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Rose-Hulman Institute of Technology

THE ROSE TECHNIC.

VOLUME XV.

1905-1906

ROSE POLYTECHNIC INSTITUTE.

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INDEX VOL. XV.

ARTICLES.

ATHLETICS.

INDEX VOL. XV.

REVIEWS.

ROSE LEAVES.

VOL. XV. TERRE HAUTE, IND., OCTOBER, 1905. No. 1

THE TECHNIC.

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WITH this issue the new Board of Editors formally takes charge, and begins the task of publishing Volume Fifteen of THE ROSE TECHNIC. We thoroughly appreciate that THE TECHNIC as it has been in the last few years is the result of years of steady growth, and therefore should not think it wise to make any radical changes. The policy of the Board, therefore, will be to make any improvements which it thinks advisable, but above all, to attempt to maintain the high standard laid down by our predecessors.

STUDENT body and Faculty unite in welcoming Mr. Alfred W. Homberger, our new Chemistry Instructor.

Mr. Homberger is a graduate of the University of Wisconsin, where he was graduated last June with very high standing. He has had some experience in teaching, having engaged in this profession for two years before entering Wisconsin. He has also had a summer's experience in laboratory work at Mt. Iron, Minnesota.

The Freshman Class does not seem to have learned the object of the bulletin boards in the hall of the main building. For a school which does not have regular general assemblies, the bulletin and letter boards furnish the only means of reaching the students at large, and to make this means effective, everyone should watch all the bulletins posted.

As our leading article this month we present a contribution from Mr. Ernest Stuetz, Vice-President of the Goldschmidt Thermit Co.

The subject of Mr. Stuetz's article, Alumino Thermics, has but recently become one of commercial importance, and hence we feel that this article will be of considerable interest to our readers.

We are very grateful to the Goldschmidt Thermit Company, not only for the privilege of publishing this article, but also for the use of the cuts illustrating it, and we take this occasion to express our thanks.

IT is with pleasure that we announce that we shall be able to publish in early issues, articles by Dr. W. A. Noyes and Dr. R. F. Earhart, both former members of the Faculty.

Dr. Earhart, whose paper is on the Conservation of Energy, is now a member of the Faculty of the Ohio State University.

Dr. Noyes, of the Bureau of Standards at Washington, and Editor of the Journal of the

American Chemical Society, has written about his recent trip to Europe, where he made an extensive tour of the large chemical laboratories.

Other articles by Dr. Thos. Gray, Prof. J. B. Peddle, Prof. Frank C. Wagner, Prof. Williams, and Prof. Hathaway, will be published in the course of the year.

THE Rose Y. M. C. A. is to be congratulated. Through the untiring efforts of several of its enthusiastic members, the affairs of the Association have now been placed in the hands of a General Secretary.

Mr. Rich, in this capacity, has shown himself to be truly "the man for the place." Mr. Rich is General Secretary for the Y. M. C. A. both at Rose and State Normal, and divides his time between these two organizations.

The annual hand-book was ready for distribution at the opening of the term, and has elicited nothing but favorable comment. The weekly religious meetings are well attended, and are now supplemented by classes in Bible study, conducted by some of the members

THERE has been a change in the Board of Editors of THE TECHNIC, caused by the resignation of Mr. T. Ludwell Lee. Mr. Lee has accepted a position as Detail Draughtsman for the General Railway Signal Co., at Buffalo, N.Y.

Mr. Russell Sage, '07, has been elected to fill the vacancy. As artist Mr. Sage needs no introduction to the upper-classmen, who have frequently seen his drawings in THE TECHNIC and the *Modulus*, and everyone who is interested in the welfare of THE TECHNIC may rest assured that our artist is a man who combines talent with a willingness to work.

WE can say without exaggeration, we believe, that never in her history has Rose had better representation on the gridiron than she has this fall. There prevails among the foot-ball men that condition for which we have long been hoping, namely, there are men enough, and good men, too, to make every first team man hustle to keep his place on the team. Coach Jamison is insisting on strict training rules, and the effect is noticeable in the work of the team.

We have played three games so far, and won them. Our old rivals, DePauw, have been vanquished. Eastern Illinois Normal gave our men an easy victory. Washington Unversity was unable to score against our team, and although we did not succeed in making any scores, the result is generally conceded to be a victory for Rose.

We are glad to note a decided change in the attitude of the local papers toward Rose. They are beginning to see that we deserve their support, and are now giving it lavishly.

To summarize the whole situation, we think that the conditions at present are most gratifying, and can see no reason why the foot-ball team of 1905 should not leave a record as "the strongest team the Poly ever knew."

HAVE you ever stopped to think how helpless the Board of Editors would be without your help? Have you ever asked yourself if you are giving us the support that you should?

The Rose Leaves and Local departments depend entirely on contributions from students. If you want us to make good departments of these, you must help. If you know of any item of interest, leave a note in THE TECHNIC mail box, on the letter board, or hand it to one of the Local Editors.

To any students who have had practical experience, we have a word to say: We need articles for the Rose Leaves department. You are the men who must write them for us. Don't give it up with the idea that "it's too much trouble." If you know of any subject on which you could write an interesting article, let us hear from you.

THE THERMIT PROCESS IN AMERICAN PRACTICE.

From Paper read at the Annual Meeting of the American Society for Testing Materials.

By ERNEST STÜTZ.

THE principle of the Thermit Process can now be said to be known to the technical world, and it will be sufficient to state that through the ignition of finely divided aluminium and metallic oxide, a reaction is started which produces heat of about 5,400° F. and at the same time reduces the iron oxide to a metallic iron almost free from carbon, in a highly superheated liquid state. Thermit Steel has practically twice the temperature of open hearth steel, and a correspondingly greater fluidity. By suitable additions of carbon, in the form of steel punchings, chilled iron shot, or Ferro-Silicon, its hardness, and by addition of Manganese, its toughness can be increased to any suitable degree.

The following analyses will confirm this.

The first is one of pure Thermit Steel; the other of the steel in the riser of a welded steel locomotive frame, drawn out under the hammer into a bar some three feet long and turned down and broken.

Analysis of steel, Illinois Steel Co., The Rookery, Chicago, Ill.:

Carbon,	0.05
Manganese,	0.10
Silicon,	0.204
Sulphur,	0.04
Phosphorus,	0.05
Aluminium,	0.18

Tensile strength, 59,320 lbs. per sq. in.

Elongation, 25.33%.

Contraction of area, 59.6%.

Pennsylvania Railroad, Altoona. Thermit steel, with addition of 2% Carbonless Manganese, 5% Iron Punchings. (Calculated on amount of Thermit):

Carbon,	0.102
Manganese,	2.330
Silicon,	1.227
Sulphur,	0.034
Phosphorus,	0.070

Tensile strength, 91,600 lbs. per sq. in.

Elongation, 21.5% in 8 inches.

Appearance of fracture, silky.

The simplicity of outfit and manipulation and the speed with which the reaction does its work are its chief recommendations for industrial purposes.

In a crucible some 20 inches high and therefore easily transportable, in a half minute can be produced 30 lbs. of liquid steel, so hot that it will melt a steel bar of 4″ square section and fuse with it to one homogeneous mass.

The essential characteristic of Thermit is that it welds by fusion, and by reason of this fact, calls for the foundryman's experience more than the blacksmith's. Its success depends on the proper material, shape and condition of the mold.

The mold into which the contents of the crucible are run must be of refractory material. The general instructions must of course be broad and cannot go beyond stating that a mixture of equal parts of sharp sand and ordinary brickmakers' clay has given satisfaction. The formula has been varied sometimes, according to local conditions, in some cases flour, in the proportion of 6 to 100, being used as binder for the sand. Some shops have already evolved their own particular formulas, which they treat as secret. The mold always must be dry—*burnt* dry. In some cases, for instance, at the Elkhart shops of the Lake Shore & Michigan Southern, the difficulty has been overcome by using fire-brick cut down to size. This certainly overcomes the question of drying molds.

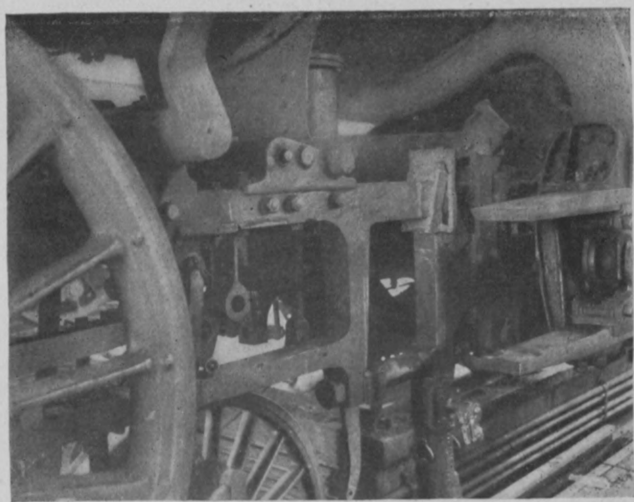
The shape of the mold must next be considered. It must be so constructed that the steel flowing down through the gate will not strike direct on to the casing or forging, but will flow underneath the lowest part and rise around and through it. What is required is good circulation for the Thermit Steel. It must flow around all the welding surfaces and as it gets chilled in contact with these, it must be driven up into a riser and be followed by a sufficient supply of fully heated Thermit Steel to effect the actual weld, which takes the shape of a collar or reinforcement, cast on or over the fracture.

The mold must therefore allow (1) for a gate, (2) for a collar, shoe or other reinforcement on the surface of the welded piece and overlapping the edges of the break or joint, (3) a riser, (4) a skim gate, to prevent the slag from getting mixed with the steel.

The formula for calculating the amount of Thermit must also allow not only for the cubic space of this reinforcement, but further, for again as much Thermit, to supply the contents of gate and riser.

In reply to a circular letter of inquiry, about twenty railroads have supplied data, which, however, cannot be considered complete, as some of the most regular and extensive users of Thermit did not care to supply the information asked for.

The first successful weld it has been possible to get a record of was made by Mr. Sanderson, Superintendent Motive Power, Seaboard Air Line, on October 19, 1904. The engine has continued in service ever since. It is one of eight engines welded on that road which has given satisfaction, which speaks highly for the care used at the Portsmouth shops in handling a new and therefore difficult problem.



Locomotive Frame Welded at Elkhart, Ind.

These are the general instructions for welding, for instance, locomotive frames—a problem which some thirty railroads in this country have investigated with more or less success. These frames are of wrought iron or cast steel and vary from 3½ x 3½ to 5″ x 6″ in section. They are very liable to break and their repair without dismantling the engine means a very large saving per engine. It has been stated that an engine, the frame of which is repaired in the forge, remains a fortnight out of commission and the actual weld costs $250.00 to $300.00. The work by Thermit can be done comfortably in three or four days, at a cost of about $50.00.

Another series of successful welds is reported by the Boston & Albany line, where Mr. Fries welded five engines quite successfully—one being in continuous service since the end of November. One, welded in the jaw, broke again, but four inches away from the weld.

Of late the Lake Shore & Michigan Southern has shown great interest, and its perseverance has been crowned by success in some very good welds at their Elkhart shops, about which Mr. Webb read a very interesting paper at the last annual meeting of the American Foundrymen's Association, giving a full account of each step in the operation. On a preliminary test, a welded bar $2\frac{1}{2}$ x $2\frac{3}{4}$ stood a pressure of 50 tons on supports 20 inches apart, before breaking, and that, after two sides of the reinforcing collar had been machined off.

In all there are records of thirty engines with welded frames that have been in service for three months or longer. Failures are recorded only in isolated instances and are assignable to three different reasons:

First, wrong construction of mold.

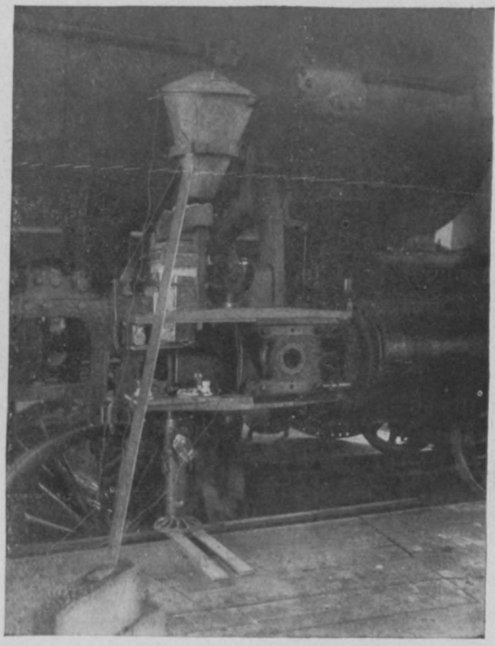
Secondly, insufficient Thermit; in other words, insufficient circulation—therefore, insufficient fusion.

mere bridging of the broken ends by Thermit Steel to overcome the innate weakness.

An important factor in success in welding locomotive frames is to allow for equal shrinkage of parallel parts; also, wherever possible, to spread the ends apart in order to let them come back when the iron begins to set.

Another operation of interest to railroad men is the welding of spokes of drivers.

In making tests of the metal of such welds, the Chicago, Wilwaukee & St. Paul R. R. found a tensile strength of 93,900 lbs. per square inch. The analysis agreed with that of Pennsylvania



Mold in Position for Weld of Locomotive Frame.

For those familiar with the process, a weld that breaks on account of lack of cohesion at the welding surface is attributable under all circumstances to the lack of experience or care, except in one particular case.

It is possible for Thermit welded frames to break in spite of proper execution of the work. The original break is due, in the first place, to a structural defect. With the break in such a position as to necessitate the entire removal of the reinforcing collar, it is too much to expect the

R. R., with the exception of Manganese, which in this case was only 0.74.

Next come repairs in Marine Engineering, which are mostly successes obtained by Mr. Des Anges, Superintendent Floating Equipment of the Long Island R. R.

A 12″ crank shaft ($13\frac{5}{8}$″ at the fracture) of the ferry-boat "Manhattan Beach" was welded with 400 lbs. of Thermit. The break was in the "wheel center," necessitating the shifting of the center to a new position and shortening the paddle boxes. The shaft was pre-heated by a charcoal fire and hand-blower, to black heat. To protect the woodwork of the ferry-boat, an asbestos curtain was hung around the crucible, which served its purpose admirably. The ferry-boat has been in uninterrupted service for nearly three months, and continues so now.

A rudder-stock, 5″ in diameter, was welded with 50 lbs. of Thermit and 10 lbs. of punchings. The collar in this case had been entirely removed, but the welded rudder-stock has now been in service eight months.

On the great lakes, through the enterprise of Capt. Johnson, at the time with the Dunham Towing & Wrecking Co., the rudder-shoe of the tug boat "Schenck" was welded, 125 lbs. of Thermit being used. The weld was sound—in replacing the propeller, a chain broke and the propeller dropped on the welded shoe without injuring it.

Some important repairs in Gray Iron Castings are also reported. At the Revono shops of the Pennsylvania R. R. a hydraulic wheel press was repaired, the part welded having to stand a pressure of 60 tons per square inch. The original "strong back" holding the wheel against which the axle was pressed was not strong enough for the purpose until repaired by Thermit.

Cylinder covers are also repaired by Thermit and have been made as good as new.

Work with gray iron castings requires more experience, in regard to pre-heating and cooling down gradually—more Thermit is necessary to effect the weld, on account of a hard, glassy scale on such castings, which resists fusion, and an addition of Ferro-Silicon (about 2%) is advisable to prevent hard spots in the lines of junction between Thermit Steel and cast iron.

The most important application of the Thermit Process is for making a Continuous Rail. The process having been brought to a high state of perfection in Europe before coming here, there was little room for changes in practice. About 30 different cities are investigating the process in actual operation and about 5,000 joints have been put in up to date. All these roads recognize in the Thermit Process the best and simplest means of joining the rails for electric traction, as long as care is taken to do small and simple things right. Competitors in the field of railwelding may send out fanciful blue-prints about broken joints, to create unfavorable impressions, but such maneuvers prove nothing beyond the fact

Track Welding in Cleveland.

that they admit the success of the Thermit Process in this field.

Some tests may be of interest. A heavy double trolley car was taken over a welded joint with supports 13 feet away, without breaking it.

To decide whether the head of the rail got softer, Micrometer Caliper measurements were taken of depressions made under equal blows of a steam hammer, by a blunt tool hardened at the head, ¼″ in diameter.

½″ away from the joint the depression was 0.1432″.
3′ away from the joint the depression was 0.1596″.

The electric conductivity of the Thermit joint is recognized to be higher than that of the rail, due to increase of area, and is permanent.

That steel foundries should have been the first to recognize the possibilities of liquid steel that can be produced anywhere in half a minute, goes without saying. There are already several of the largest with whom Thermit is as much a necessity as foundry sand. Some prefer—for no apparent reason—not to disclose the fact that they repair faults in castings by Thermit, but all can openly admit that they use it to reduce the size of their risers, an application which, through its simplicity, recommends itself to all foundries—gray iron as well as steel. Thermit thrown loosely or in a paper parcel on steel, will ignite and keep the contents of the riser fluid even after the metal has become plastic in the casting. Liquid cast iron will only ignite Thermit in the presence of the ignition powder.

This necessarily very short account of what is doing in Thermit cannot, of course, cover the entire field of the applications, but will perhaps tend to convince those who had rather be guided by results obtained elsewhere than spend time and money for what they deem experiments, and will encourage others who are doubtful from lack of experience, by showing them what has been accomplished in actual practice.

Complete Weld of the Skeg of Steamship "Apaché"

THE MOST EFFICIENT CYCLE FOR INTERNAL COMBUSTION ENGINES.

By HARRY B. STILZ, '98.

THE relationship which the science of thermodynamics bears to the practical working out of thermodynamical problems is not so close as one might expect to find in a branch of engineering of such prime importance. Neither is there a deserving amount of attention given to this relationship, either in the technical schools or without. The engineering student of today seems to be so completely engrossed with efforts to make a stand in one of the three leading branches—mechanical, electrical, or civil, all the ranks of which being in consequence overflowing with numbers and their respective fields developed to a high degree of efficiency—that the prevailing condition wherein about 90% of the energy derived from any source of heat is lost in converting the heat into mechanical work, seems to have been lost sight of in the scramble, or looked on as a necessary evil. True, steam engines are working in which the efficiency from heat to work is as high as 12% (15% nearly, if we consider the indicated work) and internal combustion engines have been built with an efficiency of 28%, but these are exceptions. Taken as a whole, the average of all the heat motors in use would probably not be equal to 7%.

The steam engine is by far the most extensively used heat motor. The inventor, James Watt, was certainly not guided by an elaborate knowledge of thermodynamical science, and yet the steam engine of today is about the same as when he left it, except for such improvements as are to the credit of the mechanical engineer. This science has, however, closely followed the advances made in connection with mechanical engineering and has served as a useful aid to prove many theories connected therewith, as well as suggest some possible refinements. The most important knowledge that has been obtained from theory in this connection is the fact, proven beyond the question of a doubt, that the highest possible efficiency of the steam engine has been nearly if not quite reached in the engine of today. With this question settled, the engineer has to look to other fields in order to save nine-tenths of heat energy now wasted in the production of power, and the course of events are bearing him into the field of the internal combustion engine.

The gas engine was first patented in England in 1794, since which time many have had a hand to assist in its evolution. To one living in this period, the advances made seem very slow and apparently quite different from those with the steam engine, which was developed almost wholly in the mind of one man. By degrees it met with improvements which have brought it slowly into the field of practical prime movers. It finally reached a point of efficiency equal to the steam engine and today has passed it considerably. But even now, running with reliability at a high efficiency and possessing many other favorable features, it is conceded to be far from its greatest possibilities.

It is interesting to note what part the science of thermodynamics has played in the development of this type of engine. Surely, with theory so carefully worked out on all points involved, we would expect to find these engines operating in direct accordance with theoretical principles, but it does not require a very close observer to see that this is not the case.

Practically all internal combustion engines on the market today are gas engines. Such as use oil for combustible, require that this oil be rendered gaseous, or in some cases atomized, which is the equivalent, before being introduced into the engine cylinder. They may be classified under two heads, the two cycle and the four cycle engines. By far the greatest number are explosive engines, in that the combustion is effected as a whole instantaneously, which gives combustion at constant volume. A few operate with the combustible burning at the rate which will cause the gases in the cylinder to expand at about the rate at which the piston clears the cylinder, in which case we get an indicator card somewhat similar to that obtained from a steam engine, and we have the engine operating with combustion at constant pressure. In this case the combustible is put under pressure by some means outside the engine cylinder and is allowed to enter the cylinder and burn in the air therein, during a short period at the beginning of the working stroke. Here the maximum pressure within the cylinder is produced by the compression of the charge of air, and the heat of combustion merely serves to extend this maximum pressure over a certain portion of the stroke of the piston.

The explosive engine is not and never can be as efficient as the engine in which combustion is effected at constant pressure. Theory proves this to a certainty, and yet there are thousands of the former type made to one of the latter. It is a well recognized fact that the amount of clearance in any type of engine cylinder should be kept at a minimum, and yet the explosive engine requires about one-third the volume of the cylinder as a combustion chamber, which is the same thing as so much clearance.

Theory proves that a gas is compressed with less mechanical effort the cooler it is, and that the hotter a gas is kept during expansion the more work can be obtained from the expansion, and yet with the gas engine of to-day both of these operations are carried out in the same cylinder, and no provision is made to assist either operation being carried on in the manner in which it can be done most economically. In answer to this it would be contended that the heat put into the air during compression and which is derived partly from the heat retained in the cylinder walls and partly from the work done on the gas in the process of compression, is not lost but returns its energy again when the gas expands. To this it must be stated that the heat, produced at the expense of mechanical effort is bought at a high price An engine working at an efficiency of 25% and using a part of its power in doing excessive work during the compression stroke, is sacrificing economy. Take the case in which this point is least noticable of any, and suppose two compressions were effected, one isothermally, and the other adiabatically, from a pressure 14.7 lbs. per sq. in., volume 12,387 cu. ft. and temperature 493° F. abs., to a pressure of 514.7 lbs. per sq. in. The work isothermally would be 119,440 ft. lbs., while the work adiabatically would be 193,300 ft. lbs. But at the end of the compression the air is at a temperature of 1400° in one case and 493° in the other, which represents an amount of work equal to $C_p\ (t_1\text{-}t_2) = 184.77\ (907) = 167,600$ ft. lbs. The air can be brought to the higher temperature after compression with the expenditure of 167,600 ft. lbs. of energy, whereas it would require $\frac{73,860}{0.25} =$ 295,440 ft. lbs. of heat energy to have produced this temperature by mechanical effort. This matter will receive further consideration later.

Theory indicates that the gases used in a gas engine, if properly burned out, will emit no odor. One has but to get in the wake of the ordinary gasoline engine to perceive an odor, worse than a Bunsen burner which has struck back The above is true for explosive engines only and supplies another point in favor of the engine in which the combustion is effected at constant pressure, from which no odor is noticeable in the exhaust.

Perhaps no subject in connection with gas engines has been more widely argued than that as to which is the better type, the two cycle or the four cycle engine. Unfortunately, theory can offer but little assistance to this question. Neither type accomplishes that which it seeks. In the four cycle engine, only one stroke in two revolutions does the work, and therefore the engines have to be of very large size for any given power, in order that during one revolution the cylinder may be relieved of its products of combustion and made ready for the next explosion, with a fresh charge of air. And there results from this process merely a cleansing of about two-thirds the volume of the cylinder, there always being enough of the combustion gases remaining to fill the combustion chamber, which chamber is not displaced by the piston. In the two cycle engine, a charge of air previously compressed to a small degree, is caused to enter the cylinder at the end of its working stroke and replace the combustion gases, blowing the same out through an exhaust port located at the opposite end of the cylinder. Admittedly this process can attain but imperfect results, and where the combustible is introduced simultaneously with the air, a certain waste is had, owing to the escape of the combustible with the products of the previous explosion. The advantages of having a working stroke every revolution and at the same time being able to force out about as great a proportion of the combustion gases as in the four cycle type is, however, a point worth consideration.

The present popularity of the four cycle engine is due, mostly, to the fact that its exhaust can be most successfully muffled. There is a demand for an engine which runs silently. People do not want a noisy engine when they seek pleasure in an automobile or launch. The inefficiency of the thermodynamical engineer was again evident in the solution of this problem. Obviously, by putting a resistance and a capacity in the exhaust pipe, they would have the result desired, and the fact that this result was attained with a reduction in efficiency of the engine mattered little—people are willing to pay for luxuries.

And yet the thermodynamical engineer is not wholly to be blamed for this state of affairs. When a member of any of the three leading engineering professions seeks advice on any subject in line with his work, he knows where to find a number of text books in which help may be had with a small amount of effort. But let the thermodynamical engineer open his text book and he finds, for the most part, the pages covered with a grand array of imposing formulae, embellished with a large abundance of double integral signs and equations, which no practical engineer would have the time or patience to wade through, all written in a most imposing style about matters, mostly of no practical importance, and leading often to no definite final result. This will probably seem a little severe, but there must be some reason why the body of engineering students, almost as a whole, shirks all work in connection with this important and not uninteresting study.

An analytical investigation of some of the operations carried out in gas engines, and some that have been attempted, is a subject of no small amount of interest.

We find that some years ago, M. G. Richard made the statement that "as far as we can see, we must have recourse in theory to the regenerator, in order to realize the only notable improvement at present possible in the cycle of gas motors." No record was found, however, of any attempt to apply this theory.

A short time later, Rudolph Diesel, in a published article, took the question of regenerators under consideration and conclusively proved, that if a regenerator was applied to a gas engine, so as to transfer heat from the exhaust gases to the air just entering the engine cylinder, the efficiency was not improved in the least, from what would be had without the regenerator. His proof was perfect, as far as he went, but unfortunately it was based on wrong premises. He applied it to operations, which must of necessity be modified, when applied to engine cycles. Had he considered all the factors which enter into the problem, he would have been able to prove that the use of such a regenerator decreased the efficiency considerably. For, suppose that one gas engine draws air at a temperature of 500° absolute, into its cylinder for compression, and another engine provided with a regenerator, has this air heated to 1,000° abs. before entering the engine cylinder, then if a pound of air is being worked in either case, one engine will have to do twice as much work in compressing its charge as the other engine. But this increase in work is compensated for by the final temperature being twice as great also. Apparently the efficiency is the same in either case, and in fact it would be, if it were not for the fact that heat can be transmitted to a gas so as to raise its temperature, at an efficiency of 100%, but heat can be converted into work at an efficiency of only about 25%. And yet, we will see later that M. G. Richard was right in his statement.

In same article by Diesel, the author having satisfied himself on the subject of regenerators, directs his attention to the Carnot cycle, and after an extended consideration of the principles involved, reaches the conclusion that: "The theory here laid down indicates, therefore, the only direction in which efforts should be made, in order to obtain the maximum possible utilization of a combustible which can at present be realized."

In the science of thermodynamics the Carnot cycle involves the most important fundamental principle. No other cycle has ever been devised which gives a higher efficiency in converting heat to work, and yet when applied for operation in a real engine it is about the most irrational cycle conceivable.

Fig. 1 shows the central portion of a Carnot cycle drawn accurately to scale for operation between temperatures of 4,000° and 493° Fahr. absolute. The whole cycle is not shown, but by extending the ends up and out, we have isothermal expansion from A, which is three times as high as the position marked, to B; from B to C, which is seven times as far out as the position marked, we have adiabatic expansion; from C to D, isothermal compression; and from D to A, adiabatic compression. In other words, the engine cylinders must stand pressures varying from 4,158 lbs. per sq. in. to 0.358 lbs. per sq in., and the working gases must be expanded from a vol-

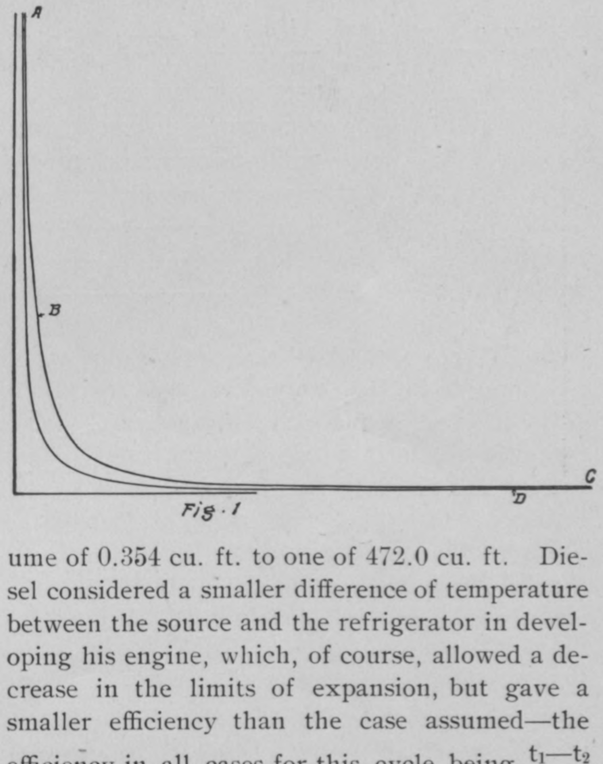
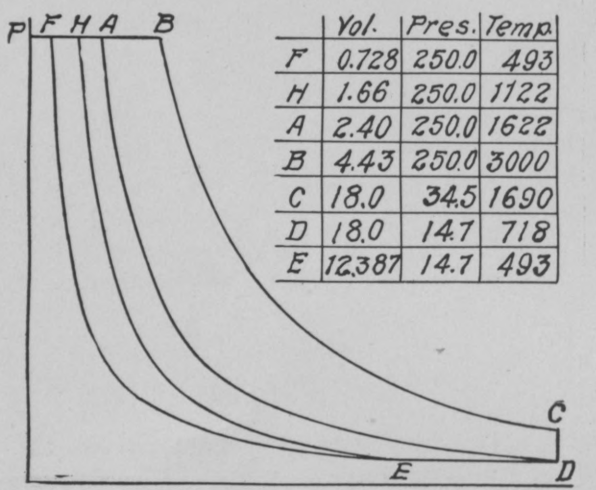


Fig. 1

ume of 0.354 cu. ft. to one of 472.0 cu. ft. Diesel considered a smaller difference of temperature between the source and the refrigerator in developing his engine, which, of course, allowed a decrease in the limits of expansion, but gave a smaller efficiency than the case assumed—the efficiency in all cases for this cycle being $\frac{t_1 - t_2}{t_1}$ where t_1 is the absolute temperature of the source and t_2 that of the refrigerator. He stated that he did not consider it impossible to work with a pressure of from 200 to 300 atmospheres. An engine was designed in line with the above. A long series of experiments was conducted on engines operating with high compression and it was found that it required first-class workmanship to make an engine which would operate satisfactorily under a pressure of 500 lbs. per sq. in. Be it said, however, with due credit, that after some years of experimenting along these lines, Mr. Diesel was able to place upon the market an engine, which has proven to be the most efficient heat motor ever made, and it still holds that position today. The cycle which was finally adopted does not, however, bear any striking resemblance to the Carnot cycle.

In. Fig. 2 are outlined several types of cycles, which will be analytically treated, in order that we may more clearly see the problem now before us. In considering these types, the engine



	Vol.	Pres.	Temp.
F	0.728	250.0	493
H	1.66	250.0	1122
A	2.40	250.0	1622
B	4.43	250.0	3000
C	18.0	34.5	1690
D	18.0	14.7	718
E	12.387	14.7	493

Fig. 2

is supposed to operate in air at freezing and all temperatures will be absolute Fahrenheit.

Cycle I, along the lines ABCDA, is similar to that which is employed in a Diesel engine, except that maximum pressure considered in Fig. 2 is only 250 lbs. instead of 500 lbs., which is used in that engine. It being a four cycle engine, the air is drawn into the cylinder from the atmosphere at 493°. The hot walls of the cylinder will heat this air to, say 718° (in all probabilities, it will be higher, but this figure will serve the purpose intended). The air is then compressed adiabatically to the position A ; from A to B combustion takes place at constant pressure; from B to C, expansion adiabatically ; and from C to D, exhaust to the atmosphere. Cycle II, along lines HBCDEH, is similar to cycle I, except that the operation is performed in a cylinder which does not transmit any heat to the air, before or during compression—an ideal case. Cycle III, along lines FBCDEF, differs from the above in that the air is compressed isothermally along the line EF at a temperature of 493°. The expansion curves are common to all the cycles, and there will therefore be the same amount of work done while expanding, in all three cases, which will be equal to

$250 \times 4.43 \times 144 + 131.4(3000-1690) = 331{,}600$ ft. lbs. The work done in compression for cycle I is equal to

$131.4\ (1622-718) + 250 \times 144 \times 2.4 = 205{,}200$ ft. lbs.; for cycle II is equal to

$131.4\ (1122-493) + 250 \times 144 \times 1.66 + 2117\ (18-12.4) = 154{,}300$ ft. lbs.; and for cycle III, is equal to $14.7 \times 144 \times 12.387 \log_e \frac{12.387}{0.728} + 250 \times 144 \times 0.728 + 2117\ (18-12.4) = 112{,}400$ ft. lbs.

The heat absorbed in cycle I will be

$184.77\ (3000-1622) = 254{,}500$ ft. lbs.

In cycle II: $184.77\ (3000-1122) = 347{,}000$ ft. lbs.

In cycle III: $184.77\ (3000-493) = 463{,}200$ ft. lbs.

Apparently the efficiency for cycle I will be equal to

$\frac{331{,}600-205{,}200}{254{,}500} = 50\%$. Similarly the efficiency for cycle II will be 51.2%, and for cycle III will be 47.3%.

But no engine can operate without mechanical losses, and in all gas engines heat is transmitted to the cylinder walls. Since the three cycles under consideration can be performed in the same sized cylinder, it will be safe to assume that the losses will be the same in all three cases. From a comparison of engines now on the market, it would appear that the following would be very nearly the correct amounts: 44,000 ft. lbs. in mechanical losses and 76,500 ft. lbs. lost in heat transmitted to the cylinder walls. The first figure must be subtracted from the indicated power of the engine and the latter must be added to the heat absorbed, since such heat does no useful work. Therefore the real efficiency of an engine working in cycle I will be equal to $\frac{331,600-205,200-44,000}{254,500-76,500}=25\%$, and for engines operating in cycles II, and III will be 31.5% and 32.5%, respectively. From which it would appear that the cooler the air is kept during compression, the more efficient will be the engine. The air should, therefore, at the end of the compression stroke, be at the temperature of the refrigerator, which condition necessitates its being compressed in a cylinder separate from the cylinder in which combustion takes place. If this is carried out, then another improvement at once suggests itself: the expansion cylinder can be kept uniformly hot by the fitting of refractory linings on such places within the cylinder as are not wearing surfaces. This will greatly reduce the amount of heat transmitted to the water jackets and will also serve as an igniter for the combustible, by retaining sufficient heat between ignitions to ignite each successive charge as it is introduced into the cylinder. But more important still, the theory of M. G. Richard can be put into effect, and a regenerator can be placed between the compression cylinder and the expansion cylinder, with a decided increase in efficiency resulting therefrom.

At the end of the working stroke, the gases within the engine cylinder will have expanded to a pressure of 34.5 lbs. per sq. in. with temperature of 1690°. The exhaust port opens and the confined gases rush out into the atmosphere. There will be a reduction in the temperature resulting, which is due to two causes: first, the gas will be given a high velocity, and the work producing this velocity must have been derived from the heat energy within the exhaust gas: and second, the gas will occupy a greater volume at 14.7 lbs. pressure than it did at 34.5 lbs. This increase in volume is effected against atmospheric pressure of 2117 lbs. per sq. ft. The exhaust gas finally loses its velocity in meeting with resistances, and these resistances return to the gas all the heat which was absorbed in producing this velocity, but the energy required for pushing aside a place for itself in the atmosphere, causes a permanent reduction in temperature. This is contrary to the generally accepted theory of the free expansion of gases,* but it is believed that such a statement of facts must stand.

The temperature of the exhaust gas, after expanding to atmospheric pressure in the regenerator, and after having had its velocity absorbed by resistances therein, can be computed as follows: Let C be a quantity which when multiplied by the drop in temperature of the gas while expanding freely, gives the amount of work done during the expansion. This quantity is not equal to the specific heat at constant pressure, or at constant volume, but is nearer the latter, apparently about 136.

If the volume of the gas just before leaving the cylinder is 18 cu. ft. and V is the volume when expanded to atmospheric pressure the work done will be 2117 (V—18), but this must equal C $(T^1-T)=136\ (1690-T)$. For a pound of air $2117\ V=R\ T$, and $V=\frac{53.37}{2117}T$. Then

$$2117\ (\frac{53.37}{2117}T-18)=136\ (1690-T)$$ and $T=1415°$. The compressed air enters the regenerator at 493° and leaves it at 1415°, while the exhaust gas enters the same at 1415° and leaves it at 493°, and the heat energy, therefore, which would be otherwise carried away and lost in the exhaust gas, is transmitted to the compressed air for future work. The apparent efficiency for cycle III would, in consequence, be increased with the aid of a regenerator to:

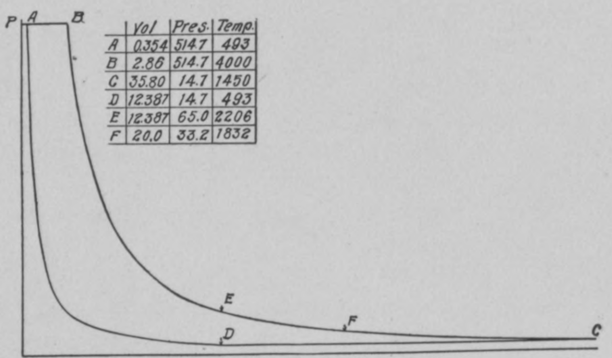
$$\frac{331,600-112,400}{184.77\ (3000-1415)}=\frac{219,200}{292,400}=75\%.$$

Assuming that the gain from the use of the refractory linings in the expansion cylinder will balance the losses in radiation in the regenerator, piping, etc., and that the mechanical efficiency is the same as assumed in the previous case, we are

*See Woods Thermodynamics, paragraph 88. Free expansion of gases. The matter therein stated is apparently in error, including the formulated results of the porous plug experiment, for all cases except where the free expansion takes place into a vacuum.

led to believe that an engine working in cycle III can be constructed with an efficiency from heat to work of amount equal to $\frac{219,200-44,000}{292,400-76,500}=$ 47.5%. This result is obtained working with with the comparatively low pressure of 250 lbs. absolute and temperature of 3000° absolute= 2507° Fahrenheit.

Fig. 3 shows a cycle adapted to the higher temperature and pressure, as noted on the figure.



	Vol	Pres.	Temp.
A	0.354	514.7	493
B	2.86	514.7	4000
C	35.80	14.7	1450
D	12.387	14.7	493
E	12.387	65.0	2206
F	20.0	33.2	1832

Fig. 3

The expansion is carried down to atmospheric pressure and the efficiency was found as follows:— Work from P to B=514.7 x 144 x 2.86=212,000; from B to C=2.463 x 514.7 x 144 x 2.86 x $\left\{1-\left(\frac{2.86}{35.8}\right)^{.406}\right\}$=335,000. Total work in expansion=547,000 ft. lbs. Work from C to D= 14.7 x 144(35.8—12.387)=49540; from D to A= 14.7 x 144 x 12.387 $\log_e\frac{12.4}{0.354}$=93,200; from A to P=514.7 x 144 x 0.354=26,200. Total work in compression=169,000 ft. lbs. Useful work=547,-000—169,000=378,000 ft. lbs. Work absorbed from the combustible=184.77 (4000−1450)= 471,200 ft. lbs. Efficiency=$\frac{378,000}{471,200}$=80.1%.

Had the expansion been carried to F only, the efficiency would have been =79.6%, and if carried to E, it would have been =77.9%.

The apparent efficiency is, therefore, not greatly reduced by limiting the amount of expansion and it is believed, the real efficiency would be greatest with the expansion ending in the vicinity of F.

It will be noted that the only heat, which is lost in working in this theoretical cycle, is that which is carried away during isothermal compression. Therefore if we add the heat lost during compression to the work done we will have the heat absorbed, or 378,000+93,200= 471,200 ft. lbs., which is the quantity found by the other method.

Obviously, by reducing the amount of compression, there will be less heat lost and its apparent efficiency ought to be greater for lower pressures, when worked between the same limits of temperature and with complete expansion. At 250 lbs. per sq. in. max. pressure the efficiency is 82.0%. At 29.4 lbs. per sq. in. max. pressure, the efficiency is 86.2%. At 20.0 lbs. per sq. in. max. pressure, the efficiency is 86.5%. At 17.5 lbs. per sq. in. max. pressure, the efficiency is 87.16%. Apparently the maximum efficiency would be found in the limit when there is zero work done and zero heat lost. By continuing the curve of efficiency from the above points, we find the result that $\frac{0}{0}$=87.5%. But the efficiency of the Carnot cycle is equal to $\frac{4000-493}{4000}$=87.5%, when worked between the same limits of temperature. This is a coincidence which may be curious, for the above relationship holds for other temperatures than those assumed, and is apparently general.

In as much as the apparent efficiency of an engine working in this cycle, drops off but slightly from its maximum value at low pressures, to that at higher pressures, it will be evident that the highest real efficiency of such an engine, will be obtained at the highest pressure, that the engine is capable of operating under.

The large area of the indicator card, the small amount of clearance allowable in the cylinders, and the high pressures possible in an engine working in this cycle, together with the fact, that there is a working stroke every revolution, which is not dependent upon an electric sparker for results, are points well worth consideration, aside from the high efficiency of the conversion.

The engine ought not to take up any more room than a steam engine of the same power and there results a saving of that large space now occupied by boilers and chimneys, most noticeable in steamships, where the greatest and best part of the hold is often lost to such uses and the most desirable parts of the decks are made unavailable, on account of uptakes and ventilators. It might be mentioned in passing, that the ocean greyhound has about reached the highest speed attainable with the aid of the steam engine. Besides the wasteful use of fuel in such a plant, there is not room enough on board to make the plant larger.

In other fields, a great advantage will be found in having an engine capable of starting at full power by drawing on a reservoir in the compressed air system, which is not subject to the losses from heat radiation, incident to the upkeep of pressure in a steam boiler. The gas engine uses heat energy only when in operation, the steam engine requires in addition a continual supply of energy, to make the same available for use.

Finally it would appear safe to say, that the internal combustion engine of the future, at least for large powers, will not be gasolene engine, but one that is adapted to the use of crude petroleum. People are not going to pay for the refined product, when the crude article can be had so very much cheaper and will serve the purpose equally well. Those engines using gas as a combustible, may find advantages in the explosive engine, but large engines employing oil as a combustible, will find greater advantages when working in a cycle, with combustion at constant pressure.

ALUMI NOTES.

A. C. Eastwood, '98, has lately been admitted to membership in the Franklin Institute, the oldest scientific institution in this country.

W. E. Burk, '96, has resigned his position as Professor of Chemistry at the Louisville Male High School, to devote his entire time to the work of the firm of Burk & Lyon, Chemical Engineers. Mr. Lyon is a graduate of Rose, '01.

Faces seen at the pipe rush: Bland, '05; Krieger, '03; Brosius, '03; Austin, '03; Bryon, '04; Speaker, '05; Claude Cox, '02; Blanchard, '05; Daily, '05; Reed, '05; Larkins, '05.

We are in receipt of the following:

The firm of Julian Scholl & Co. has been incorporated under under the same name under the laws of the State of New York, with the following officers:

Julian Scholl, President.

A. L. Oliver, Treasurer.

H. T. Miller, Secretary.

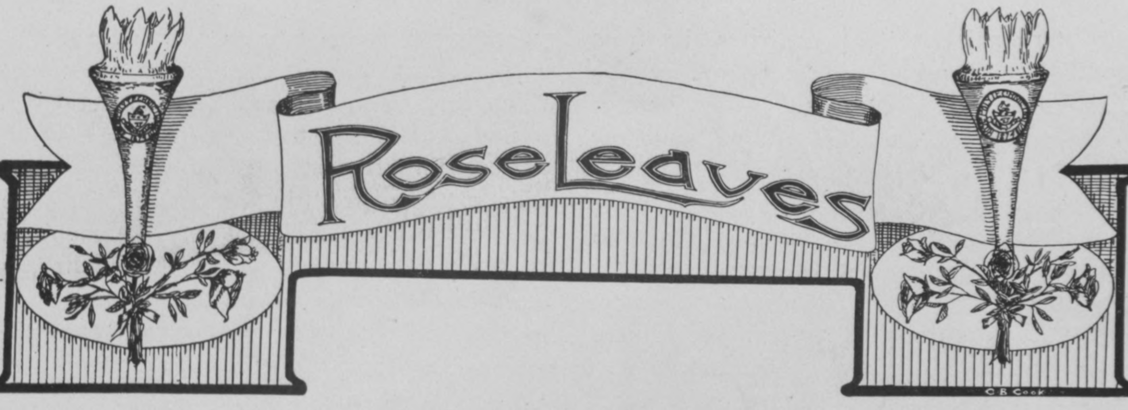
The new corporation continues the business of the manufacture and sale of road machinery. They manufacture the Universal Steam Rollers, the Reliance Steel Stone Crushers, and other machines or implements for making roads. This business was established nearly fifteen years ago by Mr. Scholl, '88.

Ralph Blanchard, '05, will attend Columbia this winter, beginning a three year course in Geology. For the last two or three summers he has been associated with the expeditions that go out to the mining districts of the West under the combined direction of several of the Eastern universities, for the purpose of making Mineralogical and Geological investigations in the natural laboratories. The work that Blanchard has done at these times has been put to his credit at Columbia. His advanced work at Columbia, together with his course in Chemistry here, will give him a Doctor's degree and will very ably equip him for the further pursuit of his interest in the mining industry.

The wedding of Carl D. Fisher, '03, to Miss Bertha May Boyer, took place at the home of the bride, 511 N. Sixth street, Terre Haute, on the 18th of September. They will be at home to their friends after October 25th at Wapakoneta, Ohio.

The following is a list of the members of the Class of 1905, and their present locations, as far as we have been able to find out :

Atherton, Gill, Mass.
Benson, General Electric Company, Schenectady.
Blanchard, Columbia University.
Bland, L. & N. Shops, Louisville.
Burr, Westinghouse Electric & Manufacturing Co., Pittsburgh.
Cook, Bullock Electric Co., Cincinnati.
Daily, Stone & Webster, Terre Haute.
Davies, Gulf, Colorado & Santa Fe R. R. Co.
Everson, Southern Indiana Coal Co., Terre Haute.
Goodman, C. & E. I. R. R., Chicago.
Gray, General Electric Co., Schenectady.
Greenleaf; Allis Chalmers Co., Milwaukee.
Haller, Cincinnati, O.
Hanley, C. & E. I. R. R., Chicago.
Heick, Worthington Hydraulic Works, Harrison, N. J.
Jenckes, General Electric Co., Schenectady.
Johnson, General Electric Co., Schenectady.
Kiefer, Fairbanks, Morse Co., Beloit, Wis.
Klenk, Blue Island, Ill
Larkins, C. & E. I. R. R., Chicago.
Lewis, Edison Electric Co., Los Angeles. Cal.
McBride, C & E. I. R. R., Chicago.
Newnam, Big Four R. R., Mattoon.
Parr, Fontanet, Ind.
Peddle, Interborough Rapid Transit Co., New York.
Pfeif, General Electric Co , Pittsburgh.
Reed, Union Pacific Shops, Omaha, Neb.
Reynolds, Chemist, Vandalia R. R., Terre Haute.
Robertson, General Electric Co., Schenectady.
Shryer, Armour & Co., Chicago.
Snider, Fairbanks, Morse Co., Beloit, Wis.
Spalding, Chicago Telephone Co., Chicago.
Speaker, Big Four R. R., Mattoon, Ill.
Sproull, J. I. Case Threshing Machine Co., Racine, Wis.
Trowbridge, Carlson, Stromberg Telephone Co.
Watson, Allis Chalmers Co., Milwaukee.
Wood, at home in New Mexico
Wright, Westinghouse Electric & Manufacturing Co., Pittsburgh.



A GLIMPSE INTO MODERN TELEPHONE PRACTICE.

By F. W. POTE, '06.

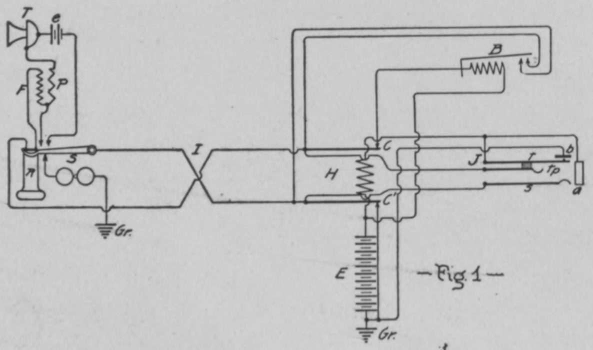
SO limited is the knowledge of telephony obtained in the general curriculum of study at Rose, and so few the number of students who are sufficiently interested in the subject to read current topics in telephone journals and magazines, that only rarely does one meet with a student who has even a slight acquaintance with the theoretical and practical working of a modern telephone exchange. As telephony has grown so rapidly in recent years as to demand more than a passing attention from the electrical world, a consideration of the subject, it seems, would be highiy valuable to the student of electricity merely from a practical standpoint. It is the object, therefore, in a few pages, to endeavor to acquaint the reader with the general working and material construction of a telephone system which bids fair to serve as an average type of the modern telephone exchange, leaving all details for his own study and solution. Any uncertainties requiring special explanation or further knowledge desired in any particular feature will be cheerfully and willingly furnished by the author.

Beginning with the subscriber's end of the line and taking note of the different apparatus *en route*, let us trace the circuit to the switch-board, to which a chief attention will be directed. After a general idea of the materials involved in the construction, we shall inquire into the general operation of the average service.

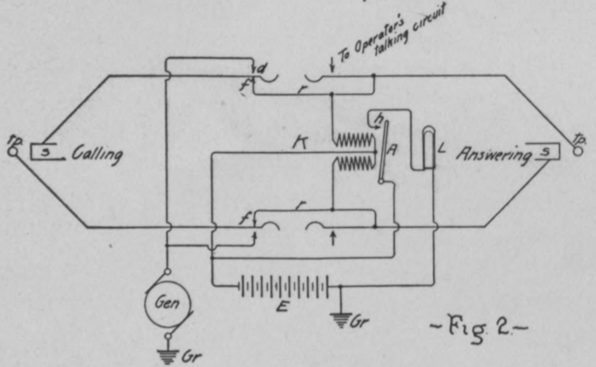
The telephone proper consists of a transmitter, receiver, and signaling device. The transmitter is in series with the primary of an induction coil and local or common batteries as the design of the circuit requires, and differing only in resistance of transmitter and coil. In series with the secondary and line, the receiver hangs, when not in use, upon a switch-hook, the object of which is to break the ground contact, and close the transmitter and line circuits upon its removal. The signaling device consists of some form of ringer and bells, and, in our case, of a polarized ringer, the action of which is quite similar to that of a polarized telegraph relay with the spring omitted, and which requires an alternating current for operation and signaling.

From the telephone we follow the "duplex" to the outside of building, thence along the "drop" and pair of wires to the nearest cable box, where, through "bridles" and line fuses, a connection is made to a pair of wires in the cable. A protecting device, whereby each side of line is sufficiently insulated from a grounded carbon block by a thin strip of silk to prevent leakage but to permit the escape of static charges, is used in conjunction with the line fuses in the box. From this box, we trace the cable containing our pair of wires to what is known as the "under-ground box" where a similar connection is made to an under-ground cable which, entering the exchange building, ends at the "terminal head," where the pair finds terminals in a pair of spring clips.

The "terminal head" generally carries from 100 to 125 pairs of springs and clips, together with the chief protection of the plant. Each pair of clips is numbered on the terminal and the numbers known as "pair numbers." Designating any pair of wires by the number of cable head and pair, completely defines any particular lead of wires. The protecting device is exactly similar in construction to that in use at the cable box with the exception that perforated mica takes the place of the silk insulators. One side of each terminal makes contact with a carbon block,



-Fig.1-



-Fig. 2-

which is insulated by this perforated mica strip from a similar block, grounded through the metallic frame of the cable head. All accumulations of electricity due to thunder storms, etc., find their way to ground through these carbons.

Connection from outside to inside is made through coils of about 27 ohms resistance. These "heat coils," as they are called, replace the line fuses at the box and are a means of protection to inside apparatus, for, when open, the line is automatically grounded against a metal bar in direct connection with a ground plate or other grounding device. Any current in excess of a quarter ampere through the coils, melts the solder which they contain, breaks the connection, and grounds the line.

Proceeding from top of cable head, a cable leads to the distributing or switch board rack. The switch board rack consists of a number of upright panels, some of which contain clips, correspondingly numbered with the terminal clips and to which the cable leads directly from the terminal head; and others, clips numbered consecutively with numbers corresponding to telephone numbers proper. The clips are supported on a wooden back by means of a hard rubber strip of about one-half inch thickness which directly carries the clips and insulates one from another. Connection is made between switchboard rack panels by means of "jumpers" or cross-connecting insulated wires. By this means, the rack serves the purpose of interchange among pairs and telephone numbers, and is indispensable to the efficient working of the Exchange.

From switch-board rack we proceed directly through cut-off relay and "intermediates" to answering rack corresponding with telephone number on rack. The cut-off relay is the dividing line for cables to "intermediates," target or line relays, and answering and multiple jacks. The intermediates are cross-connectors used to transfer busy numbers to an idle part of the switch-board, and consist of three wires for each number, the tip, sleeve, and test,—named from the corresponding springs of jack.

The jacks are the devices into which the plug is inserted when subscribers are being connected. They consist mainly of three German silver springs so arranged that when a plug is in, one spring makes contact with sleeve of plug (sleeve spring,) another with tip (tip spring,) and the third is forced against the common ground bar along the jack strip. This test spring is in metallic connection with a brass thimble placed at the face of each jack, and is insulated from the tip spring by a thin strip of hard rubber. Both answering and multiple jacks are exactly similar in construction, and either may be used for answering or calling purposes. The "multiples" are a series of jacks arranged in parallel connection, one appearing in each section of multiples. They are arranged in strips of 20 jacks each, 5 strips forming a bank and several banks, a panel, — the panels finally completing the section. The panels are distributed in easy reach of an operator, but the manner of arrangement is dependent on local conditions. For example, in a switch-board containing six sections of multiples, a given telephone number will have six jacks for communication and an answering jack, in all seven points of access. A single operator's position would be in reach of the answering jack and the section of multiples containing the given number, thus making it possible for that operator to give the subscriber any connection whatever. The use of the multiples places within easy reach of any operator all the numbers of the Exchange.

The target or line relay and lamp circuit form the signaling apparatus by which the call "comes in." When the armature is drawn toward the core, if a target relay, it mechanically exposes the number placed beneath the target or small piece of metal mounted on a pivot, which acts as the fulcrum of the lever device carried by the armature; and, if a line relay, a lamp circuit is "made" from battery through lamp to ground, a small 24 V lamp lighted, and the signal conveyed to the operator.

The cord circuit is shown in Fig. 2. It consists of answering cord and plug, calling cord, key, K., supervisory relay, A., supervisory lamp, L., and A. C. generator as shown. The figure shows the circuit for single supervision. Separate relays and lamp circuits are used in connection with condensers for double supervision. The cords, themselves, consist of a double spiral of wire, conveniently encased in cloth and connected to tip and sleeve of plug, tp., s. in figure. The key is an arrangement by which the operator can answer, ring, and listen to subscribers. It consists essentially of a pair of listening springs, a pair of generator springs, and a connection, r, from tip to sleeve and sleeve to tip of both cords as shown. By a simple cam and lever, the desired listening or ringing connection is made through the operator's talking circuit. The supervisory relay consists of two coils, one for each cord, and an armature and core, and is the means by which the signal is given the operator that the receiver is on or off the hook.

The wire chief's testing circuit is the means used in handling all trouble. It consists of an e. m. f. of 100 or more volts in series with a voltmeter. Different keys and their combinations enable the chief to test either side of line for grounds, drops in voltage due to bad joints, and to make approximations as to where lines are down, etc., etc. The variety of trouble cases occuring in practice is met by as great a variety of ways in handling them through this agency.

Let us turn now to a consideration of the operation of a subscriber's circuit. In Fig. 1. remove receiver, R, from hook, S. A spring in the hook breaks connection of sleeve side of line from ground, Gr., closes the circuit through secondary of induction coil, F, and receiver coil, and also circuit through primary, P, transmitter, T, and battery, E. Current flows out from battery, E, through target relay coil, B, through tip side of line, receiver and F, back along sleeve side to ground side of battery. This flow of current through B excites the core and draws down the armature, which in turn exposes the number of our 'phone on the switch-board, and lights the pilot lamp.

The operator seeing the signal, puts an answering plug in jack, J. This action forces the test spring, t, against ground bar, b, while the tip, tp, and sleeve, s, make contact with like named springs of jack. This grounding of test causes battery, E, to flow through cut-off relay, H, magnetizing core, attracting armature and breaking spring contacts, C,C, and consequently breaking the target relay circuit and dropping target over number. This act is called "plugging out call." The operator next moves her key lever, making contact to listening springs of key with her talking circuit, and you are met with the familiar, "number?" Upon giving her the desired number, the operator picks up a calling plug and inserts it in the desired multiple jack.

Omitting all relays, etc., we shall now consider our diagram (Fig. 2) as the called subscriber's circuit and J as the multiple jack. Upon the insertion of calling plug, the operator moves her key lever, makes contact, d, with generator springs, breaks contacts, f,f, and rings out over sleeve side of line through switch-hook and bells, to ground, thus signaling the subscriber wanted. Upon the removal of receiver and restoring of key lever to normal position, both parties are directly connected for communication.

Upon replacing the receiver upon the hook when through talking, a ground is placed on sleeve side of line. Battery flows out through one coil of supervisory relay, A, over sleeve side through ringer to ground at the telephone. One side of battery grounded and the circuit thus completed, the armature, A, is drawn towards the coil, contact made at h, and lamp, L, lighted from battery to ground. This informs the operator that receiver is on the hook. The other party hangs up and in a similar manner by the use of the other coil, the lamp circuit is "made." The connection is then withdrawn.

The cord circuit also enables the operator to detect a grounded or reversed line, and also one that is open. No supervision upon "plugging in" means an open on sleeve side of the line. Plugging in jack with the answering plug and touching the sleeve of another pair of cords to the calling plug gives the test for a ground or reversed, either of which will cause the "coil" to stay in. Supervision from sleeve of extra plug to sleeve and from sleeve to tip of calling cord of pair used in the test, indicates a ground on the tip side ; while supervision from sleeve to sleeve, and none from sleeve to tip, indicates a reversed line. The conditions and their causes are easily explained from a study of the figure. It is chiefly through this means that a trouble clerk is able to report cases of trouble without the subscriber's knowledge. These tests, however, are applicable only with a single supervision cord circuit, for the condensers in that of double supervision interfere with the continuity of the circuits.

It has been pointed out that when a plug is in the jack, the test spring is grounded, and also that the test spring and thimble are in metallic connection. This arrangement makes it possible for an operator to pre-determine whether there is a plug in the jack of any particular number. Before inserting a plug, she touches its tip to the thimble on the face of the strip. Now if there be a plug in a jack in any place along the board, battery, E, flows through coil of A; out through tip and thimble to ground, giving a click in operator's ear and lighting lamp, L. This is the "busy test" made before the insertion of every plug, and always resorted to by the operator. This prevents subscribers being rung in ear or conversation interrupted, and is highly essential to the smooth working of the system.

CIVIL CAMP.

G. E. Heniken, '07.

The annual "Civil Camp" was held at Marshall, Ill., from June 8th to 22nd, inclusive. On Wednesday preceding commencement, the party, consisting of eleven Sophomores and eleven Freshmen, with Prof. McCormick and Mr. Post in charge, took the Vandalia to Adenmoor, a little station five miles from Marshall. From there we walked to Marshall on the old National road, getting a view of the country along the route of the proposed survey.

Arriving at Marshall about 1:30 P.M., we at once started to hunt for rooms and board. But the memory of one April evening when '07 and '08 held an inter-class "meet" on their streets still lingered in the minds of the peace-loving citizens, and we met with a cool "nein" in many places, while others received us "on suspicion."

After returning for Commencement, the instruments were taken to Marshall on Friday morning and the survey of the Marshall and Adenmoor cut-off was started. About a half mile west of Marshall station the Vandalia railroad curves toward the north, and 4½ miles further, at West Mill Creek bridge, it curves back toward the south. The preliminary line was run by continuing the tangents of these curves from each end to their point of intersection about 3 miles west of Marshall.

The country along the line is rough, being broken with hills, ravines, bluffs and low creek bottoms—the greatest difference of elevation on profile being about 70 feet. The line ran through only a few acres in cultivation—most of the country along the lines being either in woods or too broken for cultivating.

Traverse surveys were made of the surrounding country and topography taken with levels, hand level, transit and stadia, for from 300 to 600 feet on each side of the line. Most of the topography was platted in the field on cross section paper. Headquarters of the "camp" were in Marshall, and with one or two Sophomores in the office each day the notes were kept up so that the evening office work took but little time.

In the evenings the boys usually made the St. James Hotel their headquarters, and spent the time at cards and in writing letters on stationery of the "Marshall & Adenmoor Railway." On this were printed the names of the '07s as Engineers, '08s as Assistants, and the two instructors as Chief Engineers.

The weather was clear and usually hot, with the exception of one day, and we appreciated the long tramp in that "soaker" in a country where dust was plentiful and bath tubs a luxury possessed by few. The good weather enabled us to carry through the work and get done on Wednesday evening, June 21.

That evening, when the final instructions for the return had been given, one of the Sophomores, in behalf of the '07 Civils, presented Prof. McCormick a 300-ft. nickel-plated tape and reel, as a token of appreciation and esteem. To this the class added "nine rahs for Mac," and waited for his reply—which for once could not come with its usual readiness.

The next morning about 10 o'clock a ball game was called between a Marshall team and one composed of Rose Civils. The Poly team was strong, and even with a little kid on the opposing team, easily took the lead in the number of *errors*. Of course we did not care for the *runs*—and gave them the odds of 7 to 1.

"Camp" was "broken" at noon and the party returned to Terre Haute tired, "glad it was over," and ready for home.

FRESHMAN CLASS.

Armstrong, Frank,	Terre Haute
Bangert, Henry J.,	Milwaukee
Beveridge, Charles E.,	Mattoon, Illinois
Bock, Walter E.,	Columbus, Ohio
Brannon, William H., Jr.,	Owensboro, Kentucky
Brennan, Edward M.,	Indianapolis
Buckley, Edmund T.,	Frankfort, Kentucky
Burgess, Fred A.,	Louisville
Comstock, Charles J., Jr.,	Louisville
Crumley, Ralph A.,	Springfield, Ohio
Curry, Glenn M.,	Terre Haute
Curry, H. Wayne,	Terre Haute
Darst, James M.,	Cleveland, Texas
Dilley, Clarence V.,	Palestine, Texas
Duenweg, Paul H.,	Terre Haute
Dugan, F. Clarke,	Louisville
Duncan, John McK.,	Cloverland, Indiana
Frisz, Frederick J.,	Terre Haute
Fuller, Henry W.,	Westfield, Illinois
Garrigus, Walter H.,	Terre Haute
Goodwin, David S.,	Terre Haute
Grammer, L. Earl,	Terre Haute
Green, R. Hewett,	Louisville
Hammond, Harry B.,	Terre Haute
Harkness, Harry E.,	Terre Haute
Hays, Howard B.,	Poplar Bluff, Missouri
Heim, Martin E. W.,	Chandler, Indiana
Hickman, Raymond N.,	Terre Haute
Holden, Edgar W.,	Terre Haute
Hummel, Harry H.,	Louisville
Isenberg, Harold,	Louisville
Johnson, James N.,	Los Angeles, California
Keiper, William G.,	Louisville
King, Jesse G.,	Terre Haute
King, Bert B.,	Corydon, Kentucky
Klatte, William,	Terre Haute
Klenk, Fernand,	New York City
Klosterman, P. Hugo,	Louisville
Lawrence, Edward R.,	Terre Haute
Lancaster, Graham H.,	Owensboro, Kentucky
Levy, Emil	Archbold, Ohio
Loucks, J. Lyman,	Scottdale, Pa

McWilliams, Michael J., . . . Wellington, New Zealand
Maddex, W. Rolland, ... Terre Haute
Markley, George E., ... Clay City, Ind
Markley, John E , ... Clay City, Ind
Montgomery, Courtney L., ... Vincennes, Ind
Mosby, Harry D., ... Terre Haute
Norton, Voris R., ... Bedford, Ind
O'Brien, Bernard, ... Louisville
Ortiz, Carlos, ... Ponce, Porto Rico
Piggott, Hubert P., ... Irvington, Kentucky
Piper, Carl W., ... Paris, Illinois
Pritchard, Amos D., ... Marshall, Illinois
Ralston, Ivan R., ... Pittsburg
Ransohoff, Nathan, ... Cincinnati
Rathbone, Walter V,, ... Harrisburg, Illinois
Richardson, Elmore, ... Terre Haute
Rockwood, William H., ... Terre Haute
Roesch, Hans A., ... Cheyenne, Wyoming
Shepard, James A., ... Deming, New Mexico
Showers, J. Ralph, ... Shelbyville, Ind
Smith, Richard L., ... Whittier, California
Sproull, Clarence W , ... Ansonia, Ohio
Standau, George F., ... Terre Haute
Stephens, Ray, ... Celina, Tennessee
Steyer, Theodore P., ... Golconda, Illinois
Thomas, Herbert C., ... Dallas, Texas
Tipton, Otto A., ... Terre Haute
Treeman, Herbert, ... Perry, Oklahoma T.
Trenary, George W , ... St. Elmo, Illinois
Tucker, Earl W., ... Wyandotte, Michigan
Tuthill, J. Kline, ... Le Roy, Illinois
Tyler, Roy F., ... Minneapolis, Minnesota
Voges, George, ... Terre Haute
Wanner, Frank K , ... Louisville
Wardin, Dwight, ... Nevada, Missouri
Waters, Arthur M., ... Terre Haute
Wickersham, Robert J., ... Terre Haute
Wiest, Frederick C., ... Ashland, Ohio
Wilson, Rolla S., ... Burnett, Ind
Wilton, Frederick C., ... Terre Haute
White, Charles A., ... Dayton, Ohio
Woody, Guy, ... Terre Haute

NEW SOPHOMORES.

Conley, Carl H., ... Newport, Indiana
Kerrick, Leo Carl, ... Valley Station, Kentucky
Maglott, William E., ... Mansfield, Ohio
Roane, William R., Jr., ... Warren, Arkansas

NEW JUNIOR.

Taylor, Howard, ... Abilene, Kansas

SUMMARY.

Seniors, ...	39
Juniors, ...	45
Sophomores, ...	55
Freshmen, ...	85
Total, ...	224

OFFICIAL DIRECTORY.

Senior Class.—President, W. R. Peck ; Vice-President, E. S. Butler ; Sec'y-Treas., E. D. Kahlert.

Junior Class.—President, H. M. Shickel ; Vice-President, B. H. Bard ; Sec'y-Treas., A. D. Schofield, Jr.

Sophomore Class.—President, C. M. Struck ; Vice-President, R. W. Johnston ; Secretary, O. L. Stock ; Treasurer, W. L. Beauchamp.

Freshman Class.—President, Richard L. Smith ; Vice-President, Carl W. Piper ; Secretary, Harry E. Harkness ; Treasurer, Glenn M. Curry.

Student Council.—President, W. R. Peck ; Vice-President, C. Wischmeyer ; Treasurer, H. M. Shickel; Secretary, C. M. Struck.

Athletic Association —President, A. W. Lee ; Treasurer, C. N. Trueblood ; Secretary, C. L. Douthett.

Scientific Society.—President, Frank A. Delle, Jr. Sec'y-Treas., C. W. Post ; Senior Councilor, J. M. Johnson ; Junior Councilor, Geo. E. Heniken.

Telegraph Association.—President, Roy Thurman ; Sec'y-Treas., H. McComb ; Superintendent, H. W. Wischmeyer.

Camera Club.—President, G. A. Kelsall ; Vice-President, J. M. Johnson ; Sec'y Treas., B. M. Lindsley.

Y. M. C. A.—President, C. W. Post ; Sec'y-Treas., H. W. Eastwood ; Corresponding Secretary, John F. Robbins

Symphony Club —President, A. W. Worthington ; Sec'y-Treas., M. Meyers

Orchestra.—President, A. W. Worthington ; Vice-President, O. L. Stock ; Sec'y-Treas., H. W. Wischmeyer.

Glee Club.—President, H. M. Shickel ; Vice-President, E. D. Kahlert ; Sec'y-Treas., Carl B. Andrews.

Mandolin Club.—President, J. J. Gibbons ; Vice-President, E. C. Ryan ; Sec'y-Treas , C. H. Seldomridge.

THE FRESHMAN RECEPTION.

The formal introduction of the Class of '09 to college life at Rose took place at the gymnasium Friday evening, September 22d. To say that it was an enjoyable affair would be stating it rather mildly; the best way to describe the affair would be to say, simply, that it was a Rose Y. M. C. A. Freshman Reception—in other words, an affair where we all enjoyed ourselves, where everybody met everybody else, and where good fellowship was the ruling spirit.

The bareness of the walls of the gymnasium had been relieved by bunting of various colors, tastefully arranged, and the scene was one of festivity. The Freshmen turned out in large numbers, and spent the evening in getting acquainted with the members of the Faculty, the upper class men, and all our friends who had come to help make the affair a success. Incidentally, the Rose Orchestra and the Rose Glee Club furnished music which was well appreciated, and the ladies served refreshments which were also much enjoyed.

When, after we had joined in singing some of our old favorite songs, the affair came to a close, the Class of '09 had been made to feel that it was "one of us," and another successful Freshman Reception had been placed to the credit of the Rose Y. M. C. A.

THE SOPHOMORE BANQUET.

The Sophomore Class held its annual banquet at the banquet hall of the Jackson Club on the evening of Wednesday, Oct. 4th. The class left the Institute in a body at about 3:10 o'clock in the afternoon and went directly to the hall, where the afternoon was spent in a social manner to the accompaniment of drum music.

At 7:15 the boys seated themselves at the long table, and then commenced two hours of enjoyment of the good things that caterer Sandison had provided in generous quantities. At the end of this time, toastmaster Emil J. Fischer stood up amid applause, and after some appropriate remarks, introduced successively the speakers of the evening. The toasts were responded to as follows:

"Our Ambitions,"	C. B. Andrews
"The Class of '08,"	W. Penn
"College Spirit,"	S. Whitehead
"The Pipe Rush,"	F. McKeen
"Our Opportunities,"	F. H. Reiss
"What Fools Ye Mortals Be,"	G. W. Dodge
"The Faculty,"	C. M. Struck

After speeches, nine rahs were given for '08 and nine for President Struck.

The peace of the occasion was entirely undisturbed by demonstrations on the part of the Freshmen, the only excitement of the afternoon or evening taking place on the street, and the opinion of all present was that the banquet was a great success, reflecting credit on those who had had it in charge.

The telegraph line has been working since about the first of this month. Considerable work was necessary to get it into working condition, as parts of it had blown down or been cut down during the summer months. At this writing, additional loops are being cut in to take in new members.

Connection has been made with the striking mechanism of the big clock in the tower, and the correct time is struck off each hour on every instrument on the line.

THE PIPE RUSH.

FOLLOWING the example set by many preceding classes, the Freshmen and Sophomores began talking fight and pipe rush as soon as school opened for the first term. Wednesday night witnessed the beginning of hostilities, when some of the Sophs., began hunting for lonely Freshmen. But, contrary to expectation, the Freshmen were also out hunting for the Sophs, and as they had the advantage of superior numbers they were not long in making prisoners of the '08's. Although the second year men fought hard for their liberty, they were compelled to take a trip into the country under the guidance of several accomodating Freshies. But all the Freshmen were not so fortunate, as several of them were taken from their rooms and put on board a Clinton car and then given a free ride north-eastward.

Thursday night the Freshmen met at the Water Works about 70 strong and marshalled by Juniors, they went to the Poly campus, where they found the Sophomores already assembled. The '08's had suspended the defiant challenge from the electric light wires on the east side of the campus and though it was most too dark to see it, all present knew that thereby the Sophs had challenged the Freshies to a base ball game and had prohibited the carrying of pipes.

It was about 8:00 o'clock in the evening when the '09's charged the '08's and by nine o'clock it was all over — the Sophs tied up and watched over by the Freshies.

Some one telephoned for a special car and when it arrived at Thirteenth and Locust, all the Sophs but half a dozen — who were taken in a baggage wagon — were put on board and taken toward Clinton.

At last, Saturday afternoon came around and in spite of rain the two lower classes met on the diamond for the ball game. Here the Freshies were outclassed by the Sophs, who made three scores in the first inning. Two and one-half innings were played and the score still remained at 3 to 0 in favor of '08, when some Freshman produced one of the forbidden corn cobs and immediately the game was superseded by a fierce fight, the Sophs trying to get possession of the pipes. During the ten minutes following the appearance of the first pipe the fighting was spirited, and although the Freshmen out-numbered the Sophs two to one, some of the Sophomores remained on top. When the whistle blew for a ten minute truce, it was found that the '08's had not obtained many of the coveted trophies. After a short breathing spell the two classes lined up in single lines about 100 yards apart and the large pipe was tossed up between the two opposing lines. In the rush which followed, the Sophs succeeded in getting possession of the pipe, but, when after ten minutes hard fighting, the whistle again sounded, it was officially decided that the Freshmen were victors. '09 had 26 hands touching the pipe while '08 had but 11.

DEPAUW; 0, ROSE; 5.

The foot ball team played DePauw at Greencastle Saturday, Sept 23, and was victorious — the score being 5 to 0.

This was the first game of the season and no exceptionally good playing was done and there was considerable fumbling by both sides.

The main feature of the game was the lack of variety in DePauw's plays. They only bucked against our line once and as that proved disastrous to them they took to punting and trying to gain on fake punts The Methodists put up a rough game and showed a disposition to hold men who were not carrying the ball. The day was very warm and two 15 minute halves were enough to exhaust both sides.

There is little else to say about the game. Rose had first kick-off. After that the ball was carried up and down the field till the end of the half, neither side scoring. Near the end of the second half Rose made a determined effort and succeeded in making a touchdown ; goal was not kicked. In the plays immediately preceeding the touchdown, Benbridge, Strecker and Pritchard made good gains. Pritchard carried the ball over the line.

LINE UP.

ROSE.		DEPAUW.
Taylor, Unkrich,	L. E.	Dorste
Strecker,	L. T.	Whitehair
Peck,	L. G.	Oncley
Schmidt,	C.	Simpkins
Jackson, Wilms,	R. G.	Eastburn
Lammers,	R. T.	Schultz
Douthett,	R. E.	Jewett
Turk,	L. H. B.	Douglass
Pritchard,	F. B.	Miller
Lee,	Q. B.	Q Jewett
Benbridge,	R. H. B.	Lathrope

Referee, McKinstray; Umpire, Jamison; Timers, Worthington and Law.

Two fifteen minute halves.

Touchdown, Pritchard.

EASTERN ILLINOIS, 0; ROSE, 27.

Rose defeated Eastern Illinois Normal in the second game of the season, Sept. 30th. The game was played on Rose campus, and during a light rain. The Charleston players were clearly outplayed during the whole game. The Poly line was more firm than it had been in practice, and only a few times was Normal able to gain through it. The first four touchdowns were made in the first half of the game. Only once was the Poly goal in danger, and Peck by a quick tackle prevented the Normals from scoring. This was when a fumble was made by a Poly man and a Charleston man picked up the ball and started for the goal with it.

Rose kicked off to the Normals, who were unable to gain and lost the ball. By a rapid succession of plays the ball was brought to the 10 yard line and then Douthett was sent over for a touchdown. Lee missed the goal. This was all done in 2 minutes and 30 seconds playing.

Not long after the next kick-off, Whitlock went around our right for a 30 yard run and a touchdown. Lee kept with him all the way as interference and prevented the Normals tackling him. Goal was not kicked. Bradford gained 10 yds. around our left after the kick-off. Strecker blocked a punt and the ball was rapidly carried down the field by Whitlock, Lammers, Benbridge, Douthett and Turk. Turk made the touchdown and Pritchard failed to kick goal.

Rose again kicked to the Normals, who fumbled to Schmidt. Lee made a run around our right and scored the fourth touchdown. Strecker kicked goal. Neither side scored after that in the first half. Score, 21–0.

In the second half, Normal kicked to Rose. After several gains, the fumble was made which nearly gave Normal a goal. Whitlock and Douthett made good gains, and Douthett scored on a play through tackle. Strecker kicked goal.

Normal kicked to Strecker, who returned the ball 40 yds., but time was called before the score could be further increased.

LINE UP.

ROSE.		EAST ILLINOIS.
Whitlock,	L. E.,	Housel (Capt.)
Pritchard,	L. T.,	Barclay
Jackson, Rotz,	L. G.,	Moore, Sargent
Schmidt,	C.,	W. W. Baker
Peck, Wilms,	R. G.,	Jones
Strecker,	R. T.,	DeWolf
Douthett,	R. E.,	Perisho, Crews
Turk,	L. H. B.,	Bradford
Lammers,	F. B.,	Montgomery
Lee(Capt,),	Q. B.,	Bidle
Benbridge,	R. H. B.,	W. E. Baker, Austin

Referee, Briggs; Umpire, Jamison; Timers, Blair and Worthington

Twenty and fifteen minute halves.

Touchdowns—Douthett (2), Whitlock, Lee, Turk.

Goals from touchdowns, Strecker (2).

NOTES.

The officers for the Athletic Association for the present year are: President, A. W. Lee, '06; Treasurer, Trueblood, '07; Secretary, Douthett, '08. The other members of the board are: Johnson, '06; Strecker, '07; Lammers, 08; Standau, '09, and Pritchard, '09.

The Rooters' Club has reorganized, with Kahlert, '06, Chief Rooter, and Worthington, '06, as Sec.-Treas. Assistant Rooters are d'Amorim and Lawton, '06; Hall and Routledge, '07; Heidinger and Lindsley, '08; Lawrence and Ransohoff, '09.

Membership buttons will arrive soon, and everyone should become an active member. Come out and yell and yell together—it helps the team more than you think.

We have material for an excellent foot-ball team this year, and if all those who have been out to date stick and work hard for Rose, there is no reason why we should not have the most successful team in our history. We have made a good start—let the good work continue.

Managers and Captains for this year are as follows:

Foot-ball—F. N. Hatch, manager; A. W. Lee, captain.

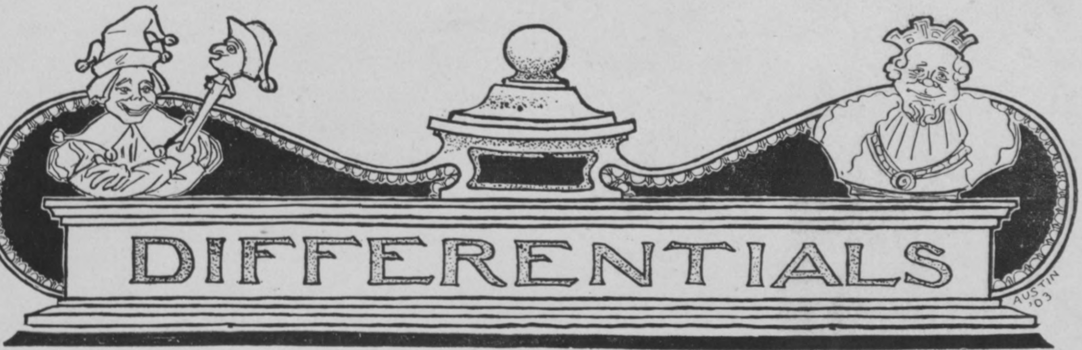
Basket-ball—E. S. Butler, manager; J. M. Johnson, captain.

Track—D. McDaniel, manager; P. Turk, captain.

Base-ball—A. W. Worthington, manager; C. Douthett, captain.

Claude Douthett, '08, has been elected captain of the base-ball team for the coming season. Douthett played third base and pitch last year, and will be Rose's mainstay in the pitching department this year

Prospects for a winning team are very good, for, although we lost six first team men last June, we have a number of new men. Baylor, formerly '06, has returned after a year's absence, and will add greatly to the team's strength.



At it again!

Have you noticed the improvements at the shops? A new stack to paint numerals on, a new boiler for the Sophs to play with, but worst of all, a new heating line. No more getting out of Chemical lab on account of cold weather.

HE'S A CIVIL.

Worthy, at the show, looking through opera glasses: — "Darn if some Freshman hasn't had hold of this and busted the cross hairs!"

Shickel: "You're coming up to see my girl some time, ain't you?"

Friend: "Sure pop."

Mooney, formerly of '08, who was elected to captain the base ball team next season, has not returned to school. He was married this summer to Miss Mabel Streetor, of St. Louis.

Barker, formerly of '07, has entered the same class at Kentucky State College, at Lexington, Ky.

It is rumored that two of our learned professors chanced to meet early one morning.

Said the first: — "Come, let's have a drink."

Said the second: — "No, no, it's entirely too early, and besides I've just had one."

"Born, to Mr. and Mrs. Harry Shickel, a daughter, Dorotha Rose, August 5. Mr. Shickel is a student of the Rose Polytechnic Institute, from which the daughter's middle name was chosen."

Congratulations, old boy.

Once upon a time an electrical engineer experienced a great big bunch of trouble, and was expressing his feelings rather fluently. A preacher passed by, and was naturally somewhat shocked at the language.

"Young man," said he, "don't you believe in a Power above?"

"Hang it, no; I prefer the third rail."

AT THE CHALLENGE RUSH.

Fischer, '08:—"Beauchamp, button my shirt, will you, there's some girls I know here."

Mac's annual perpetual motion joke of the 6s and 9s has cropped out again. This joke seems to be a fair sample of perpetual motion itself.

Nelson, '08:—"Is Mr. Dodge at home?"

Landlady—"Mr. Dodge? Which one is Mr. Dodge?"

"That wild-looking fellow."

"O, the one in the back room? Yes, he's in."

Lindsley:—"I'm looking for a mail box; I think that is one down by the fire engine house."

Hull:—"Maybe that's a fire call box."

FAITH IN HUMAN NATURE.

Notice on the bulletin board:—"Lost, in gym. Saturday P.M., one dollar."

McKeen enters Hath's room.

The class: "Sit down, McKeen."

Hath:—"Set down opposite your names on the slip if you want the text-book."

McKeen:—"Everybody seems to be telling me to sit down."

A SENIOR'S DEFINITION.

Duke's Mixture:—Applied Mechanics and Dynamo Machinery.

The Duke:—"Mr. Ankeney, why are two motors used on a street car?"

"Agony":—"One for running forwards, the other for running backwards."

Friday:—"The ratio of these quantities is inversely as three is to four."

In the following way does a writer in the *Boston Transcript* sum up the features of American university growth:

1. Attendance is growing faster than the population.
2. Western institutions are growing faster than Eastern.
3. The old arts course is falling behind relatively, while the scientific and engineering courses are forging to the front.
4. Fewer students are attending law and medical schools in proportion to the number of students.
5. The number of women students is growing faster than the number of men —[*The Tech*.

Thurman, '06 has not yet returned, owing to injuries he received in a street car accident in Chicago this summer. It is thought he will be able to be with us in a short time, and he has our best wishes for a speedy recovery.

Hatch says that if an Electrical would build a railroad according to formulae given in Foster, a car would stand on its head every time it hit a curve. We are looking forward to the publication of "Hatch's Pocketbook for Electrical Engineers."

'Arry wants it distinctly understood that the rumors of his marriage have been greatly exaggerated.

What some of the Seniors have been doing this summer:

Jackson—Training for the foot-ball season.

Benbridge—Going on hayrides in Louisville.

Canfield—Growing sideburns.

Ankeney—Working for "Daddy."

Hatch—Opening mail and telegrams addressed to "The Manager."

d'Amorim—Sending his friends postals from Michigan.

Worthy—Managing the Pennsylvania, and learning the "Pittsburg accent."

A. W. Lee—Wondering if he would make the foot-ball team.

Eastwood—Wishing it was time to come back to T. H.

Ryan—Teaching base-ball at a Louisville play ground.

Freshman:—"Say, what kind of socks do you wear here in the winter?"

Soph—"Clean ones."

Freshman:—"O, quit your kiddin'."

A Freshman was watching a practice game between the first and second teams one evening, and when, after practice, he saw the teams jog around the running track, asked if the losing team had to do that as punishment.

"Mal" Howe:—"Mr. Logan, what was the object in putting that bend in the new stack?"

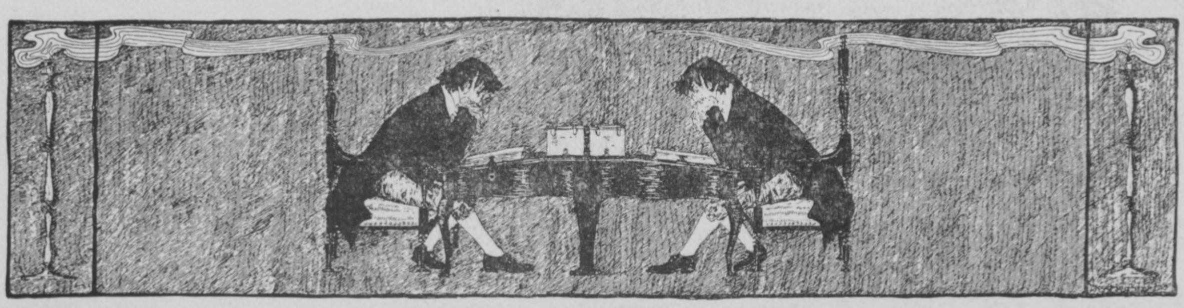
Logan—"To make the smoke curl."

Wicky (coming late to the Political Economy class):—"Well, since you boys didn't cut, I suppose we'll have to find something to do."

Beauchamp and Knopf, '08, have been initiated into the Sigma Nu, and Douthett, '08, into the Alpha Tau Omega.

Kelly (in Steam):—"Professor, can you tell me why it was that one day when I was standing on a railroad track, an engine came toward me and threw steam seventy-five or a hundred feet to one side?"

Waggie:—"I am not sure that I have ever before heard of anything of the kind, but it was probably to scare cattle off the track."



REVIEWS

High Power Surges.

AT the Asheville Convention of the American Institute of Electrical Engineers, Mr. C. P. Steinmetz gave a talk on "High Power Surges in Electric Distribution Systems of Great Magnitude." A full report of this lecture is to be found in the July number of the Transactions of the Institute and though the latter part is highly mathematical, the first part, descriptive of what occurred during a high power surge in the distribution system of the Manhattan Railway in New York, is most interesting.

"A summary of the happenings in their proper sequence is as follows: First, a static discharge over the high tension cables and insulators was observed in two of the substations. Second, in a few minutes a feeder short circuited in the manhole nearest to the power station, blowing out about twelve inches of the conductor cable and raising the manhole cover and the pavement all around it, with a loud report. Third, one of the generators operating in multiple, short-circuited near the terminals, conductors on two turns of the winding being driven out till they struck the iron frame of the generator. That is to say, the armature bars, which are 2 inches by 1/8 inch, three in each slot, were bent edgewise for over six inches, showing that the force bending them amounted to at least three thousand or four thousand pounds. Fourth, practically simultaneously several of the three conductor cables short-circuited, some of them in the man holes at a greater or less distance from the power station and some of them on the static dischargers in the power station, and one across an end bell.

"Upon examination, one of the generators which was apparently uninjured, showed that the current had jumped across between the conductors near the end of one phase, a distance of four inches through the air. At another point on another phase of the same machine, marks showed that the current had jumped from one of the end bars to the iron, through the air a distance of six inches. Other arcing distances showed conclusively that the potential must have risen to not less than 70,000 volts.

"The source of all the trouble was probably in the feeder in the manhole nearest to the power station, breaking down the insulation to ground. The large capacity current of the system, burned the insulation of the neighboring conductors in the three conductor cable and formed a short circuit which blew out the arc by the sudden expansion of the air in the manhole from the heat generated by approximately 70,000 kilowatts. The arc was probably re-established several times, thus setting up an oscillating current and giving rise to the potential above mentioned."

The Quebec Bridge.

THE Engineering Record for September 16th gives an exceedingly interesting account of the progress in the construction of the Quebec Bridge, across the St. Lawrence river. This bridge is in several respects the most remarkable which has ever been built. The total tength of the bridge is 3300 feet; the length of the central span over the channel of the river is 1800 feet. This great length of span was rendered necessary by the great difficulty experienced in constructing piers on each side of the main channel, which has a clear headway of 150 feet above the highest tide. The cantilever towers stand 360 feet above the water and the steel traveler used in construction is 212 feet high.

The Phœnix Bridge Company has the contract for this bridge, and they agreed to complete it between April 1904 and December 31st, 1908. This seems rapid work when one considers that it was necessary for them to make all designs, and manufacture and test all of the steel work, amounting to more than eighty million pounds. A great deal of the material is of the largest size that has ever been constructed and required the use of special cars for its transportation.

All of the substructure has been completed and two of the spans have been finished in the shops. The erecting plant and storage yards are in themselves very considerable establishments. All material is unloaded and stored in the yards by two 60 ton electric overhead traveling cranes. When the construction is ready, the material is reloaded on to steel flat cars by the cranes, and is delivered to the 450 ton steel traveler by steam locomotives of standard gauge. This steel traveler also far exceeds in size and capacity, all those which have previously been used.

This splendid monument to the engineering talent of our country is being constructed at a total cost of about four million dollars.

Heavy Electric Traction.

HEAVY electric traction is advanced another stage by the recent award by the New York, New Haven and Hartford, R. R. Co., to the Westinghouse Electric & Manufacturing Co. of an order for twenty-five 78-ton single phase locomotives, capable of hauling 200-ton trains at an average speed of 26 miles an hour, with stops at intervals of 22 miles, and express trains of 250 tons at the rate of 70 miles. This equipment is for the portion of the road near New York, where extensive recon truction work has already been started.

Incidentally, the recent contract is of interest because of the long experience of the New Haven Company with electric operation. Although the Nantasket experiment, begun ten years ago, was unsuccessful in some respects, it has furnished many valuable data, and the company's other electrically operated branches have given it enough experience with this system to make it certain that the contract just placed for the heavy electric locomotives has been awarded in the light of as complete knowledge, theoretical and practical, as is available anywhere today. It is understood that the locomotives can be run over the New York Central tracks used by the New Haven system to enter the Grand Central station.—[*Extract from the Engineering Record.*

Water Tube Locomotive Boiler.

A LOCOMOTIVE with water tube boiler has lately been put in service on the Paris, Lyons and Mediterranean Railway. "This boiler seems to be successful, and it is worthy of record because of an increased interest in water tube boiler possibilities for locomotives. There are two horizontal drums, the larger being over the smaller one. These provide water and steam space, and they are connected by curved tubes 26 inches in diameter, expanded into both drums. Three thimbles connect the two drums. From the rear end of the lower drum, circulating pipes connect with headers below the level of the grates. These headers are connected with the upper drum by a series of tubes placed close together, and forming the inside shell of the fire box, the two being covered with a thin steel plate as an outside envelope.

"In order to facilitate cleaning the water tubes two blower pipes extend through the central space and pierce the two forward thimbles which connect the drums. These pipes have many apertures through which jets of steam are blown in inclined directions against the water tubes for the removal of soot and ashes. The valve for these pipes is located in the cab. When first applied the boiler had copper tubes, but these have been replaced by steel. Experience has shown but little trouble with mud in the drums, but scale formed in the tubes has required removal by brushes, hammers and tube cleaners on flexible shafts. This boiler is said to steam freely and raise steam rapidly."—[*Extracted from the American Engineer and Railroad Journal.*