Winter 2-1902

Volume 11 - Issue 5 - February, 1902

Rose Technic Staff
Rose-Hulman Institute of Technology

VOL. XI. TERRE HAUTE, IND., FEBRUARY, 1902. No. 5

THE TECHNIC.

TERMS:

One Year, $1.00. Single Copy, 15 cents.

Issued Monthly at the Rose Polytechnic Institute.

Entered at the Post Office, Terre Haute, Indiana, as second-class mail matter.

DR. MEES is arranging for a Spring lecture course, but at this date has not the schedule in form for publication. We can say, however, and we are glad to announce it, that there will be in the course a lecture on Business Law and Contracts, which should be of particular interest to the student. The engineer of today must have a fair knowledge of business methods, in fact he should be a scientifically trained man of business, and to the graduate, a knowledge of business law should prove most helpful.

THE Modulus advertising board is now in place in the lower hall, and it is hoped that the merchants of the town will avail themselves of this opportunity given to advertise here as well as in THE TECHNIC and Modulus. Space will be given those who advertise in both publications.

WE solicit the patronage of our advertisers.

JUDGING from the enthusiasm displayed at the general assembly of Feb. 8, and the apparent willingness on the part of every one to take hold and help build up athletics, we look for and confidently expect great things of Rose at the Spring meet.

We make a personal appeal. Come out and give Mr. Crawford the chance to make a prize winner of you, and by so doing help to place Rose where she once stood, first among the colleges of the state in athletics.

THE question of giving a student some sort of credit for his gymnasium work, we understand, is to be considered by the Faculty.

This would make it well worth one's while to attend regularly the classes. Mr. Crawford would be instructed to keep a record of each student's work, and these records would figure in some way in his general standing. We believe this would lead many to take up gym work who otherwise would persuade themselves that they could not take the time from study.

THE books received by THE TECHNIC for review are now to be found on the library shelves. It is hoped that the privilege of drawing them from the library will not be abused, and that no book will be kept out longer than two weeks.

SENIORS have been directed to submit their thesis subjects on or before Saturday, February 15th.

Notes on the Construction of Graphical Diagrams for the Solution of Equations.

By PROF. JOHN B. PEDDLE.

GRAPHICAL methods for solving certain equations connected with engineering work are coming to be so much used nowadays that I have thought that a few suggestions as to some of the commoner processes employed in attacking such problems might be of interest.

A great deal of work has been done along these lines, one writer at least having filled a good sized volume with descriptions of the methods with which he is acquainted. In this article I shall attempt to give only the most rudimentary treatment of a few of the commonest and most useful methods employed, not with the idea of presenting anything new, but with the hope of interesting those of my readers who may not already be acquainted with the subject.

Let us begin with a very simple case and suppose that we have an equation between two variables one dependent on the other. Take for instance $v=\sqrt{2gh}$, the expression for the velocity of a falling body in terms of the height and gravity.

Fig. 1.

Draw a straight line of convenient length as in (a) Fig. 1, and starting from one end as zero graduate one side of the line to represent the h of the equation. Solve the equation for v and lay off the values of v on the line opposite the corresponding values of h. This is perhaps the simplest form of graphical table or diagram, a glance showing the corresponding values of v and h.

It could be modified by making even graduations on the v side of the line as at (b) of the same figure, in which case the h graduations will become unequal. In general the (b) form is to be preferred to the (a) for the reason that the size of the unequal graduations decreases as we ascend the scale instead of increasing as in the other case. With a scale of this description the percentage of error in reading will be more nearly the same throughout its length, for while an error of a fiftieth of an inch in reading the higher part of the scale will represent a much larger absolute value than the same error in the lower part yet, since the total reading is large, the *percentage* of error will not be greatly different.

There may of course arise special cases in which some other requirement may become paramount and make a form like (a) preferable, but such cases are the exception.

It should also be noted that in this as well as the following diagrams if we only require readings between certain limiting values of v or h we need only construct the scale between these limits, and this will enable us at times to materially increase the size of the graduations for the same sized diagram and therefore increase the accuracy of the readings.

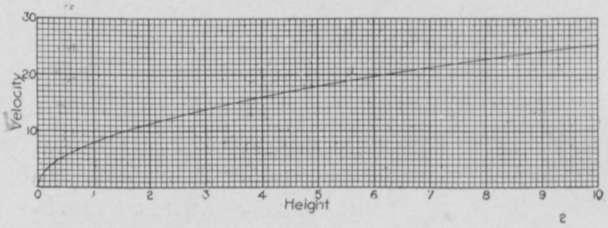


Fig. 2.

Another way of graphically solving the above equation is by means of its Cartesian curve on squared paper, as in Fig. 2. Values of h are laid off on the horizontal or X axis and of v on the vertical or Y axis. Perpendiculars erected at corresponding values of v and h on these axes will intersect on the curve, thus giving us a means of finding either quantity if the other is known.

Such a curve would not, perhaps, be of much

practical value in solving an equation as simple as the one given above. It is described to show what method could be employed if, in a more complicated graphical solution, one step involved finding a power or root of some quantity. It may be of especial use if the power or root is fractional as in such cases graphical methods will often save much mental labor.

Let us suppose next that we have an equation of the form ab=c. Suppose also for the moment that c is constant. Then if values of a be laid off on the X axis and of b on the Y axis, and we erect perpendiculars to corresponding values of a and b (as shown by the equation) these perpendiculars will meet upon a curve which will be recognized as the equilateral hyperbola. We may have as many of these curves as we have values of c. Fig. 3.

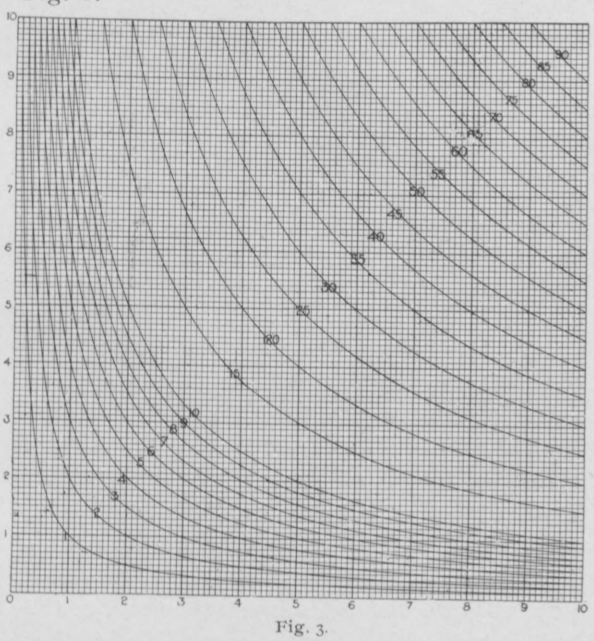


Fig. 3.

To find the product of any two numbers take their values on the X and Y axes, and from these points erect perpendiculars. The curve on which the perpendiculars meet will give the product. If they meet between two curves the value must be interpolated.

It will be readily understood that division may be performed on such a diagram by making the curves stand for the dividend.

In this diagram as well as in the others I shall describe the range is not limited to values between 0 and 10, for values on any of the scales may be multiplied or divided by any multiple of 10 so long as care is taken to see that the other scales are changed to agree.

If for instance we divide the vertical scale numbers by 10 and call the 10 curve 1, and drop perpendiculars from any point on it to the axes the points thus found will be reciprocals. The 1 curve already drawn on this diagram could of course be used for getting reciprocals, but would not be very practical on account of the sharpness of its intersections with some of the coordinates.

This form of diagram is useful in some cases, but in general the labor involved in its construction is so great as to prohibit its use for most purposes, especially as there are other methods of accomplishing the same result much more simply.

If for instance we plot the equation ab=c by laying out a and c on the Y and X axes instead of a and b, we will get a series of straight lines radiating from the origin, and corresponding to the different values of b. To multiply two numbers, take one of them on the Y axis and run horizontally to the diagonal line numbered with

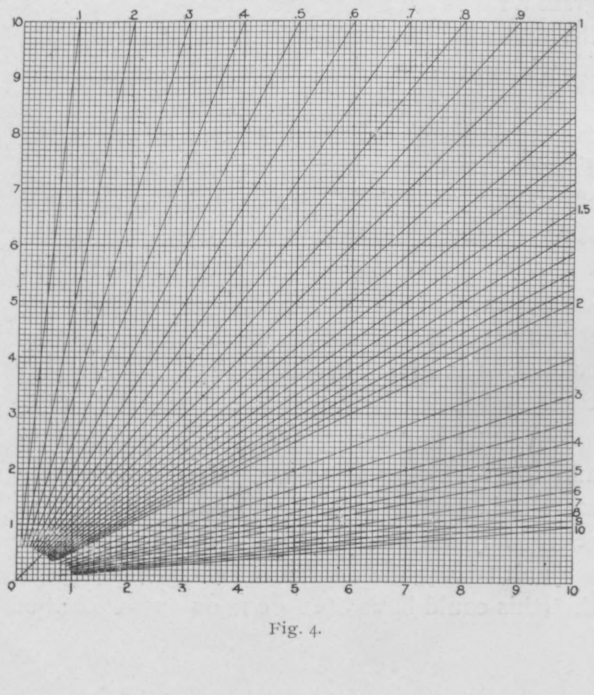


Fig. 4.

the other. From this intersection drop a perpendicular to the X axis, where the product will be found. Division would of course be performed the other way around, i.e. by entering the diagram at the dividend on the X axis, and leaving it at the quotient on the Y axis.

As in the previous case, if values between those shown on the diagonals are desired it will be necessary to interpolate for them. It is therefore desirable whenever two groups of numbers are to be multiplied, and one group is composed of even numbers while in the other the units are subdivided, to put the latter on one of the axes, where interpolations are easily made, while the diagonals are reserved for the even numbers.

It will be noted in Fig. 4 that the diagonals are considerably crowded as they approach number 10, and that moreover in running from the Y axis to these diagonals the intersections are so sharp as to make them of little value if accurate work is required.

To avoid this difficulty the scale lengths representing the multiplier and product should be nearly equal (another way of saying that the multiplying lines should make about 45 degrees with the axes) and if we do not have to cover too great a range it may pay to change the values of the scales to bring this about. If for instance, we wished to do most of our multiplying near the 10 line, the values along the Y axis could be made one tenth of what the figures now show, and the diagonal numbers increased to ten times their present values. We could then keep the numbers the X axis the same as at present and our intersections with the diagonals be much improved for accuracy.

The way in which these changes will be made for any special case will depend largely upon local conditions and must be decided specially for each case.

It will be understood, of course, that in this and the following diagrams, the choice of the scale unit has been arbitrary, and that if it had offered any advantage I could as well have made my unit two or three or more blocks as one, also that this could have been done on one or both of the axes if care is taken to change the curves or diagonals to suit.

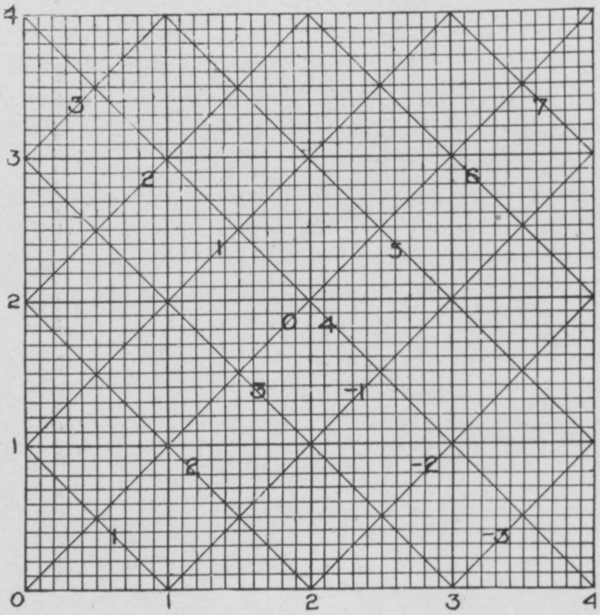


Fig. 5.

A diagram with a family resemblance to the two previous forms is shown in Fig. 5. It may be used for addition or subtraction.

Taking the system of lines sloping down from left to right, it will be noted that if we enter the diagram at one number on the X axis and at any other on the Y, the perpendiculars through these points will intersect on the diagonal numbered with their sum. The reasons for this are so simple that I will not take up space with a demonstration.

Taking the other set of lines, the ones sloping down from right to left, if we enter on the X axis and run up to one of these lines numbered with the quantity we wish to add, and then over to the Y axis we will find there the sum. Notice that the lines to the right of the zero diagonal are given a minus sign. This was of course arbitrary. Either set could have been made minus or plus according to whether we wished to enter on the X or Y axis.

In some cases it is possible to perform addition or subtraction without the use of these lines. If for instance we have a constant quantity to add

or subtract as a certain step in a graphical solution it can generally be better done by imagining the zero on the scale to be moved to the right or left or up or down a distance equal to the value of the constant. The true zero does not appear as such on the diagram, a false zero being used instead, from which we number. It should be noted, however, that in case we have to perform an operation on the quantity, such as for instance multiplying or dividing by radiating lines, immediately after the addition or subtraction is made, we must draw our multiplying lines from the *true* and not the false zero.

In solving an equation graphically we must usually take a number of successive steps, first multiplying, then squaring, then adding, and so on, and what has already been said is intended to show how each of these individual operations is to be performed. Your success in constructing diagrams will be proportional to your luck or ingenuity in getting the equation into a form easily handled, in the first place, and then making the best choice of the order in which the operations are to be followed out.

Often a slight change in the form of an equation will greatly simplify the construction of the diagram, by enabling you, for instance, to use straight lines for curves.

As an example, take the equation connecting the lengths of two conjugate foci of a lens with the length of the principal focus.

$$\frac{1}{f}+\frac{1}{f'}=\frac{1}{p}$$

where f and f′ represent the lengths of the conjugate foci and p the length of the principal focus.

In its present form it would be rather awkward to handle, but if we put $x=\frac{1}{f}$, and $y=\frac{1}{f'}$ we get

$$x+y=\frac{1}{p}$$

the equation of a straight line.

Distances along the X and Y axes are laid out as the reciprocals of the values of f and f′, and we get the diagram shown in Fig. 6, where all the lines are straight. Find the diagonal corresponding to the principal focus of your lens, and then perpendiculars from conjugate foci on the axes will meet on this diagonal.

About ten years ago a new kind of section paper was put upon the market in which the scale divisions were logarithmic instead of equal.

The idea was not new, for logarithmic diagrams had been in use long before this, but this was the first time such paper

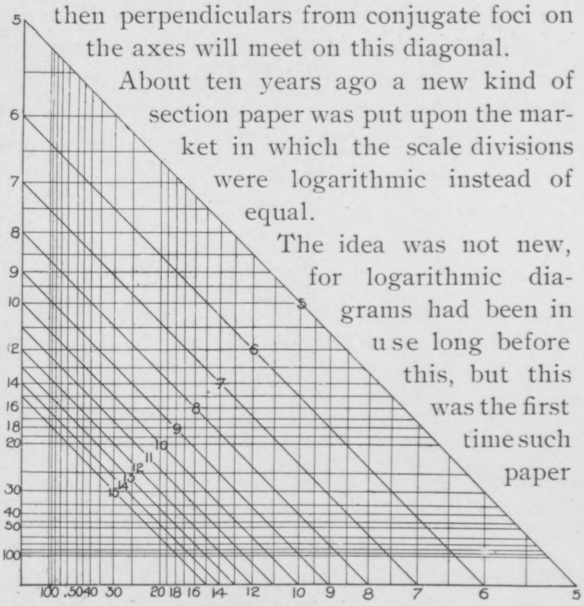


FIG. 6

could be bought ready ruled, like ordinary section paper.

It differs from the ordinary paper, in that its scales are graduated and numbered to represent the logarithms of numbers instead of the numbers themselves.

It has some rather remarkable properties, which from lack of space can be touched on only briefly here.

Our equation ab = c can be written log a + log b = log c, a straight line form.

Laying off log a on one axis of this section paper and log b on the other, we get the series of lines sloping downward from left to right in Fig 7 for the different values of c.

To multiply two numbers we enter the X axis with one of them and the Y axis with the other. Perpendiculars from these points will intersect on the line numbered with the product.

This is exactly the same diagram as that in which we performed addition above, only in this case we add the logarithms of numbers instead of the numbers themselves.

The lines sloping upwards to the right correspond to the other set of lines in the addition diagram, and are found by laying off values of log a

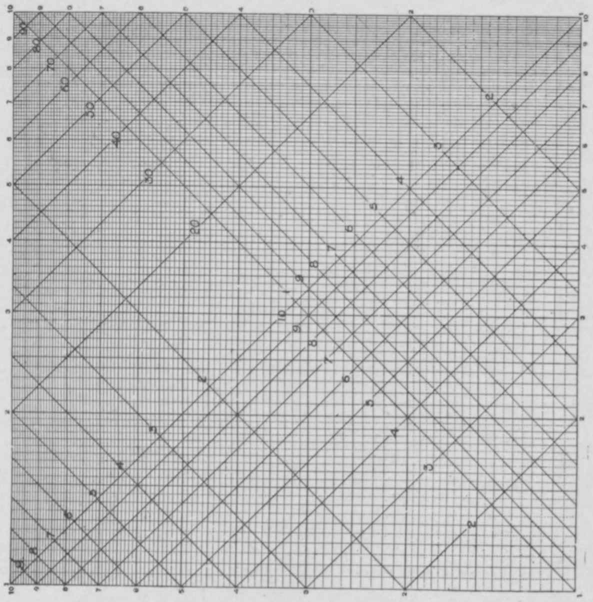


Fig. 7.

on the X axis and of log c on the Y axis. The diagonal lines then correspond to the values of b, and to multiply we enter at the X axis with the multiplier and run to the diagonal numbered with the multiplicand, and then to the Y axis for the product.

Division, of course, reverses this process.

It will be noted that the upper limit of our diagram is 10, and if we wish to go above that we should have to have the diagram extended in that direction. It is clear that the extension above the 10 line would be exactly similar in graduation to that which we already have (since the mantissa of the logarithm is not changed) and we should merely have a second block like this with the figures on the vertical scale multiplied by ten. Such being the case we can imagine the upper scale shifted down over the one before us, and the rulings will coincide in every particular. Now line 2 which runs from 2 on the left hand scale to 5 on the upper scale must run straight on, and if the upper block is shifted down upon the lower one it will appear as a line running from 5 on the lower scale to 2 on the right hand vertical scale. The same reasoning holds for the others. We must therefore remember that products obtained from the use of the diagonals to the right of line 1 will give us results which belong to a scale ten times as great as those on the left of it; that is, if I take 3 on the X axis and run up to diagonal 2 I get 6 as the product on the Y axis. If however I take that same three and run to 9 and then to the vertical I should read 27 and not 2.7.

It is understood in this case as before that I am at liberty to put the decimal point wherever I choose providing the line numbers and the other scale are altered to correspond. The lines sloping down from left to right are evidently lines of constant product, and might be used to solve equation $pv=c$. If we take line 10 of this series and call it 1, dividing one of the axis scales by 10 also, it gives us a table of reciprocals, just as in Fig. 3.

Equations involving powers and roots take straight line forms on this paper instead of the curve forms of the regular ruling.

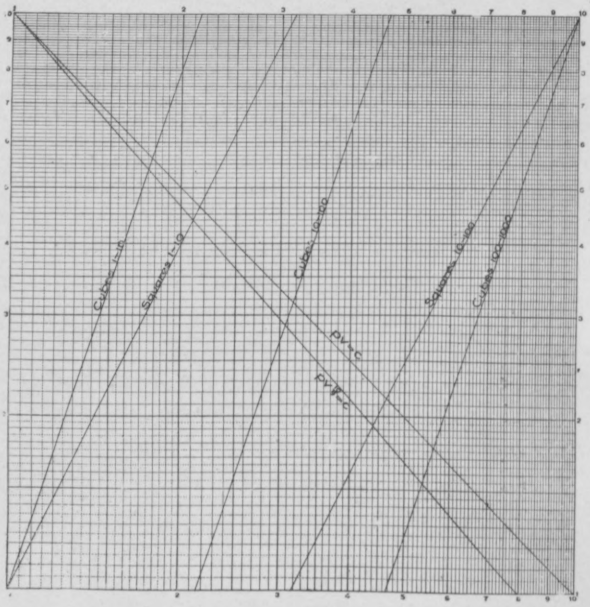


Fig. 8.

If we say $a=b^2$ we can write it $\log a=2 \log b$, the equation of a straight line passing through the origin and inclined at an angle whose tangent is 2 to one of the axes. Fig. 8 shows a table of

squares. We bisect the upper scale and draw a line to this point from the origin. To get the square of a number we enter on the X axis with the number, run up to the line of squares and over to the vertical scale where the square is found. The same remarks regarding the continuation of this line beyond 10 hold good as for the multiplying line, and we accordingly find the second section of the line appearing at the bisection of the lower scale and running to the upper right hand corner.

For the line of cubes we divide the upper and lower scales into three equal parts and draw the lines as shown.

Roots are extracted by reversing the direction of entering the diagram.

If instead of the above equation it had been $a = b^2c$ we should have written it $\log a = 2 \log b + \log c$ and have obtained a line having the same slope as before but raised through a vertical distance equal to log c.

Fractional powers and roots are handled with the same ease as the even powers, and this gives a peculiar value to logarithmic paper for certain problems.

We merely do as before, lay off a line whose tangent was equal to the fractional exponent.

As an example of this take the equation for the adiabatic curve $pv^{\frac{10}{9}} = c$, where p is the absolute pressure, v the volume and c a constant.

Write this $\log p = \log c - \frac{10}{9} \log v$. The minus coefficient means that the angle of the line must be negative. We may make c anything we choose, and it may be laid off from the origin along the Y axis.

If we call it 10 we shall get the line shown in Fig. 8 passing through the upper left hand corner of the diagram and inclined to the horizontal at an angle whose tangent is $-\frac{10}{9}$.

An interesting form of addition diagram is shown in Fig. 9, founded on the so called hexagonal system.

If we have three axes 0A, 0B and 0C meeting at angles of 60 degrees, and if we drop perpendiculars from any point p to these axes, it can easily be shown that the sum of the lengths 0a and 0c is equal 0b.

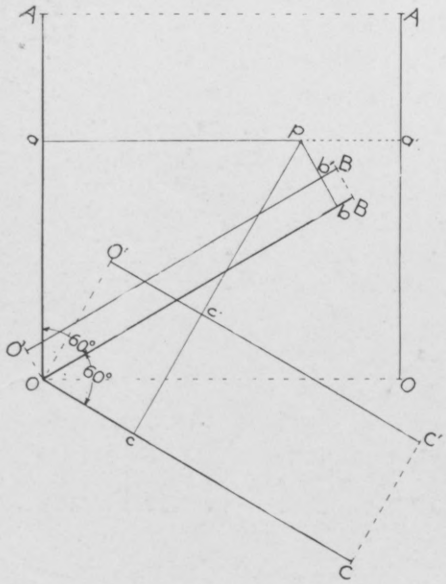


Fig. 9.

Now if we lay out logarithmic scales upon these three axes and erect perpendiculars from the logarithms of any two numbers on 0A and 0C and from their intersection drop a perpendicular to 0B we will get the logarithm of the product.

If we wished to multiply this product we could then take a line at 120 degrees to 0B and using this line and 0B as we did 0A and 0C get a product on 0A or 0B, and this could be kept up indefinitely.

Division could of course be effected by measuring off the divisor in the opposite direction from the origin as the multiplier.

It will make the work easier if a transparent index be prepared on a hexagonal piece of thin celluloid, the three long diameters of the hexagon being scratched on its surface.

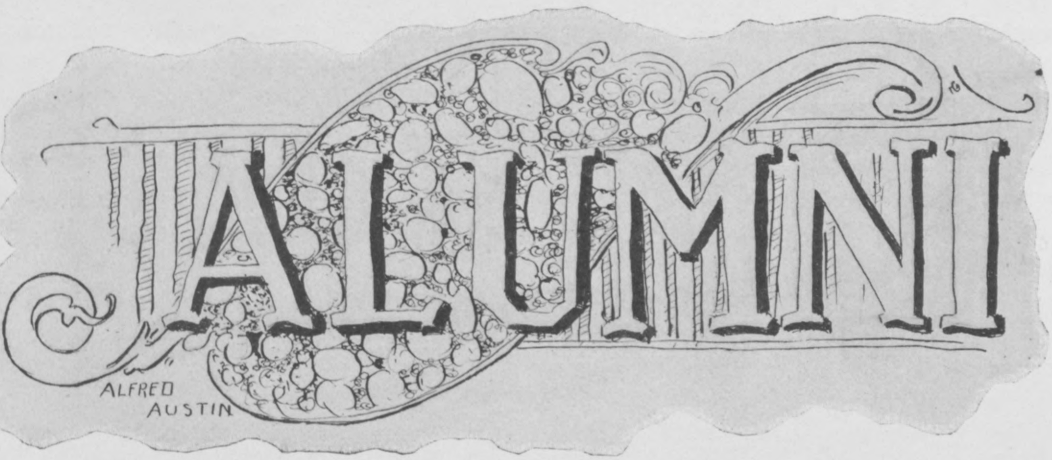
Place the index over the diagram with a long diameter perpendicular to each of the axes, and one of the diameters passing through one of the multipliers on, say, the 0A axis. Place a straight edge against one of the sides of the hexagon perpendicular to the 0A axis and slide the index till the diameter perpendicular to 0C passes through the multiplicand on that axis. Then the third

diameter will pass through the product on the 0B axis.

An interesting and sometimes valuable feature of this diagram is that the scales 0A, 0B and 0C may be moved bodily in directions perpendicular to themselves, for no matter how much they are moved the perpendiculars from p will always pass through the same point on the scales. This is shown on the drawing by shifting 0A to 0'A', 0B to 0'B', and 0C to 0'C'.

It not only gives us considerable freedom in the arrangement of the diagram but if we have to multiply back and forth we can separate the different scales belonging to the same axis, and thus avoid confusion.

NOTE—The diagrams should be made as large as convenient in order to get accurate readings. Those given in this article merely serve as illustrations of principles and are not to be taken as models of size. They are too small to be of the least practical use.



Asphalt Rock or Bituminous Sandstone in Kentucky.

By W. E. BURK, '96.

THE increasing use of asphaltum in mixtures for street paving purposes is occasioned by two factors chiefly—efficiency and downward trend of cost. Efficiency of the constructed work depends both upon character of the raw material used and in correct treatment of same in mixing and in construction of work. With the ideal asphaltum, which is closely approximated in some natural deposits, chemical and physical properties are possessed which offer the basis of a very excellent paving material. Notable among these properties is the resistive character as against solution by water and other natural solvents existing in the atmosphere and on the earth's surface.

Asphaltum of the purest varieties occur on the island of Trinidad and Venezuela, cargoes of the product often coming to United States ports containing under 5% impurities. The cost of this material, however, is not inconsiderable, prices ranging from $30.00 to $50.00 per ton in our eastern markets, and this cost item taken in connection with the growing demand for the commodity has encouraged the development of domestic deposits. There are a number of these domestic deposits of varying magnitude and richness scattered over several states, including California, Kentucky, Utah, Indian Territory and West Virginia.

The Kentucky deposits are quite extensive in scope, occurring chiefly in the counties of Grayson, Butler, Edmonson, Warren, Logan and Breckenridge, occupying a strip in the central portion of the state extending from north to south. Other counties of the state contain deposits, which, however, have not been exploited to any considerable extent.

The deposits occur in the sub-carboniferous formation and consist of strata of sandstone, usually of quite fine grain, saturated with bituminous material. The strata usually approximate their normal horizontal position, and geological evidence points to the saturation as secondary, the bituminous material representing the residual matter from pre-existing petroleum beds. The geological history of Kentucky seems to be written in the bluffs and formation along and near Green river, where it flows through the counties of Warren and Butler.

The asphalt-bearing rock is a very soft sandstone of considerable thickness, belonging to the sub-carboniferous age, the different strata being separated in some cases by shale or by limestone. At one time before the destructive erosion period,

this sort of sandstone, with an occasional impervious shale layer, offered the right conditions for becoming saturated and holding petroleum. The soft, porous sandstone, however, was easily eroded, and the channel streams of the ancient Green river cut deeply into this formation, in some instances more than one hundred feet in depth through the succeeding strata; the sandstone bluffs so formed serving as a filtering mass from which the lighter hidrocarbons and oils oozed and drained away from what was perhaps at one time a large pool or lake of soft sand saturated with petroleum.

This drainage has left the sandstone impregnated with the gummy residual pretroleum products constituting asphalt or bituminous rock. More or less impervious strata intervening here and there; coarser and finer sand particles; more or less compactness of the sandstone, all tend to determine the thickness and the richness of the deposits, which varies considerably in these respects in even small distances. There is much evidence to support this theory of the origin of the Kentucky asphalt from petroleum, among them being the proximity of adjoining oil fields, both to the southeast and to the north of this district. While both these neighboring gas and oil fields are small and of uncertain magnitude, yet they are sufficient to prove original conditions and to suggest connection with the origin of the asphalt deposits.

The rock formation over this portion of the state, in addition to the surface erosion system, presents fractures and shattered conditions which could afford drainage of the petroleum and determine the deposits where they are now found. That petroleum bearing rock of limited extent formerly existed where the present asphalt beds occur, should not be taken to mean that quantities of petroleum must exist at still further depths, for intervening rock strata of hundreds of feet in thickness represent ages of time and altogether different formative conditions.

The most generally accepted theory of petroleum is from marine animal origin; however, the close overlying proximity of the coal measures introduces a suspicion of a connection of the same with the asphalt or petroleum origin.

The deposits occur in horizontal strata of from a few inches to several feet in thickness, usually with a somewhat more compact and impervious stratum above and below. The bituminous matter present in the rock varies in percentage from 4 or 5% to 50%, sometimes higher values being found. Of the total bituminous material present in the rock, a part, usually more than three-fourths of the total consists of oily hydrocarbons soluble in petrolic ether and classed as "petrolene," while the remaining part of the bituminous matter which is insoluble in petrolic either, but is soluble in chloroform, is classed as "asphaltene."

The residue from such an extraction is a fine white sand, often as fine as 100 to 150 mesh, and occasionally iron pyrites up to 1% is found in the sand.

A 12 to 15% bituminous rock is considered of workable value, providing the deposit is sufficient in magnitude, thickness of workable veins being from 4 to 20 feet. The method of mining is to remove the overlying soil or "stripping" and to quarry the rock, the industry not having advanced as yet to the working of deep deposits.

The rock is loosened and shattered somewhat by blasting, but much cutting is necessary to remove the tenacious gummy mass. The rock is crushed, usually between heated rolls, and in this condition is ready for proper admixture with other material for street or paving purposes.

The Kentucky asphalt material possesses the unique combination of a natural mixture of sharp sand and binding material which with many of the deposits requires little or no admixture to render it a proper street or paving material.

Up to the limiting freight tariff radius, where the haulage of the sand content will prohibit the use of anything but purer varieties of asphaltum, it would seem that there exists a field of appli cation and use of this bituminous sandstone or asphalt rock.

ALUMNI NOTES.

The undersigned announce the formation of a co-partnership under the firm name of Bradford & Hood for the practice of patent, trademark and copyright law.

CHESTER BRADFORD.
ARTHUR M. HOOD.

Indianapolis, Indiana, January 15, 1902.

J. R. Riggs, '01, has resigned his position with the Ewart Mfg. Co., of Indianapolis, to accept a position in the Motive Power Dept. of the Vandalia. Mr. Riggs expects to return to Terre Haute Saturday, Feb. 8th.

Mr. John F. Schwed, class of 1899, was married to Miss Elizabeth E. Johnson, at Cleveland, Ohio. on Feb. 5th. Mr. Schwed is in the Eng. Dept. of Southern Ry., at Birmingham, Ala.

T. D. Witherspoon, '01, who has been doing some special for Mr. McKeen, Superintendent of Main Line Division, Vandalia Line, has resigned his position with the railroad and accepted the position of erecting engineer for the Youngstown Engineering Co., Youngstown, Ohio. His headquarters will be in Youngstown, Ohio.

Orange E. McMeans,'96, has resigned his position in the drafting department of the Richmond City Milling Works. Mr. McMeans has accepted a position and will begin with the Nordyke & Marmon Company, of Indianapolis, today. Mr. and Mrs. McMeans have already located in Indianapolis, and are located at 2123 Ashland avenue.

Announcement has been received of the marriage of Mr. Francis H. Miller and Miss Georgia McCampbell, at Louisville, on Feb. 11. Mr. Miller is of the Class of '95, and Chief Engineer of the Louisville Railway Co.

A. G. Shaw, '97, and Miss Mabel Markley were married at Danville, Ill., on Wednesday, Feb. 12. They will live in Omaha, Neb., where Mr. Shaw is Electrician of the Union Pacific Ry.

Clipping from a Louisville paper:

Mr. Francis Miller, who was severely burned by coming in constact with a live wire at the powerhouse of the Louisville Railway Company, is not only through with the worst results of his injury, but is actively engaged in preparing for his coming marriage.

It is solely due to Mr. Miller's cool courage and strength of will that he is alive to-day.

He was engaged in testing some new machinery, when a short circuit sent a mass of flame into his face. If he stepped back, it was to encounter a voltage that meant instant death. Placing his hands before his eyes, Miller stood perfectly still until the circuit had been stopped. Meanwhile, his face had been horribly burned, and even the enamel had been melted from his teeth.

He was taken home, and the physicians began on the difficult task of healing his wounds so as to leave no scar. This they have succeeded in doing.

Last Sunday Mr. Miller's engagement to a charming Louisville girl was announced. The marriage will take place in February, so that his good fortune is treading fast on the heels of the bad. He is the chief engineer of the company, although not yet thirty years old.

Freight Car Wheels

By JOHN A. NICHOLSON, '02.

THERE are in use in the United States and Canada at the present time, approximately, 14,000,000 cast iron wheels, costing somewhere in the neighborhood of $90,000,000. These wheels are engaged in conducting the entire rail transportation business of the United States and Canada, and it can be truly stated that the cast iron car wheel is one of the greatest iron products of this country, and one that is well worth preserving. The long continued use of the cast iron wheel testifies to its great efficiency and economy, and to preserve this useful product, as to preserve any product of industry, requires its continued development. That the quality of the wheels has been improved materially from time to time there is no doubt, but that it is in need of still further improvement, due to the increased capacity of freight cars, is without question.

The patterns from which these wheels are moulded are made from wood, with the exception of the brackets and the lettering. The brackets are made from a pattern and cast in lead or aluminum, in order to save labor and secure uniformity in ribs. The length of time required to make one and the core boxes for a wheel is about 30 hours. Its value is approximately $20, being more valuable than the wheel itself. The life of a pattern is from four to six years, and 35,000 wheels are often cast from it. All the letters used on it are made of lead. Each wheel has marked upon the outside face the name of the manufacturer and on the inside face the day, month and year upon which it was cast, together with the number of the wheel.

When the pattern of the wheel is completed it is sent to the moulder. The moulds are made of green sand in a cast iron flask, consisting of a chill, drag and cope, the cope and chill being made in one piece. The hardness given to the tread of the wheel is caused by the molten metal running against the cast iron and solidifying more quickly than the metal nearer the center of the wheel and that striking the sand. The diameter of the chill part of the flask is $33\frac{1}{2}$ inches for 33 inch wheels to allow for shrinkage. The depth of hardness varies from $\frac{7}{8}$ to $\frac{3}{8}$ of an inch. A moulder and his helper can mould from 18 to 20 per day, and nearly all wheels cast are good, the amount lost not exceeding one per cent.

The place where the iron is melted is called the cupola, and it is one of the most important factors in the manufacture of car wheels. Upon the man who has control of the charging a great deal depends, for it is his judgment and long experience in selecting iron from his piles of scrap

and pig that the right charge to make good wheels is obtained. The cupola is a large cylindrical affair, looking somewhat like a chimney. However, it is quite different. It is made of an outside covering of sheet steel, being 50 to 60 feet in height and from 6½ to 7 feet in diameter except at the lower end, where it is about 9 feet, this larger portion extending from the bottom to a height of 3 to 4 feet.

It contains eight or twelve openings, about 4 inches in diameter, through which the blast of air is introduced into the cupola.

The cupola is lined with fire brick to a depth of 8 or 9 inches to maintain a high temperature and keep the charge from burning the outside covering. The brick are renewed every four weeks. Two semi-circular doors of cast iron form the bottom of the cupola, and they are also lined with fire brick. They open downward, and when the charge is being heated they are kept closed by a prop extending from the doors to the ground. When the pouring in the foundry is completed the prop is pulled from under the bottom by a man standing some distance away, and the slag and remaining metal drop to the ground.

A platform is built about 20 feet from the bottom of the cupola, from which the charging is done. All the materials to be used are taken to this platform and carefully weighed and inspected and then put into the charging doors, which are a little above the platform. Only enough material is placed in the cupola at one time to cast ten or twelve car wheels, and when this is drawn out a similar amount is put into the cupola to be melted.

When the iron has reached the right temperature the cupola is "tapped out," as it is called, all the metal being drawn into a large ladle. The tender of the cupola "taps out" by breaking the fire clay plug, and when the metal has all been taken out he puts in a new plug. From the large ladle smaller ones are filled, each holding enough to make one wheel. The work in the foundry is much facilitated by the use of cranes and compressed air.

After the metal has solidified in the moulds and left standing for fifteen minutes or so, the moulds are taken apart and the wheels taken to the pits. The pits are circular holes dug into the ground and lined with fire brick. Each one will hold about 20 wheels. These pits are used in order that the wheels will cool slowly and uniformly to prevent shrinkage. It takes about five days for the metal to cool sufficiently so that the wheels can be handled.

From the pits the wheels are taken to the wheel grinding machine, where the tread is smoothed with an emery wheel, and then they are measured with an M. C. B. standard steel tape around the tread close to the flange. They vary in circumference due to shrinkage and are therefore paired and two wheels are placed on one axle having the same diameter. This prevents excessive wear of the flange.

The wheels are next bored out and then they are ready to be placed upon the axle, which is usually done by hydraulic pressure.

Most railroad companies, when buying freight car wheels, send specifications and drawings from which the wheels are made, also indicating the tests the wheel must stand before it is accepted. There are two tests now used, the drop test and the thermal test. Most companies require the former, while only a few subject the wheel to both. The Pennsylvania Company, however, requires both. Below are given the specifications of this railroad's test. When the wheels are bought they are generally ordered in lots of 100, or multiples of the same, and for each 100 ordered three extra wheels must be furnished by the manufacturers for tests. These test wheels are selected by the inspector at random from the lot offered for test.

Drop test :—"The wheel must be placed flange downward in an anvil block weighing not less than 1800 pounds, set on rubble masonry two feet deep and having three supports, not more than five inches wide, for the flange of the wheel to rest upon ; it must be struck centrally upon the hub by a weight of 140 lbs. falling from a height of 12 feet. Should the wheel break in

two or more pieces after ten blows or less, the 100 wheels represented by this test wheel will be rejected. Should the wheel stand ten blows without breaking in two or more pieces, the 100 represented by it will be regarded as satisfactory as to this test."

Thermal test:—"The other two wheels must each be tested as follows: The wheels must be laid flange down in the sand, and a channel way 1½ inches wide and 4 inches deep must be moulded with green sand around the wheel. The clean tread of the wheel must form one side of this channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top from one ladle with molten cast iron, which must be poured directly into the channel way without previous cooling or stirring, and it must be so hot when poured, that the ring which is formed when the metal is cold, shall be solid or free from wrinkles or layers. The time when pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plates extends through the tread in either of the wheels tested, the 100 wheels represented by the two test wheels will be rejected."

Some wheels, under this test, burst with some violence before the metal has become solid, throwing the molten metal some distance. As it takes the metal about one minute to solidify, it is well to use a little precaution for that time. In order to avoid spitting during pouring, the tread and inside of flange of the wheels submitted to thermal test should be covered with a coat of shellac. Wheels which are wet or have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances must the thermal test be applied to a wheel that in any part feels warm to the hand.

A careful examination of broken and cracked wheels indicates that they are broken or cracked principally by the expansion of the rim, or because of the internal strains, coming as a result of improper manufacture, the stresses being so great as to produce rupture when in service.

A wheel weighing 700 pounds is generally used under freight cars having a capacity of 100,000 pounds, and for every 20,000 pounds decrease in capacity the wheels decrease 50 pounds in weight, although some railroads vary the rule to some extent.

The average life of a car wheel is 10 years, and the total mileage 100,000 miles.

An average analysis of the grey iron would give approximately the following results:

Graphite corbon, 2.90%; combined carbon, 0.78%; manganese, 0.40%; phosphorus, 0.42% silicon, 0.55%, and sulphur, 0.12%. The chill in iron will consist of the same amount, with the exception of the carbon. which would be graphite carbon, 3.81%, and combined carbon, 3.39%.

MODULUS DANCE.

Although the slim attendance at this dance was a disappointment to the Modulus management, this did not mar the pleasure of the evening. The punch was excellent, the floor in good shape, and every one had a good time. There will be another dance given after Lent, when it is hoped the students with their fair ladies will turn out in large numbers. A good time is assured them.

CLIPPING FROM THE TERRE HAUTE GAZETTE.

ANOTHER NOVEL.

BY PROF. A. S. HATHAWAY OF ROSE POLYTECHNIC.

In recognition of the *Gazette's* enthusiastic mention of his really very clever story, "The Henry Will Case," Prof. Arthur S. Hathaway has presented to the office another of his works published recently.

It is entitled "Quarternion Space." The plot begins to thicken in the first chapter when the heroine has something to say about "euclidean relations in the Parallelogram" and later throws out dark hints about "triangles, tetrahedron, etc., remaining rigid." The course of true love doesn't run smooth, for we find the hero in a fit of despondency declaring that "the orthogonal projection of a hyper circular ring on either cycling plane is a circle about the center." He does not, however, go to the length of demanding his ring back and a settlement of ice cream bills; and soon a reconciliation is effected and the author draws a beautiful picture of "invariant figures, path curves and surfaces, of old conformal transformations."

All is well that ends well, as we are informed in the last touchingly beautiful line as follows:

$$S\,(\underline{\alpha\alpha'}+\beta\underline{\beta^1})=\frac{L}{2}(\underline{\cos}\;\beta+\underline{\cos\;\phi})=\underline{\cos}\;\frac{L}{2}\,(\beta+\phi)$$

An orchestra of about fifteen pieces has recently been organized among the students, ex-Polys and Polys-elect. The members have not applied for official recognition yet, but are practicing regularly in order to be worthy of such an honor. The organization is now officered as follows: Pres. and Manager, Robt. D. Landrum; Sec'y and Treas., J. E. Daily; Conductor, J. Dow Sandham. New music is being rapidly added to an already large collection of pieces, and if the present interest in the work continues, a recital is not beyond the range of possibility.

SCIENTIFIC SOCIETY.

At the meeting of the society held Jan. 11th, Mr. C. H. Hilis, '02, presented a paper on "Mechanical Refrigeration," and particularly its application to the manufacture of ice.

The meeting of the society for January 25th was held in conjunction with the Camera Club. Mr. George Holloway, the well-known "fotografer," lectured upon "Some Photographic Experiences." In the course of his talk he mentioned many difficulties encountered by amateurs and indicated how they might be avoided. He extended an invitation to the members of the Camera Club to visit his studio, and expressed a willingness to give them the benefit of his experience upon any points of which they might desire to make a particular study.

THE FRESHMAN BANQUET.

The Class of 1905 held its first annual banquet on the evening of January 31, at the Terre Haute House. The Sophomores learned of the affair early in the day, and were on their guard, not to be taken unawares, as they wished to capture as many Freshmen as possible. At noon several Freshmen were intercepted, but they were released by their captors, who had been given to understand that the banquet was postponed. Later in the day the Freshmen left school in a body, and the upper classmen after them in hot chase. Leedy and Godwin were caught on the run, and sent away in cabs. Lowrie was caught after a good fight, he being accidentally shut out of the hotel by his classmates. Ketcham and McNabb, both Sophomores, were locked in the hotel with the Freshmen. A brisk fight ensued, after which the Freshmen gave the Sophs up, at the request of the hotel management.

The three prisoners were given their supper at the usual time and were photographed repeatedly. Leedy was ludicrously dressed up and blackfaced, and in that condition forced into the banquet hall, where he pluckily stood and related his adventures, with those of his fellow-captives.

The Freshmen all agree that their banquet was

a most complete success. The class sat down to supper at nine o'clock to the music of the Ringgold orchestra, and after the meal an excellent program of responses was given to the following toasts :

"Chauncey Rose," . . . . Herbert L. Watson
"The Outer World," . . . . Fred B. Lewis
"Daddy Wires," . . . . Charles B. Falley
"Class of '05," . . . . George Benson
"Boarding Houses, ... Edward H. Spalding
"The Faculty," . . . . Sydney W. Inns
"Class of '04," . . . . Charles R. Peddle
Toastmaster, ... Allan McDonald

The table was set for fifty-two, in the large dining hall, so that the Freshmen could not have asked for a more appropriate setting for the large Class of 1905.

MENU.

OYSTER COCKTAIL

Dill Pickles Salted Peanuts

Lobster Newberg en Caisse
Claret

Dresden Cutlets, la Troulouse
Mashed Potatoes

PUNCH—CREME DE ROSE

Breast of Spring Chicken, Princess
Sweet Bread, Salad Mayonaise

Chocolate Ice Cream Assorted Cake
Champagne

American Cheese Crackers
Coffee

THE Athletic Association has, at last, secured an instructor to take charge of the gymnasium work. Mr. Dickerson has had the care of getting the new man and it is to him that the success of the undertaking is mainly due. He has worked hard and has written a great number of letters.

Our new gym. instructor is Mr. Dana H. Crawford, formerly of Detroit, but recently of Alma College, Alma, Mich. Mr. Crawford comes to Rose highly recommended, both by the instructor of physical culture in the Detroit schools and the physical instructor of tho Detroit Y. M. C. A , as well as by the authorities of Alma College. Mr. Crawford was a member of the Detroit Y.M.C.A. for eight years, and represented that instution on its track, basket ball and foot ball teams during most of the time of his membership. He has played on the Detroit Central High School foot ball team, and for the last two years has been its coach. This high school has over 1700 students and supports one of the crack high school foot ball teams of the west. Last Fall he entered Alma College and played on the foot ball team. Since Christmas, up to the time of his leaving for this place, he has been coaching the school basket ball team. He came to Terre Haute on Feb. 5.

At 11 o'clock, Saturday morning, Feb. 8, Dr. Mees, at the request of the Athletic Association, called a general assembly of the students to introduce to them Mr. Crawford, and, at the same time, to stir up some interest in gymnasium work; also to raise some money for the help of the Athletic Association in its expense of securing Mr. Crawford. Several speeches were made during the hour, and the meeting answered the highest hopes of all present.

Dr. Mees opened the meeting with some observations as to the manner in which the work of all the student organizations has been carried on. He spoke of the Scientific Society, the Glee Club, the Orchestra, the Y. M. C. A , and lastly of the Athletic Association. All of these organizations should receive greater support. In speaking of athletics in general, Dr. Mees said that in the United States, within the last fifteen years, there has been spent over $8,000,000 in the construction of gymnasiums. This fact alone proves that there must be good to be derived from systematic physical culture. He quoted some statistics from observations taken at Amherst College showing that, since gym. work had been introduced in that school, the percentage of sickness had been reduced from 30 to 19 per cent. He then introduced Mr. Crawford, who made a few remarks on the value of gymnasium work in preparing men for the hard work of the track and ball teams. He also suggested that we have an indoor class meet, soon, in order to find out what athletic material there is in the school.

Mr. Dickerson then made a few remarks and

called on Prof. Hathaway for a speech. Prof. Hathaway said that he was in favor of athletic exercise, and hoped the boys would turn out and begin work right away. He spoke of what Rose had done in athletics, and said what had been done could be done again. Messrs. McDonald, Jumper, Krieger, Flory and Ross then made short speeches, in all of which the opinion was expressed that Rose could and would be improved in its athletics. Prof. McCormick was then called, and he responded by saying that any man would waste more time than he should ever be called upon to give to athletics, and he suggested that some of this, otherwise wasted time, should be utilized in a good cause.

The question of raising money was then brought up, and it was decided that a list of the names of all persons present should be read, and that all who were willing to subscribe one dollar should answer "yes" to their name. This was done, and the result was gratifying, in that over $100.00 was subscribed. This was in excess of the $150.00 which, as had already been announced, Dr. Mees had so generously subscribed. The money thus raised will be collected as soon as possible.

The meeting closed with the Rose yell, which was given with a will.

IN the last issue of THE TECHNIC it was announced that a Mr. Perves of Indianapolis had been secured as coach and instructor for the school teams and gymnasium classes. Mr. Perves had accepted the position, but at the last minute sent a telegram stating that he could not take it. Mr. Dickerson again took up the work of obtaining a man for the position, and has secured a competent coach in Mr. Crawford for instructing the foot ball and track teams.

Preparations have already been begun for the opening of outdoor athletics in the spring. Mr. Gibbons is preparing a good schedule for the base ball team, and is making an effort to have most of the games played here. He thinks the team will play better at home than when on trips and by this means he hopes to win a larger per cent. of the games. Games will be played with DePauw, Wabash, Franklin and other schools. Many Freshmen have announced their intention of trying for the team. With these men, and with those left from last year's team, it is thought that we will be well represented on the diamond this year. The men left from last year's team are: Randall, Hills, Nicholson, Fishback, Daily, Hampton, Braman, Kellogg and Knight.

Little can be said of the track team at this early date, but the prospects are not so bad as some seem to think. There are many good men in school, and there are many others who could be good if they would get out and do some training. The State meet is to be held here, and we must get out and work and give a good account of ourselves. Nearly all the colleges of the State will be represented by teams.

Manager Jacob, of the foot ball team, is already arranging the schedule for next Fall.

T. H. H. S., 5; ROSE, 29.

The Rose basket ball team met its first outside opponents on the evening of Jan. 14, when it played the team representing the local High School. Very little was known of either team at the outset, but opinions as to the result of the game were not generally favorable to Rose. Those who doubted the ability of the Rose team were probably strengthened in their doubt when they remembered that on Jan. 14 of last year we were defeated by this same team. The spell was broken, however, and we easily wiped out the defeat of last year. A fair-sized crowd was present, each side having its rooters.

The game was called at a little after 8 o'clock in the Rose gym. Our boys took the lead at the start and kept it through the entire game. At the end of the first half the score was 16 to 2 in favor of R. P. I. In the second half Rose kept up the good work and the final score stood, Rose, 29; T. H. H. S., 5.

The High School only threw one field goal in the entire game, against nine thrown by the Rose team. Rumbley played a fine game for Rose,

throwing five field goals, while Johnson played best for the High School.

	First Half			Second Half		
	Field Goals.	Foul Goals.	Fouls.	Field Goals.	Foul Goals.	Fouls.
HIGH SCHOOL.						
Thurman, l. f.	....	2	2	....	....	1
Townley, r. f.	....	....	1	....	....	1
Ferguson, c.	....	....	1	....	....	1
Glover, r. g.	....	....	2	....	...	....
Johnson, l. g.	..	....	2	1	....	....
ROSE.						
N. H Cox, l. f.	1	....	1	....	....	1
I. J. Cox, r f.	1	....	1	2	1	....
Rumbley, c.	3	1	3	2	....,	....
Barbazette (Capt.), l. g.,	....	....	2	....	....	2
Fitzpatrick, r. g.	...	....	1	....	....	2

Score—Rose, 29; High School, 5.
Referee—Trueblood.
Umpires—Attridge and Steel.

Y. M. C. A., 35; ROSE, 17.

One passes as lightly as possible over the defeat administered to the Rose basket ball team on the evening of Jan. 22, by the strong city Y. M. C. A. team. The game was not called until late, as the gym. could not be lighted.

The two teams appeared to be almost evenly matched in the first half, Rose having a little advantage over its opponents. The score was 12 to 9 at the end of the half. In the second half the Y. M. C. A. changed some of its players, and this, together with the weakening of our boys, allowed the visitors to run up a score of 35 to 17. The Y. M. C. A. has a very strong team, and is composed of men who have played the game for a long time. They play quickly and pass well, being much faster than our team. Score:

	First Half			Second Half		
	Field Goals.	Foul Goals.	Fouls.	Field Goals.	Foul Goals.	Fouls.
Y. M. C A.						
Thurman, r. f.	1	....	2	2	....	2
Ault—Tipton, l. f.	....	1	2	1	..	1
Trueblood (Gapt.), c.	....	2	.	3	2	....
Conners, r. g.	1	....	1	1	....	....
Schroer—Ault, l. g.	....	....	1	1	....	....
ROSE.						
N. H. Cox, l. f.	1	....	....	....	....	2
I. J. Cox—Bowsher, r. f.	..	6	3	....	1	1
Rumbley, c.	1	....	....	1	1	1
Barbazette (Capt.), l g.	....	....	2	....	....	1
Fitzpatrick, r. g.	....	....	....	....	....	2

Score—Y. M. C. A., 35; Rose, 17.
Referee—Attridge.
Umpires—Fishback and Katzenbach.

INDIANA UNIVERSITY, 16; ROSE, 23.

Despite the fact that the Athletic Association had decided to play no outside games of basket ball, the team did play, and what is more, beat the Indiana University team in our gymnasium on the evening of Saturday, January 25th. The I. U. team came to the city Friday evening to play the Normal team and Manager Gilbert, with the consent of the Athletic Association, persuaded them to stay over until Saturday evening to play our team.

With only one day's notice, our team was not in the best of shape to meet a university team. Rumbley was out of the game on account of sickness, and others of the team had injuries, which, although not serious, might probably assist in losing the game. It seemed, at first, that it would be impossible to get a team together. Dailey was put in Rumbley's place, however, and the boys went into the game with the desire, if not with a great confidence of winning.

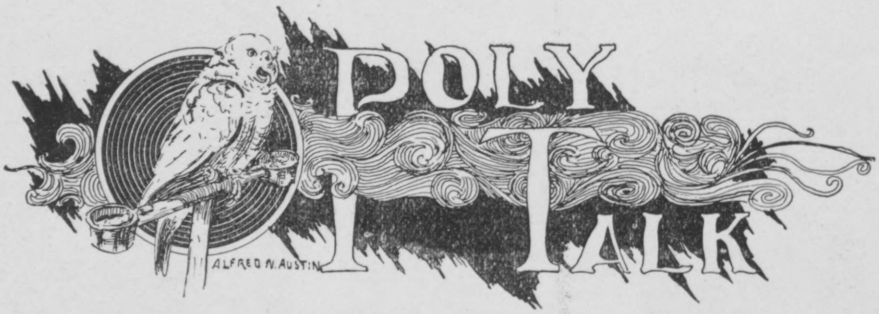
The game started off with a rush, and Rose soon had a score of 11 to Indiana's 0. This was encouraging, to say the least, and the yelling of our rooters was something to marvel at as well as to be proud of. At the end of the first half the score was 16 to 7 in favor of Rose. The second half was not so fast as the first had been, and both teams appeared to be winded. Rose still maintained the lead, however, although Indiana gained on them a little.

A large crowd was present, and both teams were well supported by the audience. Most of the Normal students were rooting for the I. U. This was probably due to the fact that on Friday night at the Normal-I. U. game a few of our boys rooted for Indiana.

The game was interesting throughout, and every one seems satisfied with the showing of the team. The game was fast, and more team work was exhibited than in any previous game. Daily played a splendid game at center, and Barbazette at guard did some good work. Rucker and Carr played best for the visitors. Score:

	First Half			Second Half		
	Field Goals.	Foul Goals.	Fouls.	Field Goals.	Foul Goals.	Fouls.
INDIANA.						
Coval, l. f.,	....	....	6	1	1	4
Rucker, r. f.,	2	....	1	1	....	....
Darly (Capt.), c.	....	1	....	....	2	. .
Carr, l. g.,	....	...	1	...	....	3
Ayers, r. g.,	....	...	1	....	....	2
ROSE.						
I. J. Cox, r. f.,	2	4	....	....	4	1
N. H Cox, l. f.,	....	....	1	....	....	1
Fitzpatrick, Nicholson, r. g.,	1	....	2	....	....	4
Barbazette (Capt), l. g.,	....	....	1	....	....	....
Daily, c.,	1	....	....	1	....	1

Score—Rose, 23; I. U., 16.
Referee—McCormick.
Umpires—Horn and Trueblood.



Lindenberger:—"May I use the horse, Mr. Clements!"

Mr. Clements:—"Why, I sent Frank to feel his pulse with a pair of tongs, and he reports him too sick for use."

Robertson, '05, can tell how to take six things, seven at a time.

"Daddy Wires," explaining parts of a building:—"And those are the sleepers on the first floor." And as he turns facing the class he adds: "And you, the sleepers on the second floor."

Knight, when asked if he would play in the orchestra, suggested that he be allowed to play a shoe-horn, or a "slide spatoot."

Bowsher (translating):—"The anger of the king waxed itself."

Dr. Johonnott:—"It is a very poor professor who makes a subject so easy that the student can understand it."

Prof. Hathaway:—"If you study analytics properly you can feel the convolutions of your brain grow."

Touzalin:—"Does it hurt?"

Prof. Hathaway:—"I didn't find that it did."

Bryon (to Prof. Hathaway):—"There are still ten minutes of the hour left. Show us how to find the center of gravity of a sweet potato."

Dr. Paterson received an invitation addressed to "Prof. and Mrs. Patterson." Something new to us.

Hazard (in Analytics Class):—"Professor, you are getting us all balled up."

Tipton, '04:—"Where is the cosent of that angle?"

The Sophomore Class recently presented Dr. Johonnott with a tray having upon it a piece of pie, some cheese, and a cold bottle. Even the tooth-picks were not absent.

Knight (at the boarding table):—"Please pass the poke." Does he mean stuck pig?"

French, '04:—"Say, Schroeder, if you don't quit fooling with me, I shall hit you so hard that you will go clear through the next exams."

Whitten, '04:—"Professor, is 50 meant for the atomic weight of that ladder?"

An apology from Ijams is due Dr. Johonnott.

The method adopted by the Athletic Association on Feb. 8th is an excellent way to raise money. No one dared say no.

"Now, remember that, Pine."

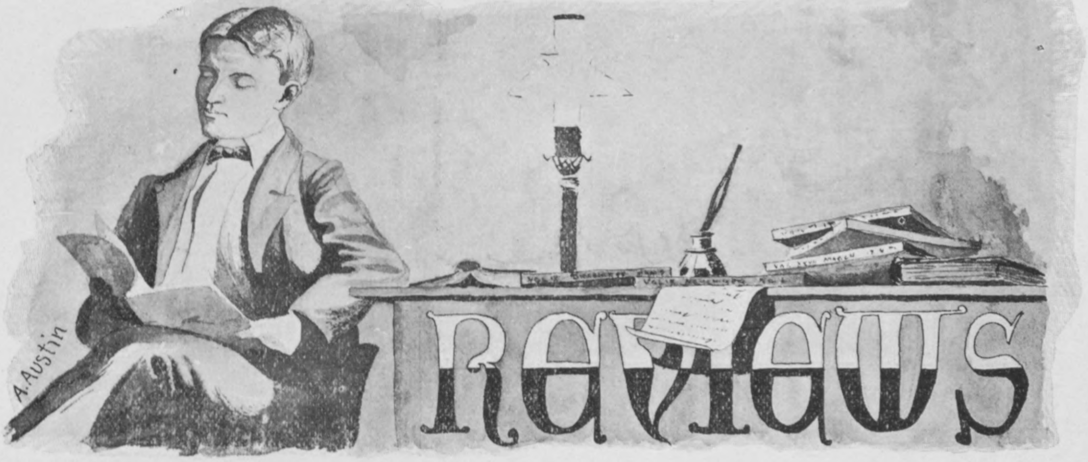
Wonder if Dickerson regretted having called on any of the Athletic Directors for speeches?

Uhl says he would like to make a test of the electric light plant at St. Mary's for his thesis.

Jags:—"Let's interpretate."

Wagner:—"Mr. Hills, you know more about it than I thought you did."

The Technic pencils have come. See the Business Manager before they are all gone.



Metallurgy of Cast Iron. By Thomas D West. Published by Cleveland Printing and Publishing Co. 4½ x 7½ inches. 627 pages $3.00.

BOOKS written by practical men, on practical subjects and in a practical manner, are always welcome and sought after by a beginner, and in constant use by men older in the engineering profession. Mr. West's book on "Metallurgy of Cast Iron" tells in a practical way the treatment of iron from the ore to the finished product. The book is well illustrated from beginning to end, thus adding greatly to the descriptions of furnaces and cupolas in the beginning of the book and to the methods of casting and testing in other parts of the book. It contains a number of tables showing the chemical analysis of iron, and tells for what purpose the different grades of iron should be used. He also gives detailed descriptions of the methods of the American Foundryman's Association for obtaining and making the tests of cast iron used for various commercial purposes.

IN Engineering Record of January 25, we notice a description and illustration of a new balanced engine, designed by Mr. M. N. Forney. The necessity of balancing an engine is known to every one who knows anything about engines. The reasons, as given by Mr. Forney, are as follows: "The reciprocating parts are usually counterbalanced by the attachment of counter-weights to the main shaft of the engine, opposite to the crank or cranks. Such attachments serve to counteract the momentum of the piston and its connected parts in their rectilinear movement; but, as the counter-weights necessarily traverse a circular path, they produce a disturbing action on the shaft at right angles to the direction of movement of the piston." Besides trying to overcome the disturbing forces, he does away with the cross-head and guides, and greatly reduces the floor space occupied by the engine. The piston-rod is connected to the connecting-rod by a system of levers forming a parallel motion. On the other ends of the proper levers are placed weights which move in the opposite direction, and thus the momentum of the weights counteract the momentum of the piston and connecting-rod. In a test they made of the engines he describes it as follows:

"To show this (the proportion of the weights to the piston-rod and manner of attachment and smoothness of running) it was suspended by four rods attached to the four corners of its base—so that it could swing freely in a horizontal plane. The engine was supported by four spiral springs, placed below the base, the vertical rods passing through them, with nuts and washers underneath. Any vertical disturbing action would thus cause it to move up and down on these springs." The steam and exhaust pipes were connected by rubber

hose, so as to allow perfect freedom for the movement of the engine. The engine was run at from 350 to 450 revolutions per minute with hardly any perceptible horizontal or vertical movement.

THE topic of general comment in this month's engineering papers is the new plant of the Manhattan Elevated Railroad. To give an idea of the enormity of the engines and generators we quote from the *American Electrician*. In the boiler room at present the equipment consists of 64 Babcock & Wilcox horizontal water-tube boilers of 525 h. p. each, arranged in batteries of two and carrying a steam pressure of 200 lbs. It is the company's intention to increase the number to 96. The boilers are equipped with Roney mechanical stokers, and one Green fuel economizer for every four boilers. They are also furnished with blowers to use in case of emergency.

In the engine room are eight 5000 k. w. Westinghouse alternators direct connected to Allis Corliss engines. The generators have a nominal capacity of 10,000 h. p. each.

The engines are compound, the high pressure cylinders being horizontal and 44 inches in diameter. The low pressure cylinders are vertical and 88 inches in diameter, giving a ratio of 4 of the piston areas. The stroke of the engine is 5 ft., and both high and low pressure pistons being connected to the same crank. The piston rods are 8 inches in diameter.

The generators have revolving fields 32 ft. in diameter, and have a peripheral speed of 7540 ft. per minute. The potential at the power plant is 11,000 volts. Sub-stations have been erected where transforming apparatus is installed to reduce the voltage to proper value for use.

This is said to be the largest single power plant in the world. It supplies the current for 37 miles of electric road.