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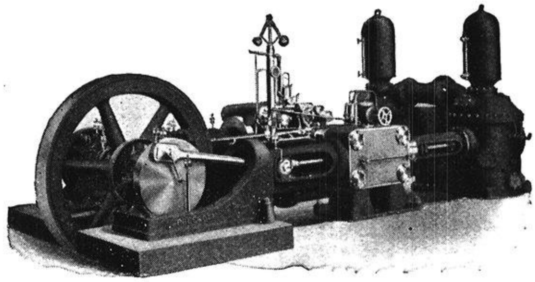
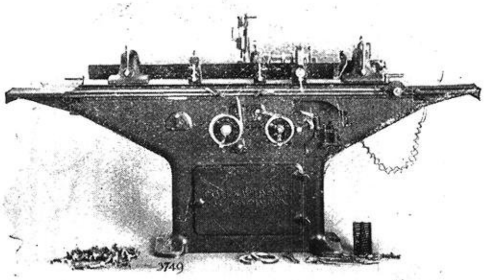




THE WISCONSIN ENGINEER

VOL. XIII — APRIL, 1909 — NO. 3

SOME COMMENTS ON OUR ENGINEERING EDUCATION AND THE MEN IT PRODUCES.

An abstract of a lecture by W. D. Taylor made before the Engineering Club of the University of Illinois, February 25, 1909, and repeated by request before the Senior Classes in Engineering at the University of Wisconsin, March 29, 1909.

During the five years spent in the University and ending three years ago I listened to a number of engineering lectures arranged for by the University by a number of eminent engineers and managers of great industrial corporations. Some of these lectures were to me very interesting but many of them were quite the contrary. Those that did not very much interest me were generally made by some expert in some particular kind of engineering work who generally knew quite well how to do his engineering work but not so well how to interest a body of students.

Perhaps I would have been more interested in what these gentlemen had to say if I had been engaged in the same line of work that they were but I was not, nor were any of the students.

There were many of these lectures that I was sorry that I attended, many of them being for the most part, bare recitals of the outlines of machines that had been used to effect this or that end, or lectures in which the author made a laborious undertaking of the description of the minutest details of the methods by which some great work had been accomplished. There was one thing about the attention that the students gave these lectures that was quite remarkable and that was that where a man discussed a real live question, such as how to get a water supply out of one valley through a chain of mountains to a city in an adjacent valley, the students always sat up and gave alert attention.

But whenever the same lecturer began to use his lantern slides to show how every little detail of a piece of work was carried out interest immediately lagged and watches were consulted to see how much was left of the hour. I often noticed the same phenomenon in teaching my own classes until I got experience enough to at least try to omit details and methods as far as possible and to confine my instruction to principles and to a discussion of the broader questions connected with each subject.

But there was one lecture, the most remarkable of all those I listened to during the five years. This lecture was delivered by an exceedingly well dressed and well to do manufacturer who shall be called Mr. Jones. Mr. Jones consumed nearly two full hours in exhibiting his collection of lantern slides that showed the details of the great plant with which he was connected. In the midst of the presentation of his lantern slides, he stopped long enough to hand out some comments of very doubtful moral value on the need of practicing in the conduct of one's business a judicious amount of tact and diplomacy. He told how he entertained the agents of firms that were large buyers of the product he was manufacturing when they visited his plant. And he told some other things that would lead one to suspect that the wonderful financial success of his business was due fully as much or more to the practice of "tact and diplomacy" as it was to good honest work, and the plain hint intended for the young man listening was, "If thou wouldst likewise succeed why go thou and do thou likewise.".

This "tact and diplomacy" idea seized upon the imagination of the engineering students of the University of Wisconsin to such an extent that our Dean was kept busy at each meeting of the students for some weeks following this lecture in explaining that by saying thus and so, Mr. Jones did not intend and could not have intended for them to understand, etc. In other words, our dear old Dean was doing all he conscientiously could to pull up and destroy the foul plants sown by the ill-timed words of the successful business man.

So, as I recall some of these lectures I have a confused memory of such things as gear wheels, tiresome machinery details, endless diagrams with little meaning, tact and diplomacy and what not, but of very few ideas that were really beneficial. Of course the students were supposed to be benefitted. They are young and their mental powers are receptive and everything that smacks of engineering is good for their minds, just as beefsteak and baked beans, and castor oil and quinine, and sulphur and molasses, are good for their bodies.

Perhaps you will say that as an engineering instructor I ought to have taken an active interest in all these things and perhaps you are right. But I want to say that I have found that I can't do it all. I have found that I am a man of very ordinary capacity, certainly so far as the whole broad field of knowledge is concerned, even of engineering knowledge. So I have learned to content myself with making a very modest endeavor to keep abreast with one very narrow field of engineering. But let me do my very best and still I will come very far short of perfection in learning even to properly construct and maintain a railroad. I know that I can't become an expert in the other fellow's line and I am really afraid to try. I fear that every time I reach out and grasp a great big idea that belongs in the other fellow's field that, my own head being of such limited capacity, something else equally as valuable to me in my own line of work will run over and spill out of the old vessel.

So, after I have spent such a part of each day as I can in making such headway as I may in my own line of work, I do not wish oftentimes to invade the domain of other engineers. I would rather walk into that wider domain that belongs to the brotherhood of all mankind. I would rather use that time in reading some of the good things stored up by generations of eminent scholars, in wandering in imagination through the interesting Scottish highlands with the great Sir Walter, in watching Miss Maude Adams in Peter Pan, or some such play, or in simply playing ball at home with my little boys. And I know that these things do me far more good.

Now in casting about for a subject for this talk, there were dozens of things that appealed to me. Following the lead of the usual engineering lecture, I could have told you about the construction of a great bascule bridge of new design we have lately put up on the Alton road in Chicago and across the south branch of the Chicago River, a bridge that carries the tracks of the Alton, the Santa Fe, the Wisconsin Central, and of the western lines of the Illinois Central.

I could have reproduced endless borrowed (the bridge was built under the Page & Schnable patents), calculations on the stresses of this bridge of new type. I could have described the difficulties we had with the foundations and substructure, with the Bridge Company that fabricated the steel, with the detouring of trains during erection, with the United States Government over the navigation question, with the laying of the cables across the river, with the installation of the motors to operate the bridge, with the Chicago labor unions, and with the mistakes of the young engineers who laid out the work, and of the old ones who drew the contracts and made up the specifications. I might have shown you a hundred lantern slides showing the construction of the bridge, with derricks cars and engines and tugs and barges moving, with block and tackle and hoisting engines lifting the great floor beams and stringers up for the brave steel workers to fasten into place while they themselves stood erect in shadowy outlines against the sky, and on frail steel angles a hundred feet in the air. And I could then have told you, what is true, that all these great difficulties are now overcome and that the trains of these four great railroads are now thundering over this bridge on their way into and out of the great metropolis of the west.

Had I taken this subject for my theme, you young men might have gone out at the end of the hour perfectly satisfied that you had witnessed the presentation of a real scientific up to date engineering subject. But all but perhaps two or three of you, I fear, would have gone out admitting secretly to yourselves that you hadn't got much out of the subject after all, though you would hope that your room-mate or some other friend, who caught on to such subjects more quickly, or who was more interested in such things than you were, had gotten a lot out of it. Now in my humble opinion young man, the reason you don't get much out of the presentation of such subjects is that for you and me, us ordinary plain every day mortals, there is not much in such subjects for us to get. And I don't think you need be alarmed about it either.

You will find as you go out into the business world that you will rarely have more than one thing to do at a time, and that one thing rarely on the heroic order. And in these days of excellent libraries and copious engineering literature covering all the range of subjects you are likely to be engaged in, you can get all the help and information you will need if you will only learn now while you are young how to make use of the information and help that are available, if you will only learn now while you are young to concentrate your mind upon a given subject until you have completely digested it mentally or, as an old teacher of mine used to say, "until you have thought it through."

But before I leave the subject of these engineering lectures: I have already told you of an objection to some of them. I want to tell you now of an objection to every one of them, and yet many of these lectures were given by men who command our sincerest regard. But in all these lectures that I heard there was not, if I remember correctly, a single discussion of a moral question. The ideas dominant in every one of them were the Thomas Gradgrind facts as to how the work was done, the results achieved, and how much money was gained or saved thereby. Seemingly there was to be no distinction in the future lives of the students as conceived by these lecturers between right and wrong. The strenuous life was urged for all it was worth, but no hint was made to these young men at this, the character forming, stage of their existence, of the world's need of their living clean, upright lives filled with beauty, simplicity, repose, and neighborly kindness. Perhaps it was thought that these things were too obvious to mention. But it is in this especial matter that the addresses to students of public men differ from those that we used to hear twenty-five and thirty years ago.

And now let me ask the teachers present if the objections I have pointed out against these engineering lectures cannot with some justice be made to much of the whole training of our engineer students. In our eagerness to fill their heads with a smattering of knowledge of all forms of engineering, or at least of as many as we can possibly crowd into our curricula,—in our eagerness to make of them good craftsmen, playrights, draughtsmen, mechanics, and engineers, are we not forgetting to cultivate that side of their lives which must be developed if they are to become men,—real *vires* not mere *homines?* Do we not assume too much in supposing that by directing our attention partly perhaps to their manual dexterity but principally to the growth of their minds that their moral and spiritual welfare will take care of itself?

It will not do to assume that because a man is educated he will follow the right and eschew the wrong. Some of the results of negro education in the South make up abundant proof of this statement. I have no faith in the oft-repeated statement that an engineer's whole training is a search after truth, and that therefore he will love the truth. A burglar feeling in the dark for your table silver is also a seeker after truth, and loves it too when he has found it.

Now I trust that you will not take me for an old croaker dissatisfied with all of the existing state of affairs. And I don't want you to believe that I have come up here with a bad taste in my mouth, nor that I am suffering from either melancholia or hysteria. On the contrary, I have abundant faith in American youth and in our country's future. And I have really little fault to find with the technique itself of modern engineering training, except perhaps, that we try to use too much of it.

We all have reason to be proud of the fact that our engineering schools can now turn out men who can so quickly qualify as expert civil, railway, hydraulic, electrical, mechanical, and sanitary engineers. We are all proud of the fact that, as Prof. Allen has conclusively shown, the rate of increase in the number of applicants asking for an engineering education at the doors of our colleges and universities is greater than those applying for any other form of educational training.

We are all proud of the fact that the demand for engineering students of late years has for the greater part of the time kept ahead of the supply so that there was lucrative work to be had for every student as soon as he could read his title clear to a diploma from an engineering school of the better class. So great has been this demand in commercial life for engineering students, that at many colleges there has been great difficulty in persuading many of the stronger members of the classes to do any postgraduate work whatever, or to enter even for a while upon the teaching profession. It has even been difficult to keep some of the students in school till they could be graduated.

It is a great pleasure to me to recall the great change too in the attitude of the officers of great railrway corporations and of the managers of industrial plants that has taken place since my youth. Now the college man in many lines of work has preference over all others. Then the college man in industrial life was ridiculed. I myself remember in my younger days applying for work to the General Manager of a railway and that I concealed the fact that I was a college man for fear that the knowledge of that fact would be prejudicial to my selection.

We are all also proud of the fact that it is no longer considered as true that a gentleman can belong to only one of the so-called learned professions, but that the word gentleman may now properly be applied to any one pursuing any honest calling if only he be a gentleman. It was not always so.

In all of these things I say I rejoice, and I rejoice in being an humble member of a profession which is adding so much to the comfort and advancement of the world. But I am in some respects better satisfied with the profession as it now is than I am with the prospects of what it may become in the years to follow. I know that the next generation will have better engineers but I don't feel so sure that those engineers will be better men. And I haven't jumped to this conclusion on the spur of the moment. This problem has filled me with more and more concern as the years roll on, just as the great social, or so-called negro problem, in the South has done.

In our modern training for our engineers as in our modern life, I fear we are going too fast. And just here I wish to remind you that there was a year or two ago somewhat of a general demand for the speed of our fastest trains to be reduced. The fast speed was thought to be responsible for the taking of too many lives. But still it is an age of rushing automobiles, or humming electric cars, and of thundering railroad trains, and we have made as great changes in our educational system as we have made in our means of locomotion and our modes of living. And in our haste to discard the older forms of training we have shelved, I fear, much that the lives of centuries of distinguished scholars have shown to be of the utmost value. I mean the development of the moral or higher and nobler side of the lives of our students.

Now let me say at once that I have no sympathy with the view that the desired moral development is tied so securely to the older forms of education that a man must study Latin and Greek and Mental and Moral Philosophy in order to develop his moral nature. I sincerely believe that such a development is just as possible for a man experimenting upon some theory of the transmission of electrical energy as in translating the odes of Horace or the orations of Cicero. It is the spirit of the old time teacher that our young men need, not his Latin idioms. Our teachers need something of the spirit that Ian McLaren has portrayed in the old Scotch Dominie in the Bonnie Brier Bush. Our colleges need men who give the whole of themselves to the mental and moral uplift and to the physical development of the students under their care.

Perhaps it is a subject which should not be discussed before such an audience as this, but I feel that I must say that I believe there is in our colleges and universities a great deal of inefficient teaching. We make a teacher's promotion dependent upon his success in research work. And it is beyond dispute that the qualities of mind which best befit a man to do research work generally unfit him to do efficient work as a teacher. There is room for a long discussion here, but I will cut it short and only say that there is not a nobler work in this world than that of devoting one's self to the profession of teaching, pure and simple, that of leading out, expanding, and helping to grow, the bodies and minds of the young men of the land, the profession of man building. And it is a pity that we cannot have in our colleges a teacher's standing and promotion determined by his success in doing the thing he is employed to do, and for which he is paid.

I differ radically from the statement made by Prof. Allen in his presidential address before the Society for the Promotion of Engineering Education at St. Louis, in 1904, where he expressed himself as follows:

"Most of what we regard as culture must depend upon environment and habit and must be acquired outside the college walls, in the home, the club, the church. Very little of real culture, little more than a taste for it, can be acquired directly from the work of instruction in the small fraction of time properly available from most college courses, academic or engineering."

Now the student comes to an engineering college to acquire the forms of thought, of speech, of work, and of action that he is to use in his professional life. If we teach him our subjects about after the manner that a burglar would use in instructing an apprentice, we could not expect to add much to his stock of integrity and refinement. But we might add some other things not quite so desirable. If on the other hand we make our instruction savor of manliness, courtesy, and uprightness, and we choose to bring into our lectures and recitation rooms occasional instances and examples calculated to exercise the students' sense of justice as well as his finer feelings, I have that faith in the absorptive power of the American student to believe that he will seize and appropriate to his own use a goodly share of those desirable characteristics while they are passing his way. Every teacher who has brought himself close to the lives and aspirations of his students knows and feels this to be true.

In discussing this question with an intelligent lady teacher in Chicago some time ago, she said in effect: "No, Professor Allen's loop hole won't answer. The teacher cannot escape his responsibility in any such way. Each student will involuntarily carry away something affecting his moral character from each teacher with whom he comes in contact who has any influence whatever in shaping his thoughts. He will either be better or worse for the association."

And now I want to make some definite charges against the engineering graduate of today and to say wherein he impresses me as not being quite the equal of former college men in some of the characteristics of a true and noble man. Please note that though I say I make charges, I do not attempt to prove logically that those charges are correct.

I grant at once of course, and I am proud of the fact that the modern engineer graduate is far more helpful than that older man was in advancing the industrial progress of the world. One must be a fool to argue otherwise. But it is difficult to see why, in these modern days when everything else has improved so much, our students should advance in one direction and recede in another. If it be true that there is a recession in some ways, it must be the fault of the student's training and environment for the American Caucassian youth is the same today that he has been for a hundred years. And if he is receding in this respect his teachers should shoulder the responsibility, for, as of old, they can mould to honor or dishonor, even as the potter has power to fashion his clay. The great body of our young graduates is just what their teachers and their mothers have made them.

Let me give you an instance now of the power of the teacher in moulding students' morals: I taught for a period of seven years ending in 1898 in the school on the banks of the Mississippi River in Louisiana that was founded before the Civil War with the man who afterwards became General W. T. Sherman at its head. General Sherman as all of you know, was a West Pointer, and he made much of drilling his early students in the need of their observing the same code of honor that he himself had learned to observe at West Point. That code could be expressed in words about as follows: "A gentleman must be slow to give but quick to resent an insult, and he must observe his word as he would his bond." General Sherman's teachings have been propagated in this school by presidents and teachers who have ever been in active sympathy with his views. You and I might believe the first part part of the code was responsible for too many black eyes and bloody noses among the students,—yet it is true that if you should go to a student in that school and ask him what is the sentiment among his companions on the subject of cribbing, he will stiffen his shoulders and haughtily reply, that any man who is allowed to attend the Louisiana State University must prove himself too much of a gentleman to cheat. And the boast is not a vain one. I taught there seven years and in that time we had one serious case of cribbing. In this case the faculty had no need to issue an edict of suspension. The students took care of that part of the case as soon as guilt was established.

But now I can take you to some northern schools in this same country of ours very much larger and of very much greater reputation where if you seek out any thoughtful conscientious student and ask him the same question as to the sentiment on the same subject among his companions he will invariably tell you it is about as bad as it well could be. It is a fact that at some of these schools there is hardly a general examination ever held that a number of students are not punished in one way or another for cribbing.

And now how is the difference in the sentiment on this subject to be accounted for at these schools? Would you say that the southern youth is naturally more honorably inclined than his northern neighbor? I know from personal experience with the youth of both sections that this is not true. I can tell you of a school in the south similar to the one referred to on the banks of the Mississippi River where the student sentiment on this subject if fully as bad as at any northern school.

I tell you the difference is accounted for by the unanimous continuous assertive force of the teachers in the interest of common honesty in the one case, and by the lack of concerted action and moral force on the part of the faculty in the other.

To me this is a painful subject but I should like to ask this question before I leave it. If we permit our students to form the habit of cribbing and cheating their way through school, what guarantee have we that they will not persevere in the habit after they leave our care and go on cheating and swindling their way through the world? Are their degrees of culpability in the acts of cribbing, cheating, swindling, and stealing? I have never been able to see such a distinction. And yet I don't wish to fight any duels for saying that I believe it is true that a man who cribs his way through school will, as a rule, steal his way through his business life if opportunity offers.

And now I make my first and most serious charge against the engineer graduate of today; owing to the fact that the development of his moral nature is somewhat neglected in present day training, he is apt to be less entirely honest than were the graduates of former days.

I will follow the first charge immediately with the second, and will say that owing to the fact that we crowd our modern engineering courses so full the present day engineer graduate is liable to be less thorough than the old time graduate was. Twenty-five years ago, fifteen or sixteen hours of recitation per week was considered enough. Extraordinary students were sometimes permitted to take eighteen. Now from twenty to twenty-one are required and frequently extraordinarily bright students, or those who have conditions to make up, are permitted to take from twenty-five to thirty.

In this charge as to thoroughness, I am supported by some very strong testimony. In the paper of President Humphrey's of the Stevens Institute, read before the Society for the Promotion of Engineering Education in 1904, on "The Crowding of the Curriculum," he said in regard to the instruction given in grammar and high school:

"Thoroughness and power to do has been sacrificed to a wrong conception of breadth. The introduction of fads has resulted in superficiality."

"There is a limit to the powers of absorption of the young mind, and I believe that in our elementary schools we have reached and passed the limit."

In regard to collegiate instruction, he said:

"Has not the time come for us to acknowledge that many of our curricula are already overcrowded, and as a result our present-day graduates are not more efficiently prepared for practical work in the industrial world than were the men graduated ten or twenty years ago? Thoroughness has in many cases been sacrified in the efforts to keep up in this hopeless race with progress in the science and arts."

Thoroughness, why let me tell you young men what thoroughness means, and please understand I am not the hero of any of my own tales. In a certain small school in the South in the late seventies, a small class of young men in their Freshman year was studying together for their semester examination in Euclid. They took turns in sending one another to the board and calling at haphazard for the demonstration of first one theorem and then another. There wasn't a failure. One young fellow full of enthusiasm said: "Boys, I know this book as well as my a, b, c's. I can start at the beginning and quote each theorem and problem in the order that they occur and give the demonstration." And upon trial, the boast was sustained, at least as far as the test extended.

Later when the same class was further advanced they were studying a more advanced subject, a subject which as taught in that school "flunked" more men than any other subject save one. One young man on the approach of the regular examinations who had a remarkably high record in his class, was twitted good naturedly by the Professor before the class at an informal meet to the effect that now at last he would meet his Waterloo and that his record would be lowered. The young fellow put upon his mettle, said: "Professor, I have studied this subject until I know it so far as it is taught in our text as well as you do, and if you will confine your examination to the text or to anything that may reasonably be inferred from the text, I defy you to put up an examination on which I can't make a perfect mark." And the perfect mark was easily scored.

Now let me ask you if you young men ever master your tasks in that way. If you do, I will assert that you don't spend five hours a day in the recitation room, six hours a day in sleep, and the remaining thirteen in the gratification of your appetites, and in worshipping the muscles of football athletes. I grant too, if you like, and very readily, there was some wasted energy in learning subjects in the way I have described, but it is better so than never to learn anything well enough to be sure of your ground.

In this connection let me tell you of an experience with modern men. A few years ago a couple of Junior students were secured from the school that claims to be the foremost engineering school in the United States to work one summer on one of the western railroads. These young fellows were specially recommended by their teacher to do the work at which they were put. They worked for three days in a vain attempt to connect two tangents out on an open prairie by a simple three degree curve. Instead of getting the work done they brought in a demonstration purporting to show that the tangents could not be so connected. The same two men ran a line of levels four miles long several times and never once came within three feet of the true result, nor did any two trials give results within three feet of each other. I should like to give you a lot of individual experiences I have had with new college men where their lack of thoroughness in the very things they were supposed to know best has dearly cost the railway companies employing them and me, and caused the young men to be set back instead of forward in their profession, but time forbids.

My third and last charge is that the present day graduate, having skimmed so hastily over so many subjects without thoroughly mastering any or all of them, and not having his sense of duty keenly developed, is in some degree wanting in real efficiency, in contentment, fortitude, loyalty, and true manliness.

Perhaps as President Woodrow Wilson intimates, it is characteristic of American national life to be discontented with one's lot and to be continually striving for something higher and better. But the degree of unrest among the engineer graduates in the positions into which they fall seems to exceed even the national unrest.

It used to be supposed that if a man received a promotion in railway work once in every three or four years, he was doing well, but like the labor union men, if the wages of the average graduate is not increased in railway work three or four times a year he feels sure that the road he is working for doesn't appreciate his eminent services. Some time ago a young man fresh from college applied for and secured a position down on the Panama Canal. He went away full of enthusiasm and ten months afterward when he came back on his vacation, I saw him. The enthusiasm was all gone. He did not know whether he would go back to the Canal at all or not. "Why, Smith," said I, "what is the trouble?" "O," said he, "there is no chance for promotion on the Canal. If you haven't got a pull you can't get ahead at all." "But I understood you had been promoted," said I. "O, yes, I got a couple of raises, but what does that amount to? A man might work always at that rate and never get anywhere." Two promotions in ten months in the government service and still dissatisfied. This man had been trained to hard work in his home but after he had graduated and been at work ten months, he probably expected the Chief Engineer to resign in his favor. The Chief Engineer did do some resigning, as you may recall, but Smith did not get the job.

I made it a practice while at Madison to ask my boys to write back to me after they had been out of school a while to let me know how they fared. I got together one day twenty-five such letters that I had received in the previous two or three years and went through them with a special purpose in view. Out of the twenty-five there were just three that expressed any satisfaction whatever with the work they were doing. Now let me tell you that every single one of those fellows had better positions than could possibly have been hoped for at so early a date in their career if they had graduated twenty-five years ago.

I sometimes think that our high schools, which are so largely taught by women, and where the number of female students is generally about three to one, are more potent in robbing our young men of real manliness than any other cause. A graduate of an average high school is really a graduate of a female seminary. A recent critic says that the average high school male graduate has learned from his association at school about enough to become a milliner or a dressmaker and that is about all. Look up some of the recent writings and speeches of the leading phsychologist in America, Dr. Stanley Hall, and you will be surprised to see what such an authority as he thinks is the effect on our young men of our women taught high sehools. Dr. Hall is quoted as saying that when a mother has brought her son to the age of 14, she ought to untie her apron strings from around him, hand him over to his father and say, "Here is our son, I have had the care of him now for fourteen years and have made the best boy out of him that I could. Now it's up to you to take him and make him a man."

This world is full of noble women, and no man has a keener appreciation of womankind, nor a greater respect for a true woman than I, but I never saw one yet that could impart any manliness to a youth. A fellow must acquire manliness by brushing up hard against men.

Now when we get these women taught high school men in college what should we do to rub out the femininity that they have absorbed? If the femininity is well grounded it sticks pretty close. Did you ever notice how diffidently a fellow acts and feels among men who has been so unfortunate as to be raised in a house full of nothing but women and girls? Such are the boys that stand on the side lines and bleachers and scream while the real men of the school are winning the football and base ball games. The poor creatures, they don't know how to yell.

The college needs to teach such students how to be men as well as how to think. And no small part of its duty is to teach them how to fight and how to stand up for one's own. And when I say they need to be taught to fight and to stand up for their own, I, of course, don't mean that they should do this in any brutal or unmanly way. But it is too often the case that young men are discredited because they do not know how to assert themselves in a firm and dignified way that commands attention. It is true that "Faint heart never won fair lady," nor any of the other prizes of this life. The possessor of the "faint heart" may ultimately win a title to the "mansions in the skies," but he wont win any mansions here below until the hoggishness of mankind is removed, and there seems as yet to be a good deal of this commodity left. Young men don't need easy lecture courses in our colleges where they can sit on the benches and fold their little hands in ecstacy and say "how beautiful." They must have mental and physical work to do in anything else than homeopathic doses. They onght not to have in my opinion too much lee way in choosing their own work, else they tend to choose it with teachers who deal too freely in flowers and pyrotechnics, or they choose a subject because it is well known as "a snap." I like authority and I like discipline, and the good old hickory switch for bad boys and something very like unto it for obstreperous young men. There are few real men developed in this world who have not been well exercised by both—by discipline and authority.

I have long ago gotten the idea out of my head as a teacher that the way to become popular with students was to make things easy for them in other words, to let them have their own way. The way to win a young man's lasting affection and gratitude is to lead him, or drive him if need be, to develop a power or capacity that he did not know was in him, or, in other words, to bring him to achieve.

I could give you many an instance where young men have failed to accomplish the results expected of them for lack of the qualities named in my third charge above, and yet young graduate engineers who fail as I have indicated often wonder why, in railroad work, brakemen, telegraph operators, section foremen, and station agents, men oftentimes who have not enough education to solve a problem in the rule of three, are promoted ahead of them. The reason is clear to the railroad manager. He knows that while the college man was attending the woman taught high school, and going to college where he sat up late at night and ruined his health by eating indigestible suppers, and where he listened to easy lectures that appealed to him intellectually only in a dim and distant way, the brakeman and the telegraph operator had been learning by getting down close to sweating humanity the lesson of how to get there. And now when the railroad needed men to get things done, it wanted men who had brushed up hard against other men until they knew how to act like men.

I was talking one day, a year or two ago, to a level headed, thoughtful, public spirited and charitable business man who has been connected with the administration of the financial affairs of one of the large schools of the country for a great many years, and I mentioned some of the ideas that I have just related and asked him to what he ascribed these objectionable tendencies in so many of our young men.

He said that he had noticed the same short-comings in the young men he came in contact with and that he believed that there was something almost radically wrong with any system of education that did not imbue the graduates of the schools with a higher sense of duty and a greater love of work for its own sake. In effect what he said was "I believe that the whole trouble is accounted for by the spirit of the teachers in our schools. The students are taught that the chief end of their education is, not to learn to enjoy life and to be useful citizens, but that they must expect to get right up to the top at once in whatever calling they enter; nothing else is worth while. These teachers in industrial and engineering schools study one subject until their minds become warped and they come to think that nothing else besides their own little subject counts. Further, they study the one subject until they become proficient in it, and coming in contact for the most part only with students of immature minds, they unconsciously assume an air of superiority to the rest of mankind. The student unconsciously apes his teacher and after he has passed his examinations comes to believe he too has mastered the subjects in his course and become a superior being; he adopts the condescending tone of his teacher and falls heir to his teacher's sense of superiority."

"When the student goes into business his employers and associates don't take kindly to the attitude the young man assumes. What they generally want is work and help instead of arrogance and advice. The busy world sits down on the graduate good and hard and the young man becomes despondent and moves away in search of some other position where those eminent abilities of his will be more appreciated."

And now, young gentlemen, I want to say that in these days there are too many engineering graduates for all of you to hope to stand at the tip top of your profession. It is an old saying that there is room at the top, but as the industrial world is at present organized, the top men must have a good many strong men upholding the platform on which they stand. Take for example, the organization of your great railroad here, the Chicago & Northwestern. It has use for hundreds of young men as track supervisors, bridge supervisors, draughtsmen, assistant engineers, signal engineers, clerks, train electricians, roundhouse foremen, road masters, yard masters, train masters, division superintendents, etc. In the next eight years, I doubt not it would be possible for every one of you young men to get into the service of that great corporation in some such capacity as I have named where you would have a chance to do some useful work and to earn a decent and honest living. But I wish to remind you of the fact that that road has only one president, one general manager, and one chief engineer. And while I do not wish to discourage you, I doubt very much if it will ever have an urgent need for any one of you in any one of these positions. Even it does, it will be safe to say that it will be so far in the future that you can't safely count on it now. It will not be until the sap has been pretty well dried out of your youthful bodies, and your minds and bodies have been strengthened by having successfully withstood many a trial and many a hardship.

But I want to say that the great need of the Chicago & Northwestern railroad and of the industrial world, which it typifies, is one of men who will do their work well in ordinary fields. It is a need of a man in each position who can be depended upon, who does not feel the need of the applause of his fellowmen to make him do his best. It is a need of men who are not seeking the spectacular and the heroic, but who are willing to do the same thing over and over again ever day of their lives, doing it too with the same thoroughness and conscientiousness that our mothers used when we were boys in regularly washing the dishes three times a day.

But men seldom work that way these days. No sooner does a man become familiar enough with his tasks to be able to do them thoroughly, than he is off again to find something different if not better. Sameness tires him. The modern young man must have his work program changed at least as often as the bill of the vaudeville show that he attends.

Now in these days we never teach our young men that there is for each man such a thing as finding his own level; and that when that level is found he will make the world better and himself far happier and more useful by adapting his life to it and quietly staying in it.

I have known several men in my life that had found their level and who consistently refused to be led out of it. And I wish I had time to relate to you the happiness that has come to some of them who declined "promotion" for the sake of duty or in order to live a quiet, orderly and useful life. There are many such men who fill up the measure of their existence fully as well as Mr. Roosevelt or Mr. Taft does his.

There are thousands of places in our great industrial country where you young men as engineer graduates can easily secure useful work that will make you and the world better for doing it. And this work does not need always to be done at the top of the ladder. I sincerely believe that the greatest kindness I could possibly do to this fine body of young men would be to make each one of you feel that in an engineer's life there is something worth while besides what's at the top, that there are many things in this life better than money, and that for the present the chief concern of each one of you should be to make himself a whole man.

SQUARE MACHINE KEYS. *

O. V. Thiele, '08.

This article is based on results obtained in connection with a thesis investigation on the subject of keys. The number of experiments was therefore rather limited, and the article will attempt rather to indicate some features worth investigating farther than to draw any final conclusions.

A fairly thorough search for formulas and tables of sizes of keys brought out the striking variation of opinion that exists. Some of the leading ones are shown graphically in Plate I. Thus Curve I, the data for which are to be found in "Stevens Indicator," for April, 1892, shows the dimensions adopted by the Wm. Sellers Co., and used by them over forty years, for both shafting and machine tools. No attempt is made to reduce the dimensions to a rational basis. In fitting the keys, the usual practice is followed of fitting them on the sides, but not necessarily on top and bottom, axial slipping of the hub being prevented by having a tight fit between hub and shaft.

Some of the other authorities, notably Frank P. Kleinhans, in an article published in the *American Machinist* for Oct. 9, 1902, attempt to establish a rational formula. But even formulas derived in this way give widely varying dimensions. This is not at all surprising. Keys work under such widely varying conditions that no formula can cover them all, unless a constant is introduced to take care of this variation.

And this points to a difficulty in an experimental investigation. It is quite impossible to reproduce experimentally the conditions under which a key works. The key fastening the flywheel of a gasoline engine to the shaft, for instance,

* The results were obtained by the author and R. O. Comer, '08.

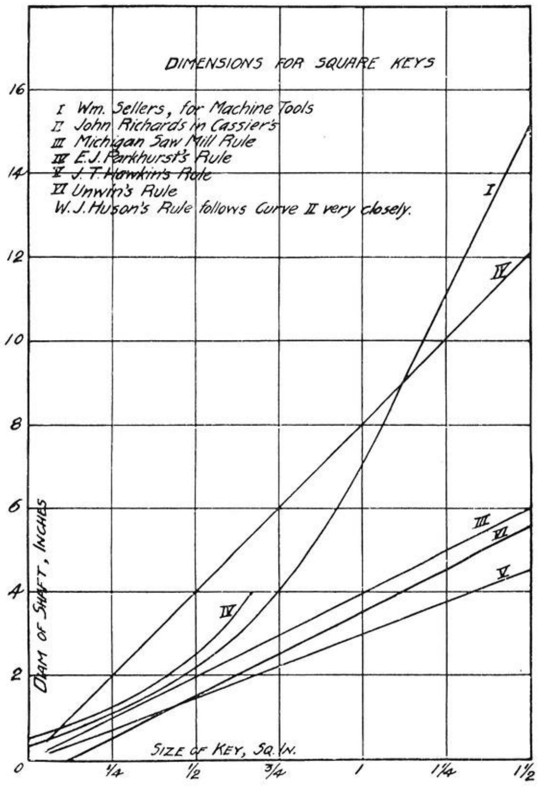


Plate I.

receives shocks due to the acceleration of the shaft being transmitted to the flywheel which it is practically impossible to determine. And even if they could readily be measured or computed, such stresses could not be reproduced experimentally where they could be measured and observed. It will be seen in the description below that the tests on the keys experimented on were made under conditions quite different from those under which keys usually operate. Yet some interesting and instructive facts are brought out in the experiments as considered.

Very little experimental work seems to have been done on the subject. Lanza, quoted by Kent, published the results of a few experiments. But the individual tests differ so widely in materials and size of parts used, that no conclusions can be drawn. It was thought best in the experiments described below to confine investigation to one shape of key —the square—and merely vary the size of the key. This was done because the number of tests was necessarily limited. In all of the tests the size of the shaft used was the same, $1\frac{11}{16}$ inch cold rolled.

The shafting used throughout the tests was cut from one length. The material showed in tension an elastic limit of 23,150 pounds and an ultimate strength of 25,600 pounds in a specimen 0.621 inches in diameter; or 76,400 pounds per square inch for elastic limit, and 84,500 pounds per square inch for ultimate strength. It will be seen that this was rather hard material. The specimen was cut from the central portion of the shaft. Its elongation was $\frac{7}{32}$ of an inch in 2 inches, or about 11 per cent. The fracture was fine and silky.

In compression a cylindrical specimen 1.886 inches long with a diameter of 0.755 inches, of the cast iron that was used for the hubs, failed at a load of 52,350 pounds, or at 117,000 pounds per square inch. This cast iron is unusually fine grained and hard, as it has been remelted a number of times.

The material used for keys was commercial cold rolled square stock. In a compression specimen 1.191″ by 0.439″ by 0.442″ it gave an elastic limit of 15,500 pounds or 80,000 pounds per square inch. In a commercial tension test a $\frac{7}{16}$-inch square specimen gave an elastic limit of 9,850 pounds, which is 51,500 pounds per square inch; and an ultimate strength of 18,225 pounds or 95,400 pounds per square inch. In shear, a $\frac{5}{16}$-inch specimen gave an elastic limit of 12,000 pounds, or 61,500 pounds per square inch. A second specimen, $\frac{3}{8}$-inch square, gave an elastic limit of shear of 18,100 pounds, which is 64,500 pounds per square inch.

So much for the materials used.

The method pursued in making the tests was as follows: Hubs were cast, and turned to the dimensions shown in Fig. 1. It was thought at the outset that in cases where the key began to tip or turn, bursting strains would be set up in the hub sufficient to destroy it. The limitations of the torsion machine used prohibited the use of a larger hub. Perhaps the jaws of the machine holding the hub reenforced it and so prevented bursting, or the bursting stresses set up may not have been very large; at any rate, none of the hubs did so break. Whether or not deformation of the hub occurred sufficient to affect materially the holding power of the key by causing friction between hub and shaft it is hard to say. The question, however, affects in no way the conclusion drawn, as will be seen later on.

Key-ways were then milled into the shaft, a length of about three feet of the shaft being used for each test. The key-ways in the hubs were cut on a planer. The hub was then placed on the shaft, and the key fitted and driven. The hub was then inserted in one clutch of the torsion machine, and the opposite end of the shaft in the other clutch, and power applied.

The torsion machine used is of the Riehlé Brothers' make and has a capacity of 125,000 inch-pounds.

It was thought of interest to determine what weakening effect on the shaft the cutting of the key-way has, and to what extent the insertion of the key reinforces the shaft. To this end a key-way one-fourth of an inch wide, one-eighth of an inch deep, and five and one-sixteenth inches long was cut near the middle of a three-foot length of shafting. This piece was then inserted in the torsion machine and gripped at both ends. By means of a deflectometer a set of readings was taken showing the deflections in a measured length of the solid shaft with various loads. A similar set was then taken of that part of the shaft where the key-way was located. The shaft was then taken out, and the hub and key put in place, the shaft reinserted, and the second set—over the portion with key-way—repeated, with hub and key in place. Here follow the readings so obtained:

SOLID SHAFT.

Inch-pounds applied (corrected.)	*Angle of Deflection (corrected.)*	*Deflection per inch of length.*
2,120	4.5	0.01125
4,300	10.0	0.0250
6,000	14.5	0.0363
8,000	19.0	0.0475
10,000	24.0	0.0600
12,000	29.0	0.0725
14,000	34.0	0.0850
16,100	39.0	0.0987
18,000	44.0	0.1100
20,080	48.5	0.1212
22,000	53.0	0.1325
24,000	58.0	0.1450
26,000	62.0	0.1550
28,000	66.5	0.1662

SHAFT WITH KEY-WAY CUT.

1,930	2.5	0.0625
3,800	5.0	0.1250
5,880	7.5	0.1875
7,800	10.0	0.2500
9,800	13.2	0.3300
17,750	24.0	0.6000
25,800	35.5	0.8880

HUB AND KEY IN POSITION.

1,550	1.5	0.0074
3,550	4.5	0.0222
5,550	7.0	0.0346
7,550	9.5	0.0469
9,550	12.9	0.0593
11,550	14.5	0.0716
13,550	17.0	0.0840
15,550	20.0	0.0988
17,550	22.5	0.1110
19,550	24.5	0.1210
21,550	26.5	0.1308
23,550	29.5	0.1457
25,550	31.5	0.1556
27,550	34.5	0.1720

The "inch-pounds applied" and "angle of deflection" are corrected for zero readings.

The shearing modulus of elasticity computed from the readings under "solid shaft," is 12,350,000 pounds per square inch.

Plate II shows the curves plotted from the above data. It shows that the cutting of the key-way results in a weakening to about 87.7 per cent of the original stiffness. 68 per cent of this loss is again made up by the key. So the net loss is 4 per cent. This is not very serious.

The size of the key-way selected was somewhat below what would be used for average work. Further tests with other

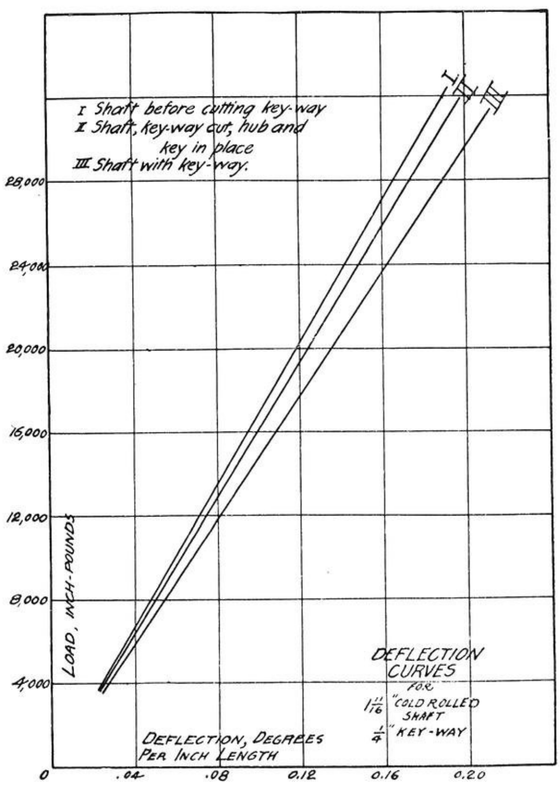


Plate II.

sizes would have been instructive; but lack of time forbade this.

In selecting size of keys to experiment with, six were decided upon, the smallest being one-eight of an inch, and the largest seven-sixteenths of an inch, all square. In all cases the length was four inches. This question of length will be spoken of again.

The first key tested was one-eighth of an inch. The key did not tip, but sheared off squarely, what seemed to be the

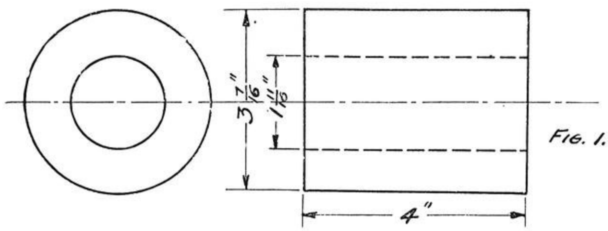


FIG. 1.

FIG. 2

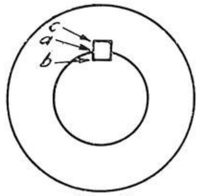


FIG. 3

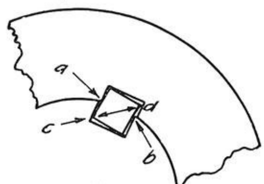


FIG. 4

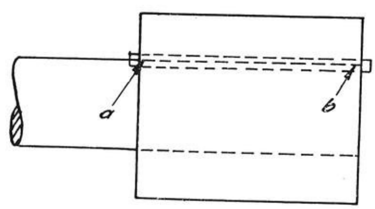


FIG. 5

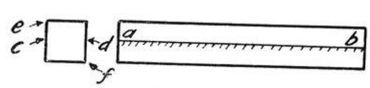


FIG. 6

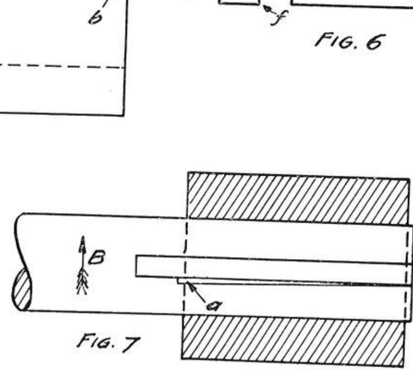


FIG. 7

elastic limit being reached at 39,500 inch-pounds. The key-way in the shaft was uninjured, while that in the hub was rounded off at b, Fig. 2.

This and the three-sixteenths inch key were the only ones which failed by shearing. But even in these two cases it was not certain whether there was not some crushing before shear took place.

The remaining experiments showed some results that are rather surprising, and tend to show that a theoretical method of calculation based upon considerations of shear and crushing only is fallacious. The tabulated results are first given. It was found that keys of one-fourth of an inch or larger were strong enough to twist the shaft beyond its elastic limit, though the elastic limit of the key was reached long before the shaft was injured. In all cases the elastic limit reached first was the elastic limit of crushing for the keys. In practice it would depend upon the kind of materials used, whether the key or key-way were injured first. The shafting used in these tests was harder than cold rolled shafting usually is.

ELASTIC LIMIT OF KEYS.

Size of key	$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$
	inch-pounds.	*inch-pounds.*	*inch-pounds.*	*inch-pounds.*
	44,500	48,190	50,700	48,000
	45,000	50,800	46,580	49,950
	50,070	50,800	51,320	50,360
	48,000	......	49,200	49,370
Average	46,890	49,930	49,450	49,420

At first thought one would say that, since both shearing and crushing strength are proportional directly to the size of the area subjected to the shearing or crushing stress, the strength of a key and its key-way increase directly with their size. But from the results above tabulated it is clear that this is not the case. The elastic limit is reached with considerable uniformity at a loading of about 49,000 inch-pounds, quite irrespective of the size of the key.

A factor that should be spoken of in this connection is that of initial stress set up due to the wedging action of driving the key. The keys were fitted in the usual manner; that is, after the hub had been driven on so the key-way in it registered with that of the shaft, the key was inserted well greased and driven with moderate taps of a hammer. It was then removed with a drift and filed with a fine file at the "high spots." This process was repeated as often as necessary until the key could be driven all the way without using too hard a blow. It was found that a hammer blow beyond a certain intensity resulted regularly in cutting between the key and and the key-way in the shaft. This fact leads to the conclusion that the initial stresses are neither very great nor very different in the different cases.

A study of the keys and the key-ways after failure discloses several important facts. Referring to figure 6, which represents the appearance of the key after failure, the arrows at *c* and *d* indicate the direction in which the forces are applied during the test. These forces appear not to be applied uniformly over the entire area from *c* to *e* and from *d* to *f*, but to be concentrated along a line at *c* and another at *d*. The shaded portion of the other view in figure 6 indicates the place showing the result of crushing action.

This, then, is one fact shown: That the force is not distributed evenly from *c* to *e* and *d* to *f*, figure 6, but is most intense at *c* and *d*.

It was next seen in the key (see figure 5) that the crushing was more pronounced in every case at the end *a* than at the end *b*. In some cases the experiment was carried beyond the elastic limit, until shearing of the key began to occur. In such cases this shearing began at *a*, figure 5.

The key-way in the shear was stressed beyond the elastic limit also in such cases, the injury being confined to about an inch from the end of the key-way, as indicated in figure 7.

The explanation is very simple: The shaft not being absolutely rigid that part of the key and key-way nearer to end *a* (figure 5) is stressed beyond the elastic limit before the fibres some distance from this end have reached this limit.

This, it is seen at once, limits the useful length of the key. The rigidity of the shaft, or, in other words, its diameter, should therefore be a factor in any formula for determining the length of the key. If greater strength of key becomes necessary it must be reached by the use of two or more keys.

The area between *c* and *e*, and between *d* and *f*, Fig. 6, or, in other words, the depth of the key, seems to be comparatively unimportant. The area over which crushing takes place is a rather indeterminate quantity. The experiments made, however, led us to believe that a square key gives an unnecessarily large crushing area. That this additional area above *c* and below *d* (Fig. 6), is not useful is shown by the fact that the larger keys fail at the same loading as the smaller.

The leading conclusions toward which the data point are:

1) Failure of keys, proportioned to any of the current rules, occurs by crushing.

2) The crushing stress is not distributed uniformily. It is most intense near the end from which torsion is applied. It is less intense as we go radially inward or outward from the middle of the bearing surface of the key.

3) A key will not bear as much crushing stress as is indicated by a formula which assumes uniform distribution of this crushing stress over the affected area.

4) Shearing stress is not uniformly distributed. It is most intense at the end of the key toward the side from which torsion is applied. The intensity varies with some function of the distance from this end.

5) A key will not bear as much shearing stress as is indicated by a formula which assumes uniform distribution of this stress over the stressed area.

A perusal of this articlc to this point will have convinced the reader that the question of keys and their proper size is not so simple as at first glance it seems, and that the subject lends itself to experimental investigation. A very much larger number of tests would have to be made before any final conclusions can be reached; but we believe that this article indicates a method of investigation which if pursued further would yield valuable data.

GAS ENGINE DEVELOPMENT IN WISCONSIN.

F. W. Ives.

It is not the intention of this article to go into the minor details of the subject, but to try and give in a general way a brief history of several firms who are engaged in the gas and gasoline engine industry in this state. The scope of the article is intended to cover simply engines used as prime movers, and no account has been taken of engines designed for marine or automobile purposes.

The Corporation of Fairbanks, Morse Mfg. Co., located at Beloit, Wis., was formed from the consolidation of the Eclipse Wind Engine Co., and the Williams Engine & Clutch Works. The articles manufactured by the two concerns included the well known Eclipse windmills, wood and steel towers, water tanks, Eclipse friction clutch pulleys and other power transmitting machinery; a line of steam pumps, steam hoisting engines and steam engines.

In the year 1893 the manufacture of the present Fairbanks-Morse gas and gasoline engines was taken up as an additional line. At this time the types of gas engines were confined to what is now their Standard Horizontal or "Type N" engines, ranging in power from 4 up to 50 H. P. inclusive, and built to run on either gasoline, natural or city gas. Perhaps the most important single feature of these engines which has led to their remarkable success was the simple patented device used for feeding the liquid fuel. This has continued to be one of the most important features of the engine and has never been excelled for its simplicity, efficiency and reliability. In the year 1898 the well-known Fairbanks-Morse Small Verticalengine, now made in sizes from 2 up to 12 H. P. inclusive, was added to the line. This line immediately proved popular—so much so that in its general features it has been widely copied. In the year 1903 a line of large Vertical Multi-cylinder engines was added, having units as large as 200 H. P.

In the year 1904 the construction of Suction Gas Producers was taken up in sizes to go with the line of engines from 15 to 200 H. P. inclusive. One of these producers, together with its accompanying gas engine, constitutes a power plant of unequalled economy, and is arranged to operate on anthracite, coke, charcoal or lignite. These plants are adapted to every service for which steam plants are used, and at present their development promises to replace, to a large extent, the use of steam power. This company was one of the pioneers in this country in developing and offering this new power for use on American coals and for American conditions. The gas engine business of the Company during the year 1907 consisted in the manufacture and sale of 10,000 gas engines, aggregating 62,000 horse power.

The Baker Manufacturing Co. at Evansville placed its first engine on the market in 1904, which was a 2 H. P. vertical type, and the following year made a 6 H. P. vertical, and are now making 10 and 14 H. P. horizontal engines. They are now making designs for a 20 H. P. traction engine. The sales of this Company approach about 1,000 annually.

J. Thompson and Sons Mfg. Co., of Beloit, took up the manufacture of Lewis gas engine in 1897 and has since put out several thousand of these engines. About the year 1905 this Company began to build the Thompson Automatic Producer Gas Engines and suction producers and are now making many marked improvements in both engines and producers. One of the features of the Thompson Producer in the no-grate construction and water sealed bottom and vent valve.

In 1897, The John Lauson Mfg. Co., of New Holstein, built their fist engine, which was rated at 4 H. P. This engine was of 4½-inch bore by 9-inch stroke and had a hit-and-miss governor acting on the exhaust valve and hot tube ignitor. Later improvements did away with the hot tube ignitor and objectionable valve cage on the side of the cylinder. In 1903 the Company brought out what is now, with a few changes, their standard engine. These engines are made horizontal in $2\frac{1}{2}$-4-6-8-10-12-15-20 H. P. sizes. This engine was one of the pioneers in the hopper cooling or frost-proof type of engines. The Company is now building a two cylinder 10-inch by 12-inch vertical engine to operate at 275 R. P. M., and to use producer gas as a fuel.

Among the other firms in this state engaged in the manufacture of gas and gasoline engines, are the Fuller & Johnson Co., of Madison, who introduced the oil-cooling to some extent as a frost-proof system. The Gilson Co., of Port Washington, are producing an air-cooled type of small farm engine. The International Harvester Co. (Milwaukee Works), have a very large output of the smaller sizes of farm engines.

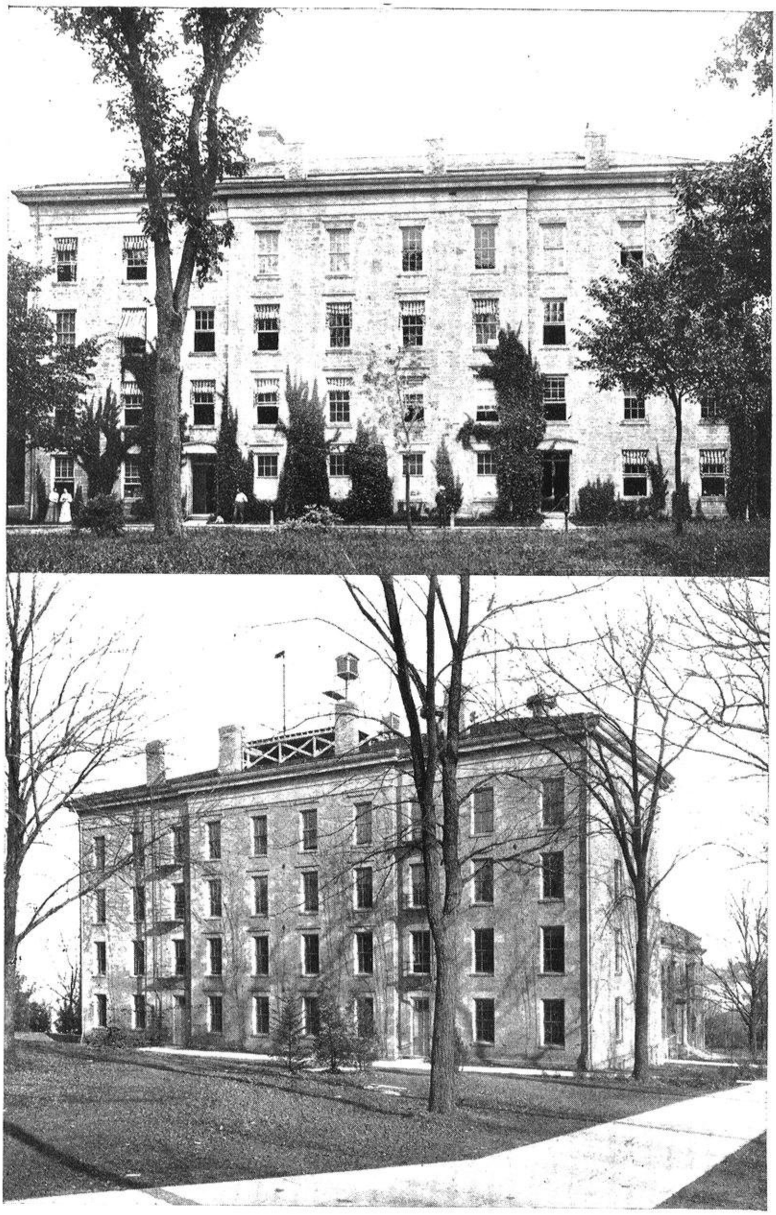
The Allis-Chalmers Co., of Milwaukee are building some very large units of 1,000 H. P. and upward. Two of these units, each of 2,000 H. P. may be seen in the power-house of the Milwaukee Northern Ry., at Port Washington, Wis. Another notable installation by this Company was made for The Indiana Steel Co., at Gary. Eight horizontal, twin tandem engines having cylinders 42-inch diameter by 54-inch stroke comprise the installation.

THE GENERAL DESIGN OF THE UNIVERSITY OF WISCONSIN.

ARTHUR PEABODY, Supervising Architect.

An architectural design has for its end the disposition of constructive parts, whether of buildings alone or with supplementary elements, in a pleasing and intelligent manner. Without this the result, however useful or enduring, fails in completeness. Architecture, beginning, perhaps, as a simple expression of foresight in the arrangement of rooms in a dwelling or of modelling of the exterior mass, ends only with the subordination of the surrounding landscape to the final purpose in view—the happiness of the man. In its best estate it extends to every detail, even so far as to control absolutely the whole vicinity of the building in question. Examples of this are not common. The great chateaux of France, the castles and monasteries of the Middle Ages and certain public institutions of the present time reflect more or less this complete flowering of architectural art.

In so far as such perfection is not attained, however, something less than complete satisfaction is felt. True, it is often possible to go even half way toward such a consummation. The effort is too great. That is to say, not enough money is afforded. Work must be done with poor materials and insufficient labor. Control of surroundings cannot be obtained. Discordant elements cannot be kept away. The work is dwarfed on one side, constricted on another, and thrown out of harmony on a third. Or there is a lack of wisdom. Money is spent on ornament when color is required, or on ostentation where it cannot be afforded. Useful purposes are sacrificed for aesthetic reasons, so that the design intrudes upon convenience. Where the first condition is a misfortune, the second partakes almost of the nature of a crime. Both, however,



South Hall and North Hall—a type of original architecture.

are preferable to the results obtained where buildings or institutions of learning have, like Topsy, "jus' growed."

Recognizing the truth of this, several great universities in America, and a number of smaller institutions of learning, have had prepared formal designs for their future development. In California two universities have done this, and in the east a much larger number, although in nearly every case the institutions have been in existence for a considerable time and have, therefore, to reckon with the past as well as the future.

This is precisely the condition of the University of Wisconsin.

About sixty years ago the first buildings were erected here; University Hall on the crest of the Hill, and the two dormitories, North Hall and South Hall, at the right and left. Too much credit cannot be given to the architect of these first buildings. Their simple, dignified style, correct proportions and honest treatment of materials gave the keynote for future work. Fewer regrets for present conditions would be felt had his example been followed more closely.

In latter years when the University began the vigorous growth common to other institutions, a deference to prevailing styles produced results that can with difficulty be brought into consonance. Not only was architectural harmony seriously trenched upon, but, by a misconception of the scope of the University as the educator of men of affairs, as well as of scholars, practical ends were defeated. The extent to which science could expand was estimated and provided with a building of large dimensions but without the possibility of extension. Engineering was set down between the lake shore and the main campus; an absolutely limited situation.

With the present administration a wise policy of reserving sufficient room for considerable increase in the size of each building was inaugurated, and recently—now a year ago—the Board of Regents, with a breadth of mind ever to be remembered, authorized the preparation of a General Design of the University, and appointed a commission composed of

Warren P. Laird, Professor of Architecture in the University of Pennsylvania, and Paul P. Cret, Architect, Professor of Design in the same institution, working in conjunction with the Supervising Architect of the University of Wisconsin, to carry their wishes into effect.

The title, General Design, is self-explanatory. The work of the commission is general, not particular. While every part of the University is studied, even into considerable detail, the main controlling idea is general in its nature. It concerns, first and last, the University. Upon this design will be indicated the manner in which development will be directed, and the prevailing architectural idea of all development.

In a broad way it will indicate the form of each building in the many groups proposed.

Main Features of the Design.

1st. Improvement of the Main Campus.

2nd. Creation of a monumental center.

3rd. Grouping of Departments by affinity as far as practicable with existing conditions.

4th. Improvements of the thoroughfare system.

The design will determine the location of groups, the relation of one science to another and to the mother science of which it is a part. It will show the avenues, the arteries, so to speak, through which the life of the University will flow; mark the points of greatest interest, bring together or in conjunction departments having allied interests. In short, it will provide an intelligent scheme of a University for educating men and women. That is the ultimate purpose of the Artichitectural design. This education is obtained by the convenient and accessible arrangement of men and books, laboratories and other places where information may be imparted and experience obtained. An education from the buildings themselves is afforded also. The daily impression upon the mind, unconsciously received, persistently applied

Engineering Building.

each day during the four years of college life is never forgotten. Here is one advantage of the older universities over those of less age. The buildings on the campus at Harvard, Princeton, Columbia, Brown—who can measure their influence on the men attending these institutions?

Certain general conclusions have been already obtained. While not absolutely settled, they may be mentioned as probable.

First, the treatment of the Upper Campus. As many have observed, the axis of the Campus is at an angle with State street on the east. Many have regretted this, and the architects, not being able to move mountains, accepted the situation, and have created a dignified and adequate entrance to the campus at the intersection of State and Park streets.

The Main Campus.

The approach on State street will receive an architectural treatment with balustrades, steps and possibly a statue. The general scheme of arrangement of the buildings along the main campus has been injured by the unfortunate location of the Law School building, Library Hall, the Engineering Building and Science Hall. With the intent to correct this, the following arrangement has been suggested:

(a) A new building on the south side of the campus placed symmetrically to Science Hall.

(b) Two new buildings located immediately west of these corresponding to North and South Halls, and of the same dimensions, thus strongly marking the direction of the main axis of the campus.

(c) These buildings will be connected by porticos to Science Hall and to the corresponding building on the south side of the campus, forming a fore court and thereby correcting the change of direction existing between the lower and upper buildings of the campus.

(d) The Engineering building will be maintained without inconvenience to the general scheme, its irregular location being masked by the treatment of the fore court.

(e) As is pointed out by the Dean of the Law Department, the present Law Building, already insufficient, is inextensible and its architectural treatment is sadly in contrast with the character of the other buildings of the campus. It would be possible to move this building bodily to a better location.

(f) Library Hall, which it is also proposed to remove, does not seem to be susceptible of remodeling for other purposes.

By this fore court the alignment of the buildings on each side of the campus is corrected, or, more properly speaking, the faults in alignment are obscured, so that the first impression of the University will be greatly bettered.

The Monumental Center.

In all important groupings of buildings there should be one point of chief interest or significance. This is the focus of the design. The part of the grounds in front of Univeraity Hall will be this point, and will become somewhat the Acropolis of the future University. With this end in view, it will be necessary to complete the court or plaza already started with the three buildings, University Hall, North and South Halls. In front of University Hall, extending eastward to North Hall and South Hall, a wide plaza or terrace is indicated, with buildings of a monumental character at the north and south. This is the principal feature in the treatment of the Upper Campus, and will constitute a proper background for the proposed statue of Lincoln.

About this campus are grouped the buildings assigned to liberal arts. In University Hall language and mathematics may probably continue for all time, together with allied subjects. On the north side of the campus the buildings will be used principally for history, economics, sociology, commerce, possibly the College of Law, and in Science Hall physics, geology and other pure sciences. The south side of the campus is now already occupied to some extent by buildings assigned for subjects particularly attractive to women, such as home economics, music and the like.

The south drive will enter this Plaza, passing along South Hall, and continue to Linden Drive. On the north, University Drive will enter symmetrically, and passing north of University Hall, continue approximately the same as at present to the Park and Pleasure Drive on the west.

Development Westward.

Applied sciences need indefinite room for expansion. For this reason University avenue appears to be the natural artery along which development is practicable.

Beginning near the Chemistry Building, chemistry being the science upon which (with physics) all others are based, the engineering laboratories will be developed. The first

A View of University Hall.

building of the group, the Central Heating Station, is already completed. In this building the work of heating and power for the entire University will be centered. Floor space is provided for the installation of approximately 4000 H. P. in the shape of steam boilers arranged symmetrically upon a central corridor. The coal, brought to the building upon railway cars by means of a side track or spur from the C. M. & St. P. Ry., passes through crushers and by mechanical means to the coal bunkers in the upper part of the building. Descending again in chutes to the fires, it will produce the steam for distribution through the under-ground tunnels to the farthest limits of the University Grounds. Something over a mile of tunnels is now plotted upon the map, and when completed will give heat and power at every required point. Here, too, space is reserved for further increase, and the smoke chimney designed for double the capacity of the present installation of boilers will suffice, it is thought for a considerable time. About this building it is intended to build laboratories for the study of engineering, and the shops, forges and other similar buildings.

North of this the zoology, botany and pre-medical groups will be placed—flanked on the east by University Hall and stretching out toward the Agricultural Buildings. There is provided a close connection in this way between the study of the pathology of men and of animals. Agriculture and biology again join closely with botany and zoology and with the mother science—chemistry. It is not yet determined what will be the full measure of development of the pre-medical course; but there is room for anything that may transpire. The College of Agriculture has already departments of Horticulture, Dairy, Agronomy and Agricultural Engineering, and will presently have others of equal importance. Space is needed at the University, not for large crops of grain, but for buildings for imparting knowledge that will serve as with the engineer in operations on a large scale.

The Scientific Library.

The other important buildings of a general character remain to complete the general scientific group. A Library of

Science should be placed at a location central to students of engineering, chemistry, biology and agriculture. A point midway between Agricultural Hall and Charter street, fronting on Linden Drive; may probab'y be fixed upon for this.

The Physics Building.

Whether the Science Hall will be the permanent home of physics is not certain. Like chemistry, physics is mother to several applied sciences. But for the splendid equipment now in Science Hall there should be no question of an ideal location, centering upon steam engineering, electricity and the many similar branches of engineering now existing and to come in future.

A space for such a contingency as a transfer to the neighborhood of the Chemistry Building will be provided.

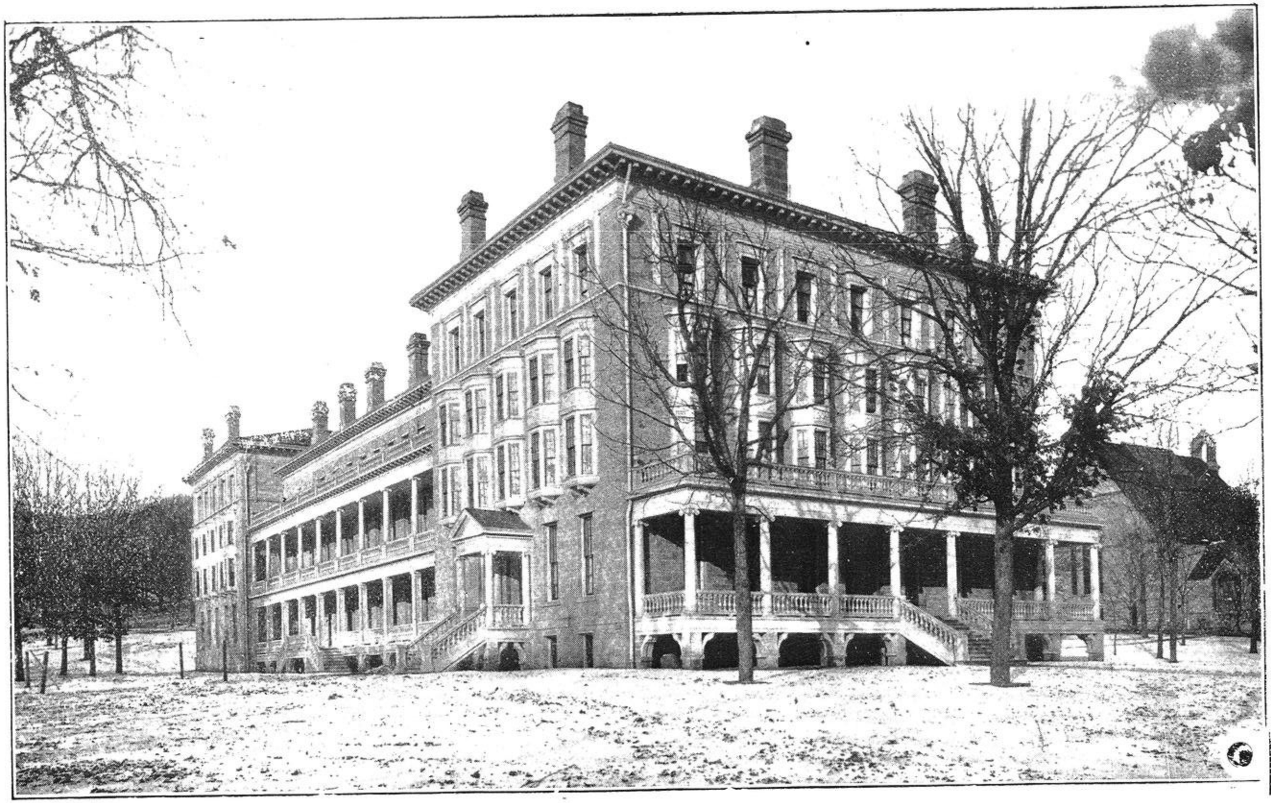
Buildings for Student Purposes.

The last legislature made an appropriation for Student Buildings. Already sketches, in conformity with the general design are nearing completion for the first buildings of the dormitory quadrangles. These buildings, including commons and union, as well as dormitories, will extend farther west: the quadrangles for men in the vicinity of the athletic field.

Social and Athletic Buildings.

At Wisconsin the same or similar provisions must be afforded to men and to women. For this reason duplication of commons, union and gymnasium is imperative.

The men at Wisconsin have already a gymnasium. The Women's Gymnasium and Building now designated as Lathrop Hall, will afford the women equal advantages, besides providing the Union. Some nine hundred women are now in attendance. The building will accommodate about double the number. In this buiding the social needs have been amply met. When the building is outgrown, as it must be confessed



Chadbourne Hall.

all university buildings come to that condition, social functions must be transferred to the Women's Union, the other great building of the Women's Quadrangle, and the present building made to serve the purpose of a gymnasium only.

I said that the men already have a gymnasium and armory. If the existing building had been located on Camp Randall the probability is that it would continue in its present use for a considerable time. The separation from the athletic field is not vital, so far as concerns gymnastics alone. For military purposes, however, it is unfortunate, considering the distance from a parade ground large enough for the batallion, especially when the historic field, dedicated for such uses by the state, only awaits adequate equipment. When the Men's Quadrangles are completed the condition will be greatly aggravated, and for this reason, as well as others, the Commission has planned an armory at Camp Randall and separately a gymnasium. The athletic field is laid out for a stadium and for various games, such as tennis, hockey, la crosse and baseball. About half of Camp Randall is taken up for the parade ground, armory, rifle range, etc.

The Lower Campus.

Buildings of monumental character are designed to front upon the Lower Campus, and the rather uninteresting piece of ground upon which the great Historical Library fronts will some day become the "Court Beautiful," around which the intellectual life epitomized by these buildings will gather by inevitable attraction.

Thoroughfare System and Landscape Features.

The present system of drives and walks is based upon past requirements. The University Campus now sustains the condition of a beautiful park with University buildings in it. It has been the effort of the Commission to preserve this so far as possible. It cannot be forgotten, however, that the University must one day dominate the campus, rather than that the campus should dominate the University. As time passes and the demands press more and more imperatively, some of the wide open spaces must inevitably be built upon. Certain elements, like the wild-wood northwest of University Hall, will be permanently conserved, not only for its beauty, but for its value as the habitat of plants and animals of scientific interest. The picturesque views of Lake Mendota will likewise be as little disturbed as possible.

Everywhere, however, thoroughfares must be developed and all parts of the campus be made accessible. The University grounds are peculiar in that the northern slope of the ridge parallel to the lake is in a general way isolated from the south expanse. Private drives will connect all parts, but the only public conveyance likely soon to serve the Campus is the electric car line on University Avenue. The Commission realizes that arguments for development along the shore of University Bay are not without force. The beauty of the landscape and the proximity of the water's edge call in enticing tones for dormitory quadrangles and athletic fields, boat houses, water entrances and other charming advantages of a lake frontage.

The General Design as a Present Asset.

Whether the time be long or short in which the General Design of the University shall be entirely carried out is of small consequence. The University has but to demonstrate its value to the state, measured in benefits to its people to obtain the necessary funds for its up-building. The State is in fact the students of yesterday, today and tomorrow. Those whose fortunes and happiness are to a large measure due to the University will think of the University as a good investment. Its increase will be the increase of the State. There is no doubt of its progress. The General Design contemplates many things not now in the power or intention of the State to give. As times goes by, however, and their use to the people becomes plain, the vacant places will be filled.

The value of the design is not in its immediate completion. It is here now. It saves money at the erection of each building. It locates surely everyone with regard to those already built and those to come. There will be no more remodelling of new buildings for new purposes because of small size and impracticable p'an, not to mention incorrect location that forbids enlargement under any circumstances for the original purpose of the building. It is one thing to enlarge a building for the same purpose. All University buildings should be planned to permit such expansion. Quite different is it to alter them for a purpose of opposite character, tearing down and wasting equipment that cannot be transferred but must be reproduced throughout.

This may be called the practical value of the General Design. With it the University can proceed with confidence. Changes may be made in certain instances, but the general development must be right. Its aesthetic value is no less.

The Architectural Style of the University.

Should it be granted that the architectural style adopted may not suit every taste, any general style is better than none. A good style, for which University Hall gives the keynote, cannot fail to produce a dignified and satisfactory impression. Again, it is the style prevailing at the University already. The three original buildings and the Historical Library, Chadbourne Hall, Agricultural Hall and the two new buildings in this department, the Engineering Building and Washburn Observatory follow the traditions of the classic. The Law Building and Music Assembly Hall, Science Hall and the Chemical Engineering Building are out of touch with the rest. Of these the Law Building, a good example of its style and built of excellent stone, is unfortunately out of harmony both in design and color. Such a thing could not happen under the new policy.

Harmony of Materials and Color.

While it is not necessary that buildings should be of Madison stone or of stone at all for that matter, a violent change of design and color upon the main campus is, to say the least, unfortunate. On the other hand, different groups of buildings may be of other materials, as for instance, the Agricultural group, mainly harmonized in color by the use of tile roofs and carried out in brick. Principal buidings, however, should be in noble materials. Stone has a character that no other materials possess. To this University Hall owes much. Science Hall with the same facing would probably have been more generally acceptable, all things considered.

However good the present buildings are individually, and most of them reflect credit upon their architects, the ensemble is not what it might have been. Individuality carried far enough to make discord upon an otherwise harmonious whole, has no justification in theory or in fact. The University was here before any of the later architects and will outlive all who have added to the original conception as a group of buildings. The plain duty of future designers will be to carry out this idea, with such variety as the style affords, and the latitude is great, and with materials that do not clash with the general tone of color now prevailing.

The Work of the Commission.

The detail of the work of the Commission cannot be gone into in review of this length, partly on account of its magnitude, and partly for the reason that the plans are yet under advisement by the Regents. The work was begun by making a thorough canvass of the ground by personal examination, and by inquiry among the University faculty and other authorities concerning conditions past, present and future. A circular letter addressed to each College Dean and Professor requested statements of the amount of floor space in use at the present date for the purposes of their department, and an estimate of the space probably required at the expiration of twenty years and fifty years, together with other data of interest.

In nearly every case approximations were made, based upon previous experience and from these the tentative sketches were prepared and submitted for criticism and revision. A second sketch having been prepared from this, the final drawings were begun in September, 1907.

The work upon the main campus was the first to be exhibited; afterward, studies of the Agricultural Department, the Athletic Field, the Biology Group, etc. In this way the entire University was covered and the various parts correlated to each other.

Then followed the formal study of the entire scheme. Meanwhile, such buildings as are being planned and erected, are made to conform to the lines already laid down as final, and thus incorporated into the General Design.

Note.—Since the publication of this article in April, a year ago, the work of the Commission has reached a practical conclusion. When the Committee of the Regents has passed upon the report, and recommended its publication, it will be seen to be thorough and exhaustive from the practical as well as the artistic point of view.

Certain new elements of the greatest importance have been incorporated into the design, as would naturally follow from such influences as the remarkable and admirable bequest of the late Senator Vilas; the recent decision of the Federal Government to locate a Forestry Laboratory at Wisconsin; and the declared intention of the citizens of Madison to adopt a plan for civic improvement. All these make for increase in dignity and usefulness. Progress should be orderly and intelligent, and to this result the purpose of the General Design is directed.

PRACTICAL RAILWAY TRACK WORK—SWITCHES.

K. L. VAN AUKEN.

A matter of first importance in switch construction is the proper distribution of material; this is also very important in other kinds of track work, but is especially true of switch construction on account of the number of different parts, nearly all of which are dependent on others. Below is given a list of material necessary for a standard Chicago & Northwestern Railway, No. 10 turnout.

Two oak ties...........	6 in. x 8 in. x 15 ft.
Nine oak ties...........	6 in. x 8 in. x 8 ft.
Fourteen oak ties	6 in. x 8 in. x 9 ft.
Eight oak ties..........	6 in. x 8 in. x 10 ft.
Seven oak ties..........	6 in. x 8 in. x 11 ft.
Seven oak ties..........	6 in. x 8 in. x 12 ft.
Four oak ties...........	6 in. x 8 in. x 13 ft.
Four oak ties...........	6 in. x 8 in. x 14 ft.

One pair 15-feet split rails (switch points).
One set of standard tie rods (3) with clips (6).
Two heel plates, 2 cast fillers, 8 heel bolts and nut locks.
One set of standard slide plates (16).
One switch-stand with connecting rod (5-inch throw).
Sixteen ajax rail braces.
One standard right or left, spring rail or rigid frog.
Two fifteen-foot guard rails.
One toe casting (used only with spring rail frog).
Four slide plates (used only with spring rail frog).
Spikes, nut locks, track bolts, angle bars, and rails.

Work may be seriously delayed by the absence of any of the objects on the above list.

On account of the many small but important details which must be attended to in laying switches, such work is generally entrusted only to an experienced track foreman. More careful supervision is necessary here than in other track work, and unless first-class men can be obtained as assistant foremen, it is advisable that the gang be kept small enough for the foreman to oversee everything himself. A good foreman with one competent assistant can handle as large a gang, laying lead-switches in yards, as he could in laying track.

The subject under consideration may be divided into four parts: (a) Laying temporary switches; (b) Laying ladder tracks or "leads" (lead is used here as synonymous with ladder track); (c) Laying turnouts and crossovers in main line; (d) Laying slip switches.

Temporary Switches.

The location of a temporary switch is frequently left to the foreman. In this case the position of the frog point is practically limited by the track or grade to which it must connect. Such a location should be chosen that no rails in the track need be moved transversely, in order that the joints may clear the switch points, and that only one cut will be necessary behind the frog. It is generally permissible to locate the switch in this way even if it necessitates a reverse curve behind the frog. The foreman should be able to explain his reasons for the location chosen, if such a curve appears, for the apparent defect would be discovered immediately by a superior.

It is a very difficult matter to procure men who will not take too much pains with temporary work. This is true of nearly all vocations; generally an artisan or workman who takes pride in his calling, dislikes to leave an inferior piece of work behind him, even though it be done well enough to fulfill the requirements. No argument is necessary to show that a piece of work which is to last only one or two months should not have as much time spent on it as one which is to remain for several years. Frequently no switch ties are provided for a temporary switch, in which case it is necessary to use eight-foot ties, these to be interlaced in such a way that the rails may be spiked safely. It is necessary many times to obtain plates, etc., by borrowing from other switches. If slow speeds only will be used on the track, the number of such parts absolutely required may be reduced one-half, or even more, with safety.

Laying Ladder Tracks in New Yards.

In laying a ladder track an organization should be effected such that few changes in the disposition of men are necessary in order to keep the gang compact, and to leave each part of the work completed. The gang might be organized as follows.

Tie distributors.
Lining and spacing gang.
Steel gang.
Bolters.
Spikers.
Rail cutters.
Guard rail gang.
Bolt, spike and plate peddlers.
Rail drillers.

It is impossible to keep men well organized, unless the gang remains for some time at the same kind of work, and even then it is more difficult to maintain a permanently organized switch crew than a track laying gang. Frequently the organization will be broken up in order to finish up back work, or on acconnt of lack of material.

On a large construction job, gangs are moved now aud again to places where the work is more urgent, and it is seldom that a ladder track will be begun and finished by the same crew, without frequent interruptions. An effort should be made, therefore, to complete the work started, on the same day; this would mean that a strict adherence to the organization shown in the above list would be impossible during the entire day.

The tie distributors are under the supervision of the assistant foreman. These men lay down a set of switch ties approximately to line and space. The ties must have been previously measured, and the length of each one marked in feet and inches; the shortest tie is laid immediately behind the head blocks, and the others follow in the exact order of their lengths. The head blocks are the first two ties under the switch points, and the switch stand is set on and spiked to them. The ties are then correctly lined and placed in their proper positions by the spacers. This operation is described in Double Tracking. *

As soon as the ties have been properly placed, the steel gang sets up the rails, switch points, and frogs, each switch being completed without reference to those preceding or following. Generally a car load of rails of assorted lengths is provided so that the off or straight rail on the ladder track may be laid continuously, requiring no connections to be made by the rail cutters. The work of bolters, spikers, and peddlers is the same as described in Double Tracking. †

The rail cutters measure up all spaces left on the track, and then cut and place in position the connecting rails; they also cut the pieces required in each switch lead. In cutting a rail, the latter should be chisel marked—it is important that the chisels be sharp and well tempered—to a depth of about $\frac{1}{8}$ inch on both sides of the base and web, but not on the ball. The cuts should all lie in a plane perpendicular to the axis of the rail. Light square blows on the

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*Page 115, Wis. Eng., Feb., 1909. †Page 116, Wis. Eng., Feb., 1909.

chisel are necessary or there is danger of breaking or chipping the edge. The rail should then be turned on its side, the ends placed on blocks, the chisel held on the web of the rail close to the base and hit a sharp blow with a hammer. A number of men standing on the rail will bend it so that it will break easier. As soon as a crack can be seen in

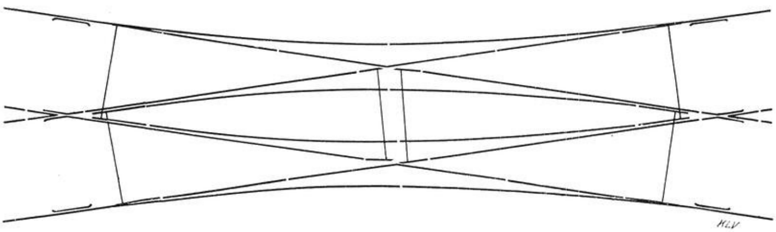

Diagram of double slip switch with movable points at center.

the cut, the rail should be turned on the other side, and the process repeated. After this operation the rail should be turned "work-ways" or ball up, and it will generally break when subjected to the combined weight of the men; if the latter fails, the chisel should be held on the ball directly above the cut, and struck with a hammer. Rails cut in this way often show a smoothness of face rivaling that of a sawed rail. An older method of breaking a rail was to chisel mark the ball in addition to the cut made in the first method. A short rail or "dutchman" was placed under the cut, one end of the rail was lifted high off the ground by a number of men, and allowed to drop. This last method has the following disadvantages compared with the first: (a) It exposes men to the liability of being caught under the falling rail and injured; (b) It requires more cutting and therefore more time; (c) It requires more men; (d) It does not produce as clean a break. The ease with which a rail break depends not so much on the depth as on the straightness and sharpness of the groove. If the rail is hot, the process of cracking may be facilitated by chilling the rail with cold water at the section where the cut is located. The use of the "hack-saw" is becoming common for rail cutting in careful work. Recent improvements have greatly shortened the time for cutting a rail, and increased the durability of this tool. Its use is hardly warranted in ordinary track work.

The switch stand gang connects up the switch points and stand, and also adjusts the throw, *i. e.* the maximum distance the switch points move. To set the switch stand correctly, the points are thrown so that one lies snugly against the stock rail, the handle and target are properly placed, and the stand is then spiked down solidly, parallel to the track. The points are thrown in the opposite direction, the maximum distance allowed by the switch stand, and the other stock rail is spiked against the switch point. Slide plates are inserted on each head block tie during the above process. After these have been solidly spiked on one side, there is danger when spiking the opposite end that the tie will move laterally. The tie would then fall off of the opposite rail. This must be prevented, and is accomplished by nipping up both ends of the tie. It is preferable to have the gage of track at the points loose rather than tight. If the gage is tight, and point works loose, a sharp flange may more easily force its way between the point and rail, causing a derailment. Recently switch rods have been manufactured which may be easily adjusted to a very fine point. If this is the case, a different method for setting a switch stand may be used advantageously, viz.: the stock rails are spiked to gage, after which the switch stand is spiked with one switch point resting against the stock rail; the No. 1 rod is then adjusted so that the opposite point fits when the switch is thrown over.

The guard rails used across the frog vary from ten to twenty feet, the usual length being fifteen feet. Some railroads do not furnish guard rails, in which case the foreman must manufacture them. A straight rail of the necessary length is bent outward at each end, and the base of the rail is chisled off on one side. This method is expensive, and causes a great variety in the lengths used. There is a danger here that the guard rail may be set so far from the main rail that it is practically useless, because the base of the guard rail has not been cut off sufficiently. The exact location of the center of the guard rail is given differently by different railways. It is customary to locate the middle point directly across from the point of frog, but some railroads specify that two-thirds shall be ahead of such point. The reason for the last location is as follows: A guard rail is necessary to protect a frog point only when a train is passing the frog as a facing point. Thus no guard rail is needed behind the frog point.

Joint bolt holes are bored by the rail drillers in all rails which, on account of having been cut, are not provided with them. In order to obtain a fair amount of work from the rail drill and not to overwork the men at this tiresome job, it is advisable to detail three men for this work, instead of the two which are absolutely necessary. The men may then work in relays, two turning the drill, while the third manipulates the oil and water cans.

The curved leads of the switches are usually lined by eye from heel of switch point to toe of frog, although it is sometimes possible to obtain the correct distances between the straight track and the curved rails, at points such as joints and centers. Before lining the curved lead, the tangent rail of the ladder track should be put in correct alignment. It is customary to lay a number of switches before lining, as this gives a longer stretch of tangent, which allows of more accurate alignment. The stock rail which the straight track switch point rests against, must be bent at a distance of from 10 to 16 inches ahead of the point, in order to fit snugly against it. The correct angle is rather hard to obtain on account of the spring, which may be different in different rails.

Laying Turnouts or Crossovers.

The first operation is to remove the ballast from between, and insert suitable ties in place of the eight foot ties. If trains are liable to pass during this operation, it may be accomplished as follows: One-half of the ties are unspiked and removed from the track, jacks being used to raise the rails slightly. Into the spaces made in this way, the full set of switch ties is put, and enough of these spiked to hold the track. The rest of the short ties are then removed, and the switch ties are correctly spaced. The first joint behind the frog as located, is broken, and the track rails are thrown out to the ends of the switch ties, where they serve for the inside of the turnout curve. In place of these rails are placed a switch point, lead rails, frog, and connection piece. These are all spiked to gage, slide plates inserted under the switch point, and a guard rail set across from the frog point. During this process the track must be protected by flagmen, but they may then be called in as the insertion of the curved lead does not disturb the main line rails, unless they must be shifted longitudinally in order that no joint shall fall at the switch point. If a turnout is being constructed, the distance between the frog point locations should be checked, for if this is not right, the rail between the switches on the crossover will not be tangent. Having correct locations for frog points the crossover may be constructed as two turnouts, and then the connections cut in later.

A rapid method for putting in a No. 10 switch is as follows: Set up and spike the guard rail. Remove one rail from the track and insert the frog and a 15-foot piece. Remove the angle bars two joints ahead of the frog, and bend the rail ahead of that joint, to serve for a stock-rail. Place the heel of the switch point against the end of the two rails left in the track. This method holds the track the shortest length of time, and is adapted to lines having a great deal of traffic. Two old rails are left between the frog and the switch point. If those rails are badly worn, the frog and switch point will be battered, and in the latter case, this method should not be used.

Laying Slip Switches Under Traffic.

An examination of the diagram of a double slip switch will give some idea of the complicated details which must be worked out in its construction. The later designs show great intricacies of detail. For instance: (a) Movable points instead of frogs; (b) Anti-creepers or binding braces; (c) Slide plates or tie plates for every tie; some ties will have but one, a continuous plate, while others will have as many as four of different design. The plates used are of three general types: (1) Slide plates for switch and frog points; (2) Thick plates for giving the outer rail on the curve some elevation; (3) Continuous or gage plates, to prevent spreading of the track. Some plates are a combination of the first and third.

The spacing of ties is important, for the tie plates are designed for an exact point in the switch. On the C. & N. W. standard No. 10 slip switch, tie spacing is given to within one-eighth of an inch. Unless these figures are followed tie plates are likely not to fit, and the gage of the track will be wrong. The proper method for putting ties in their true alignment is to line their middle points to the center line of the switch, *i. e.* the line joining the point of the extreme frogs. In this way the ties may be properly lined and filled between with ballast before any of the actual switch work is done. If the straight line rail is to be spiked first, no better method could be found for obtaining the varying distances of the ends of the ties from the base of the rail. If, on the other hand, the time available is sufficient, the ties might be lined to one of the outside curved rails; the latter would not be as good a method as the one discussed first.

The switch should be connected up as far as possible in two sections, on opposite ends of the ties. The flagmen are then sent out, after which the track rails are unspiked and thrown out of the way. The switch is then thrown into place with bars, spiked and gaged at centers and joints, and guard rails set. If the use of straight line side only is immediately required, the switch may be put in on one side at a time, requiring in the end as much time, but holding the track for two short intervals instead of one long one. If this method is used, and the straight track is put in correct line before the switch work is done, the switch when finished will be in correct line. This is a decided advantage with such a heavy structure. The weight and rigidity of one of these switches is a great factor in sustaining traffic, and four spiked ties per rail length will be sufficient for moderate speeds. Caution must be used in spiking switch and frog points, as a loose one, or one spiked in the wrong place may cause a derailment. The time the main track must be held is reduced to a minimum by intelligent preparation and disposition of tools and material. On an inter-locking plant, the construction of which was observed by the writer, one side of two slip switches and a short stretch of track between them were thrown in place and a passenger train passed over at slow speed, within twenty-five minutes after the first break in the track was made. The finishing of the switches occupied a much longer time than this, but no trains were delayed by it.

In all kinds of track work it is desirable to make as few cuts as possible, and generally, in order to cut down waste to a minimum, to cut short rails in preference to long ones. The latter is not the case, however, if one rail is of such a length that cutting it once will make two pieces of required length. Thus the work of making one cut is saved and there is no waste. There are three general cases where a saving in rail cutting may be made as follows:

(a) When any part of the switch point will fall at a rail joint. The latter must be moved forward or backward to clear. The distance that the joint must be moved may be determined, and this amount cut out of a rail of the same length as those in the track. According to the direction the joint must move, a rail is removed trom the track either ahead of or behind the switch. One of the two pieces is put in this space; all the rails falling within the switch are moved up as a unit against this short rail, and then the other piece of rail will just close the track at the opposite end.

(b) When in laying tangent with square joints, a curve is encountered which must be laid with broken joints. In this case a standard length rail is cut in two pieces; the required lengths which are needed in order to emerge from the curve with square joints is determined from the rule that the difference in length between the inside and outside rails of a track is $1\frac{1}{16}$ inch per one hundred feet per degree of curve. If the length and degree of the curve are known this difference may be calculated. The rail is cut into two pieces such that the difference in their lengths is equal to the amount calculated. The shorter rail is then put on the inside and at the beginning of the curve; when the longer piece is inserted on the opposite side at the end of the curve, the joints will again become even.

(c) When a switch lead is of such a length that one rail may be cut in two, to supply the necessary pieces for both curved and straight leads. It has been found in practice that considerable variation may be permitted in the length of lead as compared with that theoretically required, without visible or practical injury to the switch. A comparison of Chicago & Northwestern standards and theoretical leads is given below.

Number.	*Theoretical lead.*	*C. & N. W. Standard.*
5	47.08	47.08
6	56.50	56.50

7	65.92	61.14
8	75.33	67.75
10	94.16	81.50
14	131.33	109.72

The changes are made with the view to economize in length, and amount of material required for a switch, and also to reduce cutting waste to a minimum. The points of a switch should be exactly square; therefore it is necessary that rails in the curved lead be from one to two inches longer than those for the straight lead. This fact should be taken account of in making cuts.

Many valuable hints may be obtained by inspection of switches similar to those under construction. Care must be exercised, however, in order not to copy those things which may be unsafe or wrong as regards prevailing practice, standards, or changed conditions. All switches under construction should be kept in correct surface and alignment, or else properly protected by "slow" flags and "slow" lights. In laying either ordinary or slip switch crossovers, the distance between frog stakes should be checked before starting work. If such distance is correct, both switches may be laid independently; if the distance is incorrect, one switch may be built and the connection behind it laid up to the other track. The correct alignment of this connection will locate the second frog point.

In laying any kind of a switch, especially if it be in main line, the material should be very carefully checked by the foreman; thus he will be sure before the track is cut that he can again connect the track and so avoid disastrous delays to traffic.

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EDITORIALS.

PURSUING the policy adopted in a number of neighboring states the engineers of this state have organized a society, which is to be known as the Engineering Society of Wisconsin. The first meeting occurred in Madison, in the auditorium of the Engineering building, during the latter part of February, at which time officers were elected and a permanent organization was effected. The objects of the society, like those of similar societies, are the encouragement of professional intercourse between engineers of the state, and the advancement of its members in scientific research in the various branches of engineering. For the attainment of these ends annual meetings will be held for the discussion of scientific papers and other matters of interest. The society will also attempt to collect and preserve books, papers, maps, plans, etc. It will also publish such parts of its proceedings as may be deemed expedient. All engineers or other persons affiliated with engineering work, in the state, are eligible for membership to the society. It is planned to have the annual meetings occur some time in January or February. This society will have a special function with relation to the Public Utilities of the state. The powers which have been delegated to the State Railroad Commission regarding the control of these utilities have created, in the management of the latter, many new and important problems. This society will afford an opportunity for engineers in all kinds of work, which relates to Public Utilities, to get together and discuss these problems in such a manner as to assist very materially in their successful solution.

The following officers of the society were elected:

President—Dean Turneaure, Madison.

Vice-President—McClellan Dodge, Appleton.

Executive Secretary—W. G. Kirchoffer, Madison.

Trustee, two year term, E. P. Worden, Milwaukee, and B. F. Lyons, Beloit.

Trustee, one year term, E. Gonzenbach, Sheboygan, and E. B. Banks, Superior.

ONE of the biggest hits of the year in the line of amusement, was made by the engineers in their "Senior Minstrels."

The parade at noon demonstrated what can be accomplished in short time, by united action. All the classes of the College of Engineering took part and paraded in the order of their rank, carrying slide rules, T squares, stadia and level rods and all the paraphernalia common to engineers and dressed in regular engineering costumes. So much enthusiasm was wrought up that the freshmen were there in large numbers with their "green caps" and coats wrong side out. John Babcock, in darkey costume, guarded the ministrel banner, and Joe Cutler, Fred Ives and F. H. Canfield, variously attired as darkeys lead the parade. The department stunts by the Civils, Electricals, Chemicals, Mechanicals and Miners contested for first honors. The Mining Engineers' stunts were certainly unique, and have made a place for them on the engineering map at Wisconsin.

The opera house on the evening of the performance was crowded to the limit. Fussers and non-fussers fussed at the Ministrel Show and all conceded that the engineers had surpassed their expectations, and in their efforts had excelled any amateur dramatic production of the year.

The first half of the program consisted of choruses by a chorus of thirty-six voices; songs, jokes and dancing by the end men, "Billy" Huels, Henry Traxler, W. C. Elmore, A. F. Coleman, Harold Drew and J. A. Cutler. Interspersed with this gaity was the more serious strain consisting of quartettes and solos by H. W. Marsh, F. C. Henke, C. D. Brandel and C. M. Halseth. Mr. R. D. Lewis, dressed in a suit of white satin, dignified the whole affair as interlocutor. The olio was a tremendous success. Mr. Lee H. Stewart, assisted by A. F. Coleman, held the audience spell-bound by their tricks with cards and magic. A song, touching many of the phases of college life was rendered by Mr. H. W. Marsh, and illustrated by scenes familiar to every Wisconsin student, prepared by Mr. Roherty. The double sextette variously attired, made the biggest hit on the program in "Something Fierce." Six charming maidens were a feature of this. Mr. F. W. Huels, amused the audience by a humorous monologue entitled, "Mind Wandering." The program was completed by an exhibition of acrobatic stunts by the University Gym Team.

Much credit is due the general manager, Mr. F. W. Huels; the manager, Mr. A. B. Ordway; the musical directors, S. M. Fisher, F C. Henke and Harold Drew; the advisory committee, and all those who assisted and took part for the big success of the undertaking The show committee plan on contributing the proceeds to the Wisconsin Union for the purpose of adding something permanently ot the organization.

INASMUCH as there has been a large demand, which we were unable to supply, for Vol. XII, No. 3, of the WISCONSIN ENGINEER we reprint in this issue the article on the General Design of the University by Mr. Peabody. The University of Wisconsin is rapidly growing and the work on the general design is comparatively new. For this reason and also that there are unforeseen factors arising, the original design will necessarily be changed considerable. It was hoped that some of these changes which have been proposed might be embodied in this article, but the board of regents have not yet adopted them.

AT the semi-annal initiation of Tau Beta Pi, held at the Woman's Building on the twenty-sixth of March, the following were initiated:

Walter Küstermann, Madison, of the class of '09; Wilmar F. Dent, Washington, D. C.; Linwood T. Richardson, Turtle Lake; Elwood A. Richardson, Turtle Lake; H. Herbert Magdsick, Madison; George W. Chamberlin, Whitewater; Robert Iakisch, Granton; George A. Glick, Marshalltown, Ia.; Edward L. Kastler, Racine; Lewis M. Hammond, Wauwatosa; Guy H. Suhs, Waupaca, and Ivan H. Spoor, Oshkosh, of the class of '10.

SINCE the last issue of the ENGINEER five lectures have been given to the senior engineers in the auditorium in the Engineering building by the following: W. D. Taylor, chief engineer of the Chicago and Alton Railroad; M. C. Rorty, general commercial superintendent of the Pittsburg Telephone Company; Prof. W. K. Hatt of Purdue University; Mr. S. A. Ranney, of the International Harvester Co., and L. Miller, of the Gisholt company. Prof. Taylor's lecture we print in this issue.

MR. RORTY lectured on the organization and discipline of a corporation. He gave the following rules:

1. Each position should have definite work and authority.
2. Responsibility and authority should be in the same hands.
3. No shift of responsibility should be made without all men concerned knowing about it.
4. No dispute about authority should be settled without due judication.
5. The official in clarge should have his decisions and opinions caried out.
6. The work should create the position rather than the reverse.
7. A sure field for exertion by the subordinates is obtained by promotion.
8. A general policy of the organization should be outlined.

Each corporation must work out its own organization as there are many things which should modify the form of organization. Among these are geographical distribution of the work, nature of work and number of persons employed. The number of subordinates should not be less than three nor more than nine if they handle different work. If the number of subordinates is less than three each handles so much of the total work that there is liable to be a case of the tail wagging the dog. A man should not be removed before his associates see that he is unfit for the work. The superior should study the problem carefully and point out the important points to the subordinate.

PROF. HATT lectured on the structure of timber. Prof. Hatt illustrated his lecture with slides showing the microscopic formation of the wood and the effect the various structures have upon the characteristics of wood. Each kind of wood has some use for which it is specially adapted on account of its strength, lightness, stiffness, toughness, softness, hardness or resilience or a combination of several of these characteristics. The qualities depend to a large extent upon the growth of the trees. Twenty-one rings per inch appear to give the strongest timber. The worst defect in timber is where the rings are not properly united. It is impossible to find a substitute for hickory where strength and toughness are desired, such as in wagon spokes and axles. Its adaptability for this use is not alone due to its strength as there are other woods, such as maple and oak, that are nearly as strong as hickory; but it is due to its ability to hold a load after its ultimate strength has been reached. Other woods give way almost immediately after the ultimate strength is reached.

In the hard wood failure in compression is due to the crushing of the cells, while in soft wood such as long leaf pine failure is due to the column action of the fibres. The characteristics of wood change as the temperature changes. For steaming the most satisfactory pressure appears to be about thirty pounds gauge. A higher temperature is liable to char the wood.

MR. RANNEY spoke on The Business Organization of a Modern Industrial Corporation. He traced the process of manufacturing farm implements from the raw material to the finished product, showing how the company effects economies at every stage of the process, by owning the sources of the raw material, by operating transportation lines, by specializing the work of different factories, and by manufacturing the accessories for its machines. Mr. Ranney, then outlined the work of the selling department of the company, giving in detail the method by which the general office keeps in touch with the work of the branches. After speaking of the benefits to the farmer of improved machinery, Mr. Ranney closed with a word of praise for the progressive spirit of the College of Agriculture of the University of Wisconsin, and for the work of President Van Hise in making this a university for the people of the state.

MR. MILLER lectured on cost accounting. He showed views of the office and the cards and sheets used by the Gisholt Company in their system, and traced an order through the shops showing the records that are kept as the work progresses. The object of the system is to find the actual cost of making each piece, and to file the information so that it can be readily obtained at any time, and also have an accurate inventory upon the books at all times. Under the system an inventory is taken on the first day of each year without delaying the work in the shops in the slightest degree.

A COMPARISON of the different ways of lighting railway trains by electricity, showing the advantages and defects of each method, has just been published in a bulletin entitled "Investigation of Methods of Railway Train Lighting," in the engineering series of the University of Wisconsin. The author, Edward Wray, received his degree of Electrical Engineer at the University in 1906.

After tracing the advance of lighting methods in railway cars from the single candle used in English coaches in 1825, through early experiments with oil lamps and adaptations of all the various methods used in lighting streets and houses, Mr. Wray describes the storage battery equipments, steam driven generators in baggage cars and axil generating equipment in individual cars.

"It is impossible to make a sweeping claim of superiority for any one type of equipment," says the author. "Each is more or less applicable to certain kinds of service. The success of any of the types of lighting equipment lies largely in the hands of the railway operating department. The simplest of all the electrical equipments is undoubtedly the straight storage equipment." Storage batteries, however, must be charged each day, the bulletin points out, requiring expensive charging stations at terminals, and making this mode of lighting impractical for long overland runs. For short runs with heavy traffic and a large number of cars, the storage battery is most economically operated.

Steam-driven generators are also comparatively simple, but require an attendant and demand that the train be a unit, not allowing any car to be introduced which has not that system of wiring. Thus they are most applicable to trunk line trains with a definite run, especially overland trains.

For a large number of cars the only suitable method of lighting by electricity is that in which the power is generated by the axil of the car, says the author. Though the machinery is complicated, and gets out of order easily, necessitating constant attention, it is one which makes each car an independent unit, so that it may be used either in block trains or on miscellaneous runs. Satisfactory and economical returns may be secured from this form of electric lighting of trains if the railroad places in charge a competent man who understands the theory of axil equipment and the practice of storage batteries.

U. W. ENGINEERS' CLUB.

The U. W. Engineers' Club has shown marked progress, both as to quality of program rendered, and new members initiated. The usual policy of the club, in regard to the rendering of the program by student members, has been continued.

At the beginning of the semester, W. Platten gave a very instructive talk on "An Acceptance Test of the Garden City Power Plant." He explained very clearly the difficult features in the organization and execution of a plant test.

During the winter numerous troubles have occurred at the new heating station. Mr. F. W. Ives explained, in detail, how those defects have been overcome.

The Chicago Electric Show has, within the last few years, received marked attendance. W. F. Lunt and B. Borssenburegge explained the exhibits in a very interesting manner, aided in a very marked degree by souvenirs of the show.

W. R. McCann, who previous to his entrance to the University was engaged in the engineering work of the Panama Canal, delivered a very able address on this important work. He supplemented his paper with numerous photographs and maps.

At the first meeting in March, Mr. W. Krabu, P. J. Nee, and A. F. Shultz presented interesting and instructive topics before the club. Mr. Krabu explained the methods involved in railroad location.

P. J. Nee gave a paper on flaming arc lamps. This paper explained in detail the principle involved in each type of lamp.

A. F. Shultz gave an instructive talk on the measurement of vessels. Diagrams and data presented clearly demonstrated the methods involved.

A joint meeting with the C. E. Society was held March 12, '09, at which E. R. Miller, explained the "Relation of the

Weather Bureau to The Engineer." Numerous lantern slides were shown. These, in connection with the very able address by Mr. Miller, clearly demonstrated the immense importance of this bureau.

Mr. E. E. Browning and H. H. Hoenig, rendered the program for the third meeting in March. Mr. Browning explained the methods involved in the manufacture of beet sugar as used by the Madison Beet Sugar Factory.

The vital importance of punch press tools in the modern electrical manufacturing company was clearly demonstrated by Mr. H. H. Hoenig.

At a joint meeting with the C. E. Society, Mr. A. H. Christie gave an illustrated lecture on a trip through Western Canada. The meeting was very well attended, and the program highly appreciated. The lantern slides which illustrated some of the wonderful mountain scenery of the West, were the very best that could be obtained.

At the business meeting, the following officers were elected:

President—H. H. Hunner, '09.

Vice-President—W. C. Andrews, '10.

Secretary and Treasurer—H. J. Newman, '10.

Censor—J. R. Shea, '09.

Assistant Censor—L. Witt, '09.

ALUMNI NOTES.

Karl Kaulfuss, '08, is now located at Hadfield, Wis., where he has a position as assistant engineer for the La Crosse Power Co.

A few days ago the smiling face of our friend Shorey, '08, was seen on the Hill. He has been at Chisholm, Minn., with the Oliver Mining Co., but has now accepted a position in the Zinc mine at Galena.

W. M. Matthews, '08, has accepted a position as assistant engineer with the Chicago and Alton Railway. He is stationed at Bloomington, Ill.

A short time ago a letter was received from Schenectady giving us the situation in and about that place concerning the Wisconsin Club. The majority of the fellows are with the General Electric Co. The following is a list of those from whom we heard: E. Bovchert, '05, J. E. Brobst, '03, F. H. Blood, '05, and C. H. Hansen, '05, are all in the engineering department of the General Electric Co.

R. T. Wagner, '05, is now in the commercial department of the General Electric.

R. C. Muir, '05, is now in the General Electric Turbine department.

H. Feige, '06, who was formerly with the Chicago Telephone Co. in their engineering department, is now in one of the General Electric power houses.

A. J. Goedjen, '07, and C. H. Smeaton, '07, are in the testing department.

E. P. Hubbard, '07, was formerly in the General Electric testing department, is now located in New York City, and is engaged in the Electric Testing Laboratories.

Work is reported to be quite slack there, but reports from the office would indicate that in a short time every one will be busy again.

W. S. Russell, '06, is in the engineering department of the American Locomotive Works, Schenectady.

R. J. Hawn, '01, has accepted the position of superintendent of the Virginia Portland Cement Co. at Fordwick, Va.

T. B. Moorhouse, '04, is still in San Antonio, Texas, with the San Antonio Gas and Electric Co.

H. F. Lardner, '93, E. E. '95, who has until recently held a responsible position with the J. G. White Co. in New York City, has resigned and accepted a responsible position in Los Angeles, California.

It is with pleasure that we give the St. Louis Wisconsin Association a little space in this issue. A very interesting letter was recently received from W. F. Hine, '07, one of its members. The Association is to be congratulated upon the success with which they maintain interest among its members. Mr. Hine says he is still "doing time" with the Laclede Gas Light Company. The following is a list of the other members:

Mr. W. A. Baehr, '94, resigned his position as chief engineer to the Laclede Gas Light Co. and will devote his time to consulting work. He has offices at 1943 Commercial National Bank Building, Chicago, Ill.

E. L. Barber, '04, the popular secretary of the St. Louis Wisconsin Association is still connected with the engineering department of the Bell Telephone Co. of St. Louis.

V. W. Bergenthal, '97, is still with the Wagner Electric Company.

C. E. Brenton, '05, is in the auditing department of the Union Electric Light and Power Co.

J. B. Emerson, '99, formerly with the U. S. Steel Co. is now with Robert W. Hunt and Company.

G. A. Fields, '08, is one of the new comers in St. Louis. He is in the meter department of the Union Electric Light and Power Co.

G. F. Gotlard, '07, who started in two years ago with the Laclede Gas Light Co. and later went to the Molony Electric Co. has just resigned his position as shop superintendent for the Molony people to accept a position with the Illinois Central R. R. He is located at Freeport, Ill.

Arthur Keller, '07, just resigned his position with the Laclede to accept a job further north. Art never did like to leave the north.

A. F. Krippner, '04, formerly with the Kinlock Telephone Co., is now in the contract department of the Union Electric Light and Power Co. Krip's old smile is always on tap and is bringing lots of business to the Union.

E. M. Kurtz, '94, is with the Light and Development Co., of St. Louis.

H. A. La Roy, '05, is at present with the Rockwell-Barnes Co.

A. J. Luick, '07, is superintendent in charge of coal gas at the Laclede Gas Light Co.'s Station "B."

T. J. Lucas, '07, is looking after the engines and boilers at Station "A" of the Laclede Gas Co.

Donald McArthur, '04, is superintendent of the Laclede Co.'s Station "A" plant.

J. A. McKim, '91, is with the West Lake Construction Co., of St. Louis.

H. M. Sanbert, '06, is with the Laclede Gas Light Co., as assistant engineer.

R. R. Ripley, '06, has left the Laclede Co. and is now with the County Gas Light Co., as chief engineer and purchasing agent. Rip found a better half last fall, and fortune has been with him ever since.

J. T. Tierney, '08, has joined forces with the other Wisconsin men at the Laclede's Station "A" plant.

J. L. Van Ornum, '88, is Professor of Civil Engineering at Washington University.

F. E. Washburn, '01, is at present in St. Louis. He has charge of the work on the bridge being built across the Mississippi by the Central Illinois Construction Co.

We were very much pleased to learn that C. A. Semrad, '08, who has been very ill with typhoid fever for the past weeks is out again, and is feeling more like living than ever before. Charlie had a hard pull.