according to it the supposed misdemeanors upon the gridiron must be avenged upon the diamond and the track, but the gridiron suffers not one whit. And since our delegates mentioned in the discussion this injustice, DePauw asserts that this

alone prompted us to vote against the expulsion of Butler; that moved only by our own selfish interests we refrained from joining in her rascally attempted injustice towards Butler. Need we brand this as a fabrication? Does DePauw mean to say that we would at any time, either with or without a prospect of Field Day, lend our aid towards suspending a member who has violated no law of the association? If so she is mistaken. We of Rose have not had our consciences dulled by a law school training and therefore cannot array ourselves with equal advantage for the wrong as for the right. We are pleased that our delegates were upon the side of honest and fair legislation, and would have been greatly chagrined should they have aided DePauw in her pernicious intentions.

The matter now assumes the aspect of a malicious scheme on the part of DePauw to damage the I. I. A. A. if not to disrupt the organization. Did we term such action as pettish? Indeed the expression was by far too mild.

The Purdue delegates we understand were particularly gentlemanly during the convention, in marked contrast to those of DePauw, nor have we heard them railing and ranting, though they were as much concerned as DePauw.

Such disdain as the recent Legislature and DePauw have shown for all customs of Legislative bodies bespeaks a brilliant and spectacular career for dear old Hoosierdom. It is indeed to be regretted that any Indiana college should have so proclaimed its contempt for the American methods of government, or should have exhibited a disregard for all law and order worthy only of a band of train grabbing Coxeyites.

* * *

OUR quarter-mile track has proven to be an inspiration to our athletes, and for the past several afternoons the soft, slanting rays of the setting sun have lent an additional beauty to the stirring scene upon our campus. There glisten the wheels under our cyclists who rapidly cover their ten or twelve miles in training "for wind." Here are sprinters of all classes dashing over their hundred yards or plodding at less rapid pace for the longer runs, while the more methodical pedestrian strides along apparently all absorbed in his arduous task. All are enthusiastic over the new arrangement, and this enthusiasm of the track athletes seems to put new energy into the devotees of the diamond and the tennis court.

But now for a gymnasium! With this provision for winter training our athletic equipment will be complete; and complete in this particular it soon will be, for the success of the gymnasium enterprise is assured since the students have come forward with hearty support and liberal donations. The alumni are not doing their part, however. Those who have subscribed have been more liberal than was expected, and we feel sure of the interest of our alumni in their Alma Mater, but they seem afraid of taking the initiative and wish the students to complete their donations first. What nonsense is this! Can not every man decide what he can pledge himself to give without respect to what his classmates or the under-graduates or any one else can afford to donate? As above stated, the students have supported the cause much better than was expected, and within the next ten days the canvass of the school will have been completed. Then we must patiently await the pleasure of our alumni to send in their little slips of paper with some half dozen words written upon them. A deal of labor it is to do such an amount of chirography, and of course it takes much valuable time for any one to complete the task! Verily, the amount of puffing and blowing and snorting and coaxing which it takes to get the alumni of Rose Polytechnic to do anything whatever would exhaust the patience of Job. Now the alumni should send in their pledges—to be redeemed next January—within the next two weeks. And why not do so and have done with the whole affair as far as they are concerned?

* * *

ANOTHER Field Day of which to make a great success! This means work for all, and not only for the athletes. The committee on nominations has been appointed and their selection of other Field Day committees will be made shortly. But if you should not happen to be appointed

upon any committee do not let this deter you from offering your assistance whenever an opportunity is afforded. This especially applies to the Sophomores and Freshmen who should now take their first lessons in the management of a Field Day that they may profit by their experience when such matters will devolve more directly upon them in the future.

* * *

MR. QUINN, the lecturer, makes a sweeping accusation against the Polys in one of the Terre Haute papers. His statement that "there is gambling among the Polys" brings to the minds of many people visions of tender youths being fleeced in gambling dens and of students neglecting their studies for the exciting games of chance. We may say that nothing of this sort is carried on among the students, while it is only the minority that indulge in billiards or matching stray pennies. Mr. Quinn does not stop with this statement founded only on hearsay, but upon the strength of it attacks the faculty for allowing this supposed state of affairs to continue. We are in sympathy with the gentleman in his crusade against gambling but cannot appreciate such rash statements as these which are damaging to the students as a body, to the reputation of the Institute and are especially hurtful to the cause for which he is laboring.

* * *

THE thirteenth annual catalogue of the Institute has appeared. The opening pages have a most familiar aspect, and even the "well lighted room in the basement" paragraph still remains intact, after some eight years of continuous useage. Lecture courses and Senior trips are still to be hopefully looked forward to. However, the catalogue has been greatly improved and brought up to date by having the various "departments" rewritten. We might remark that the Seniors are rather impatiently waiting for the lectures to materialize, it having been particularly emphasized early in the year that the lectures could certainly be expected.

GRAPHIC TABULATION.

BY PROFESSOR MALVERD A. HOWE.

In nearly every issue of the various engineering periodicals there is found a diagram or a graphic table either illustrating some particular series of experiments or representing some formula in constant use by engineers. It is unnecessary to more than mention that these diagrams are educators as well as time and labor savers. A diagram illustrating a series of experiments shows at once the effects of various changes in the conditions governing the problem in a manner to be obtained by no other device. If the diagram represents some formula, the engineer can tell at a glance what effect any change in a function will have upon the conclusion he is working for.

It is not the purpose of this article to discuss the utility of such diagrams, but to indicate in a brief manner how some of the formulas in common use can be graphically tabulated with but little labor and yet have the results obtained from the diagrams quite accurate enough for all practical purposes.

It will be assumed that rectangular co-ordinate paper is to be employed.

Take the well-known formula for rectangular wooden beams subjected to cross bending

$$M = \frac{1}{6} R\, bd^2$$

In which

M=the bending moment (inch pounds),
b=the breadth of the beam (inches),
d=the depth of the beam (inches), and
R=the allowable stress per square inch in the extreme fibre (pounds).

In practice it is more convenient to express M in "foot pounds;" then this equation must be written as follows:

$$M' = \frac{1}{72} R b d^2$$

Given the values of M′ and R, the values of b and d are required.

R has many values depending upon the structure in which the beam is to be placed, the kind of wood composing the beam and the factor of safety employed by the engineer. The values of d usually run in even inches.

Now if the values of M′ are taken as ordinates and those of d as abscissas, for each value of Rd (where d may be assumed as unity) there must be drawn a curve, which is a parabola, requiring considerable labor in first computing the ordinates and then laying them off upon the paper. Such a diagram is very useful and, without one easier in construction, well repays the labor of its formation. But these curves can be dispensed with by taking the values of Rb as abscissas when the parabolas are replaced by right lines, one being drawn for each value of d. Such a diagram shows at a glance, for any value of R the value of d required for a beam *one inch wide* to resist a known moment.

The general formula for beams, of which the above is a special case, is

$$M = \frac{2RI}{d} \text{ or } M' = \frac{1}{6}\frac{RI}{d}$$

where M′=the moment (foot pounds) and I=the moment of inertia.

Given M′ and R it is required to determine I and d. Transforming the equation

$$\frac{I}{d} \quad \frac{6M'}{R}$$

If the values of $\frac{I}{d}$ be used as abscissas and those of M′ as ordinates, for each value of R a single right line is required to give all the values of M′ for any given values of $\frac{I}{d}$. This diagram is easily constructed and is very useful in proportioning iron and steel beams where the values of I and d are given in the various hand-books published by manufacturers, etc.

The above formulas are quite simple and require but a limited number of computations for the formation of diagrams very extended in application.

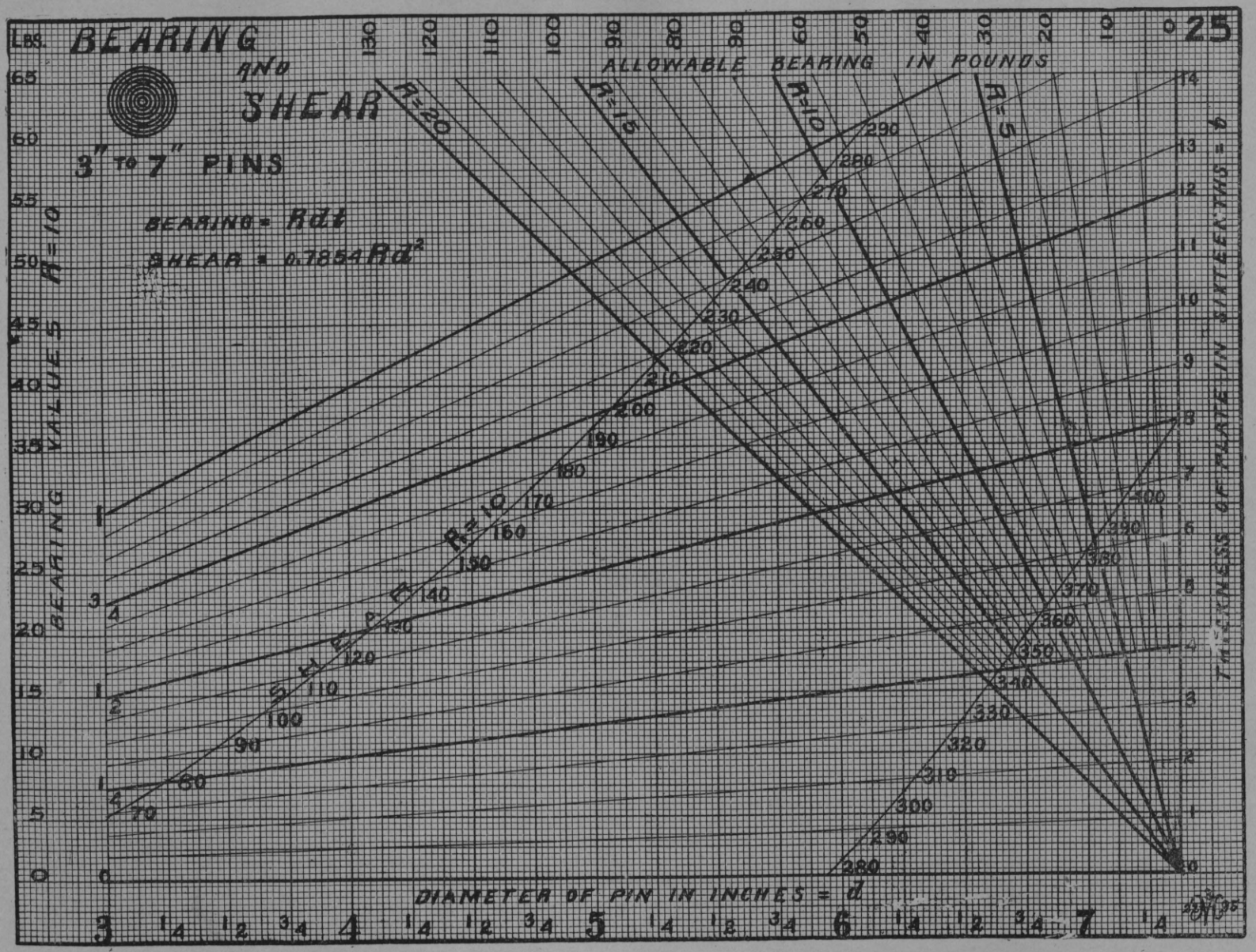
The bearing values of pins for various thicknesses of plates are constantly required in proportioning metal structures; these are obtained from the formula

Bearing = B = R d t, where
R = the allowable bearing per square inch (pounds),
d = the diameter of the pin (inches), and
t = the thickness of the plate (inches).

For a given value of R a diagram can be formed by laying off the values of B as ordinates, the values of d as abscissas, and representing the various thicknesses of plate by a single right line for each. This requires a diagram for each value of R, and as R varies considerably with different specifications, the number of diagrams would soon become large. This difficulty can be overcome by first assuming R=10000 and then constructing a diagram according to the suggestions given above. The values of B can now be multiplied by the proper factor obtained by dividing the given value of R by 10000; to do this graphically requires but a single right line for each value of R, hence it is a simple matter to construct a diagram which will enable the bearing values of any plate upon any pin with any value of R, to be obtained almost instantly, thus making the diagram applicable to all specifications.

To illustrate the construction of such a diagram, Plate Twenty-five of a series of graphic tables is presented. This diagram includes pins from 3″ to 7¼″ in diameter, inclusive. A few examples will show the application of the diagram to practical problems:

Ex. 1.—Given a pin 5″ in diameter, how thick must be the bearing plates to carry an ultimate


BEARING
AND
SHEAR
3" TO 7" PINS
BEARING = Rdt
SHEAR = 0.7854 Rd²
ALLOWABLE BEARING IN POUNDS
BEARING VALUES R=10
THICKNESS OF PLATE IN SIXTEENTHS = t
DIAMETER OF PIN IN INCHES = d
R=20
R=15
R=10
R=5
Lbs.
25

stress of 60000 lbs. when R=12500?

Enter the diagram at the top with 60000 and follow downward this ordinate until it cuts the inclined line corresponding to R=12500 (midway between R=12 and R=13), thence follow the horizontal to the left until it cuts the ordinate corresponding to 5″ as marked at the bottom of the diagram. This point is a little above the inclined line corresponding to a $\frac{15}{16}$″ plate; hence a 1″ plate must be employed.

By formula, $t=\frac{60000}{12500\times5}=0.96=\frac{15.36}{16}$.

Ex. 2.—If B=50000, t=$\frac{1}{2}$″ and R=15000 lbs., what must be the value of d?

Enter the top of diagram with 50000 and follow downward the ordinate until it cuts the inclined line where R=15000, thence follow the horizontal until it cuts the inclined line corresponding to t=$\frac{1}{2}$″; this point lies in an ordinate corresponding to a pin less than $6\frac{11}{16}$″ and greater than $6\frac{10}{16}$″ in diameter, hence a $6\frac{11}{16}$″ pin is required.

By formula, $d=\frac{50000}{15000\times0.5}=6\frac{2}{3}=6\ \frac{10.66}{16.}$.

The above cases briefly illustrate the construction of right line diagrams. Often it is not possible to represent a formula by right lines alone and then curves are employed. One example will be sufficient to illustrate the construction of such diagrams.

Take the hydraulic formulas for the flow of water in circular conduits

$$v=\frac{64.4\ d}{1.505\ d+c\ v\ l}$$ and $Q=A\ v$, where

v=the velocity of flow (feet per sec.),
d=the diameter of the conduit (feet),
l=the length of conduit in feet falling one foot,
c=a factor depending upon v,
A=the area of the conduit (square feet), and
Q=the discharge (cu. ft. per sec.)

In sanitary work the grade or fall and the discharge are usually known and there is required the diameter of a conduit which will, if laid upon this grade, discharge the given volume at a reasonable velocity.

Now, the diameters of the conduits are practically standard and vary by even inches, hence the diagram need contain but one line for each diameter and this may be curved as no interpolation will be required. If the values of v be laid off as ordinates, those of Q as abscissas, a right line drawn for each grade likely to occur and then the curves for the different diameters drawn, the resulting diagram will show by inspection the velocity and discharge for any conduit laid at any grade. The construction of such a diagram is not very tedious after the necessary computations have been made.

The application of the formula directly in practice demands too much time and as a result tables have been computed which are necessarily somewhat limited in scope. If the labor employed in computing tables is used in deducing a few values separated by equal steps and a diagram constructed, no more energy will be consumed but the result will be far superior in range and utility.

Before constructing a graphic table, the formula must be studied and those quantities determined which may require interpolation in practice and an attempt made to represent these functions by right lines or as ordinates. Standard dimensions can be represented by curves without injuring the utility of the diagram.

The application of graphics to tabulation is exceedingly varied and the above is only a hint to aid those interested in such problems.

COKING METHODS.

BEST PRACTICE IN THE CONNELLSVILLE AND POCAHONTAS FLAT-TOP FIELDS.

Coke-making is done much by "rule o'thumb," and the hit or miss methods employed are calculated to make shivers of horror course up and down the back of the technical man, with his careful and accurate training.

When we consider the vast improvements in the other processes involved in the manufacture of steel, coking is still in its crude and primitive infancy. It is only within the past few years that the patentees of the Otto-Hoffman and the Solvay processes have taken any steps looking to a more scientific method of manufacture and to a saving of the valuable by-products. Think of the improvident waste in the Connellsville region alone, with its 17,000 ovens, of the gas, tar, ammonia, &c. But it is hardly probable that the above processes will soon supplant the old methods now in use, owing to the greater first cost of the ovens and the necessity for high priced skilled labor to run them. The present method briefly outlined is as follows: The coal, without weighing or measurement, but the amount simply guessed at, is charged into hot ovens, the doors closed by means of brick and mud, leaving only a small space to supply air. The charge is allowed to burn for from 48 to 72 hours, the coal melts and runs together or cakes and the volatile matter is driven off. The hot coke is then cooled off with water, drawn out of the oven and loaded in railroad cars for shipment to the furnaces and foundries. This process is then gone over again and again. The above is the usual method in use, the variations being only slight and made necessary by the character of the coals used.

COALS.

The Connellsville region is the oldest coke field in this country and for that reason is the standard by which other regions and their product are compared. Its coal is a true coking coal, rich in bitumen and low in sulphur, soft and (aside from the two binders usually present) free from slate and faults, so that it can be easily and cheaply mined. This softness and a liability to find gas in the mines prohibits the use of powder in mining. This coal is part of the Pittsburg seam and occupies the *Blairsville (or Connellsville) synclinal*, a trough lying west of Chestnut Ridge and east of the *Blairsville* and *Fayette anticlinals* and extending through the counties of Westmoreland and Fayette in Pennsylvania on across the West Virginia line.

The following table will show the chemical composition and is compiled from a great number of analyses from various sources.

	Average six analyses. Second Geological report, Penn.	Average 20 samples across the seam. (Wiley.)	Selected sample coal. J. S. Carey, chemist, World's Fair.
Moisture	1.00	1.02	.65
Volatile Matter .	30.0 to 34.0	29.71	32.05
Fixed Carbon . .	59.0 to 64.0	62.70	62.55
Ash	3.5 to 6.0	6.57	4.35
Sulphur	1.00	1.34	.40

On the other hand, the Pocahontas Flat-Top coal is not a true coking coal, but rather a steam coal (considered one of the very best, as it is used by the great ocean liners and always employed by the Cramps in the official trials of war vessels to determine the speed premiums). It is much harder than the Connellsville coal, so that powder can be used in mining it; it is also a drier and "leaner" coal (not having so much volatile matter or bitumen) and is remarkably free from slate. The percentage of sulphur and phosphorus is low. In the Pocahontas region, now about thirteen years old, coke-making is only a side issue, a necessity forced on the operator to get rid of his slack. This field is traversed by the Flat-Top Mountains, whence its name, and as it is now developed is confined to the counties of Mercer and McDowell in West Virginia and Tazewell county in Virginia.

The following table shows its chemical composition.

	Average 40 samples across the seam. (Wiley.)	Selected sample. J. S. Carey, chemist, World's Fair.	Selected sample. McCreath, Penn. state chemist.
Moisture	.65	.60	.59
Volatile Matter . . .	18.52	20.02	17.99
Fixed Carbon . . .	74.92	75.88	77.64
Ash	5.91	3.05	3.17
Sulphur	.431	.450	.612

Bearing the differing characters and compositions of the two coals in mind, a description of the best coking practice will be detailed in each case, with the precautions to be observed.

CONNELLSVILLE PRACTICE.

This coal, being rich in bitumen and volatile matter, melts, runs together and cakes or cokes quite readily, so that run of mine coal is used, however, better and more uniform results are obtained if the coal is mined fine, the larger lumps should not exceed the size of "stove" anthracite. This will allow the lumps, which always run to the sides of the ovens, a better chance to coke, thus preventing the formation of spongy coke. The oven best suited to the coking of this coal is the common bee-hive oven, a drawing of which is shown in Fig. 1. The best results are obtained with ovens 12½ feet in diameter and with a 7-foot crown; the bottom should be of 3-inch tile and have about 7 inches fall from the back to the door of the oven. This gives the surplus water, due to careless watering, a chance to escape and makes the drawing of the coke less laborious.

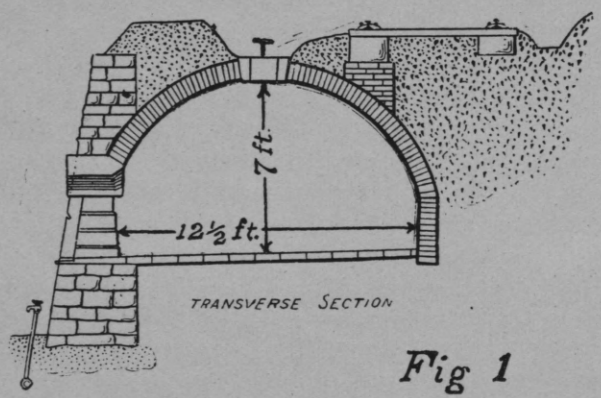
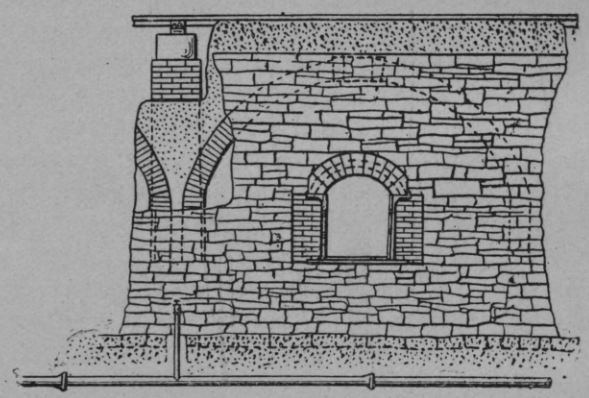


Fig 1



STANDARD 12½ FOOT BEE HIVE OVEN.

The coal should be charged, through the trunnel head (T), into the ovens, which must be in good repair, hot and have all the coke and ashes of the previous burning carefully scraped out. The door had previously been bricked up half way, now the coal is leveled with an iron scraper, *i. e.* pushed clear up against the walls of the oven. To get good results the charge should be perfectly level and even a little higher next the walls than it is in the middle of the oven, for the reason that

the coal, when charged, packs in the center, thus making more coal there than around the walls which prevents the charge from burning uniformly, raw coal being a result.

The door is then bricked up and loam plastered over it, leaving an air space of from 1 to 2 inches at the top between the bricks and the arch of the door. The size of this air space is determined by the character of the weather, being less in stormy and windy than in mild and calm weather. If the draught is too strong the flame will be blown off the oven and the charge will not burn properly. The oven should be burned with an air as heavy as the weather will permit until within five or six hours, and longer for heavy charges, of the time the coke is to be drawn, the blaze will then be off and the coke apparently ready to be drawn; if, however, the oven door is closed up tightly and the air cut off, the smoke and flame in a few minutes will blaze out of the trunnel head. By this means the coke will be burned clear down to the bottom of the oven, getting rid of impurities and spongy black butts which otherwise would remain with it and spoil its quality.

When the oven is down all the bricks in the door are removed, this prevents the surplus water being held and the bottom thereby chilled; the front coke is watered out so that the drawer can get up to the oven and work with some degree of comfort. A hose with a 16 or 18-foot pipe nozzle should be used. Then starting at the back of the oven and watering towards the front (by this means a large excess of water is prevented as the hot coke absorbs the excess as it flows forward, thereby keeping the bottom of the oven from being chilled and the oven hot) until all the fire is out of the coke. The hose should be held in the hand all during the watering.

After the coke is cooled down it should be allowed to stand for a few minutes to steam and dry, then if the fork is slightly shaken the ashes will fall off. The coke is now drawn out of the ovens with an iron scraper and loaded by means of wheelbarrows and forks into railroad cars for shipment to the furnace and foundry consumers.

POCAHONTAS PRACTICE.

This coal being a steam coal and not a true coking variety requires some modifications of the Connellsville practice, and a much hotter oven. The style of oven giving the best results is the bottom flued Welsh oven (a sketch which is given in Fig. 2) 12 feet long, 6 feet wide and 5½ feet high at the center of the arch. By this flue device the otherwise waste heat is utilized, keeping the bottom and back wall hot, thereby insuring harder and brighter coke. These flues cause the charge to burn from the bottom upward in addition to the usual downward burning of the ordinary oven, the result is a parting about midway between the top and butts of the coke which is no drawback in the quality of the coke. Slack, instead of run of mine, coal must be used, that passing through a ⅜-inch mesh screen gives the hardest and best grained coke. The ovens should be perfectly

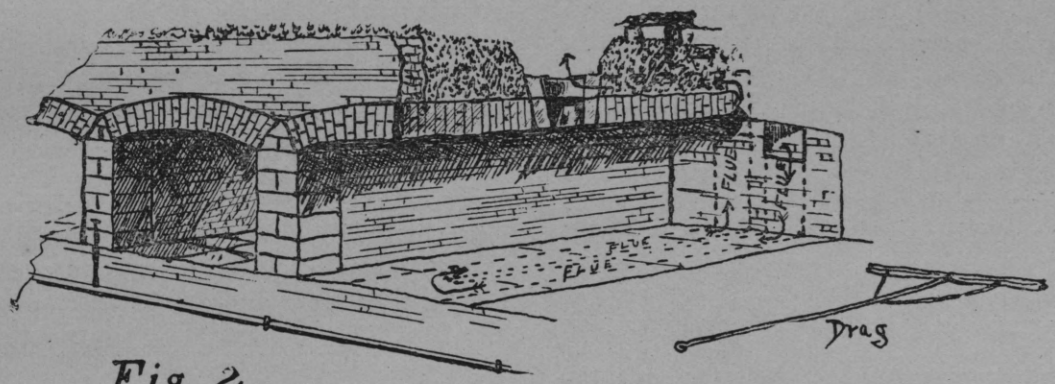


Fig 2.

SKETCH SHOWING ARRANGEMENT OF FLUES IN WELSH OVENS.

clean and very hot. A drag, (see Fig. 2), consisting of a piece of rail 5 feet long to which is welded a rod 12 feet long with an eye on the free end, is placed in the oven and the coal charged upon it. The oven is leveled, the door bricked and daubed as in Connellsville practice, except the ovens are given much more air. The air is gradually shut off (as otherwise the coke cuts away, burning at the expense of the carbon) until the oven is daubed up tight from 6 to 12 hours before the coke is to be drawn. When the oven is down and ready to be drawn the door is removed and the coke watered out enough so that the drag can be handled and will be cold and strong enough to work with. A chain is now hooked into the eye of the rod and, by means of a movable windlass at the edge of the yard or an engine (either locomotive or stationary) and a series of sheave wheels, the whole charge is drawn out on the yard. The watering is now completed, this open air watering blackens the outside of the coke but does not affect its quality, and the coke loaded for shipment. A discussion of the comparative commercial value and the behavior of the two cokes in the furnace and foundry practice is hardly within the scope of this article.

The table given below shows the comparative chemical composition of the two cokes.

CONNELLSVILLE.			POCAHONTAS.	
Selected sample J. S. Carey, chemist, World's Fair.	Average 25 samples. (Wiley.)		Selected sample J. S. Carey, chemist, World's Fair.	Average 27 samples. (Wiley.)
.10	.17	Moisture	.10	.44
.80	1.09	Volatile Matter	2.20	1.22
92.03	89.29	Fixed Carbon	91.51	92.57
6.25	9.45	Ash	5.40	6.07
.82	1.015	Sulphur	.79	.698

W. B. WILEY, '89,

MT PLEASANT, PA.

BESSEMER STEEL.

"Direct metal" is now used at most of the larger Bessemer plants in this country, the molten metal being taken in ladles direct from the blast furnace to the steel mill instead of being first cast in beds and then remelted in cupolas. The saving of this plan as regards fuel, labor, cupola plant, etc., is obvious. To insure more uniform product it is customary to take the "hot" metal from several furnaces to one or two "mixers" and tap from there as the mill requires. The mixers at South Chicago are large horizontal cylinders receiving metal from above at one end and tapped from a lip on the side by partially revolving. They may hold as much as 250 tons. The iron is kept molten by its own heat or, if necessary, oil is burned over the surface. Cupolas are used in connection with direct metal to melt up Sunday iron, etc.

The molten metal, tapped from the mixer into a ladle is transferred to the steel mill and poured into the converter. This is turned up and blown till the carbon is practically all gone when it is turned down, the recarburizer added and the metal poured into the casting ladle or sometimes first into an intermediate ladle. The casting ladle is transferred from the receiving crane to the casting crane and the steel "teemed" into iron moulds around the pit. After solidifying or in about 10 minutes the ingots are "stripped" by the ingot cranes and then placed on cars and taken to the rolling mill. A successful mill must be designed to work fast and handle immense quantities of molten and red hot material with rapidity and precision. The relative merits of two and three vessel mills has been a subject of considerable discussion. Delays due to changing bottoms, relining vessels, etc., are certainly less serious with three vessels than with two and the three vessel mill works smoother and is capable of larger output. The best record for an American three-vessel mill is 110 "heats" in twelve hours! Ten to twelve tons is the usual capacity of modern converters.

The intense heat developed during the blow is due to the oxidation of the silicon, carbon and manganese in the iron and the combustion of some of the iron itself. For various reasons it is desirable that the temperature of the blow—judged by the appearance of the flame—should be neither too high nor too low. If the former, steel scrap is added to the converter or steam is introduced into the blast. Both have a cooling effect

and by their use it is possible to blow very hot iron, that is iron high in silicon; but the silicon limits for best work should probably be from 1.00 per cent. to 1.50 per cent.

The appearance of the flame varies greatly as the blow progresses. At first it is small and yellow with sparks of burnt iron. It then pales and increases in size and when the silicon is nearly all gone becomes large, dense and white. The carbon then starts to go and the flame becomes transparent with a bluish tinge and when the carbon is practically all gone there is a sudden drop, not easily distinguished except by an expert, and the converter is turned down. The right amount of spiegel is then added in the vessel to give the steel the required composition, or in case soft steel is being made, ferro-manganese is used, usually added in the ladle however. The length of blow will depend on the amount of impurities present in the iron, the pressure of the blast, weight of charge, etc., but in established practice the silicon is the most important variable, 1.00 per cent. Si taking 9 to 10 minutes, 1.50 per cent. 13 to 15 minutes. The tendency at present is toward lower silicon, thus allowing more rapid work. In the acid Bessemer process the sulphur and phosphorus are not removed but owing to concentration are somewhat higher in the steel than the iron. Rail steel for the heavier section at South Chicago will generally have about the following composition—C .42 per cent., Si .100 per cent., Sul .045 per cent., P .084 per cent., Mn 1.00 per cent.

As illustrating the manner in which the non-ferrous elements are removed during blowing, a table is added giving analysis of metal and slag at different periods of a blow made at South Chicago, August, 1890. (See Trans. American Inst. of Min. Eng. Vol. XIX, page 1127).

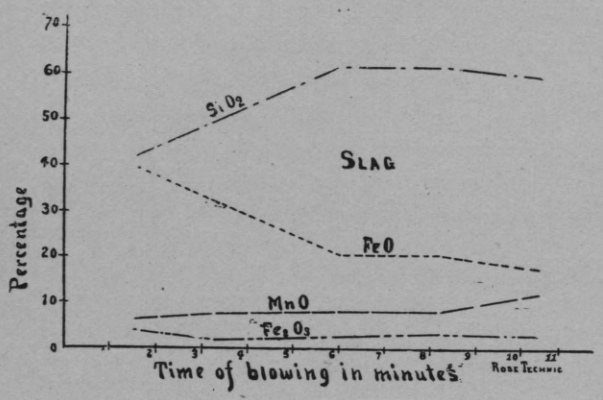
The diagrams with time for abscissa and per centage for ordinates illustrate the table. The vessel was turned up for 10 seconds after the spiegel was added. This is not now the practice.

The Mn, C and Si in the blown pig plus the amount of these elements in the spiegel more than equals their amount in the steel. The loss is due to the "spiegel reaction" by which the oxide of iron dissolved in the blown pig is reduced by the Mn. C and Si of the spiegel, the MnO and Si O_2 thus formed going into the slag, while the CO is dissolved in the metal or burns on the surface. Mn is of course the important reducing agent and high Mn in steel insures the absence of FeO. Allowance must be made for this loss in determining the composition of the spiegel mixture and the quantity necessary to be added. With the varying conditions found in steel mill practice it requires careful watching to keep the chemical composition within the required limits.

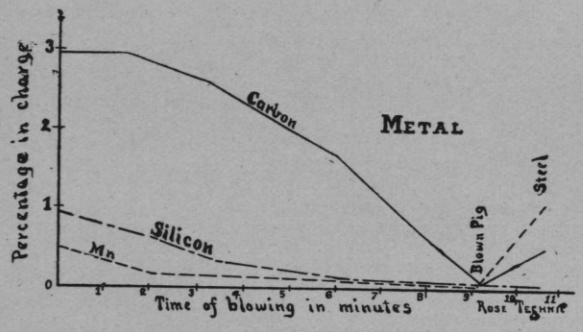
REMOVAL OF NON-FERROUS ELEMENTS—F. JULIAN.

	INITIAL CHARGE.			TIME OF ACTUAL BLOWING.						
	Molten Metal 21,500 lbs.	Steel Scrap 1,000 lbs.	Average.	2 min. 0 sec.	3 min. 20 sec.	6 min. 3 sec.	8 min. 8 sec.	9 min. 10 sec.	Spiegel, 2,500 lbs.	Steel.
Carbon	3.10	.36	2.98	2.94	2.71	1.72	.53	.04	4.64	.45
Silicon	.98	.08	.94	.63	.33	.03	.03	.02	.35	.038
Manganese	.40	.97	.43	.09	.04	.03	.01	.01	14.90	1.15
Phosphorus	.101	.10	.10	.104	.106	.106	.017	.018	.139	.109
Sulphur	.06	.08	.06	.06	.06	.06	.06	.06		.059
Silica	Slag			42.40	50.26	62.54	63.56	Flame drops		62.20
Alumina				5.63	5.13	4.06	3.01			2.76
Ferrous Oxide				40.29	34.24	21.26	21.39			17.44
Ferric Oxide				4.31	.96	1.93	2.63			2.90
Mang. Oxide				6.54	7.90	8.79	8.88			13.72
Lime				1.22	.91	.88	.90			.87
Magnesia				.36	.34	.34	.36			.29
Phosphorus				.008	.008	.010	.014			.010
Sulphur				.009	.009	.014	.008			.011

The physical condition as temperature of blowing and teeming, condition of vessels and ladles, the appearance of the steel and its behavior in the moulds require constant attention.



The escape of gas, nitrogen, hydrogen, and carbonic oxide, probably mostly from solution, during the solidification of an ingot leads to the formation of blow holes and under certain conditions with different kinds of steel to metal that will rise or scatter in the mould. These phenomena, as well as piping, if not kept within bonds, lead to unsound ingots.



The tendency of the non-ferrous elements to segregate toward the last freezing point of the ingot, the upper central portion, leads to heterogeneous steel. While segregation is often of alarming extent, yet in regular work it is usually kept within reasonable limits.

B. R. PUTNAM, '92.

SOUTH CHICAGO.

A METHOD FOR TAKING LARGE CURRENTS FROM HIGH VOLTAGE MACHINES FOR THE CALIBRATION OF AMMETERS.

It is frequently desirable to calibrate the heavy current main ammeters of power machines, but owing to the variations of the current sent out in regular service this calibration is difficult or impossible in case a standard current meter, such as a Thomson balance or Siemens dynamometer, is used as the calibrating instrument.

The following method is used at the Louisville Electric Light station with complete success:

The meter requiring adjustment is operated by its own dynamos with a Siemens dynamometer in circuit with it, (usually cut in at the main fuse blocks) and a time is taken when the dynamo is not carrying a load—that is, the day machines are calibrated at night and the night machines during the day. The dynamo and meters are short circuited by twisting a heavy wire around the bus bars of the switch board. The shunt field winding circuit is opened near the rheostat and a small water rheostat is put in the field circuit. This rheostat is a brass can 2″ x 5″ with a triangular brass electrode dipping into the water. The water nearly fills the small can and the dipping electrode is hinged on a wooden support so that its depth in the water can be varied from a point until the base of the triangle is covered. Sometimes a little salt is added to the water to increase its conductivity. The series coils of the generator are short circuited by a heavy jumper, which must not, however, be too heavy as a small amount of compounding is necessary.

The current may then be run up as high as desired, or to the limit of the dynamo, by pushing the electrode deeper in the water. A machine thus arranged usually gives 10 to 20 per cent. of its current with the shunt field open.

An example of this method may be of interest:

No. 5, 500 volt generator ammeter was calibrated by the writer in one hour and fifteen minutes, March 5th. This machine is a 500 horse

power, direct connected, Westinghouse generator, giving 700 amperes at 550 volts.

The switch board bus bars were short circuited with 5 feet of No. 4 wire. A water rheostat as described above was used, and the compounding coils of the field were short circuited with a piece of 0000 wire 10 feet long.

The current was varied from 50 to 200 amperes with the greatest ease—200 amperes being the limit of the Siemens dynamometer, though the current might as easily run up to 700 amperes. The meter was found to be out of adjustment, the weights were changed and the scale again gone over and the machine connected again for service in the time above mentioned.

J. B. Speed, '94.

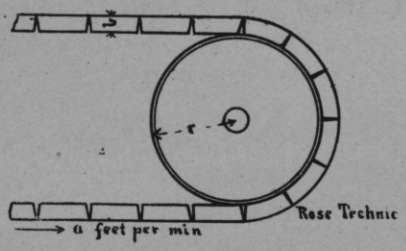
Louisville, Ky.

A NOTE.

Though a running gear is one of the easiest problems in machine designing, the designer is not even then free from liability to error.

An error of this kind recently came under the notice of the writer, which seems worth mentioning, from the very simplicity of the problem, and the fact that men of position in engineering were deceived by it.

A machine was designed, and built, with parts



to run at a given number of revolutions per minute, but when tried, it would not produce the required speed, and it was evident that something was wrong with the design. The calculations were all carefully gone through with again, but no error was discovered, and the superintendent seemed quite excusable for saying that it "beat the d——l."

In the gearing was a construction which was, in effect, like the accompanying sketch, though so arranged that the difficulty was not so apparent. The calculations were the same as for a belt problem, the belt running a feet per minute over radius, r. Therefore, the pulley would apparently make $\frac{a}{2\pi r}$ revolutions per minute, but the fact was overlooked that it was practically a belt running over a pully of radius $r+b$.

This error is present, more or less, in every belt problem, but in this case it was so magnified as to become a very serious matter.

H. B. Sperry, '92.

St. Albans, Vt.

NOTES.

The theses this year will be as follows:

Darst, Crowe and Brown—Engine and Dynamo Test at the Street Railway Power House.

McTaggart and Craver—Heating Power of Indiana Coals.

Shaneberger, Wiggins and Crockwell—Design of Fixed, Two Hinged and Three Hinged Arches.

Wade and Bigelow—Tests on Tensile Strength of Steel by Impact.

Phillips, Burtis and Tuller—Comparison of the Different Methods of Transformer Testing.

Robinson, Anderson and Miller—Test of the Direct Connected Engines and Generators at the New Electric Light Plant.

Troxler, Speed and Mundy—Tests on Motors of the Louisville Electric Street Railway.

George R. Wood, '92, is with the General Electric Co., and is working upon a large electric mining plant for the Youghiogheny River Coal Co., at Scott Haven, Pa. The plant is being installed under the supervision of the Pittsburgh office of the General Electric Co., of which Ed G. Waters, '88, is resident engineer. The equipment consists of two electric locomotives, three pumps and three fans, consuming a total of 450 H. P. The plant will be the largest of the kind in the country.

Fred F. Hildreth, '94, has severed his connection with the Long Island R. R. Co., and accepted the enviable position of foreman of engines on the T. H. & P. R. R. His headquarters are in this city.

H. F. Goetz, '87, is to be married to Miss Jessie A. Morgan, Wednesday evening, April 17th, at the First Congregational church, Quincy, Illinois. Miss Morgan is one of the most popular young society ladies of that place and has also a number of friends in Terre Haute. They will be at home after May 15th at 1677 Maine street, Quincy.

A. M. Hood, '93, will be married Tuesday evening, April 16, to Miss Alice B. Johnson, of Washington, D. C., in the First Congregational church of that city. THE TECHNIC extends to a former member of its board and to his bride best wishes, for prosperity and happiness.

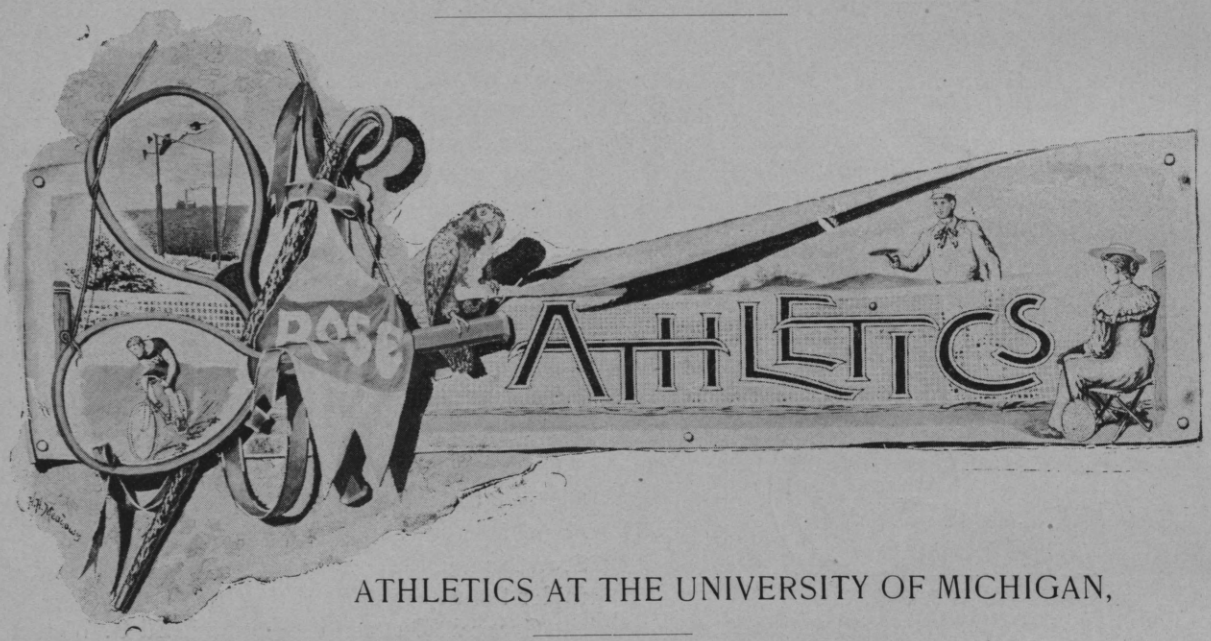
H. S. Hart, '93, has made two business trips to Terre Haute recently.

H. J. Kilbourne, '94, is doing, among other things, a rushing business in life insurance. He confidently told one of his classmates that he intended to get married in the fall.

J. S. Royse, '94, has discontinued his post-graduate work in chemistry in order to assist his father. He thinks that he will continue his work when school opens in the fall.

J. Chas. Young, '92, has been recently elected general manager of the interests of the People's Light and Power Co., at his old home, Davenport, Iowa.

W. J. Davis, '92, is in the engineering department of the General Electric Co., at Schenectady, N. Y.

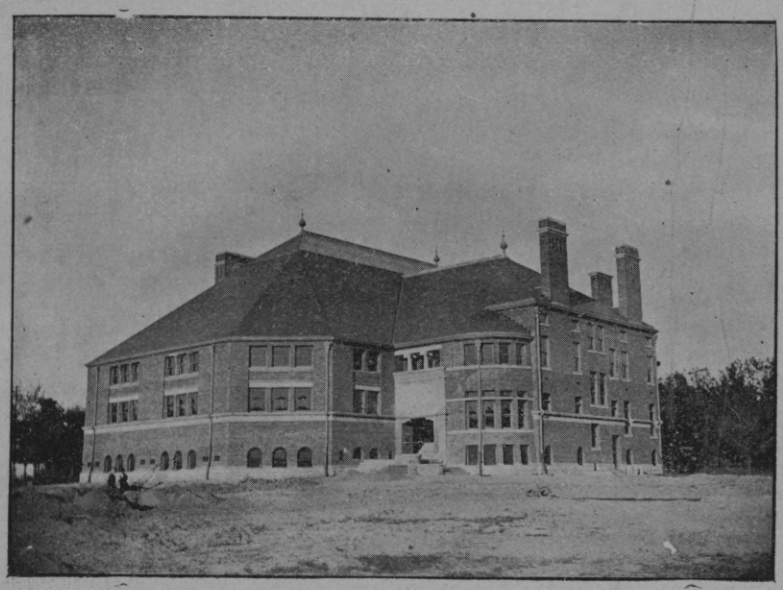


ATHLETICS AT THE UNIVERSITY OF MICHIGAN,

At no time in the history of this University has there been such an universal interest taken in general athletics as there is to-day. And this is true of the co-eds as well as of the men. While the women do not belong to the athletic association, they take a lively interest in the meets and games in which Michigan's contestants participate. Until this year Michigan has been practicing without a gymnasium, but she can now boast of one of the finest and best equipped institutions of the kind in the west—one in which her stand for co-education is maintained as it is in all her other departments. As in most of the Western universities and colleges, the athletic association in past years has found it difficult to secure the support it deserved from the student body, but a new era in its his-

tory seems to have dawned with the beginning of this college year and the prospects for a bright future are very flattering.

The Athletic Association now has a membership of nearly three hundred, to whom every possible avenue of athletic development is open. The charges are low enough so as not to deter any from joining who have the desire, the membership fee being $3.00, which includes the privilege of the tennis courts, owned by the association. The control and supervision of association affairs is vested in two governing boards. First, there is the Board of Control, consisting of eight members, four of whom are chosen from the members of the Faculties and four from the students. This board has direct supervision over the contests and prescribes rules as to eligibility and management of contestants. The business management is in the hands of a Board of Directors, the members of which are elected from the various classes—only members of the Association, however, are allowed a voice in their selection. As an encouragement to those students athletically inclined the University Senate, composed of members of the Faculty, has made permanent provision for a valuable silver cup to be presented each year to the student who holds the record as the best all-around athlete. The cup is suitably engraved and becomes the personal property of the lucky contestant. In addition to this, the Delta Kappa Epsilon fraternity offers a large silver cup for the best high kick. Each year the winner's name and record is placed upon the cup and at the end of five years it is to become the property of the Association and will then be placed in the trophy-room of the gymnasium. For class contests there are the usual flags and banners, which also go to adorn the trophy-room.



THE WATERMAN GYMNASIUM.

On the campus, lying immediately south of the gymnasium, is a large open space, which is used both for general team practice and for class foot and base ball games. Besides this, the University has an athletic field upon the south edge of the city. These grounds, containing about ten acres, are enclosed and have a grand stand, which, though not a marvel of architectural beauty, serves the purpose for which it was intended. It will seat about three hundred persons. There is a 16-foot ¼ mile cinder track with a hundred yard straight finish in front of the grand stand. Here, too, arethe diamond and the grid-iron, upon both of which the teams of this institution have won many important victories. Michigan's inter-collegiate athletic relations, as far as track events are concerned, are not very extended. She does not belong to the State association on account of her conceded supremacy over the smaller colleges of the State. At different times teams have been sent to Chicago and the east, but these trips are not regular occurrences. Our foot and base ball connections, however, are upon a broader basis and each year extended trips east and west are arranged for both teams.

In all the history of the University there has probably been no one thing which has aroused so much interest and awakened such a spirit for

athletic development among the students as the completion of the gymnasium.

About five years ago Joshua W. Waterman, a prominent lawyer of Detroit, gave $20,000 to the University for the building of a gymnasium, providing the friends and students of the University would raise an equal sum. Previous to this time a small sum of money had been raised by various means for this purpose but it had increased slowly and there seemed to be no genuine interest taken as to the outcome. Now, however, this generous offer furnished an incentive and soon the necessary amount was raised. So, during the college year of '91 and '92, there was available a fund of over $42,000 and plans were drawn up which provided for a building commensurate with the needs of the University. According to these plans there was to be at some future time a co-ed annex, almost as large as the men's department. The contract for the men's part of the building was let and the work was begun early in 1892 but on account of a lack of funds the building could not be equipped until last year, at which time the State legislature appropriated $20,000 for completion and equipment. The building was finally completed about the middle of last October and as it now stands, fully equipped, it cost about $65,000.

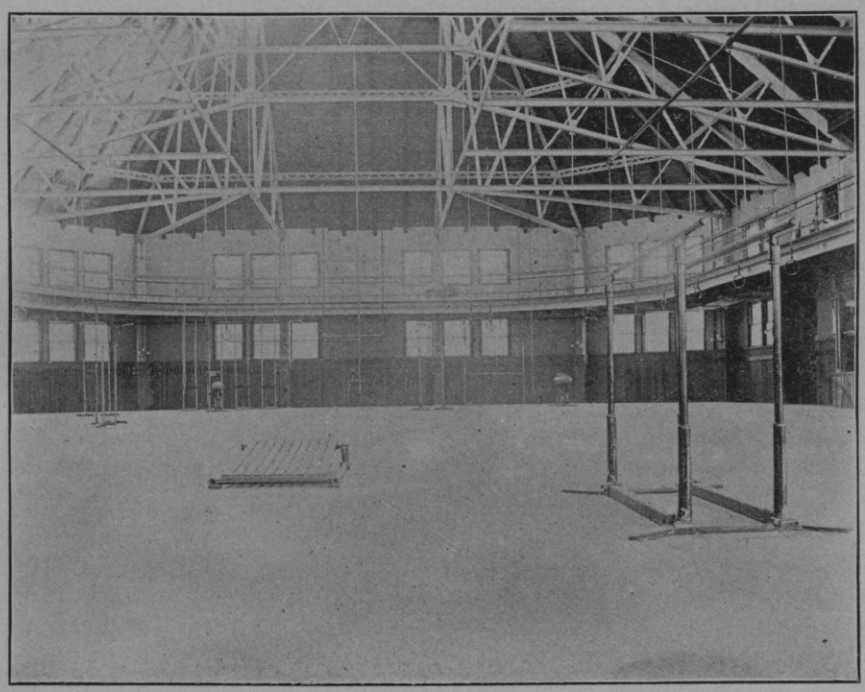
The "gym" is a three story, pressed brick building, with white stone trimmings and a blue slate roof. It is thoroughly ventilated and is well lighted by numerous windows on all sides except the north, where a solid wall was left, in anticipation of the building of a woman's annex. Besides the windows in the walls an immense skylight crowns the building and furnishes of itself almost the necessary amount of light for the arena.

Upon entering the door at the southwest corner of the "gym," the visitor finds himself in the main corridor, to the right of which is a large reception room, from whose windows a good view of the practice field and campus may be obtained. Continuing on through the corridor, the visitor finds before him the director's room, offices, measuring room, containing scales and scientific apparatus, and smaller rooms for various other purposes. To the left of these rooms stands the arena, the gymnasium proper. The floor of this room is 150 feet long and 90 feet wide and can accomodate a class of over 200 for regular drill work. Above the arena is a running track, which, eighteen inches from the rail, measures 434 feet, or about 12 laps to the mile. This track is covered with a padding of felt and specially prepared canvas which makes it suitable for bicycle training when outdoor work is impossible. The equipment of the gymnasium consists of 200 pairs of dumbbells, 100 pairs of Indian clubs, 2 sets of parallel bars, 4 rowing machines, 2 wrist machines, 24 sets of chest weights, 2 vaulting machines, 2 horizontal bars, 4 pairs of vertical bars, a quarter back, head machine, horizontal ladder, kicking machine, 10 mats and a number of swinging and double rings. Descending now to the basement the first thing which meets the gaze of the visitor are the tiers of lockers. Each locker is almost three feet high, by one and a half feet square and is made of quartered oak and furnished with a combination lock. The lockers are arranged in sections of 80, two rows being placed back to back, each row containing 20 lockers in length and two in height. In all there are about one thousand lockers, some two hundred of which are used by the co-eds. To the left of these lockers is a place reserved for the construction of a swimming pool. Moving now around back of the lockers to the north side of the building we find a space in which it is intended to put a bowling alley, when circumstances will permit. Facing the lockers on the south are two rooms containing shower and sponge baths. Upon the second floor are boxing and fencing rooms supplied with the necessary appliances, while upon the third floor is the visitors' gallery which commands a good view of the arena.

About the middle of last November the gymnasium was thrown open for use and there are now 1,200 men and about 275 women taking work. From 9 to 12 o'clock every morning the "gym" is given over exclusively to women, they having class work at 11:15 and 12:15. During the rest of the day the men have control, and for them are

formed two classes in the afternoon and one in the evening. The attendance upon the men's classes averages about one hundred each. In all classes the regular class drill work is only about fifteen minutes in length. The charges for gymnasium work are confined solely to the fee of $2 per year for the use of the lockers, and as there is no requirement as to the uniformity in the "gym" suits, the instructions may be said to be upon a practically free basis.

Perhaps this article would not be complete without a mention of the instructors in charge of this great department of the University. At the beginning of the year the directorship was tendered to Dr. J. B. Fitzgerald of Worcester, Mass. He had previously been connected with gymnasiums in the East, but had given this work up and had accepted a position as head of the medical department of Worcester Academy. He resigned however, and accepted the position offered him as director of the Waterman gymnasium. He is a graduate of the Boston College of Physicians and Surgeons, now a part of Tuft's College, and is a member of the Massachusetts Medical Society and the Boston Medical Association. He received his gymnasium instruction under R. J. Roberts, one of the oldest and best known instructors in the country. After spending some time at Harvard, Dr. Fitzgerald had charge of several gymnasiums in the New England States. As an assistant and trainer, Dr. Fitzgerald secured in Mr. Keene Fitz Patrick a valuable addition to the gymnasium instructors. Mr. Fitz Patrick has been trainer for the Michigan Athletic Association of Detroit for some years past. He has trained track teams for Yale, and in 1891 he cared for their great foot ball team which won so many remarkable victories. Mr. Fitz Patrick was not unknown to Michigan before she secured his services, for he had given some attention to her athletes during his connection with the M. A. A., of Detroit.



INTERIOR OF GYMNASIUM.

The recent announcement of the gifts of Regent Levi L. Barbour of $25,000, and of Regent Charles Hebard of $10,000 for the erection of a woman's annex to the Waterman gymnasium has aroused special interest and enthusiasm among the women of the University. An effort is to be made on the part of all the women throughout the state to secure an additional $15,000. Ground will be broken and construction will begin as soon as this is done, and it is quite likely that in a comparatively short time the coeds will be swinging Indian clubs and exercising in various other ways in a home of their own.

Thus athletics are thriving here as they never have before; every one is moved by a new enthusiasm for this work, and active practice for the track and ball teams has been in progress for many weeks. There are about forty candidates

for the 'Varsity base ball team and about fifteen of them will be selected and placed at the training table about the last of this month. Hope is strong and all are pulling together, and we confidently expect to see Michigan maintain her rightful position as the leader of the West in all future athletic meets in which her men take part.

C. A. MANNING, Ex-'95.

BASE BALL.

The base ball season is now but a few weeks off and every spare moment is being devoted to preparation for it. By the new arrangement of the schedule the men will have from an hour to an hour and a half to practice every afternoon. The diamond has been leveled and rolled and is in better condition now than ever before.

At the last meeting of the directors of the athletic association, Mr. W. E. Burk was again elected to manage the team for the coming season, and the efficient manner in which he filled that office last year insures competent management of affairs this year. Some twenty-five men have been selected to be on the campus every evening, and from these a first and second team will be selected. These two teams will play at least three or four practice games a week, as this is the only way in which good results may be attained.

Though the first team has not yet been selected, the majority of the positions are pretty well assured, most of which will be filled as last year. Pitcher, catcher, short stop and right field are still open, but as the number of candidates for these positions is not overwhelming, a great deal of trouble will not be experienced in making the selections.

The primary object of the second team is to practice the first, but a secondary and quite important one is that it will offer a good opportunity for the selection of substitutes for the first nine. Up to the present not a single candidate has appeared from the Freshman class, and it has been a matter of much regret to the manager, as well as to all others who have the interest of base ball at heart, particularly so, because several of the present nine are Seniors and unless next year's class brings in a number of good players the possibilities for a team in '96 are rather remote.

GET TO WORK.

The training season is upon us and every man that makes any pretense toward field athletics should be on the campus every afternoon at five o'clock and put in every moment of the hour the faculty so kindly arranged to give us, in training along the line for which he is best fitted. The time is short and we can't afford to delay. Ball players should all get out and play ball; runners should take advantage of the new track to train as they have never trained before; this same track should also be a source of great encouragement to wheelmen to try for records; as soon as the courts are put in shape the tennis players should get to work, for we must buckle down to good, steady, earnest and hard work for the next month and a half, if Rose is to hold her own against the larger colleges of the state.

For the benefit of new men and those who have not burdened their memories with the records of the different events, we give below a list of the events as they occurred on last Field Day, together with State records, in order that those training may know what they have to contend against:

100 yards dash	$10\frac{2}{5}$ secs.
Putting 16 pound shot	39′ 5″
Running broad jump	20′ 1″
¼ mile bicycle	$31\frac{4}{5}$ secs.
One mile walk	8 min. $4\frac{2}{5}$ secs.
Pole vault	9′ 10″
Throwing baseball	361′ 5″
Standing high jump	5′ 2″
220 yards dash	$23\frac{4}{5}$ secs.
½ mile bicycle	1 min. 9 secs.
Hop, step and jump	44′
120 yards hurdles	$18\frac{2}{5}$ secs.
Throwing 16 pound hammer	98′ 3″
High kick	9′
¼ mile run	$54\frac{4}{5}$ secs.
One mile bicycle	2 min. 41 secs.
Running high jump	5′ 3″
Standing broad jump	10′ $5\frac{1}{2}$″
One mile run	4 min. $53\frac{2}{5}$ secs.
Two mile bicycle	5 min. 28 secs.

THE GYMNASIUM.

The prospects for the success of the gymnasium scheme are extremely encouraging as far as the students are concerned, as the average of the subscriptions thus far obtained is much larger than was anticipated by the committee.

The alumni, however, are not doing so well, as only about thirty have responded so far. This number appears rather small in comparison to the one hundred and fifty letters that were sent out, since it was expected that more interest would be shown by them. But if they give us the assistance which we have reason to expect of them, the gymnasium will be an assured thing, since the students have taken hold of the matter in the spirit that they have. If a sufficient amount is subscribed by the end of the school year, work will in all probability be begun during the summer.

THE TRACK.

At last the quarter mile track has been completed and is ready for business.

It was thought that the lateness of completion of the work would render it of little use to athletes this year, as sufficient time would not be allowed for settling, but the heavy roller of the city was made use of to good advantage, and the cinders are packed almost as hard as a macadamized road.

The ends, which are circular, are well banked, having a rise of one in six, giving bicyclists a feeling of perfect security even when going around at their best clip.

With a good track, a splendid diamond and more than the usual amount of time for practice, we hope that Rose may come up to her usual standard of excellence in field athletics this year.

EARLHAM WILL DO HER BEST.

Rose Polytechnic Institute is claiming to have a walk over at the coming State College Field Day to be held at Terre Haute. Prof. E. P. Trueblood was spoken to concerning this claim, and said that Earlham is in better condition than ever before, and would no doubt do exceedingly well. There are some of the features which he thinks Earlham can undoubtedly win, and while his claims are modest, it could be plainly seen that he thinks his boys will everlastingly sweep the field. We hope so.—*Richmond Daily Palladium.*

NOTES AND CLIPPINGS.

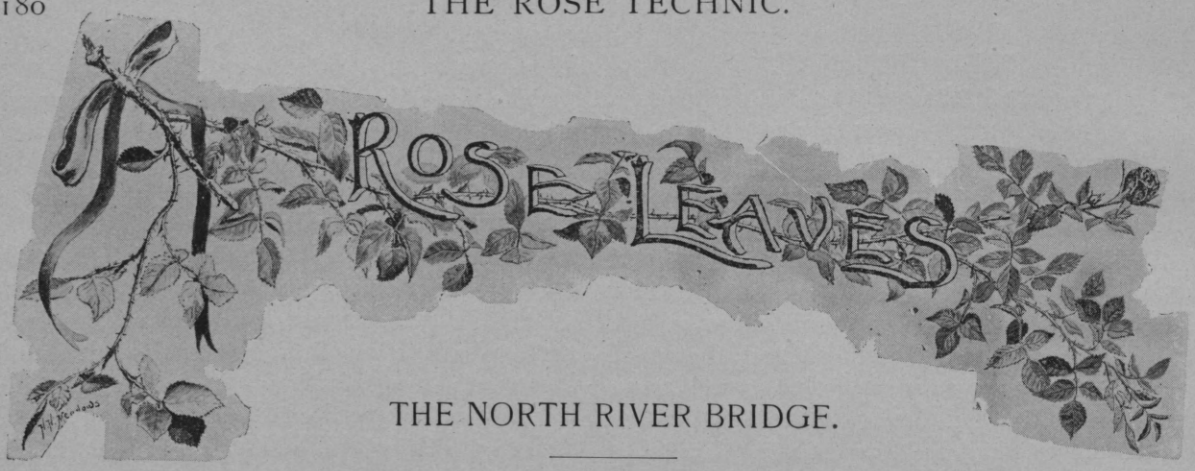
A recent issue of the *University Courier* contains a suggestion for the formation of an intercollegiate bicycling organization, which has received the endorsement of all the other prominent colleges. One of the principal points urged in favor of the organization is the danger to cyclists in riding at full speed on ordinary running tracks, and should the organization be consummated the meets will be held on tracks properly banked, insuring safety to the riders.

It was recently voted by the Harvard faculty that "No student under our charge shall be permitted to take part in inter-collegiate foot ball contests." This naturally raised a howl in the school, and has been the cause of much speculation outside of it. No satisfactory agreement between students and faculty has yet been arrived at, and the outcome is being awaited with a great deal of interest by the other colleges.

The tennis courts are the only part of the campus that have suffered from inattention during the recent improvements. They will probably be loosened up and rolled during the coming week, so that they will be in condition for playing by Saturday, the 20th. All needed apparatus will be ordered and will be here by the time the courts are ready.

The abrupt rise between the diamond and surrounding sod, which has always been a source of annoyance to fielders, especially with ground balls, has been removed by rolling back the sod, digging away the soil beneath to the proper level and replacing the sod. This is an improvement the players will appreciate.

There has recently been completed in the shop a sixteen pound spring-handle hammer to be used by Darst in the hammer throw this year. There is considerable advantage in such a hammer over the old stiff, wooden-handled instrument, and we expect to see Darst excel himself in this, his last appearance.



THE NORTH RIVER BRIDGE.

Probably, during the last five or six years, no subject has been of more interest in engineering circles than the proposed bridge over the North River at New York City. The inconvenience and loss of time experienced in crossing the river by means of the several ferries has caused the want of such a bridge to be widely felt, but the enormity of the undertaking from an engineering point of view, together with the large amount of capital required, has, until within the past few years, prevented any definite action being taken.

In 1891 a company was organized under the name of "The New York and New Jersey Bridge Company," and applied to the state legislature of New York for a charter and permission to place a pier in the middle of the river. The argument against the pier was so convincing that the act giving the charter to the company, insisted on a single span for the bridge. The company then appealed to congress for permission to build the pier. The President, however, in view of the danger to the commercial and navigation interests of the first port of the country, vetoed the bill. The objections to such a pier are well set forth in the action taken by the chamber of commerce of New York city. An extract taken from their report is as follows:

"The lower part of the Hudson river not only serves the purposes of river traffic and of accommodation of the enormous trade which finds its way from the great west through the Erie canal to tide water, and from the brick, lumber and stone yards, manufactories and ice houses along the river, but this great river between the New York side and New Jersey shore furnishes such a harbor as can not be found in any other part of the world. It provides the most varied traffic and vessels with accommodation, and renders it possible for the largest ocean steamers to maneuver safely throughout its whole extent. In connection with the future extension of harbor traffic it should be borne in mind that ocean steamers tend to grow larger, and that the space required for their maneuvering should therefore also be larger. The placing of a pier in the river between the pier-head lines will, inevitably, seriously interfere with the maneuvering of these ocean steamers, as well as with the harbor traffic in general. Besides these objections, it is feared that such a pier would prove a source of much danger in foggy weather both to the bridge and to vessels and also tend to cause the formation of shoals. Since the bridge company represented in congress that a span of over 2,000 feet was a practical impossibility, a board of five disinterested bridge engineers was appointed by the President to examine into the question thoroughly, whether a bridge could be built longer than a 2,000 foot span, which in this case means a span over the entire river, for if built of 2,100 or 2,300 foot span it would still leave a dangerous obstruction between the pier-head lines, and would render the New Jersey shore in the vicinity practically useless for dock purposes. The question that came before the board then, was what length of span not less than 2,000 feet would be safe and practical and

not prohibitive in cost. The location selected was midway between 59th and 60th streets, the pier head lines at this point being 3,130 feet apart. The board made their report at the end of thirty days, and it is from this report that most of the information has been obtained.

Owing to the fact that the river must remain unobstructed during the erection, the kind of bridge selected must be one which can be erected without falsework. The only two forms fulfilling this condition for a 3,000 foot span are the cantilever and suspension bridges. The cantilever consists of a rigid framework balanced on a pier at or near its center and anchored down at one end. Such bridges are usually built from the pier towards the ends at the same time, and can be built without false work. The water at the proposed site for the pier of the 2,000 foot span is about 50 feet deep, under this is a layer of mud or silt 100 feet deep, and under this fine sand and finally rock at a depth varying from 125 to 260 feet.

For the comparitively moderate weights sustained by bridges of usual dimensions, sand would be a suitable foundation, but for these piers which must bear such an enormous pressure, solid rock only is deemed a safe foundation. Each of the piers for the 2,000 foot cantilever will consist of four cylinders placed 200 feet apart in each direction. Each of these cylinders for the east pier will contain 866,000 cubic feet of masonry and will cost $866,000, making for the four cylinders a total of $3,461,000. At the site of the west pier the depth to rock is 260 feet making the cost much greater. It is estimated at $9,710,000. Adding in the cost of the anchorages, we have for the total cost of the sub-structure of the 2,000 foot cantilever $14,644,000. A careful estimate prepared by the Union Bridge company shows the weight of the superstructure to be from 230,000,000 to 240,000,000 pounds. This at 4½ cents per pound would cost $10,800,000 making the total cost of the bridge $25,443,000. This is the cost of a cantilever bridge of the minimum length of span which the board was authorized to consider; the length of the entire structure from anchorage to anchorage being 4,320 feet.

The weight of a 3,100 foot contilever, spanning the entire river, would be about three times that of the 2,000 foot span, and as the reaction on the piers would be at least 2½ times as great as that of the short span, the volume of the piers would be proportionately increased. Figuring on this basis $51,128,000 would probably be a low estimate for the cost of the long span, total length from anchorage to anchorage being 6,100 feet. From a careful estimate of the amount of traffic crossing the North River by means of the ferries, it is judged that an investment of this amount would not be a financial success.

A suspension bridge is another possible form of construction at this location. In the suspension bridge the floor system is hung, by means of vertical suspenders from overhead cables, which may be either of wire or steel eye-bars. These cables pass over towers on the piers to masonry anchorages some distance back. Like the cantilever it can be erected without false-work; unlike the cantilever it has not been generally considered well adapted to railroad uses. It has less rigidity than the cantilever and deflects more from the combined effects of temperature and load; the flexibiltty of the cables tends to cause vertical undulations of the platform under a moving load, which are more objectionable in a railroad than a highway bridge where the live load is less concentrated and is applied less rapidly. These objections lessen in importance as the span of the bridge and the proportion of the dead to the live load increase. In this bridge, which will provide for, at least, six independent tracks, the condition approaches that of the highway bridge. The position of trains producing a maximum disturbance would be of very rare occurrence and could easily be prevented from ever occuring by proper police regulations.

The inclination of the platform, longitudinally and transversely, arising from the undulations of the cables, under the effect of moving trains can be reduced within admissible limits by a proper system of stiffening; and the effect of wind upon the cables and platform may be taken care of by

cradling the cables and by a lateral system of bracing similar to that of truss bridges.

Three principal methods have been employed to secure greater rigidity in suspension bridges: (1) by inclined stays extending from the top of the towers to the platform. This method has been extensively applied, and found successful, the only objection being that the stresses in these stays are somewhat indeterminate; (2) by trussing the cables by a system of braces between the cables, as proposed by Mr. G. Lindenthal. This method might prove the most economical, but is, as yet, untried. (3) By a stiffening girder fastened to the platform and extending from tower to tower. This system is a feature common to nearly all suspension bridges, but has seldom been applied in the most approved form, so as to give the best results. The function of a stiffening girder is to distribute a load covering only a part of the bridge over the entire span, thus preventing an undue sag in the floor system as the live load moves on the bridge. By hinging this girder at the center all stresses in the girder, due to temperature effects in the cables, are eliminated. The hinge at the center also has the effect of conferring upon the cable an increased facility of adjustment under varying conditions of moving load and hence an enhanced capacity for receiving such load directly through the suspenders without direct action of the girder An analysis of the stresses in this girder, especially with the hinge, would be rather long and complicated for a place in this paper. A paper by Professor Howe, read before the Engineers' Club of St. Louis, may be found in the Journal of the Association of Engineering Societies for December, '93. By using this stiffening construction the deflection of the platform, for a live load of 13,500 pounds per linear foot is reduced to 6 feet in the quarter span.

The form of stiffening truss, selected for the North River Bridge, is a riveted lattice girder, 120 feet deep. The web members are all inclined at 45° and are in eight systems. The floor beams are hung from the suspenders and carry the stiffening truss, the weight of which is never entirely overcome by the moving load. The upper, lateral system is a comparatively light riveted lattice. The whole lateral work to resist wind pressure is done by the lower system, in which the floor beams form lateral struts, and the diagonals are in tension.

The greatest stress in the cables will occur at the ends and will amount to 243,724,000 lbs., which at 60,000 lbs. per square inch, will call for 4,062 square inches of steel. This may be divided into twelve cables, each containing 6,000 No. 3 wires having a diameter of 0.259 inches. The cables are arranged six on a side and twenty feet apart, at the towers. All but the two middle ones are cradled towards the center for rigidity. Horizontally, this cradling amounts to 100 feet in 3,200 feet. The weight transferred to each of the towers is 218,000 lbs. These towers are 570 feet high from the top of the masonry to the saddles, or 620 feet above the water. The cost of these towers would be about $76,000, making a total for the suspension bridge of $35,367,671. The estimated cost of the 2,000 foot cantilever was about $25,000,000; to compare it with the suspension bridge 1,280 feet of viaduct must be added; this makes the total cost $26,723,000; the estimated cost of the suspension bridge is $8,644,671 more, or about 32½ per cent. more. From these figures it is evident that the suspension bridge is, financially, the most desirable of the two forms considered.

The New York and New Jersey Bridge Company have in view the construction of a bridge for utilitarian purposes only. There is to be, in the words of Mr. Charles McDonald, of the Union Bridge Company, nothing of the monumental or sentimental character about it, except in so far as must be inseparably connected with its magnitude. While this is doubtless the question of first importance, that of proper æsthetic effect should not be altogether lost sight of. Besides the educational effect produced on our own people, such a structure would be one of the first to attract the attention of foreigners and since first impressions are always the most lasting, it would seem desirable that such impressions be as pleasing as possible. It has been too much the custom in this

country, in bridge design, to totally ignore this question. No large building, especially for public accommodation, is erected to-day without proper attention being paid to its ornamentation, and so it should be with all large bridges.

W. WIGGINS, '95.

January 4, 1895.

THE ORCHESTRA CONCERT.

The sixth annual concert of the Orchestral Club, given at the Congregational church on the evening of March 21st, was another flattering success. Under the direction of Mr. Colberg the orchestra has developed wonderfully, and with the inspiration afforded by such an audience of friends and admirers as greeted them that evening, they acquitted themselves admirably.

The programme, in which the allegretto and larghetto were well commingled, was thoroughly appreciated, and encores were frequent and enthusiastic.

The Misses Paige, Miss Hysung and the R. P. I. Mandolin Club assisted the orchestra in making the evening enjoyable.

The programmes were tastefully arranged and are excellent souvenirs of the event.

PROGRAMME.

PART I.

1. March—Directorate.....*Sousa*
   Orchestra.
2. La Bresilienne.....*De Janon*
   R. P. Mandolin Club.
3. Vocal Duet.....Selected
   Misses Paige.
4. Overture—Bridal Roses
   Orchestra.
5. Violin Solo—Ari Varie.....*De Beriot*
   Mr. E. F. Colberg.
6. Waltz—Mia Bella.....*Roeder*
   Orchestra.

PART II.

7. Selections—Robin Hood.....*Wiegand*
   Orchestra.
8. Piano Solo—Il Trovatore.....*Melnotte*
   Miss Winifred Hysung.
9. Quartet—Andante Cantibile.....*Tschaikowsky*
   Mr. Colberg, Mr. Willius,
   Mr. Beebe, Mr. Kloer.
10. Solo—For all Eternity.....*Marscharoni*
    Miss Paige.
    Violin Obligato.
11. Waltz—To Thee Alone.
    Orchestra.

MEMBERS.

1st Violin—G. Willius, Jr., J. S. Royse, H. G. Kilbourne, *2d Violin*—I. M. L. Werk, F. W. Schneider, F. Brachmann.
Viola—R. Wallace Beebe. *Cello*—O. Kloer.
Bass—David Ingle, Jr.
Cornet—C. H. Holderman, E. L. Shaneberger, *Clarinet*—W. M. Bundy. *Flute*—H. H. Meadows, H. T. Liggett, F. G. Hunt.
Trombone—J. E. Lufkin, Jr.
Oboe—E. B. Harris. *Piano*—J. J. Kessler.

Mr. Colberg is an excellent violinist, a former pupil of Jacobsohn, and a very careful but enthusiastic leader; he undertook the direction of the orchestra when the outlook for a successful year was anything but promising, and by his genial presence and energy roused all the old life and interest of the organization. Many thanks are due him for his interest in the concert, and we wish him an equal success in all musical undertakings.

His strong right arm embraced her
  Perhaps a bit too tight,
A soft, weak wail—"bone broken,"
  Escaped her lips so white.
Her sister's whispered question
  At once divined the cause,
For to her words the maid replied
  "Why, yes; of corset was."

—*T. H. S. in Williams' Weekly.*

Several new bicycles are to be seen this term.

Shin guards are in order on the baseball field.

A Soph is earning for himself the sobriquet of Ward McAllister.

E. K. Hood, ex-'96, spent a day among Rose friends last month.

The base ball back stop was partly torn down by the wind a few days ago.

Lash, ex-'94, is superintendent of the telephone exchange at Greencastle, Ind.

The telegraph association has gotten its wires up and is ready for business (?).

The new water supply tastes supiciously as though it had come from Chicago.

The Sophs are to have one lecture a week on Quaternions for the rest of the term.

It is rumored that the Chemists and Civils will contest for supremacy on the diamond soon.

Moore is Poly agent for the Lovell bicycle. It is the best wheel made. Ask him if it isn't.

Prof. Hathaway has been detained from his classes for several days on account of sickness in the family.

There are soon to be improvements made in the library in the shape of new tables for the periodicals.

Instructor in Chemistry—The hour has ex-. pired, gentlemen.

Soph.—Ah, we have succeeded in killing the time.

In the Freshman exemption examination in Algebra which was held a few days ago, three men in one section passed and all but three in the other.

Jones can't be called a hen-pecked man,
Unless it be, perchance,
When "wheeling" on the boulevard,
Then Mary wears the pants. M. '94.

Prof.—"Und es giebt weiter dampf Kraft."

Junior.—"How strong did you say, professor?

Fletcher, ex-'96, passed through Terre Haute a few days ago and came out to see his old classmates.

Two Normalites were seen lately hovering on the outskirts of the campus while a practice game was going on. We hope that they got the pointers they were after.

An unusually large number of students remained in town during the holidays. The excuse that is generally given is the tightness of the money market.

Borrower—"Meadows, how do you tighten the head of your wheel? It's too loose."

H. H.—"Drive it down with a brick until it won't turn; then oil it."

It is a pleasure to see Hildreth, '94, a former member of THE TECHNIC board, among us again even if he is not in school. He and his full beard are welcome boarders at his old place, 934 North Ninth street.

At a recent class meeting '97 elected the following officers for the remainder of the year: J. David Ingle, Jr., President; J. E. Lufkin, Vice President; Ned M. Austin, Secretary; Gustav Willius, Treasurer.

Terre Haute is now the proud possessor of two tracks, one already famous, and the other with a reputation to build. The use which is being made of it is a good indication of the manner in which it is appreciated.

Instructor Simon accused one of the Sophomores of misconduct in the German class recently. The refutation was characteristic. "I haven't done nothing, Professor, honest I haven't."

Prof.—(finding some difficulty in setting up the apparatus.) "This confusion of images is produced by infernal reflection,—excuse me, I mean internal reflection." But he evidently considered his first statement correct.

Prof. Howe is evidently a better civil engineer than clock maker. He undertook to repair his "cuckoo" clock a few days ago, and now the cuckoos sing out the hours with the accent on the wrong syllable, "But he can't change it."

We have recently observed the most absent-minded man on record. Stopping on his way to dinner to light his pipe, he turned round to strike the match on a wall he had just passed, forgot his bearings so absorbed was he in the process, and leisurely retraced his steps toward the institute.

Prof. Ames says that some of the results the Juniors get in Machine Design, look like they had been arrived at as he used to see pigs weighed by the farmers in his country, viz.: by swinging them over a tree limb by a rope, balancing them with stones, then guessing the weight of the stones.

"I dont no," "who r u," etc., are frequent abbreviations used over the telegraph line; but we are indebted to one of the faculty members of the association, for the following ingenious abbreviation for "repeat." "Will you kindly send the last part of your sentence again? My instrument was slightly out of adjustment, and I failed to catch it."

Conable some nights ago, had a dream in which he went through the terrible experience of having his head amputated. He was standing by the band saw when it parted with its accustomed regularity and wrapping around his neck severed the head from the body. With great presence of mind he stooped, picked up his head and carried it to Mr. Smith who glued it on and shellaced the joint with his usual dispatch.

Darst was climbing over the garden wall, and as it usually happens, the board broke letting him knee deep and more into the barrel of soft tar; that night he laid away another pair of long black stockings for field day.

Harris, '96, has made a compound in his laboratory work of which he can find no previous record in any of the chemical journals. We will not give the name, as there are hardly enough permutations of the twenty-six letters of the alphabet to express what he has called it.

Kessler fell asleep in the library a day or two ago, about five minutes before recitation, and wrapped in the arms of Morpheus sat snoring in blissful unconsciousness of duty, when he was rudely awakened by a shake and the words "Wake up Jake, you darn fool, its ten minutes after."

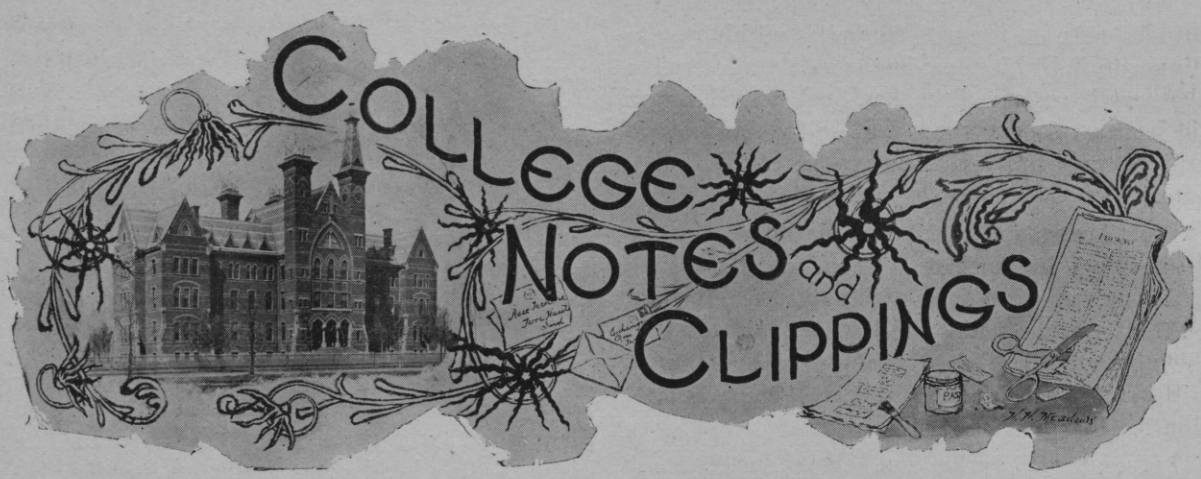
The Seniors are busy in the midst of their thesis work and the majority are having very good success. Indeed, some of the boys have all the experimental work completed. With the exception of four members, the class spent the vacation in the city, the quietude and silence of the other classes lending inspiration for more careful and faithful work.

Camp recently made the acquaintance of two young ladies through the "Ahem, smoky Evening" process and inveigled Sinks into calling on them a few evenings after. They arrived at the home of the adored ones, and after standing before the house some half hour ascended the steps and rang the bell, when their nerve left them and both bolted for home. Sinks, we excuse on the ground of inexperience, but are at a loss to account for the unbecoming action in Camp.

"Shortie" Sanford was observed in the corner of the wash room the other day assiduously gnawing at something he was evidently trying to conceal. A dozen soapy hands turned him around, and revealed the object, a shirt with two hard knots in the sleeves. Baffled in every attempt at unloosing them, he finally borrowed Patterson's adjustable pocket sword, and with the air of a little Alexander the Great cutting the gordian knot, he severed the sleeves from the body and climbed in.

A Poly sitting in his room recently was startled by hearing groans and cries of anguish coming from across the hall where several young lady Normalites were rooming. Springing to the door to ascertain the cause, he heard the following intermingled with the groans—O umlaut sounds like———modified u———etc. What may he expect when they begin on the French nasal tones.

The local columns have for some time been bare of news of a sanguinary nature from the wood shop and, while sympathizing, we eagerly seize the opportunity of reporting Mr. Schneider's misfortune. While working at the lathe his tool was wrenched from his hands and struck him in the forehead leaving a bad gash, but fortunately no serious injury. Mr. Schneider is again at his place in the shop.



It requires $1,000,000 to pay the running expenses of Harvard for one year.

Princeton Freshmen have been deprived of the right to vote at the election of all the officials of the various athletic associations.

"Tomorrow at ten we go to the press,"
Said the scribe with the massive brow,
Said she, Sir Editor, I confess
I wish you were going now.

Attention is already being paid to tennis, although it is quite early in the season. The U. S. Lawn Tennis Association held a meeting at New York a week ago Tuesday night. The Harvard, Yale, Princeton and Columbia tournaments will be held at the respective colleges May 4, the winners to meet at Newport on the 2d of August.

There now seems to be some possibility that Pennsylvania and Princeton will meet on the foot ball field next November.

Over 40,000 women are attending the various colleges of America, yet it is only 25 years since the first college in the land was opened to women.

My daughter's on her dignity,
My son is on the sea,
While I am on a howling lark,
And my wife is on—to me.

—*Ex.*

According to the *U. of C. Weekly*, that institution now has 308 graduate students. This is more than any other university in the country has, as Johns Hopkins has only 261 and Harvard has 258.

PADDED.

I took my Lilian to drive
Along the river Spree,
"Ah! lily-pads," cried I, and now
She doesn't speak to me.

—*W. D. R. in Univesrity Courier.*

The student body at Vassar has voted to establish an Athletic association and a committee has been appointed to draw up a constitution and by-laws.—*Brown and White.*

At a mass-meeting of Princeton under-graduates recently, it was voted that the Freshmen should hereafter have no voice in the election of officers for the various athletic associations. This action was taken by advise of the Graduate Advisory and Executive committee of Princeton.

The faculty of the University of Pennsylvania have recently adopted a new system of marking. Instead of the old numerical record, standing will be reported by letters as follows: d. (distinguished); p. w. (passed well); p. (passed); n. (not passed).

Eighty thousand dollars has thus far been subscribed to the Phillips Brooks Memorial Fund of Harvard. It is desired to raise $300,000. With this sum will be built and endowed a Phillips Brooks House, to provide a permanent home for the religious interests of the University.—*Hamilton Review.*

President Kendrick, of the I. C. A. A., sent on Tuesday a formal challenge to Oxford and Cambridge Universities for international track sports. The answer to these challenges will be awaited with considerable interest. The fact that the Oxford-Cambridge dual games have been put back until later in the spring seems to some an indication that the intention of the English Universities is to accept such a challenge.—*Pennsylvanian.*

A record kept at Yale for eight years shows that non-smokers are 20 per cent. taller, 25 per cent. heavier, and have 60 per cent. more lung capacity than smokers. An Amherst graduating class recently showed a still greater difference, the non-smokers having gained 25 per cent. in weight and 37 per cent. in height over the smokers, and also exceeding them in lung capacity.—*New York Tribune.*

PAINTED.

The tempest howled; the fragile girl
Clung frantic to the wreck,
Wave swept; the color fled her cheek,
And ran adown her neck.

—*Ex.*

The students of the College for Women of Cleveland are trying to find a name for their institution which does not require such a large expenditure of breath as does the present one. Of the various names suggested, Chilton College seems to be meeting with the most favor, and it seems to be in a fair way to be adopted.

At Harvard there is a company of riflemen who are making preparations for a competitive drill with the M. I. T. Military Batallion, at which there will be prizes for proficiency. Yale already has a batallion, and at Princeton they are trying to form a company. If successful there is every prospect of a competitive drill between the three colleges.—*Wesleyan Argus.*

At a meeting of the Union College alumni, held at Albany, recently, there was considerable discussion concerning the removal of the college from Schenectady to Albany, where the departments of Law, Medicine, Pharmacy, and the Dudley Observatory are already located. It is not improbable that this step will be taken in the near future. —*Orient.*

The income and expenditure of Harvard college for a year is nearly double that of the Province of New Bruswick. More than 100 professors and instructors have been added to the number of her teaching staff in the last six years. It has been estimated that it would take a student 70 years to go through all the courses in the different schools of the University.—*Orient.*

COLLEGE GIFT ACCEPTED.

COLUMBUS, O., April 11.—James Hulne Canfield, chancellor of the University of Nebraska, has been elected president of the Ohio State University to succeed Dr. W. Scott, resigned. A gift of $10,000 from Emerson McMillin, president of the East River Gas company, New York, to found an astronomical observatory at the State University was accepted.