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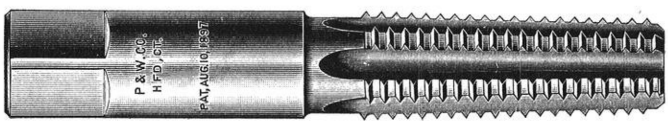

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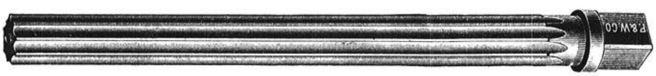

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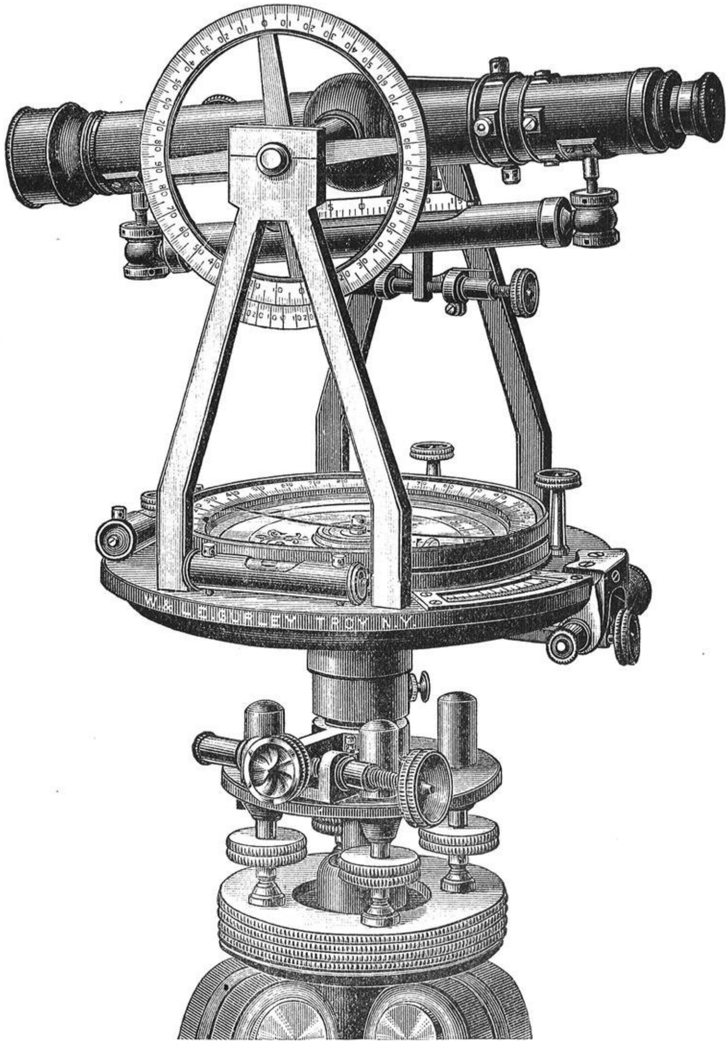
W. & L. E. GURLEY TROY, N.Y.

The Wisconsin Engineer,

Published Quarterly by the Students of the College of Engineering,
University of Wisconsin.

Vol. 6. MADISON, WIS. No. 1

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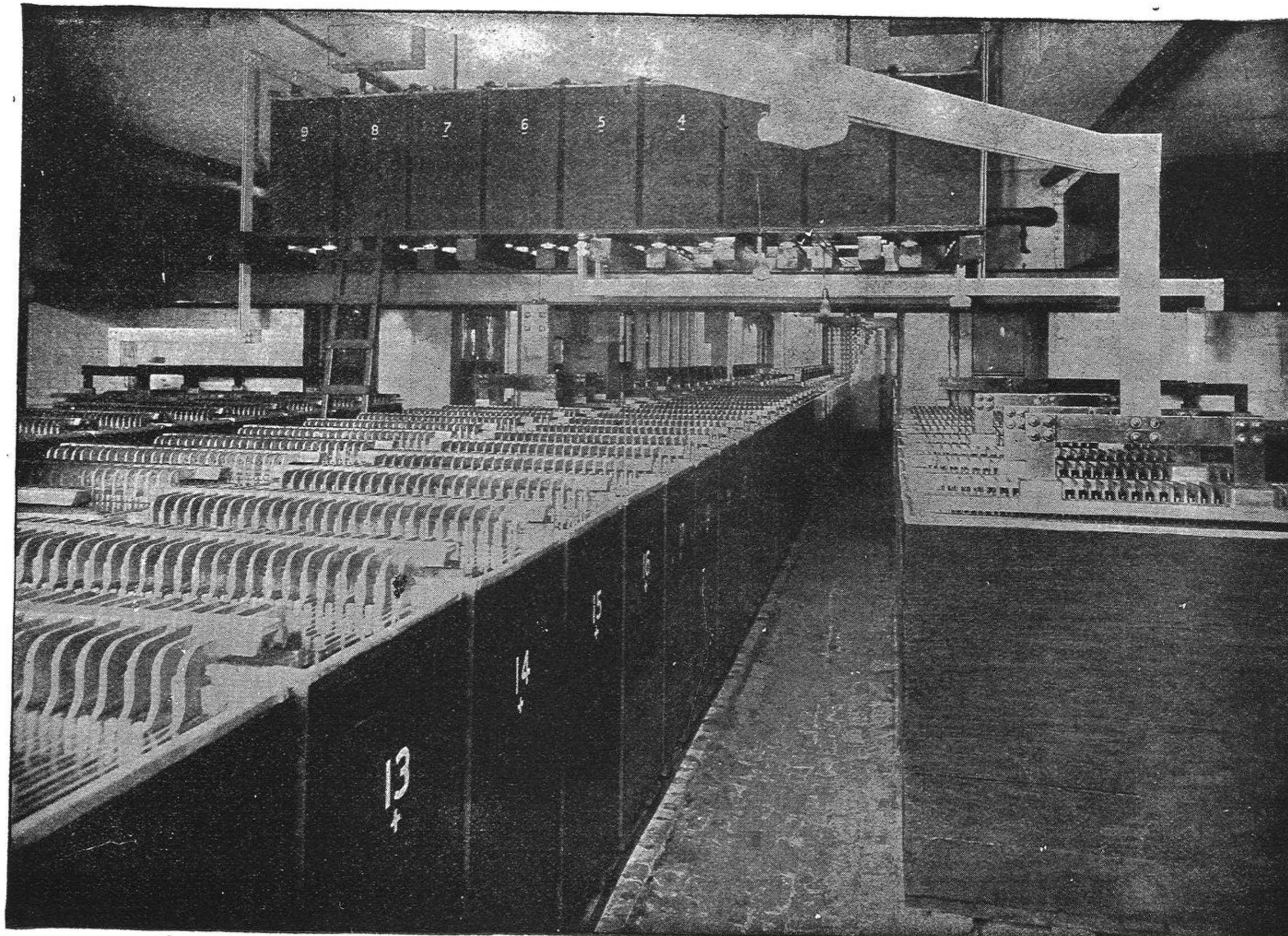

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THE WISCONSIN ENGINEER

VOL. 6. DECEMBER, 1901. NO. 1.

TWO KINDS OF EDUCATION FOR ENGINEERS.*

BY J. B. JOHNSON, DEAN OF THE COLLEGE.

Definitions.

Education may be defined as a means of gradual emancipation from the thraldom of incompetence. Since incompetence leads of necessity to failure, and since competence alone leads to certain success, in any line of human endeavor, and since the natural or uneducated man is but incompetence personified, it is of supreme importance that this thraldom, or this enslaved condition in which we are all born, should be removed in some way. While unaided individual effort has worked, and will continue to work marvels, in rare instances in our so-called self-made men, these recognized exceptions acknowledge the rule that mankind in general must be aided in acquiring this complete mastery over the latent powers of head, heart, and hand. These formal aids in this process of emancipation are found in the grades of schools and colleges with which the children of this country are now blessed beyond those of almost any other country or time. The boys or girls who fail to embrace these emancipating opportunities to the fullest extent practicable, are thereby consenting to degrees of incompetence and their corresponding and resulting failures in life, which they have had it in their power to prevent.

An Address Delivered to the Students of the College of Engineering of the University of Wisconsin, Friday, October 11, 1901.

This they will ultimately discover to their chagrin and even grief, when it is too late to regain the lost opportunities.

There are, however, two general classes of competency which I wish to discuss today, and which are generated in the schools. These are, *Competency to Serve,* and *Competency to Appreciate and Enjoy.*

By competency to serve is meant that ability to perform one's due proportion of the world's work which brings to society a common benefit, and which makes of this world a continually better home for the race, and which tends to fit the race for that immortal life in which it puts its trust.

By competency to appreciate and enjoy is meant that ability to understand, to appropriate, and to assimilate those great personal achievements of the past and present in the fields of the true, the beautiful, and the good, which brings into our lives a kind of peace, and joy, and gratitude which can be found in no other way.

It is true that all kinds of elementary education contribute alike to both of these ends, but in the so-called higher education it is too common to choose between them rather than to include them both. Since it is only service which the world is willing to pay for, it is only those competent and willing to serve a public or private utility who are compensated in a financial way. It is the education which brings a competency to serve, therefore, which is often called the utilitarian, and sometimes spoken of contemptuously as the bread-and-butter, education. On the other hand the education which gives a competency to appreciate and to enjoy is commonly spoken of as a cultural education. As to which kind of education is the higher and nobler, if they must be contrasted, it all depends on the point of view. If personal pleasure and happiness is the chief end and aim in life, then for that class of persons who have no disposition to serve, the cultural education is the more worthy of admiration and selection, (conditioned of course on the bodily comforts being so far provided for as to make all financial compensations of no object to the individual.) If, however, service to others is the most worthy purpose in life, and if in addition such service brings the greatest happiness, then that education which develops the ability to serve, in some capacity, should be regarded as the higher and more worthy. This kind of education has the further advantage that the money consideration it brings makes its possessor a self supporting member of society instead of a drone or parasite which those people must be who cannot serve. I never could see the force of the statement that "they also serve who only stand and wait." It is possible they may serve their own pleasures but if this is all, the statement should be so qualified.

The higher education which leads to a life of service has been known as a professional education, as law, medicine, the ministry, teaching, and the like. These have long been known as the learned professions. A learned profession may be defined as a vocation in which scholarly accomplishments are used in the service of society or of other individuals for a valuable consideration. Under such a definition every new vocation in which a very considerable amount of scholarship is required for its successful prosecution, and which is placed in the service of others, must be held as a learned profession. And as engineering now demands fully as great an amount of learning, or scholarship, as any other it has already taken a high rank among these professions, although as a learned profession it is scarcely half a century old. Engineering differs from all other learned professions, however, in this, that its learning has to do only with the inanimate world, the world of dead matter and force. The materials, the laws, and the forces of nature, and scarcely to any extent its life, is the peculiar field of the engineer. Not only is engineering pretty thoroughly divorced from life in general, but even with that society of which he is a part his professional life has little in common. His profession is so new it practically has no past, either of history or of literature, which merits his consideration, much less his laborious study. Neither do the ordinary social or political problems enter in any way into his sphere of operations. Natural law, dead matter, and lifeless force make up his working world, and in these he lives and moves and has his professional being. Professionally regarded, what to him is the history of his own or of other races? What have the languages and the literatures of the world of value to him? What interest has he in domestic or foreign politics, or in the various social and religious problems of the day? In short what interest is there for him in what we now commonly include in the term "the humanities?" It must be confessed that in a professional way they have little or none. Except perhaps two other modern languages by which he obtains access to the current progress in applied science, he has practically no professional interest in any of these things. His structures are made no safer or more economical; his prime-movers are no more powerful or efficient; his electrical wonders no more occult or useful; his tools no more ingenious or effective, because of a knowledge of all these humanistic affairs. As a mere server of society, therefore, an engineer is about as good a tool without all this cultural knowledge as with it. But as a citizen, as a husband and father, as a companion, and more than all, as one's own constant, perpetual, unavoidable personality, the taking into one's life of a large knowledge of the life and thought of the world, both past and present, is a very important matter indeed, and of these two kinds of education, as they effect the life-work, the professional success, and the personal happiness of the engineer, I will speak more in detail.

I. The Technical Education of the Engineer.

I am here using the term engineer as including that large class of modern industrial workers which makes the new applications of science to the needs of modern life their peculiar business and profession. Such a man may also be called an applied scientist. Evidently he must have a large acquaintance with such practical sciences as surveying, physics, chemistry, geology, metallurgy, electricity, applied mechanics, kinematics, machine design, power generation and transmission, structural designing, land and water transportation, etc., etc. And as a common solvent of all the problems arising in these various subjects he must have acquired an extended knowledge of mathematics, without which he would be like a sailor with neither compass nor rudder. To the engineer mathematics is a tool of investigation, a means to an end, and not the end itself. The same may be said of his physics, his chemistry, and of all his other scientific studies. They are all to be made tributary to the solution of problems which may arise in his professional career. His entire technical education, in fact, is presumably of the useful character, and acquired for specific useful ends. Similarly he needs a free and correct use of his mother tongue, that he may express himself clearly and forcibly both in speech and composition, and an ability to read both French and German, that he may read the current technical literature in the two other languages which are most fruitful in new and original technical matter.

It is quite true that the mental development, the growth of one's mental powers and the command over the same, which comes incidentally in the acquisition of all this technical knowledge, is of far more value than the knowledge itself, and hence great care is given in all good technical schools to the mental processes of the students, and to a thorough and logical method of presentation and of acquisition. In other words, while you are under our instruction it is much more important that you should think consecutively, rationally, and logically, than that your conclusions should be numerically correct. But as soon as you leave the school the exact reverse will hold. Your employer is not concerned with your mental development, or with your mental processes, so long as your results are correct, and hence we must pay some attention to numerical accuracy in the school, especially in the upper classes. We must remember, however, that the mind of the engineer is primarily a workshop and not a warehouse or lumber-room of mere information. Your facts are better stored in your library. Room there is not so valuable as it is in the mind, and the information, furthermore, is better preserved. Memory is as poor a reliance to the engineer as to the accountant. Both alike should consult their books when they want the exact facts. Knowledge alone is not power. The ability to use knowledge is a latent power, and the actual use of it is a power. Instead of storing your minds with useful knowledge, therefore, I will say to you, store your minds with useful tools, and with a knowledge only of how to use such tools. Then your minds will become mental workshops, well fitted for turning out products of untold value to your day and generation. Everything you acquire in your course in this college, therefore, you should look upon as mental tools with which you are equipping yourselves for your future careers. It may well be that some of your work will be useful rather for the sharpening of your wits and for the development of mental grasp, just as gymnastic exercise is of use only in developing your physical system. In this case it has served as a tool of development instead of one for subsequent use. Because all your knowledge here gained is to serve you as tools it must be acquired quantitatively rather than qualitatively. First, last, and all the time, you are required to know not how simply, but how much, how far, how fast, to what extent, at what cost, with what certainty, and with what factor of safety. In the cultural education, where one is learning only to appreciate and to enjoy, it may satisfy the average mind to know that coal burned under a boiler generates steam which entering a cylinder moves a piston which turns the engine, and stop with that. But the engineer must know how many heat units there are in a pound of the coal burned, how many of these are generated in the furnace, how many of them pass into the water, how much steam is consumed by the engine per horsepower per hour, and finally how much effective work is done by the engine per pound of coal fed to the furnace. Merely qualitative knowledge leads to the grossest errors of judgment and is of that kind of little learning which is a dangerous thing. At my summer home I have a hydraulic ram set below a dam, for furnishing a water supply. Nearby is an old abandoned water-power grist mill. A man and his wife were looking at the ram last summer and the lady was overheard to ask what it was for. The man looked about, saw the idle water-wheel of the old mill, and ventured the opinion that it must be used to run the mill! He knew a hydraulic ram when he saw it and he knew it was used to generate power, and that power would run a mill. *Ergo,* a hydraulic ram will run a mill. This is on a par with thousands of similar errors of judgment where one's knowledge is qualitative only. All engineering problems are purely quantitative from beginning to end, and so are all other problems, in fact, whether material, or moral, or financial, or commercial, or social, or political, or religious. All judgments passed on such problems, therefore, must be quantitative judgments. How poorly prepared to pass such judgments are those whose knowledge is qualitative only! Success in all fields depends very largely on the accuracy of one's judgment in foreseeing events, and in engineering it depends wholly on such accuracy. An engineer must see all around his problems, and take account of every contingency which can happen in the ordinary course of events. When all such contingencies have been foreseen and provided against, then the unexpected cannot happen, as everything has been foreseen. It is customary to say "The unexpected always happens." This of course is untrue. What is meant is "It is only the unexpected which happens," for the very good reason that what has been anticipated has been provided against.

In order that knowledge may be used as a tool in investigations and in the solution of problems, it must be so used constantly during the period of its acquisition. Hence the large amount of drawing-room, field, laboratory, and shop practice introduced into our engineering courses. We try to make theory and practice go hand in hand. In fact we teach that theory is only a generalized practice. From the necessary facts, observed in special experiments or in actual practice, and which cover a sufficiently wide range of conditions, general principles are deduced from which effects of given like causes can be foreseen or derived, for new cases arising in practice. This is like saying, in surveying, that with a true and accurate hind-sight an equally true and accurate forward course can be run. Nearly all engineering knowledge, outside the pure mathematics, is of this experimental or emperical character, and we generally know who made the experiments, under what conditions, over what range of varying conditions, how accordant his results were, and hence what weight can be given to his conclusions. When we can find in our engineering literature no sufficiently accurate data, or none exactly covering the case in hand, we must set to work to make a set of experiments which will cover the given conditions, so as to obtain numerical factors, or possibly new laws, which will serve to make our calculations prove true in the completed structure or scheme. The ability to plan and carry out such crucial tests and experiments is one of the most important objects of an engineering college training, and we give our students a large amount of such laboratory practice. In all such work it is the absolute truth we are seeking and hence any guessing at data, or falsifying of records, or "doctoring" of the computations is of the nature of a professional crime. Any copying of records fro mother observers, when students are supposed to make their own observations, is both a fraud upon themselves as well as dishonest to their instructor, and indicates a disposition of mind which has nothing in common with that of the engineer, who is always and everywhere a truth-seeker and truth-tester. The sooner such a person leaves the college of engineering the better for him and the engineering profession. Men in other professions may blunder or play false with more or less impunity. Thus the lawyer may advocate a bad cause without losing caste; a physician may blunder at will, but his mistakes are soon buried out of sight; a minister may advocate what he no longer believes himself, and feel that the cause justifies his course; but the mistakes of the engineer are quick to find him out and to proclaim aloud his incompetence. He is the one professional man who is obliged to be right, and for whom sophistry and self-deception are a fatal poison. But the engineer must be more than honest, he must be able to discern the truth. With him an honest motive is no justification. He must not only *believe* he is right; he must *know* that he is right. And it is one of the greatest elements of satisfaction in this profession, that it is commonly possible to secure in advance this almost absolute certainty of results. We deal with fixed laws and forces, and only so far as the materials used may be faulty, or of unknown character, or as contingencies could not be forseen or anticipated, does a necessary ignorance enter into the problem.

It must not be understood, however, that with all of both theory and practice we are able to give our students in their four-or five-year course, that they wil be full-fledged engineers when they leave us. They ought to be excellent material out of which, with a few years actual practice, they would become engineers of the first order. Just as a young physician must have experience with actual patients, and as a young lawyer must have actual experience in the courts, so must an engineer have experience with real problems before he can rightfully lay claim to the title of engineer. And in seeking this professional practice they must not be too choice. As a rule the higher up one begins the sooner his promotion stops, and the lower down he begins the higher will he ultimately climb. The man at the top should know in a practical way all the work over which he is called upon to preside, and this means beginning at the bottom. Too many of our graduates refuse to do this, and so they stop in a middle position, instead of coming into the management of the business, which position is reserved for a man who knows it all from the bottom up. Please understand that no position is too menial in the learning of a business. But as your college training has enabled you to learn a new thing rapidly, you should rapidly master these minor details of any business, and in a few years you should be far ahead of the ordinary apprentice who went to work from the grammar or from the high school. The great opportunity for the engineer of the future is in the direction and management of our various manufacturing industries. We are about to become the world's workshop, and as competition grows sharper and as greater economies become necessary, the technically trained man will become an absolute necessity in the leading positions in all our industrial works. These are the positions hitherto held by men who have grown up with the business, but without technical training. They are being rapidly supplanted by technical men, who, however, must serve their apprenticeship in the business, from the bottom up. With this combination of theory and practice, and with the American genius for invention, and with our superb spirit of initiative and of independence, we are already setting a pace industrially which no other nation can keep, and which will soon leave all others hopelessly behind.

II. The Cultural Education of the Engineer.

In the foregoing description of the technical education and work of the engineer, the engineer himself has been considered as a kind of human tool to be used in the interest of society. His service to society alone has been in contemplation. But as the engineer has also a personality which is capable of appreciation and enjoyment of the best this world has produced in the way of literature and art; as he is to be a citizen and a man of family; and moreover, since he has a conscious self with which he must always commune and from which he cannot escape, it is well worth his while to see to it that this self, this husband and father, this citizen and neighbor, is something more than a tool to be worked in other men's interests, and that his mind shall contain a library, a parlor, and a drawing room, as well as a workshop. And yet how many engineers' minds are all shop and out of which only shop-talk can be drawn! Such men are little more than animated tools, worked in the interest of society. They are liable to be something of a bore to their families and friends, almost a cipher in the social and religious life of the community, and a weariness to the flesh to their more liberal-minded professional brethren. Their lives are one continuous grind, which has for them doubtless a certain grim satisfaction, but which is monotonous and tedious in comparison with what they might have been. Even when valued by the low standard of money-making they are not nearly so likely to secure lucrative incomes as they would be with a greater breadth of information and worldly interest. They are likely to stop in snug professional berths which they find ready-made for them, under some sort of fixed administration, and maintain through life a subordinate relation to directing heads who with a tithe of their technical ability are yet able, with their worldly knowledge, their breadth of interests, and their fellowship with men, to dictate to these narrower technical subordinates, and to fix for them their fields of operation.

In order, therefore, that the technical man, who in material things knows what to do and how to do it, may be able to get the thing done and to direct the doing of it, he must be an engineer of men and of capital as well as of the materials and forces of nature. In other words he must cultivate human interests, human learning, human associations, and avail himself of every opportunity to further these personal and business relations. If he can make of himself a good business man, or as good a manager of men, as he usually makes of himself in the field of engineering he has chosen, there is no place too great, and no salary too high for him to aspire to. Of such men are our greatest railroad presidents and general managers, and the directors of our largest industrial establishments. While most of this kind of knowledge must also be acquired in actual practice, yet some of it can best be obtained in college. I shall continue to urge upon all young men who can afford it to either take the combined six-year college and engineering course, described in our catalogue, or the five-year course in the College of Engineering, taking as extra studies many things now taught in our School of Commerce. The one crying weakness of our engineering graduates is ignorance of the business, the social, and the political world, and of human interests in general. They have little knowledge in common with the graduates of our literary colleges, and hence often find little pleasure in such associations. They become clannish, run mostly with men of their class, take little interest in the commercial or business departments of the establishments with which they are connected, and so become more and more fixed in their inanimate worlds of matter and force. I beseech you, therefore, while yet students, to try to broaden your interests, extend your horizons now into other fields, even but for a bird's-eye view, and profit, so far as possible, by the atmosphere of universal knowledge which you can breath here through the entire period of your college course. Try to find a chum who is in another department; go to literary societies; haunt the library; attend the available lectures in literature, science, and art; attend the meetings of the Science Club; and in every way possible, with a peep here and a word there, improve to the utmost these marvelous opportunities which will never come to you again. Think not of tasks; call no assignments by such a name. Call them opportunities, and cultivate a hunger and thirst for all kinds of humanistic knowledge outside your particular world of dead matter, for you will never again have such an opportunity, and you will be always thankful that you made good use of this, your one chance in a lifetime.

For your own personal happiness, and that of your immediate associates, secure in some way, either in college or after leaving the same, an acquaintance with the world's best literature, with the leading facts of history, and with the biographies of many of the greatest men in pure and applied science, as well as of statesmen and leaders in many fields. With this knowledge of great men, great thoughts, and great deeds, will come that lively interest in men and affairs which is held by educated men generally, and which will put you on an even footing with them in your daily intercouse. This kind of knowledge, also, elevates and sweetens the intellectual life, leads to the formation of lofty ideals, helps one to a command of good English, and in a hundred ways refines, and inspires to high and noble endeavor. This is the cultural education leading to appreciation and enjoyman is assumed to possess.

Think not, however, that I depreciate the peculiar work of the Engineering College. It is by this kind of education alone that America has already become supreme in nearly all lines of material advancement. I am only anxious that the men who have made these things possible shall reap their full share of the benefits.

III. Conclusion.

In conclusion let me congratulate you on having selected courses of study which will bring you into the most intimate relations with the world's work of your generation. All life today is one endless round of scientific applications of means to ends, but such applications are still in their infancy. A decade now sees more material progress than a century did in the past. Not to be scientifically trained in these matters is equivalent today to a practical exclusion from all part and share in the industrial world. The entire direction of the world's industry and commerce is to be in your hands. You are also charged with making the innumerable new discoveries and inventions which will come in your generation and almost wholly through men of your class. The day of the inventor, ignorant of science and of nature's laws, has gone by. The mere mechanical contrivances have been pretty well exhausted. Henceforth profitable invention must include the use or embodiment of scientific principles with which the untrained artisan is unacquainted. More and more will invention be but the scientific application of means to ends, and this is what we teach in the engineering schools. Already our patent office is much puzzled to distinguish between engineering and invention. Since engineering proper consists in the solution of new problems in the material world, and invention is likewise the discovery of new ways of doing things, they cover the same field. But an invention is patentable, while an engineering solution is not. Invention is supposed in law to be an inborn faculty by which new truth is conceived by no definable way of approach. If it had not been reached by this particular individual it is assumed that it might never have been known. An engineering solution is supposed, and rightly, to have been reached by logical processes, through known laws of matter, and force, and motion, so that another engineer, given the same problem, would probably have reached the same or an equivalent result. And this is not patentable. Already a very large proportion of the patents issued could be nullified on this ground if the attorneys only knew enough to make their case. More and more, therefore, are the men of your class to be charged with the responsibility and to be credited with the honor of the world's progress, and more and more is the world's work to be placed under your direction. The world will be remade by every succeeding generation, and all by the technically educated class. These are your responsibilities and your honors. The tasks are great and great will be your rewards. That you may fitly prepare yourselves for them is the hope and trust of your teachers in this college of engineering.

I will close this address by quoting Professor Huxley's definition of a liberal education. Says Huxley: "That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic-engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to respect others as himself.

"Such an one and no other, I conceive, has had a liberal education; for he is, as completely as a man can be, in harmony with Nature. He will make the best of her, and she of him. They will get on together rarely; she as his ever beneficent mother; he as her mouthpiece, her conscious self, her minister and interpreter."

STORAGE BATTERIES ON ELECTRIC SYSTEMS.

BY HAROLD SEAMAN, '00.

The question of Storage Batteries as auxiliaries to electric systems is one which, for some years past, has claimed and is at present receiving the consideration of the large contracting engineers of the country, and a railway or Edison station is not considered complete, or well equipped, without such an auxiliary. There are in daily operation in railway, lighting and isolated plant service Chloride Accumulators with an aggregate capacity of thousands of kilowatt hours—nearly every large and dividend-paying electric power plant or lighting station using direct current transmission in the country, having a storage battery equipment, which for the best results is an absolute necessity for this class of work.

Before taking up the operation of the battery as a whole, applied to the system, it will be necessary to discuss the operation of the cells or units which make up the battery. There have been constructed, and are at the present time, innumerable types of so-called storage batteries; alkaline cells, copper zinc couples, lead-zinc, etc., but inherent defects in all of these soon become apparent when subjected to practical tests. The type which survived these tests and is now universally used commercially, is the old lead-sulphuric acid cell, which depends for its action upon the formation of lead peroxide on one plate and spongy, or porous lead on the other. Though it is probably well known to many of the readers, a general description of this type of cell may be of interest to some, especially as it leads up to the description of the particular make of cell that is now most commonly used by the Edison and railway companies in this country.

The original lead-sulphuric acid storage battery was composed of two sheets of pure lead immersed in dilute sulphuric acid. These were energized by forcing a current through by means of several primary cells, first in one direction and then in the other; this process being repeated until one of the plates become "formed," that is, peroxidized, and the other "reduced." This is called the "Plante" process of formation. The next step was that of mechanically increasing the surface of the plates exposed to the action of the acid, as upon this factor the capacity of the cell depends. This was done in several ways; by cutting grooves on the sides of the plates, by corrugating, rolling, etc., the process of formation being as above. A brief description of the chemical changes taking place in the above process will be necessary in order to fully understand the next step.

The chemical changes which occur during the charge and discharge of a battery are exactly those of this process of formation, and are extremely complicated, but explained by numerous theories; the one most commonly accepted, leaving out of consideration complications such as per sulphuric acid formation, etc., being substantially this. When the current is first forced through the electrolyte from one plate to the other, the sulphuric acid is broken up into ions, H_2 and SO_4 ($SO_3$and O), the acid radical passing to the negative plate and escaping in the form of gas; the oxygen liberated passes to the positive plate, and combining with lead, forms a layer of PbO_2; the SO_3 remaining in the solution will combine with water ($SO_3 \times HO_2 = H\ \ SO_4$), forming sulphuric acid. When the current is reversed the positive plate (PbO_2) gives off oxygen, taking a light sulphate of lead, while on the negative (pure lead) a low oxide of lead is formed, as well as a sulphate. This continues until the limit of capacity of the cell is reached, when the former negative plate will become peroxidized and the positive reduced to pure lead. This process is repeated, charging first in one direction and then in the other, until the plates are sufficiently porous, each operation penetrating deeper into the plate and thereby increasing the amount of surface exposed to the action of the acid, and therefore the capacity of the cell. It is readily seen that this is an extremely long, laborious and expensive process, and hardly a practical one, hundreds of reversals being necessary to properly form such a set of plates.

To overcome these difficulties, chemical preparations were resorted to, and the plates, after being grooved, or milled, to increase their surface area, were immersed in a bath of nitric, or other acid which attacks lead, and then formed up in the way above described, there being already (before the forming process is started) a large surface area, due to the eating action of the acid. Batteries were also made by the "Faure" process. A plate of this type consists of a lead grid into the holes of which were pressed litharge (negative) and red lead (positive) dampened and glued together by dilute sulphuric acid, and then formed up by a few low-rate charges and discharges. Both of these types were decided advancements over the previous methods of manufacture, but both had their disadvantages. The cells formed by the "Plante" process were necessarily constructed of pure lead, as the plate itself furnished the active material; pure lead being a pliable and soft metal, unable to resist the expansion and contraction caused by charging and discharging, these plates had an irresistible tendency to buckle, which, in addition to the fact that the more they are used the less able they are to resist this tendency, due to their corroding (peroxidizing deeper with each charge and discharge), rendered them valueless for commercial use. The "Faure" type of cell, though the tendency to buckle could be diminished by making the grid of an alloy of lead, had so many faults, such as the formation of a white sulphate which insulated the grid from the pellets, pellets dropping out and short circuiting the cell, etc., that it claimed the attention of the electrical world only a short time.

The cell which has superseded these various types is the result of these former failures and is made by a combination of the above mentioned methods in addition to some entirely original processes. This cell is the "Chloride Accumulator" manufactured by the Electric Storage Battery Company, Philadelphia. The "Manchester" positive plate of this cell is composed of a very stiff lead alloy grid, the holes in which are circular about three-quarters of an inch in diameter. The active material contained in these holes is made of a ribbon of pure lead about one-half an inch wide and one-sixteenth of an inch thick, corrugated on one side and then rolled up making a button, with a very great surface area, in a cylindrical form which exactly fits into the holes in the grid. These buttons are forced into the grid by hydraulic pressure, and after the expansion caused by the forming process, they fit very tightly, making good electrical contact with the grid. The forming process is an electrochemical one which enables the production of these plates on a commercial basis by reducing the time and power necessary. In this type of cell, buckling is overcome by means of the stiffening effect of the alloy grid, which is non-corrodible, and will not weaken with the life of the cell. A very large surface area is obtained by the corrugated ribbon buttons, and in addition to these advantages the cost of manufacture is so reduced that they can be used commercially.

The negatives are made by a patented process which gave the name to this cell: Some years ago both positives and negatives having been made in the same way as are the present negatives. A lead alloy grid is cast under pressure around square tablets three-quarters of an inch on a side and one-quarter of an inch thick. The tablets are composed of a compound of lead and zinc chloride. After the grid has been cast around these tablets, the plates are immersed in a dilute chloride of zinc solution, the former, being in electrical contact with sheets of zinc, the zinc in them going into solution and the chlorine combining with the zinc sheets to form zinc chloride. After a thorough cleaning, these plates are tested for chlorine and then considered finished. The tablets are extremely porous allowing a free circulation of the electrolyte through the cell, and access into the interior.

The electrolyte is a subject which demands more attention than is commonly understood to be the case, as upon its purity, density and temperature the whole operation of the battery depends; in many cases whole batteries have been ruined by neglecting this consideration. Commercial acid contains so many impurities, such as iron, arsenic, nitric acid and hydrochloric acid, that its use is out of the question, as any one of these impurities is extremely injurious to the plates. Specially prepared sulphuric acid with all impurities removed and at a density of 1.200, is commonly furnished with the battery.

Containing vessels are made of various materials; glass and hard rubber being used for the smaller sizes, and either hard wood, lead-lined tanks, or all-metal alloy tanks for the larger sizes. Separators are made of rubber in various forms, such as perforated sheets, strips, etc., for the smaller installations and glass tubes of about three-eighths of an inch in diameter are used for the larger installations.

The difference in potential across the terminals of a cell of this type varies greatly under different conditions. On open circuit, the voltage measured by a voltmeter varies between 2.08 and 2.22, depending upon the condition of the cell, whether charged or discharged. At the normal, or 8-hour rate of discharge, the voltage drops from 2.00 at the beginning of discharge to 1.75 at the end of discharge. On charge the potential difference rises from 2.10 at the beginning of charge to 2.50 at the end. Other conditions, such as temperature, acid density, ratio of positive to negative capacity, etc., affect the voltage; but a detailed description of this action would occupy more space than that allowed for this article.

It was the endeavor in the above, to describe in a general way the construction of a Chloride Accumulator cell, in order to be able, by a few typical illustrations of the operation of such a battery, to give some idea of the many conditions under which these batteries are now operating; a knowledge of the individual action of the units being essential to fully appreciate their action as a whole upon a system.

The three largest fields for the application of Chloride Accumulators to electric systems are in railway work, central stations and isolated plants.

A typical installation of Chloride Accumulators in connection with an Edison lighting plant, is that of the Detroit Edison Company, and as, by a description of one such installation, a good idea of this particular application of Chloride Accumulators as auxiliaries, can be obtained, a description of this plant follows:

A year ago this company was up against the proposition of supplying more power than the capacity of the power house would permit at certain times during the day and year, and it was thought necessary to either install new generators, engines and boilers to take care of these peaks, or, as an alternative, a storage battery. After a thorough investigation of the existing and contemplated conditions, it was decided that a battery of Chloride Accumulators would prove the more economical of the two, as during the greater part of the day the station was not running to its full capacity, and that by operating the engines in service at full (which means at the most economical point on the load curve) load the greater part of the day, a battery could be charged and ready to help out on the peak which occurred about five o'clock in the afternoon. Such a battery directly across the generator feeders (a distance of about half a mile from the power house) was installed, having a capacity of 2750 amperes for one hour, the number of plates in the cells determining the capacity, 120 volts on a side of the three-wire Edison system. This battery has since been increased to a capacity of 5920 amperes at the hour rate.

A description of the setting up of this battery will probably be of enough interest to warrant its insertion at this point.

The foundation, a very important factor when the fact is considered that it is to support 350 tons, and that there must be no failing or sinking which would throw the cells out of alignment and perhaps cause a serious short circuit, was constructed on a clay bed with a system of drainage sunk in, covered by tiles, and then a 16-inch layer of concrete graded from the coarse at the bottom to fine stones at the top. Upon this were laid heavy paving bricks imbedded in pitch; the whole when dried, providing a heavy and good insulating foundation. Each tank 70x21½ inches by 44 inches high, weighing with the acid and plates complete, about two and one-half tons, is supported upon eight porcelain petticoated insulators mounted each on a vitrified brick. Glass sheets, one on each side of the tank, are next put into place, and then the plates, the lugs resting on these glass supporting sheets. The battery plates are then "burned" to lead bus-bars, one between adjacent cells, the positive plates of one cell being burned to one side of this bus-bar and the negative plates of the next cell, to the other side.

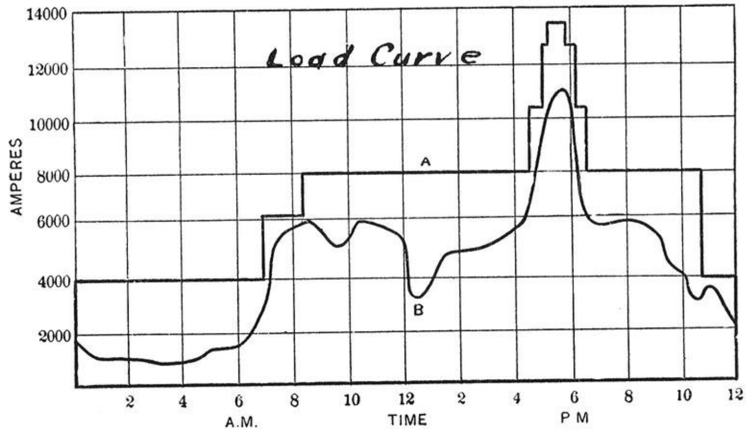


Fig. 2.

Fig. No. 1* shows part of a battery installed in this manner in the Philadelphia Edison Electric Lighting Company's Sansom street station. After connections have been made by lead-covered copper bars, the lead covering providing a protection for the copper against the acid fumes, to the switchboard, the cells are filled with acid and the battery is put in charge at a low rate, and kept charging for from thirty to thirty-six hours.

There are fifty main cells and thirty "end cells" on each side of the Edison system; the end cells being connected to end cell switches operated by motors controlled by buttons at the switchboard. The object of the end cells is to provide a means for close voltage regulation, and the controlling switch is so

* Frontispiece.

arranged that cells may be cut out or thrown in, one at a time, as circumstances demand, either for lowering or raising the voltage on the system, the number of cells of course determining the pressure on the line. In connection with this battery a shunt charging booster (motor-generator) was installed in series with the battery for the purpose of raising the voltage at the battery terminals sufficiently during charge to force the necessary current through the cells; the booster being out of circuit during discharge and while the battery is floating on the line.

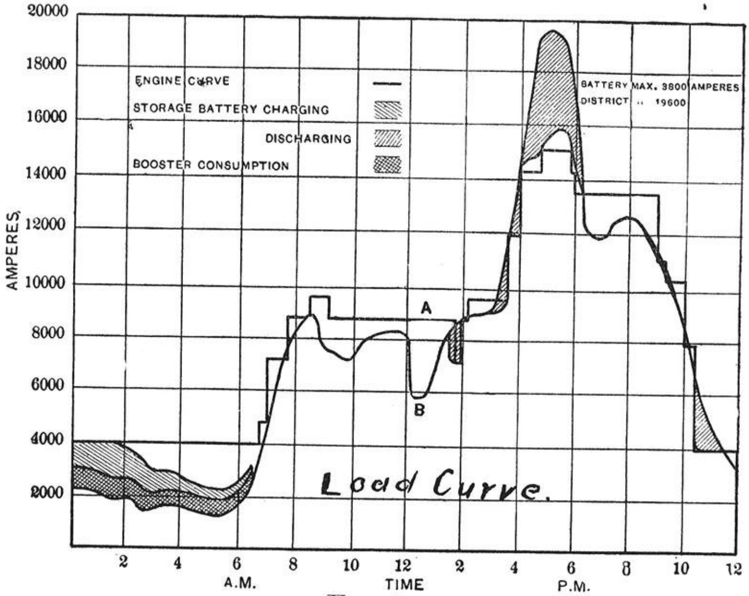
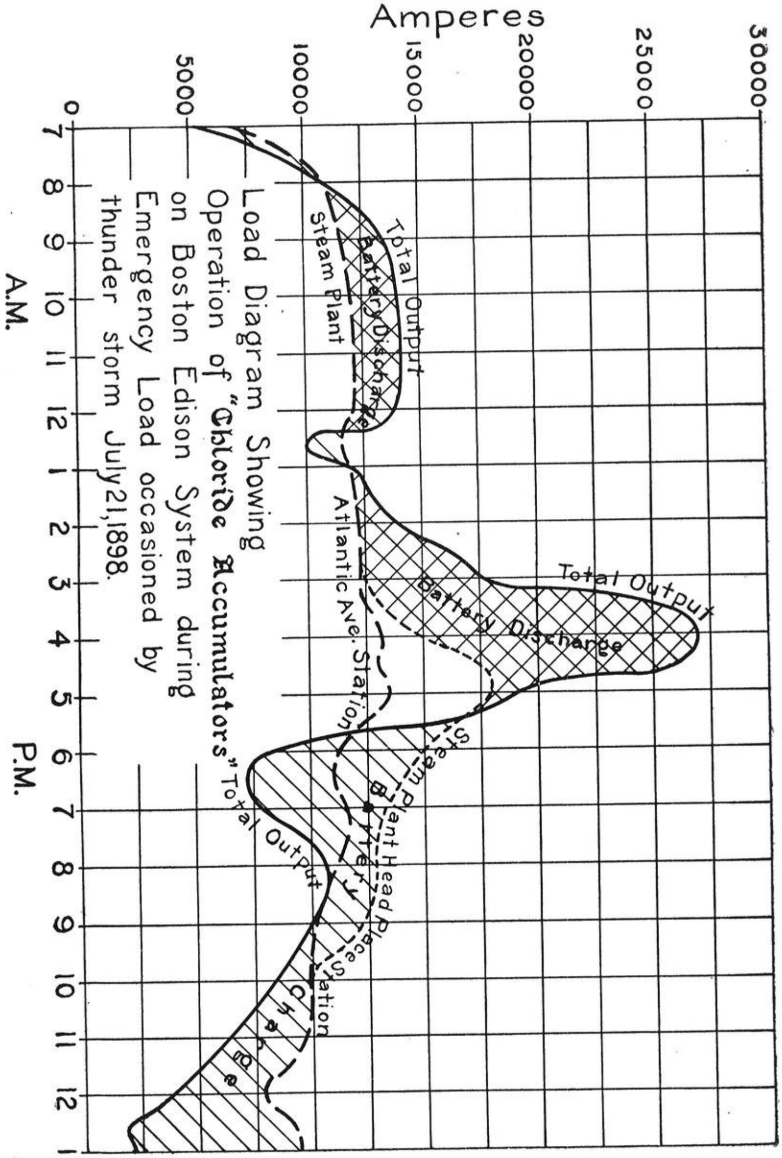


Fig. 3.

To show in a concise and accurate manner exactly what this installation has accomplished, two station load curves are illustrated. Fig. No. 2 shows the dynamo capacity in service and the load before the battery was installed. Fig. No. 3 shows the same conditions after the battery is operating on the line. It will be noted that the load factor, viz., the ratio between the generator capacity operating and the load, is much higher after the battery was installed than before, due to the fact that now the battery will take care of any sudden demand for power while before its installation enough generating capacity was necessarily operated continuously to provide for an emergency load, to insure reliable and uninterrupted service.



An interesting example of the value of a battery of Chloride Accumulators in an emergency is shown by Fig. No. 4, which is self-explanatory and is only one of a number of cases where batteries have prevented an interruption of service of Edison stations. A similar case, when on June 24th, 1901, an accident to the boiler plant at the Harrison street station of the Chicago Edison Light Company caused the entire plant to shut down, and the battery together with Station No. 5, carried the entire load; the battery supplying 23,000 amperes to the feeders for about forty minutes. Without the battery it would have been necessary to shut down half of the system for this length of time. A full description of this occurrence is given on page 254 of the Electrical World and Engineer of August 17th, 1901.

In railway work, the object and the operation of batteries is quite a different proposition than in the type of installation just discussed. Although there is some little "peak" work at certain times in the day during certain seasons, the main object of the battery floating on the line is to take the fluctuations and to relieve the generators and engines of the racking caused by the sudden and heavy variations in the load and to improve the economy of operation. The character of a railway load is such that the maximum momentary demand for current often amounts to 100 per cent. above average, dropping almost instantaneously to 50 per cent. below this line. From this fact it is apparent that necessary power must always be on hand to, without an instant's notice, take care of these heavy demands; while for the greater part of the time the demand will be far under this amount, which means that if only generators are operated, they are running very uneconomically and that their depreciation is a maximum, on account of the large variations in their load. By installing in multiple with the generators a battery which when automatically controlled by a booster in series with it, will absorb power when the load is light and return power back to the line when necessary, a constant load on the generators is assured, and they will only have to furnish power for the average load. Large savings in fuel and operating expenses, as well as better service, are the result of such an installation. Fig. No. 5 shows a curve taken from the power plant of the Peekskill

Traction Co., Peekskill, N. Y., illustrating the regulating effect of their battery, which, it will be noted absorbs practically all of the fluctuations.

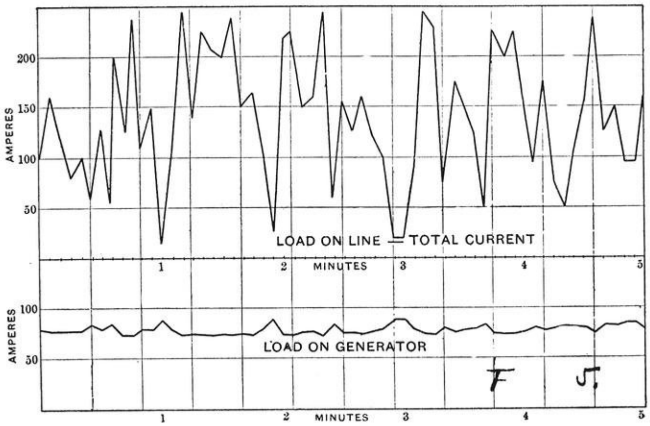


Fig. 5.

Chloride Accumulators are also often installed at a point out on the line, distant from the power house, to maintain the voltage and to obviate the necessity of carrying the maximum current over the feeders, thus not only providing capacity to take care of momentary heavy demands for current but also effecting a large saving in investment in copper feeders. Fig. No. 6 is a chart of a Bristol Recording Voltmeter across a battery at Chestnut Hill, about 11 miles from the power house in Philadelphia. This chart illustrates the effect of a line battery very nicely. It will be noted from the chart that between 1:00 a. m. and 5:00 a. m. with the battery off the system, the fluctuations in pressure were marked and the average somewhat lower than when the battery was operating.

Isolated plants in private residences, hotels, office buildings, factories, etc., where power and light are desired, or either one alone, present a wide and interesting field for Chloride Accumulators. Where both power and lights are desired, one generator with a battery can be used for both, due to the regulating effect of the battery. The voltage, if the battery is properly equipped with a constant current booster, will not vary more than 1 volt from standard pressure, while without a battery such a proceeding as feeding both power and lighting circuits from the same busses is out of the question, for the regulation would be atrocious, the flickering of the lamps being noticeable to the eye. Smaller generating units can be used and operated at the average load, or their full load, the battery taking all fluctuations

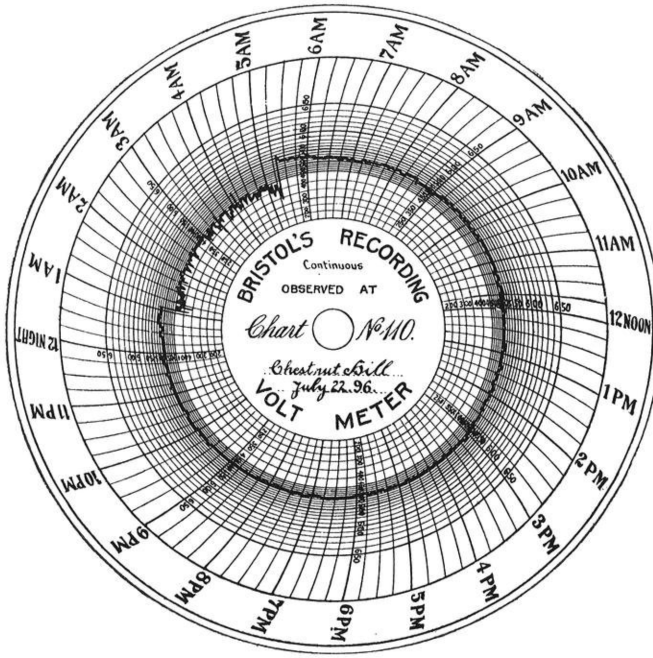
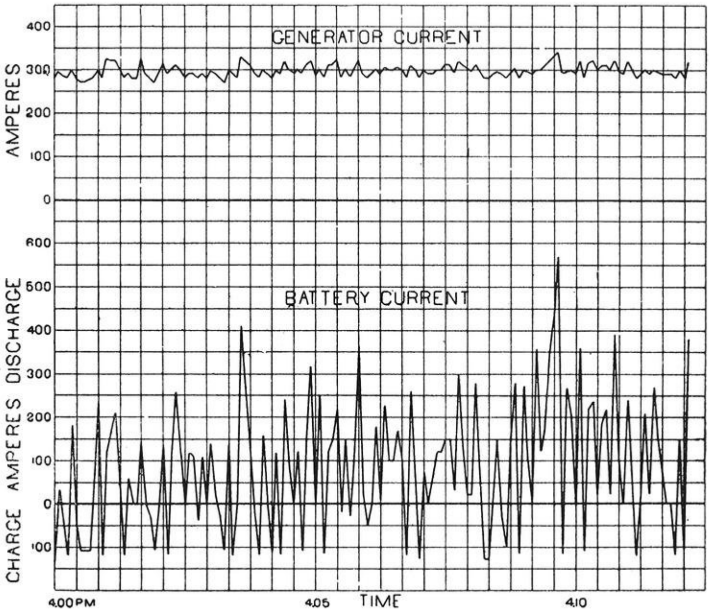


Fig. 4.

caused by starting elevators or other apparatus consuming power. Batteries in plants of this kind are often charged in the daytime and discharged at night, requiring no attendant while operating, as does an engine and generator outfit, thereby dispensing with the services of a night engineer.

Fig. No. 7 shows the regulating effect of a battery of Chloride Accumulators installed in the Dun building, New York. The generators are operated at a constant load of about 300 amperes and the battery takes all of the fluctuations caused by elevators, etc., carrying at times a momentary load of from 500 amperes discharge to 100 amperes charge. The lighting circuits are thrown in between the battery and the generators, and with the elevators directly across the battery, no fluctuations or flickering of lights occur.

These are the three largest fields for Chloride Accumulators, though there are thousands of cells now operating in almost every kind of direct current work. Electric vehicles, launches, train, yacht, and carriage lighting, fan motors, telegraph, telephone, fire alarm, sewing machines, dental, surgical, medical, laboratory work, etc., all using Chloride Accumulators of various types and sizes. In many classes of service primary cells are continually being replaced by Chloride Accumulators, the cost of maintenance of the latter being considerably smaller than for primary cells, and the service obtained very much more reliable and satisfactory.



LOAD DIAGRAM.

Fig. 7.

SUMMER SCHOOL FOR APPRENTICES AND ARTISANS.

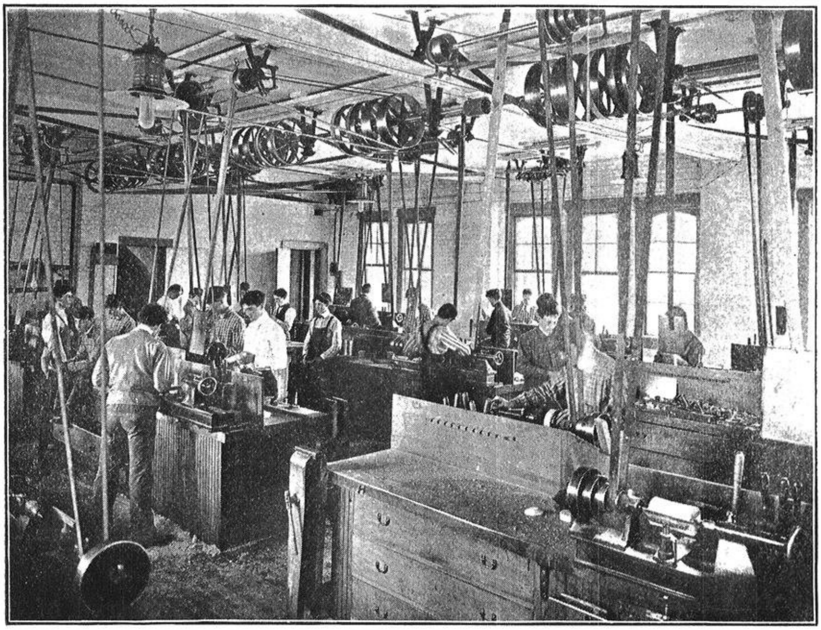
The initial session of the "Summer School for Apprentices and Artisans" opened on the first day of July and closed on the ninth of August, occupying just six weeks. It was the first enterprise of this kind ever attempted in this country and attracted considerable interest, not only in Wisconsin, but throughout the whole United States. The purpose of the school, its method of operation and its attendance are given in the following official reports. That it was a great success and well merited all the commendation which it received, may also be inferred from these reports and from the few of the many unsolicited testimonials.

October 22, 1901.

Dr. E. A. Birge, Acting President, University of Wisconsin:

Dear Sir: I beg to submit herewith the report of Professor Mack, chairman of the faculty of the Summer School for Apprentices and Artisans, on the work of the first session of the school. This school was purely an experiment in industrial education. It had seemed to me that this college could render a service to stationary engineers, superintendents of power stations, machinists and artisans of various trades, in the way of teaching mechanical drawing, the use of simple mathematical formulae, the scientific uses of steam and electric power, and of machine tools. The proposition to do work of this character, using a part of our regular teaching staff, during six weeks of the summer vacation, was approved by the Board of Regents at their meeting in January last and one thousand dollars appropriated to pay in part the expenses. A fee of fifteen dollars was charged, and laboratory and shop fees of five cents per hour for all work taken in this way. The total income proved nearly sufficient to cover the cost of instruction and of material consumed.

A prospectus was prepared early in the calendar year, outlining the work which could be offered, and several thousand of these were sent out. One correspondence school addressed for us over two thousand of these to its students in the state of Wisconsin. The trade journals also took up the matter and gave liberal notices, and often editorials, concerning this new departure in technical education. The result was a very considerable correspondence, a liberal call for the prospectus, and an early promise for the success of the undertaking. Two causes acted, however, to reduce our numbers. The school came in the



WOOD SHOP.

busiest season for all industrial workers, and the necessary traveling expenses served to keep many from coming from a distance for so short a term. The necessary expense of the course, including living expenses, was not less than fifty dollars, and for a number of those who attended the traveling expenses were as much more. This made the six weeks' instruction come pretty high.

Evidently the proper place for such a school is in a manufacturing city, and it should be in operation the year round, the terms being short, as from six to eight weeks. The fact that we are a state institution, however, seems to place upon us the obligation to do for this class of industrial workers whatever lies in our power, even though situated as we are in a small city with few industrial interests.

Prof. Mack's report contains full information concerning the operation of the school, the numbers in attendance, their vocations, etc., and I have appended thereto extracts from letters I have received from several of thge students who attended. These last show a very high appreciation of the benefits received from the course, the only criticism offered being that the term was too short.

I may say that the numbers in attendance were sufficient to keep the teaching staff fully employed. Larger sections in the steam and electrical laboratories would require additional instructors.

I wish here to express my grateful appreciation of the enthusiastic support given to this educational venture by the teaching staff who had the work in charge. In spite of the excessive heat which Madison experienced throughout July, the work was carried on from eight to ten hours every day, except on Saturday, when the forenoon only was taken. The students of the school were a unit in praising the unremitting efforts of the instructors in their behalf.

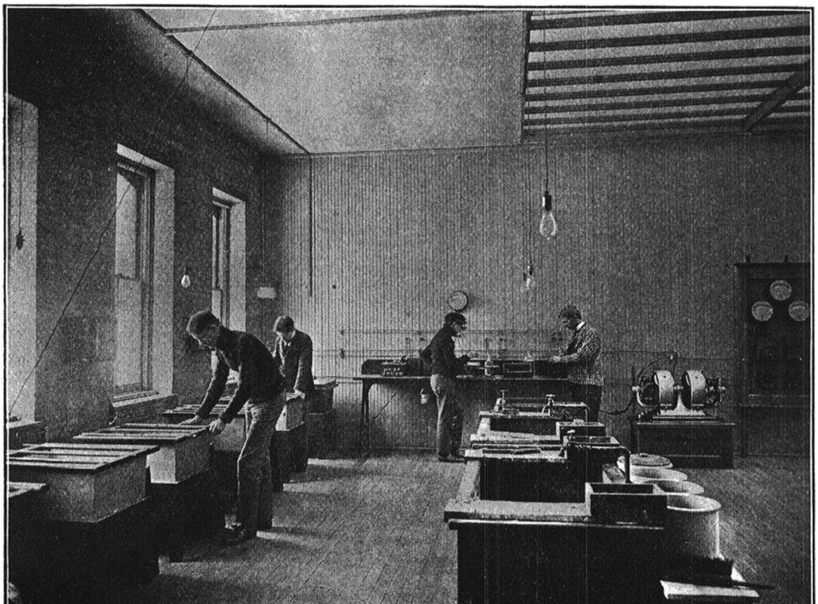
In view of the pronounced success of this our first trial of this kind of assistance to the industrial workers of the state, and of the very salutary influence it has had in engaging the interests of these classes as well as of their employers in the work of the University, I recommend that the school be continued as a "summer school for apprentices and artisans" until some other provision be made for this class of technical workmen. If this be done, I think another appropriation of $1,000 should be made to cover the expenses. I would then have the work arranged in two sequence courses so as to provide for attendance for two sessions in the same department. By continuing the school on this basis, under its present title, and without the granting of any formal certificates, there will be no danger, I think, of confusing its work with that of the regular courses in the College of Engineering.

I may say, in closing, that this school has attracted wide attention from other colleges of engineering and it now seems clear that a number of them will at once inaugurate similar summer schools and probably with the same titles.

Respectfully submitted,

J. B. Johnson,

Dean College of Engineering.



Electro-Chemical Laboratory.

Dean J. B. Johnson, College of Engineering, University of Wisconsin.

Sir: I have the honor to submit the following report of the first session of the Summer School for Apprentices and Artisans held under the direction of the College of Engineering, from July 1 to August 9, 1901.

This school being a new departure in education, required a very careful planning of its work by the faculty of the College of Engineering some months in advance, and no material change in these arrangements was found necessary in the operation of the school.

The corps of instruction, principally from the regular faculty of the College of Engineering, was as follows:

John G. D. Mack, Assistant Professor of Machine Design, Chairman of the Faculty of the Summer School for Apprentices and Artisans—Elementary Mathematics and Mechanical Power Transmission.

C. I. King, Professor of Mechanical Practice—Shop Work.

A. W. Richter, Assistant Professor of Experimental Engineering—Steam Engineering.

B. V. Swenson, Assistant Professor of Electrical Engineering—Applied Electricity.

O. B. Zimmerman, Instructor in Machine Design—Mechanical Drawing and Manual Training Methods.

J. M. Shuster, Fellow in Electrical Engineering—Assistant in Applied Electricity.

W. G. Lottes, Instructor in Forge Practice—Forge Work.

Henry Kratsch, Instructor in Machine Shop—Machine Work.

P. L. Hankinson, Wood Work.

L. D. Rowell, Assistant in Steam Engineering.

After the work had been distributed the divisions were found to be merely equal in steam engineering and applied electricity, and it was found necessary to secure the services of Mr. Rowell to assist Professor Richter; Mr. Rowell's position corresponding to that of Mr. Shuster in Applied Electricity.

The number of students registered in the School for Apprentices and Artisans was 45, of which number 28 may be considered as typical students of the classes for whom the school was projected. The remaining 17 were principally regular students of the College of Engineering, who took advantage of the facilities of the summer school in order to make up shop work.

Among the 28 typical students above referred to, the following occupations were represented:

Draftsman, Inspector of Railway Motive Power, Professor of Mathematics in Engineering School, Professor of Mechanics in Engineering School, Teacher of Manual Training, Machinist, Central Electric Station Employe, Gas Works Employe, Engine Shop Foreman, Lineman, Stationary Engineer, Machine Shop Apprentice.

Nearly all of the courses of study offered were given during that session, the only exceptions being sub-courses in Telephones, Electric Batteries, Electro-Plating and Electrotyping.

The division of students among the courses was as follows:

Dynamo laboratory	28
Steam laboratory	22
Testing of Materials laboratory	4
Shop	25
Mechanical Drawing	10
Manual Training Seminary	4
Elementary Mathematics	6

The students were advised to attend lectures in other courses than those in which they were registered, and this plan was followed by a large proportion of the students. In the class room work, time was devoted entirely to lectures as the time was too short to allow any of the periods being used for recitations.

The object of the instructor in each study was to select the portions of his subject having the greatest bearing on the conditions met with in practice, and then to present these portions in as clear a manner as possible, making use of the minimum of mathematical formulae on account of the wide variation in the preparation of the students.

In the laboratory work, divisions of small number must be arranged as no time can be used for preliminary practice with the instruments which must be constantly under the eye of the instructor.

It was found by the faculty working as they did under the above conditions regarding class room and laboratory work, that a large and satisfactory amount of work could be covered in the six-weeks period

Many of the students had had correspondence school instruction, which was well supplemented by the summer school work.

In case a student had had this correspondence instruction or preliminary training of equal grade, it is believed that he could spend his time profitably in attending two sessions of the Summer School for Apprentices and Artisans.

While unnecessary at the first session, it is recommended that at coming sessions a portion of the students be divided into an elementary and an advanced grade. This would provide for those attending a second session as well as for the widely varied preparation among those attending but a single session.

It is believed that the expectations of the School for Apprentices and Artisans were fully realized and the practical value of this form of education demonstrated.

The principal source of information from which this conclusion has been drawn has been the reports of the students of the school, many of them being men of experience in their trades and professions.

Several expressed an intention of returning next year, and all pronounced the work they had received as eminently satisfactory.

Respectfully submitted,

J. G. D. Mack,

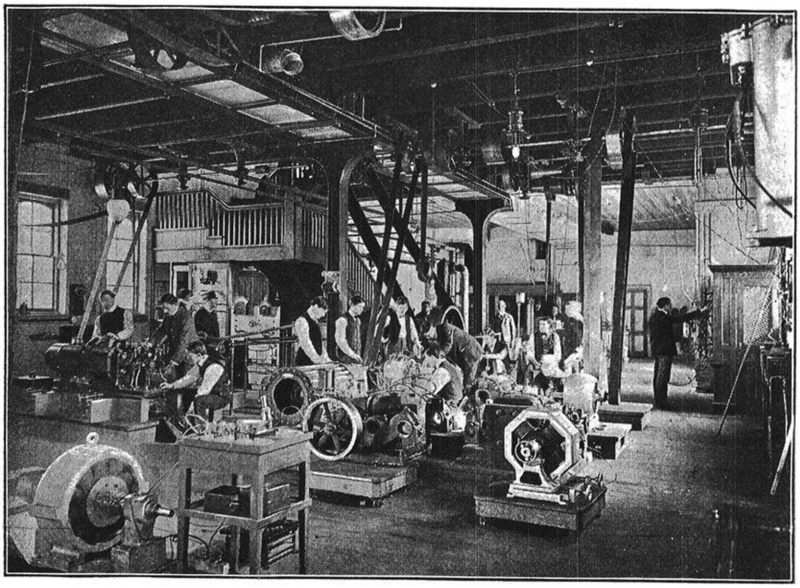
Chairman of the Faculty of the Summer School for Apprentices and Artisans.

Personal Endorsements.

The following extracts have been taken from letters received from students who attended the first session, in the summer of 1901.

From F. S., Plymouth, Wisconsin. Age 37 years. Has had ten years' schooling in Germany and one year in an American correspondence school. His business, electric line-man.

He says: "My intention is to become a central station man, and I think after finishing my course in the Scranton Correspondence School, which I can do in a short time, I will be able to look after a station well, both outside and inside, although it is my intention to come again next year for advanced work. The practical value of the instruction cannot be spoken of too highly, and every student must feel himself under obligations to the different members of the faculty for their untiring effort to do good to each individual student."



DYNAMO LABORATORY.

From D. M., Ludington, Michigan. Age 35 years. Has had three years in a high school and is taking correspondence school work. Is a machinist by trade and is now erection foreman. Has had fifteen years experience as a journeyman. He is fitting himself for a superintendent of machine works.

He says: "To say that the work has been fully up to my expectations is putting it very mildly. In my opinion the plan of the summer school is an excellent one and has been a wonderful help to me technically; with the fine laboratory equipment it has been of great practical value, and I consider it has been one of my most profitable investments. I know of no way in which the school might be improved except in the length of time it is open, which if possible should be two months. As to the teachers, allow me to say that I have never met more obliging and pains-taking intructors. They have always been ready to assist us in work *not* in the regular course."

From L. R. W., Belvidere, Illinois. Age 18 years. Has had four years' high school course, and work in a correspondence school. Has no trade but is fitting himself either to take charge of an electric power station or to go as a second-class electrician in the United States navy.

He says: "I have the highest opinion of your summer school, and can think of no improvement which would bring it nearer to perfection. It has great practical value in that it applies directly to the work of the young man who must work his way rather than receive a college education. The chief value to me has been the actual management of machinery. The lack of this is the one fault of the schools of correspondence. I hope that it may always have the success of the summer session of 1901."

From W. A. L., Racine, Wisconsin. Age 21 years. Has had four years' high school course and work in a correspondence school. Came to the school to study the comparative cost and efficiencies of gas engines and steam and electrical motors; also the comparative cost and lighting values of gas and electric power.

He says: "My idea in attending the Summer School was for obtaining a better understanding of the above works, and to be able to handle the subjects understandingly in business and conversation. My expectations have been more than realized, and I can say that I have been benefited a great deal, in so far that I have obtained a fair understanding of some of the fundamental ideas.

"My attendance at this school has made me better able to benefit from my correspondence work, and I expect to obtain a great deal more out of it. It has shown me the practical application of some of the scientific principles. The school certainly is a benefit to persons who are unable to attend the University for a full course. If the school could be run the year round for periods not exceeding six weeks, in some of the larger towns of the state, the number attending would be increased, I think, owing to the reduction of expense in attending. I hope the school may become a permanent one, for it benefits a class of people who would otherwise find it impossible to get any training in practical work under the supervision and guidance of scientific men."

From E. M. F., Columbus, Ohio. Age 29 years. Has had two years of high school work and one year at a technical school. Is a machinist by trade. Came to study electric motors and their adaptation to the direct driving of machine tools.

He says: "Every bit of the time spent here has been profitable to me and will aid me very materially in my study, and when I come in actual contact with this class of work. The whole course has encouraged and interested me very much, and yet, I might add, it has also discouraged me to no little extent—there is so much to learn. The plan is certainly a good one for the reason that it meets the needs of a certain class of workers, who are desirous of advancement in their particular lines. The lectures are not burdened with mathematics, and at the same time they are clear and right to the point, and this is followed up by actual work in the laboratory, where a person can see and feel and can ask questions, and be right in touch with the subject. It seems to me that instruction of this nature is just what a man, a working man, from apprentice to manager of works, would want in order to advance along his line of work and study."

From an assistant professor in charge of a physical laboratory of a neighboring state University.

He says: "I desire to express my thanks to the faculty of your Summer School for the advantages which I have enjoyed during the past six weeks. I have been able to do exactly the work I came for in Strength of Materials and Hydraulics, and I was also able to perform considerable valuable work in the steam laboratory—much more than I expected to accomplish in the limited time of six weeks. Your laboratories are so well arranged and equipped that the student can work to the best advantage.

"My work in the steam laboratory was taken along with the men for whom the course was primarily intended. I find the work as given to be thorough and intensely practical. I have had some experience as an instructor of Mechanics in connection with tthe National School of Electricity and with Y. M. C. A. evening classes, and I am sure that I am justified in saying that the work of your Summer School is exactly what they want and need. The idea of your school, as I have heard it expressed by members of your faculty, is, in my judgment, the correct one, and I am sure it will prove a great success in extending sound engineering principles and correct practice."

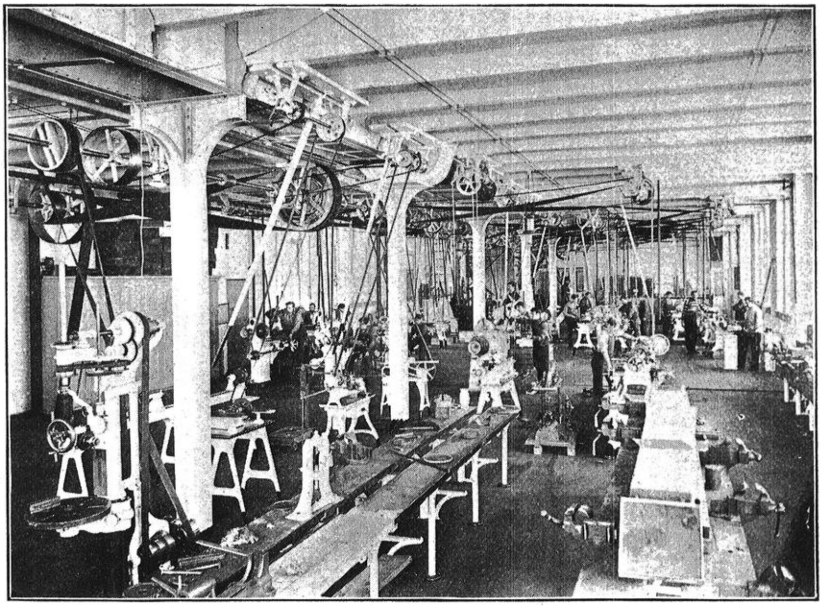
From J. R. K., Kenosha, Wisconsin. Age 20 years. Has had two years in the College of Engineering of this University. Came to study electrical apparatus.

He says: "I wish to recommend most highly the courses taken up in the Summer School for Apprentices and Artisans. My expectations have been more than realized, and although my plan of work will not be changed, I will be able to do my work in a way more beneficial to me and I hope to my employers also. The course of instruction is entirely practical and would be of great service to any one in the electrical or mechanical line. I shall heartily recommend the school to anyone who might be able to take the courses."

From F. A. W., Milwaukee, Wisconsin. Age 23 years. Is a graduate of a manual training school. Has had one year in a machine shop and is a teacher of Mechanical Practice in a Manual Training School.

He says: "My convictions are, after attending this Summer School, that it is no longer an experiment but a success. A great help has been extended to those who have not the means to take a college course. I am satisfied in every way. My general knowledge of mechanics and engineering has been expanded. I am thinking seriously of taking the regular engineering course sometime in the future."

From F. J. W., Oshkosh, Wisconsin. Age 22 years. Has had two years' high school work and work in a correspondence school. Is a printer by trade. Hopes to become a practical mechanical and electrical engineer.



MACHINE SHOP.

He says: "The Summer School for Artisans is one of the finest institutions for learning for a person who wishes to advance in any trade. It has benefited me by giving me a good start in the machinist line. It is of inestimable value to anyone wishing a mechanical education."

SAVANNAH HARBOR.

By A. S. Cooper, U. W. '81.

The formation of Savannah harbor, as far as nature alone is concerned, is one that has taken untold centuries to complete. Way back in the past ages a reef of sand was probably thrown up many miles from the mainland, leaving an immense area of comparatively deep water in the form of an inner bay. The Savannah river has brought down into this bay for ages large quantities of silt, fine mud, and all grades of sand, and when spread out into this comparatively still water, it has settled to the bottom and gradually filled it up until i tis now an enormous stretch of salt marsh, with a surface height ranging from half tide to high water, excepting such places as have been kept open by a sufficient ebb and flood of salt water or flow of fresh water to prevent filling. This process is still going on, but a much larger percentage of this material is now being carried to sea than in olden times.

When this coast was first settled, Savannah harbor was not selected on account of its natural deep water, as there were others that afforded much deeper draught, but for other reasons. Mainly, because it afforded an anchorage where the teredo would not eat into the wooden vessels, then exclusively used, and would kill those already in the ships that came in to anchor. Also because it afforded a fine high bluff only twenty miles from the sea, with a river for light draught boats leading 300 miles inland. Besides in those days deep harbors were not considered important.

The earliest records show that vessels could load to 13 feet. There was no thought of improving this until about 1787. Between that time and 1826, $100,000 was collected as a direct tax on commerce of the port to be expended on improving the harbor. This was expended under the pilotage commission. The work was confined to the closing of some side channels, but in all cases failed to accomplish the desired end. These commissioners were responsible to no one, and were required to make no report of their doings. At this time the harbor was gradually getting worse, vessels could only load to 12 feet.

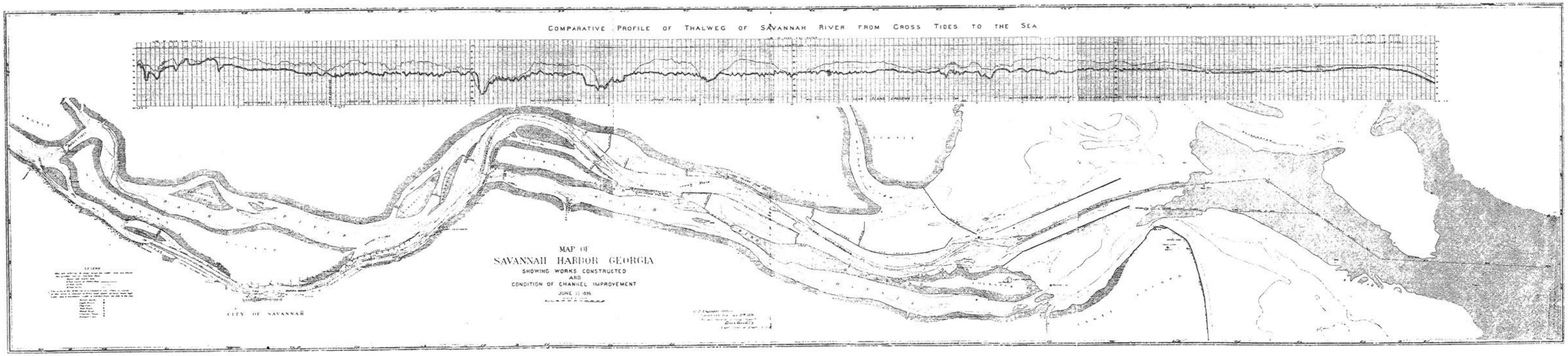
In the year 1826 the government assumed charge of the improvements, at first devoting the entire appropriations to dredging and secured immediate results. Vessels loaded to 14 feet in 1830. Up to 1856, there had been expended $375,963.68 by the United States government, all in dredging except what was necessary to close the Fig Island channel in 1854 (between Hutchinson's and Fig Island, not shown). No more work was done on the harbor now until after the civil war. During this war two lines of obstructions were placed across the river, one at Fort Jackson, now called Fort Oglethorpe, and another at the head of Elba Island, crossing both the north and south channels. These obstructions consisted of timber cribs fastened in place in most instances with piling and filled with brick and cobblestone from the streets of Savannah. Besides these obstructions several large ships were sunk in many places in the harbor. At the close of the war it was found that these obstructions had caused many shoals that must be removed before commerce of any kind could be renewed. The city of Savannah now took charge of the work and up to 1871 spent $157,000 in dredging alone. The cost of removing the obstructions was afterwards paid by the government.

In 1873 the government again assumed charge of the improvements, at first by the treasury department, and afterwards by the war department, through the U. S. engineers of that branch of the service, under whose charge it has remained up to the present day. As soon as the engineer departments took hold of the work, a survey was made and definite plans adopted. This at first consisted almost entirely of dredging, the exception being a few closing dams like Cross Tides Dam and Barnwell Island Closing Dams. This project was afterwards modified into what was known as the 22-foot project. In addition to dredging this prodject contemplated the construction of Cross Tides Dam, South Channel Submerged Dam, Spur Dams Nos. 1, 2, 3, 15, 4, 6, 25, 10, 27, 14, 29, 13, 26, 33, 28, 35, and 31. Also Fig Island Training Wall, Philbrick's Cut Dam, Big Gap Dam and Dutch Gap Dam. The position of these works (except the last one not shown) can be seen on the accompanying map.

At the close of the year this project had been practically completed at a cost of $1,325,132.96, about $400,000 of which had been spent in the removal of obstructions placed during the civil war, and vessels sunk during that war and the revolutionary war. A depth of 21 feet at mean high water had been secured by this expenditure; but the channel was very narrow, and would not maintain itself without the aid of considerable dredging each year. This unsatisfactory state of affairs led to the demand for a better and more stable channel for Savannah's now rapidly increasing commerce.

Between the years 1887 and 1900 the now famous 26-foot project was prepared and finally adopted and money appropriated for its completion in 1892. This project contemplated the expenditure of $3,500,000. To prepare this project a very careful hydrographic survey was made of the entire harbor, including careful gaugings and current meter observations at all necessary places. The harbor at this time, while it had several places where there was more water than called for by this project, had many places where there was less. There were many side channels and branches; also many places where the harbor had excessive width, although a part of this error had been corrected in the execution of the 22-foot project. The action of these wing dams however, was not satisfactory, being too far apart to properly confine the water.

Beginning at the old waterworks just above the city, there was at that time 10 feet of water at mean low water and only 3.5 feet at the upper end of the Central Railroad wharves. There was about 8 feet at the central portion of these wharves and 12 feet at the lower end, that is in the channel, with a somewhat deeper water along their face. From the lower end of this property the water gradually increased to 18 feet at the City Exchange, and about 17 feet thence to the Gordon Bank Shaol, on


COMPARATIVE PROFILE OF THALWEG OF SAVANNAH RIVER FROM CROSS TIDES TO THE SEA
MAP OF
SAVANNAH HARBOR GEORGIA
SHOWING WORKS CONSTRUCTED
AND
CONDITION OF CHANNEL IMPROVEMENT
JUNE 30 1896
CITY OF SAVANNAH

which there was 15 feet, and about 16 feet from there to Wrecks channel. In this channel there was 15 feet at the upper end, 17 to 18 feet in the central portion and 14 feet at the lower end. At this point the water from Back River joins with that of Front River and forms what was formerly known as Five Fathom Hole, opposite Fort Oglethorpe. This combined flow maintains an ample channel down as far as the mouth of the South Channel. Owing to this serious drawing off of the flow down the South channel a bad shoal has always formed here known as "Obstructions." It might seem to some that the best method at this point would have been to improve the South channel instead of the North, and it undoubtedly would have been if money had been available in the first instance to start and carry on the work to completion. That question was considered when the original 22-foot project was made. The North channel at that time had about 10 feet in it at mean low water and the South channel about 5 feet. Appropriations were made then only in small amounts and at very irregular intervals. If one appropriation had been spent in the South channel not enough depth could have been secured to allow shipping to use that channel, whereas the North channel in the meantime would have deteriorated. On the other hand, all work done on the North channel gave immediate results. For these reasons no work was ever done in the South channel. In the "Obstructions" channel there was in 1890 about 15 feet at the upper end, 18 feet in the central portion and 17 feet at the lower end. We now come to what is known as the "Bigert," where there is ample draught of water until the "Upper Flats" is reached. Here the river widens out considerably and has always shoaled badly, there being at this time only 15 feet. At the lower end of this shoal where the ebb flows against Elba Island, there has always been plenty of water. The next shoal place occurs where the crossing is made to Jones' Island, known as the "Lower Flats." On this shoal there was then only 14 feet. From here the ebb flows along Jones' Island and maintains a sufficient depth for navigation. The crossing to Long Island again causes a shoaling known as "Long Island Crossing." On this shoal there was about 15 feet for a length of two miles. At the "red light" near Fort Pulaski, there was a shoal on which there was 16 feet. This brings us to the "Tyber Knoll" channel, where there was only 15 feet at the upper end and 14 feet at the lower end. To secure the depth of 26 feet at high water these low water depths must be increased to depths ranging from 20 feet at the mouth of the harbor to 22 feet at the city of Savannah. To aid in accomplishing this object it was decided to construct training walls at all places where contraction of the river's width was considered necessary. The proper width between these training walls to secure the best results then beame the most serious question to decide in the whole project. To aid in this decision sections where the proper depths were maintained were studied comparison with those that did not maintain a proper depth. In the former instances it was found that during ebb tide there was a mean velocity of two feet per second and a mean hydraulic radius of about 18 feet. By knowing the mean ebb discharge at any point, then the width between training walls could be computed. As a further aid in determining these widths a table of sections showing area, mean depths, etc., was compiled at regular intervals from the city to Fort Pulaski. With the aid of these facts, together with a careful study of the general outline of the shore and shape of the channel, it was finally decided to adopt a width of 600 feet at Savannah, with a general increase according to conditions, to 2,400 feet at the mouth of the harbor between the Oyster Bed Training Wall and the Cockspur Island Training Wall. The general plan of the various structures for the 26-foot project is as follows:

Repairs to Cross Tides Dam only until a sufficient flow of water going into Bark River is diverted into Front River. Removal of parts of King's and Marsh Islands to better facilitate this flow. The building of Marsh Island Closing Dam to secure more flow in front of Central Railroad wharves. The building of Marsh Island Training Wall to better train and confine this flow. At the City Exchange it was planned to cut off about 75 feet of Hutchinson's Island, but this part of the project was afterwards abandoned, as it was found to be unnecessary. At Garden Bank Spur Dams 1, 2, and 3 to be connected with a training wall in order to make a more uniform flow at that shoal. Fig Island Training Wall to be raised and extended to regulate and improve Wrecks channel. To build Mackey's Point Training Wall, partially closing South channel in order to increase the ebb flow through "Obstructions" channel. It was feared that if any considerable portion of this section were interfered with the tidal range would be reduced. So much of the ebb was drawn off here however, that it was thought proper to suffer some loss of tidal range in order to gain a greater flow through "Obstructions." Mackey's Point Training Wall was therefore so designed as to cut off about one-third of the low water section of the South channel. At this point in the harbor it was also thought best to build closing dams up to high water between the mainland and Barnswell Islands Nos. 1, 2 and 3, and also to build a training wall at the lower end of Barnswell Island No. 3, to or toward the mainland, with a view to increasing the ebb flow in "Obstructions." It is the opinion of the writer that these closing dams and Barnwell Island Training Wall should not have been built, for the reason that all that flows behind Barnwell Islands would have been that much more volume of ebb secured for the North channel lower down, where it was badly needed. The "Obstructions" could have been taken care of by cautiously building Mackey's Point Training Wall up until a sufficient flow had been forced into that channel to maintain it. The loss in tidal range would not have been serious, as experience has shown that the loss in tidal range at this point due to the construction of all walls and dams as built, including Mackey's Point Training Wall, was only 0.3 out of a total of about 6.0 feet. At the Upper Flats there was planned the Ducks Puddle Closing Dam and North and South Elba Island Training Walls. At the Lower Flats there was planned the North Elba Island Training Wall, the Elba Island Spur Dams and Lower Flats Training Wall. From here to the

Long Island Crossing there was to be only Spur Dams for shore protection on one side and Venus Point Training Wall on the other. It would seem, however, that this training wall might have been omitted as the ebb tide does not strike it. Then follows the North Long Island Training Wall with no protection on the other side. To improve the Knoll channel there was planned the Cockspur Island and Oyster Bed Training Walls, about two miles long each. Here again one wall, the Oyster Bed Training Wall, a very expensive structure, appears to play no important part in improving the channel, and in fact it may be a detriment as it shuts out some small portion of the flood tide. It was decided to build these training walls only up to mean low water so as to interfere with the flood tide as little as possible.

In addition to this work there was to be dredged a channel 400 feet wide to the required depth from old water works above the city to Tyber Raods as per the following estimate:

Partial removal of King's Island..............	$ 770,000
Partial removal of Marsh Island..............	500,000
Water works to C. R. wharf..................	700,000
C. R. wharf to Fort Oglethorpe................	2,000,000
Obstructions	200,000
Upper Flats	330,000
Lower Flats	385,000
Long Island Crossing.....................	900,000
Oyster Bed Shoal	2,205,000
Tybor Knoll	751,000
Total original estimate	$ 8,741,000

This project was reported to congress in 1890, and if a more detailed statement of it is desired it can be had by referring to the Chief of Engineers Report of 1890, Part II.

Construction work began on this plan in 1891, but only with a small appropriation. This consisted mainly of work on training walls at the Upper Flats. The larger work was not started until the fall of 1892. Up to this time most of the dams in the harbor except in 1891, were constructed of log mats loaded with rip-rap stone, varying the widths to suit the place to be improved. To execute the 26-foot project with this style of construction would cost so much as to make the whole plan impossible. Therefore in 1891 the plan of pile dams with brush filling was started as an experiment and proved so successful that at all places in the new plan where possible, this style of dam was substituted for the more expensive one. These pile dams consist of a double row of piles spaced 8 feet, and g feet between rows, with a 6″x10″ timber bolted on the outside of each row. At first these rows were tied together with wire to prevent spreading, while the space between rows was being filled with brush. After the brush had settled,, 6x10 cross ties were substituted for these wires. It was at first expected that this brush would fill up with mud and that no rock need be used, but it was afterwards found that some rock was necessary in order to prevent the brush from being washed out by passing steamers or by storms. One great advantage of this style of construction was the rapidity with which it could be put in place, sometimes as much as 400 feet being built in one day. But these dams could not be built in deeper water than about 14 feet, nor can they be used where the water is salt, on account of the teredo. As the work progressed down the river, therefore, dams of mattresses covered with stone had to be substituted for them. The old log mats were not used for two reasons. First, the timber to make them out of was getting scarce; and second, they were more liable to be eaten up by the teredo than the smaller poles and brush. The style of mats used consisted of two layers of poles spaced 8 feet apart, both transversely and longitudinally. On this a layer of bundled brush was placed, and then another grillage of poles the same as at the bottom and the whole bound with wire. These mats were at first built on a set of inclined gin-poles off the end of a barge and sunk as fast as built. This proved to be a very slow process, especially where dams as high as 15 or 20 feet had to be built. To improve this, three courses of mats were built at once and sunk as before. Progress was still too slow; besides this method necessitated keeping at least four barges at the point where work was going on, and when the weather was bad this became either dangerous or impossible. Some better method was therefore needed if the work was to be completed in anything like the required time. The device finally adopted was to build the entire dam, slopes and all, on a tipping gin barge, tow it into place and dump it overboard, afterwards placing on the necessary rock. There were many details and difficulties to overcome in this method, but when it was finally gotten into working order about 300 feet of dam was built in a day, whereas by the old method not over 50 feet of completed work could be turned out in that time. By following this plan the work was completed nearly six months ahead of the specified time. The jetty work was completed in July, 1895. The quantities of material used in their construction are as follows:

Mattresses, square yards	1,435,751
Brush fascines, cubic yards	263,019
Stone, cubic yards	157,347
Timber	704,972
Iron, pounds	76,556
Piles	14,786

The dredging was not completed until July, 1896. Very little dredging was done in the early part of the contract, hoping that scour would accomplish part of the object sought. A complete survey in 1894 revealed the fact that very little scour was taking place, and that the channel must be dredged. Seven or eight large dredges were therefore set at work and continued operations until August, 1896. The amounts of material moved during the entire contract are as follows:

Partial removal of King's Island	126,850.40
Partial removal of Marsh Island	36,920.10
Marsh Island channel	1,013,469.76
City front	522,111.40
Wrecks channel	667,507.00
Obstructions	261,642.00
Upper Flats	302,579.80
Lower Flats	369,628.10
Long Island Crossing	1,072,401.80
Oyster Bed Shoal	193,392.71
Tyber Knoll	1,468,144.39
Outer Bar	2,616.00
Total dredged	6,037,263.46

This amount of dredging secured the amount of water called for by the project, 26 feet at high water, but not for the full width. A width of only 250 feet was secured, whereas the plan called for 400 feet in most places. It will be noticed that nearly three-quarters of the original estimated quantity of material was removed, whereas only a little over one-half of the original width was secured, showing that considerable filling took place while the work was in progress. To investigate this fact, as well as for other reasons, a complete survey was made in 1900. This survey has been carefully compared with a similar survey made in 1894. Between these two dates there has been scoured out of the space between the jetties, from King's Island to Tyber Roads, about 1,000,000 cubic yards of material besides what has been dredged out. This filling in of the dredged cut then must have been mainly from the sides of the banks between the cut and the jetties. The cut being so small as compared with the total width between the jetties, the ebb tide could not maintain a sufficiently strong flow below the general depth of the river bottom to prevent material from being deposited in it. This filling of the dredged channel is still going on, and it will never be stopped until a sufficiently wide cut is made to secure a strong flow for a considerable portion of the width between jetties. When this is done it is not likely that any more serious trouble will be experienced from shoaling in the channel. Behind the jetties and islands there has been deposited between the dates mentioned, 2,500,000 cubic yards of material besides what was dumped there from dredgings. At the same time, in the South channel, which was not improved in any way, 800,000 cubic yards of material has filled in through natural causes.

While the jetties in Savannah harbor have not been as successful as their designer hoped they would, yet from the above statement of facts, it will be seen that they have accomplished a good deal. It is at least safe to assert that had they not been built the filling of the dredged cuts would have been much more rapid. As to whether they have been a good investment or not the writer is not prepared to say. That question can better be answered after more time has elapsed.

After the completion of the 26-foot plan, another project was adopted to build a breakwater just northeast of Tyber Roads, to protect ships at anchor. As this was placed parallel to the ebb tide, it had nothing to do with the plan of the harbor improvements. After about one-tenth of the work was done, it was abandoned as being useless.

The bar at Savannah, having 27 feet of water at high tide, does not need any improvement under the present demands of commerce. It has been much more constant in depth and position than the other bars on the South Atlantic coast. It has moved to the southward about one-half a mile in the last 50 years, and has increased hlightly in depth. The survey of 1900 shows that this process is still going on.

THE PROGRESS MADE IN ENGINEERING DURING THE NINETEENTH CENTURY. *

By J. L. Van Ornum, B. S. '88. C E. '91.

The progress made in engineering during the nineteenth century, on the one hand, furnishes itself a reminder of its ultimate dependence upon mathematics and the sciences, and, on the other hand, it attests the fact that its great and growing inspiration has been the welfare of all the civilized world. A hundred years ago but little of engineering worth or prominence was in existence; so little, comparatively, that a glance at contrasting conditions then and now will reveal striking differences.

A century ago traveling in its highest development was limited on land to the horse and coach, covering perhaps a wearisome fifty miles in a day; now a day's travel is eight hundred miles. Then, a trip from New York City to Philadelphia consumed as much time and occasioned more fatigue than one from New York to St. Louis now; or a journey then from New York to St. Louis consumed the greater part of a month at best and was considered a greater hardship than a journey to India or China now. Then, the wind furnished the sole motive power for the hips of the ocean, and a voyage took as many weeks as now it does days. A hundred years ago the great canals were not built (one making the route to India as short as was formerly the distance to the half-way point—the Cape of Good Hope); nor monolithic light houses erected along the coasts for the safety of ocean voyagers. Then a building three stories in height was unusual; now a sixteen-story building is not uncommon. The century has seen the chaise give place to the horse-car and this to the cable, and finally the electric car with its speedy service brings the office within easy reach of the suburban residence.

The military engineer, while still trained and ready to engage i nthe fiercest shock of battle, has also developed plans of hasty works to accelerate transportation and the march, to make practicable the temporary entrenchments of the battlefield or the more permanent works of encampment and the seige; and he has perfected to a high degree the many stupendous works of permanent fortification and defense. While in the preceding century architecture was considered a branch of engineering, yet in the century just closed they have been definitely divorced.

The mine engineer has developed methods and perfected details, until the total yield of mineral wealth now each year exceeds a thousand millions of dollars, while a hundred years ago it was but a modicum. Copper has been needed for electric purposes and the arts, and he has driven adits and shafts, drifts and tunnels, until some regions are honeycombed in the search for the metal to depths exceeding a mile. The same watchful enterprise characterizes the search for other metals. But by far the most important products of the mine are coal, devoting over seven hundred million tons a year to the countless uses of commercial and industrial life, and more than seventy million tons per annum of iron and steel, whose services in the century's developments are preeminent.

The marine engineer has developed not only the speed of ocean vessels as noted, but their safety and size as well, developing a marvel of steel construction that will contain the lading of a score of barks of a hundred years ago and carry a small city of people across the seas with a safety all but perfect. Less than a hundred years ago the first successful steamboat was built, of 4 H. P. and steaming at a rate of seven miles per hour; now the tonnage of our great steamships reaches 16,000, with a H. P. of 37,000, a length of more than seven hundred feet and a speed of twenty-seven miles per hour, while some military steamboats attain an hourly speed exceeding forty miles. A century ago the tonnage of steamships was naught; now this yearly addition to the commerce of the world is more than two million tons. Since the days of the *Clermont* and the *Savannah*, the marine engineer has been applying new discoveries and evolving improvements, slowly at first and then with increasing success, until the perfected steel giants of to-day cost about four million dollars each, instead of twelve thousand dollars for the sailing vessel of a century ago. And now there are more than fourteen thousand steamships in the world aggregating nearly twenty million tons register—a great world's fleet that, steaming abreast, would cover a width of a hundred miles.

The electrical engineer, within the latter portion of the century, has developed a field felt in all phases of practical progress, ranging from the inauguration of the telegraph of the mid-century and the sub-marine cable of about forty years ago to the enormous electric stations, furnishing power for our expanding industries, turning night into day in our cities and making practicable the great development in electric traffic in urban districts, electric elevators in our stores and electric apparatus of infinite variety everywhere to minister to our needs and comforts. Through the electric transmission of power has a vast field of industry been opened. Through all the ages had great water power been useless because of its remoteness, until the development of electric machinery, suited to the purpose, made practicable the transmission of power, twenty, thirty, forty miles, with much greater distances in prospect. As indications of the inevitable result, witness the busy life in the new cotton mills of the Piedmont regions of the Southern States or the quickened industries of the Pacific coast.

The mechanical engineer had invented the steam engine before the beginning of the century just closed, but its development was crude, as shown by the winding and pumping engines, the sun and planet, and beam engines placed in South Kensington Museum to illustrate the practice of that day, engines which were then considered unusual if they developed one two-hundredth part of the power of engines of today; while the total for the world is now not far from seventy million horse-power, which is greater than the average physical power of the total population of the world, even were it possible to exert this power without cessation. And the engine is only one instance of the unparalleled advance; we should also mention such inventions and developments as the cotton-gin and cotton-baling machinery, the gas and oil engines, the harvester, the sewing machine, the hydraulic press and other hydraulic machinery, the steam-hammer, and countless other labor-saving, epoch-marking machines of wide import and far-reaching significance, like the printing press, capable now of printing, folding and counting 1,600 eight-page newspapers per minute, where the hand-press a century ago could make not more than four or five impressions in the same length of time.

The metallurgical engineer has added his full share to the increased productive capacity of the world. A hundred years ago only a pitiful modicum of iron and steel was produced, and this with great expense and almost infinite pains. The blast furnaces then were about one-half their present diameter and one-third the height, producing perhaps five thousand tons per annum, where furnaces now will produce thirty to forty times that amount. Wrought iron was produced by the Bloomery, Catalan or other crude direct processes, or by the direct open-hearth fineries of Sweden or Wales; and steel by the Catalan, cementation or crucible steel processes, likewise very expensive and slow. At the present day we have, for the production of pig iron, blast furnaces a hundred feet high, costing seven hundred thousand dollars each: and for the finished product we have the puddling furnace (first introduced by Cort close to the end of the eighteenth century)' producing malleable iron, and the Siemens open-hearth and the Bessemer processes (developments of the last half-century) for the production of steel. These last two inventions mark the greatest advance ever made in metallurgical processes, and have made possible the wide range in construction in steel in all the various branches of engineering. Figures are wanting to give the quantity of steel produced a century ago. It could not have exceeded a hundred thousand tons, for fifty years ago Sheffield, then the great steel-producing city of the world, manufactured about fifty thousand tons per year; and the cost of crucible steel, made from Swedish iron, worth seventy dollars, was two hundred and fifty dollars per ton. Now steel is produced at less than thirty dollars; single steel firms produce millions of tons each year, and the annual product of the world is nearly thirty million tons. To show the great growth of this interest, Sir Henry Bessemer illustrated the total production of Bessemer steel of the world by saying that if the product of a single month were made into a solid shafe of one hundred feet diameter it would reach 557 feet high. This illustration of the world's production eight years ago is now equally applicable to the United States alone, nor does it include the production of open-hearth steel, or wrought or pig-iron, the total for the world approaching eighty million tons annually. There is hardly any personal, municipal or corporate life, or hardly an enterprise of war or peace, that has not more or less closely connected with its development the use of this remarkable engineering material.

In the domain of the civil engineer progress is none the less marked. Within a score of years there has been developed the tall office and other buildings of the steel skeleton type, where the engineer has had to so design the steel frame that it will support sixteen, eighteen or twenty stories, crowded with busy life and industry, as well as to bear the weight of the walls and the great wind pressures that such high buildings sometimes must sustain; and not only this, but he has so considered and controlled methods and materials in the design and in protecting this all-important steel skeleton from fire that the occupants are safer in them than in the older style of building. Steel bridges have had a longer reign, though less than forty years ago it was considered a very remarkable feat to build an iron bridge whose length of span was 320 feet. Thirty years ago the magnificent steel-arch bridge of our own city, consisting of three spans, with the central one 520 feet in length, was erected by Captain Eads. Twenty years ago the Brooklyn suspension bridge, of 1,600 feet length of span, was being constructed. Ten years ago the great cantilever bridge across the Frith of Forth was built, containing two spans of 1,710 feet each. And now there are plans, perfectly practicable, for a suspension span of 3,200 feet, to carry eight railway tracks across New York harbor and to weigh between sixty and seventy thousand tons. In railway affairs the engineer has perfected the problems of transportation as we have seen, until the total mileage of the century is great enough to girdle the world fourteen times. In questions of water supply and sewage all our cities provide systems as a necessity, where a hundred years ago they were the luxuries of the very few, and woefully inadequate at that; and the engineer and the biologist have been colaborers in developing successful methods of preventing danger of contagion from these public utilities. Harbors and docks have been constructed and improved consonant to the spirit of the age. Foundations for great bridges and towering buildings are carried to depths requiring methods and inventions of particular resourcefulness, including the famous pneumatic processes. The development of hydraulic principles has made possible a varied series of achievements of far-reaching significance. Irrigation enterprise, which had been dead for centuries in its ancient home and was dormant even in India, has spread over the arid regions of the globe and is making oases of the waste places of the earth. In only two-thirds of the year one of the small canals of the century transports merchandise of a greater value than have the imports of China, for which the great world powers are so strenuously alert. The construction of the proposed canal from ocean to ocean across Central America will be a stupendous undertaking; humanity has never ceased to marvel because of the great pyramids, and they have always been considered one of the wonders of the world; but, reckoned at the present cost of casonry, a dozen such pyramids could be built for the expense involved in the Nicaragua Canal. And when it shall be built the engineer may well improve the great waterways of the interior and build fleets of steel barges that can withstand the sea, so that our products can be sent without transhipment from our inland cities to the western coasts of the Americas. Another product of the century of significant import is Portland cement. With the aid of the chemist this material has been so improved and made accessible that now the artificial stone made from it is most widely used and is superior to most natural ones. Furthermore there is the unequivocal indication that, in combination with the all-important steel, many classes of structures of superior characteristics will be designed. Already there have been built many steel and concrete bridges which are a hundred feet in span and more, and for the Memorial Bridge at Washington, maximum spans of this construction are planned to be 192 feet each in length; while the engineer who designed it considered perfectly practicable an alternative plan of similar arches 283 feet in length. Arches of such majestic span are among the imminent constructions of the engineer.

A half-century ago Macaulay said, "Those projects which abridge distance have done most for the civilization and happiness of our species." And yet, since then, transportation facilities have increased many-fold, the first ocean cable had not been laid, nor was the telephone in use, nor other distance-annihilating inventions made. The attainment of results both definite and valuable has been in constantly accelerating ratios through all the broad field of endeavor which marks the domain of the engineer, viz., the 'direction of the great sources of power' and the development of the boundless resources of materials in nature to the use and convenience of mankind. The effect and value of this art pervade all lines of human interest and of contact, whether following Macaulay's idea of potentially bringing peoples nearer together or in the way (largely developed since his day) of rendering it possible to make life more thorough and intense by the concentration of power and of effort in great centers of activity, which is made possible by engineering structures and developments such as the towering office and industrial buildings of the last score of years; the tremendous concentrated power in steam and electric machinery of the present; the penetrating circulation of life-bringing, waste-removing water, ministering to our cities as does the blood to the body;

and other examples of almost infinite variety which would cause amazement were they not so common now.

The glory and the power of the civilization of to-day result from the concentration of forces, both human and material, commanding the resourcefulness of mankind, applying the principles and discoveries of pure science, and developing the resources of nature for this purpose; and such is the degree of successful adaptation already reached, that the span of life of man potentially surpasses the millennial existences of legendary times. 'Better fifty years of Europe than a cycle of Cathay.' And the crowning glory of the measure of achievement thus far reached is that its inspiration is the welfare of the race.

J. L. Van Ornum.

Washington University.

THE CIVIL ENGINEERS' INSPECTION TRIP.

Seventeen students and two professors comprised the party. The teachers had written and made arrangements beforehand for the students to visit the principal engineering objects of interest in and about the city. Each student was assigned to some one special subject that he was to visit to which he was to pay especial attention and make written report concerning it both from assigned readings and from inspection.

Under special guides arranged for and appointed for the purpose, the students were taken through the Pullman Car Company's shops, the docks, furnaces, and steel plant of the Illinois Steel Company at South Chicago, and the Lassig branch of the American Bridge Company's shops.

The students inspectedthe long concrete sea wall at the south end of Lincoln Park, the failure of which is giving the city authorities so much concern. The methods to be adopted for preserving and reconstructing the sea wall were inspected and discussed.

The city pumping station at Chicago Avenue was visited where are engines still in use that pumped water for the city before the great fire and which have now been in constant use nearly half a century.

The students visited the interesting street bascule bridge at Clyburn Place, which is in course of erection, and the foundation in course of construction of the pivot pier fr the new draw span the Milwaukee road is building under its track at the north end of Goose Island.

A profitable afternoon was spent in examining the joint track elevation work of the Alton, the Santa Fe, and the St. Charles Air Line, between the Fort Wayne tracks of the Pennsylvania road and Bridgeport. Through the courtesy of the Engineer in Charge, Major G. W. Vaughn, and his principal assistant, Mr. Snyder, the class had an excellent opportunity to inspect all the work under way; the plans and drawings in the draughting room, the cement testing laboratory, the construction in process of the concrete retaining walls and abutments, the temporary timber subways across the streets, the heavy steel girders ready for erection, and the elevating and arrangement of the tracks under traffic. These gentlemen and their assistants went with the students over the work and explained it to them in detail.

The system of intercepting sewers to connect with the drainage canal was explained and the students were taken over the part now under construction of the long 16-foot sewer to extend along the Lake front from 72nd to 39th street. This sewer is being put in by an open cut and the work was spread out for half a mile so that an excellent opportunity was afforded to inspect all the details of the work. The driving of heavy Wakefield piling, the excavation with clam-shell dredges of the cut for the sewer, the timbering to prevent caving, the centrifugal pumps, the actual construction of the sewer, and the back filling, were all in progress; and as at the other works visited, the engineer in charge was kind enough to go over the work with the students and explain it in detail. Continuing, the students went down into the 39th street tunnel which is under construction at a point about two miles from the lake, where they inspected the compressed air plant, shield, shaft, and tunnel construction.

The students went over the newly re-constructed, double tracked, stone ballasted road of the Alton to Lockport and visited the controlling works of the drainage canal. By special arrangement the bear trap dam was raised and lowered for them, varying the outflow while they looked on from nothing to 200,000 cu. ft. per minute.

But to the students the most enjoyable feature of the trip came through the courtesy of Mr. J. N. Faithorn, President, and Mr. F. E. Paradis, Chief Engineer, of the Chicago Terminal Transfer R. R. Mr. Faithorn tendered the party a special train and his own private car for an entire day for a trip over the property of the Terminal. Mr. Paradis went with the party and explained from plans brought for the purpose the engineering features visited on the trip. The massive Schertzer rolling lift bascule bridge over the drainage canal at Taylor street, just now on the point of completion, but not yet in service, was raised and lowered for the students. This is the longest bridge of its kind in the world. The pneumatic interlocking plant now being installed at the crossing of the Terminal and the Pennsylvania and North-Western tracks was then visited, and as far as the work was ready, was operated for the students' inspection. This, it is said, will be the first interlocking plant of the kind put in operation. The new McHenry coaling station at the round house of the Terminal was then visited. Here Mr. Paradis explained to the students the new arrangement perfected by which an engine can take on coal, water, and sand in about five minutes instead of an hour's time as formerly required. The arrangement by which the amount of coal taken by each engine is automatically registered by weight was very interesting. The great eight-tracked bascule bridge over the drainage canal on Campbell avenue had been inspected by the students on the afternoon before. The attention of the students was called to the construction of the cinder pit, the automatic recording track scales, the various interlocking plants, the plans of some of the handsome suburban stations, a number of interesting overhead crossings of other railroads, and the arrangement of the tracks and roadbed to handle the traffic of the Terminal road.

A most interesting feature of the day's trip was a visit to the yards now under construction of the hicago Transfer and to the yards now under construction of the Chicago Transfer and Clearing Co. These yards are located just west of the city limits and south of 63rd street. They already contain 100 miles of track that were constructed this season. The general plan of this work is designed to include four separate parallel yards similar to the one already laid out. They are each to be operated by gravity switching from a "camel back." At the foot of each incline the tracks diverge fan-like to the "receiving yards" both east and west of the camel back. The grade in both directions from the camel back is 0.9 per cent. The yards are built of 75-pound steel rail on oak ties in slag ballast covered with gravel. The camel back has five tracks on it, one for through movement and four for switching. The switching will be done by the Westinghouse pneumatic-electric interlocking system of the Union Switch & Signal Co. The signals and switches will be operated from a tower at the summit of the camel back. The yards are to be lit up at night by arc lamps strung on each side of the camel back inclines and strung also through the level parts of the classification yards. The power house for engines, pumps, air compressors, and dynamos is now near completion and is built on the same massive scale that characteries all the work included in this enterprise. The Clearing Co. purchased about 4,000 acres of land here in the edge of the city for this plant. The scale on which the work is laid out is large enough to fill one with amazement as he looks at it from the tower, and the student wonders how an adequate return for such an expenditure could be expected from simply switching cars and making up trains. And this to be done, too, entirely for railway and terminal companies which now do this work for themselves.

The new line the Terminal road has constructed recently to Chicago Heights was then passed over, lunch being served on the train en route. It was near eight o'clock when the train ran into the Grand Central Station at the conclusion of the trip and the students startled the awaiting passengers for the outgoing trains and made the walls of the building quiver as they expressed their appreciation of the days' entertainment with the "Varsity Yell."

W. D. Taylor.

ELECTRICAL AND MECHANICAL ENGINEERS' TRIP

The annual inspection trip of the senior engineers was taken during the third week of October and was arranged to take advantage of the very low rates which were given to Buffalo at that time. It was proposed at first to visit both Buffalo and Pittsburg, but the electricals at the last moment, decided not to go to the latter place. The very generous sum which Prof. Johnson donates for this purpose each year as a loan fund, enabled a good many to go who otherwise would have missed the opportunity.

The party consisted of Professors Bull and Swenson, Mr. Frankenfield, and the following students; electricals: A. C. Atkinson, M. R. Bump, F. A. De Lay, R. G. Krumrey, P. J. Kelley, O. B. Kohl, J. M. Lea, P. W. Pengra, G. W. Scott, L. A. Terven, J. W. Watson, H. W. Young; mechanicals: B. F. Adams, F. W. Boldenweck, C. M. Cole, H. W. Dow, J. C. Gray, W. W. Gore, G. McEvoy, A. B. Saunders, R. T. Smith, S. P. Starks; general engineers: A. B. Grindell, H. D. Lennon.

We left Chicago Tuesday afternoon at 2:30 over the Nickle Plate for Buffalo. The company had very kindly placed a special car at our disposal, which added greatly to our comfort and convenience. As a "sleeper" especially, it was just the thing, although not in strict accordance with the "con's" views on the subject. The first part of the trip was made by daylight, so we had a little chance of seeing the country. Through Indiana and Ohio, excepting in the vicinity of Cleveland, the country was very level, being covered for the greater part with cornfields and small patches of woods. In central Indiana we passed through an oil region, with its numerous towers and tanks. With the exception of this, the trip was uneventful, the monotony being broken only by bridal couples and lunch counters.

We arrived in Buffalo Wednesday morning at 8:30, very tired, but anxious to begin our sight-seeing. The entire party put up at the Park Hotel—a two-story temporary affair, but conveniently located opposite the east entrance to the grounds. After breakfast we all went to the Exposition. We visited the Machinery, ransportation and Electricity buildings, examining only the most important exhibits in each. These were explained, and the workings of some of the machinery illustrated, either by the person in charge or by our professors. The operations of the Westinghouse air brake and magnetic brakes for electric cars are examples. The party was treated to a short ride in a car provided with these magnetic brakes while their operation was being demonstrated. The brake itself consists of a solenoid and an armature, the latter being held tightly to the rail when a current flows through the solenoid. This action also mechanically sets the brakes upon the wheels themselves. The current required for its operation is obtained by utilizing the current generated by the car motor, running as a dynamo after the power has been shut off. By this method power is made use of which would otherwise go to waste. It is claimed by the manufacturer of this brake, that a loaded car going at full speed, can be stopped within 20 feet. The Westinghouse exhibit also included dynamos, engines, etc., also a 300 H. P. gas engine directly connected to an alternator, an installation similar to that which is being installed here in Madison now. Locomotives, automobiles, trolley cars, etc., were inspected briefly, only the most striking characteristics of each being mentioned.

Perhaps the largest and most interesting exhibit however, was that of the General Electric Co., which occupied the entire northwest corner of the Electricity building. Here was situated one of the sub-stations of the Niagara Falls Power Co., consisting of 19 air-cooled transformers of 250 K. W. capacity each. They formed a part of the company's exhibit, although they were rented to the Exposition. The Niagara Falls power circuit of 11,000 volts was here transformed down to a pressure of 1,800 volts for use in the building and on the grounds. One of the most conspicuous exhibits, perhaps, was a large field ring of nickle steel, similar to those which form the revolving part of the Niagara machines. It weighed 34,000 pounds and was 12 feet in diameter.

One of the novelties in the Electricity building was a system of sentence-making by incandescent lights, the lights being arranged in similar figures and the words formed by turning on certain lights automatically. One of our alumni was beaten out in the patent of this arrangement by only a few hours. Wednesday afternoon was spent mostly in general sight-seeing of an engineering nature and otherwise, chiefly otherwise.

Thursday was spent in inspecting the interior mechanisms connected with the different novelties and exhibits. We first visited the electric tower and saw how the huge cascade was formed, which issues from the front of the tower, 70 feet from its base. 500,000 gallons per hour flow in this cascade, and, by using a parabolic reflector, its volume is made to appear even larger. The beauty of the tower itself is beyond description, the illumination of the 40,000 incandescent lights at night, being especially so. In order to have the light well blended, 8 c. p. lamps instead of 16 were used. Several elevators ran to the top of the tower, from which an excellent birdseye view of the grounds could be obtained.

We next visited what was one of the features of the "Expo." Although not open to the public, we obtained admission through the courtesy of the superintendent. It was a small shanty, elevated on stilts, which contained the water rheostat, for bringing the 200,000 8 c. p. used in the decorative lighting, gradually up to candle-power. The transmission lines, consisting of two three-phase circuits of 11,000 volts, enter direct from the Niagara Falls Power circuit. The rheostat proper consists of three tanks, 10'x 3'x 3' filled with water, one for each phase. Three cast iron plates $\frac{3}{4}''$ diameter form one set of terminals. Each is pivoted at one end so that it describes an arc of a circle when being lowered into the water. By this means the resistance is changed gradually, and when fully under water the tip strikes a submerged clip which short-circuits the rheostat. The plates are raised and lowered simultaneously by an electric motor working on a worm gear and a part of the plate is always kept under water in order not to break the circuit. About 80 seconds is the time usually required to bring the lights up to full candle-power. When in operation the water boils violently and the frames are strongly charged with static electricity.

The party next visited one of the sub-stations put up on the grounds, more for service than exhibition. Instead of coal they used natural gas as fuel, the gas being piped under relatively high pressure from the natural gas region. The generators and engines were mostly second hand.

The illuminated fountain was visited and its mechanism explained by the person in charge. This ended our inspection trip for the day.

On Friday the entire party went to Niagara to inspect the large power plants and manufacturing concerns located there. The first place visited was the power house of the Niagara Falls Hydraulic and Manufacturing Co., located at the foot of the gorge of Niagara. The generators here were of the ordinary pattern, directly connected to water turbines. The water which supplies the turbines is admitted through a pipe 11 feet in diameter under a head of 200 feet. The station has a capacity of 13,000 H. P., most of which is used by the manufacturing concerns in the vicinity.

In the afternoon we went out to the Niagara Falls Power Co.'s plant, the largest of its kind in the world. The building is rather a handsome one of brown stone, surrounded by a well-kept lawn, which gives the plant a very neat appearance. The ten huge generators stand in a row, each being directly connected to a water turbine. The generator is mounted on the upper end of the shaft, in a horizontal plane. The main shaft is 38″ in diameter except at the bearings, where it is solid and of a smaller diameter. The shafts, and the punstocks which carry the water, extend down into a pit 180 feet deep, 180 feet long and about 30 feet wide, cut out of solid rock. The penstocks are 8 feet in diameter and bring the water down under a head of 160 feet. to the turbines which are at the bottom of the pit. Water is admitted at the lower end in order to balance the great weight of the wheels, shaft, etc. A centrifugal governor is used. Each generator is a 5,000 H. P., 2,200 volt, 25 cycle, 2-phase machine with rotating field magnets. The water for the turbines is supplied by a canal 180 feet long which contains enough water to generate 100,000 H. P.

Just outside the power house is the transformer house, where the pressure is raised to 22,000 volts, 3-phase. Opposite the power house and across the canal, another power house is being contructed of the same capacity as the original. The canal contains enough water for both power houses, but the new machines are to operate under a head of 185 feet. This building has already been two years in course of construction owing to the fact that the wheel pit has to be cut down 190 feet through solid rock and it will be eighteen months more before it is completed. The combined output of the company will be 100,000 H. P. or about 1-700 of the estimated power of Niagara Falls.

From here we went out to he Corborundum Works. Here we were shown through the entire plant. This product is obtained by heating a mixture of sand, salt, coke and sawdust to a very high temperature for a considerable length of time. The ovens are 16x5x5, with ends 2′ thick through which the electrodes enter. Each of these consists of 6 carbon rods, 30″ long and 3″ wide. The mixture is packed in between these electrodes around a central core of coke, and a current of about

1,000 amperes at from 250 to 100 volts pressure is applied for 24 hours. The corborundum is then powdered and formed into abrasion wheels.

From here a portion of the party went to the new factory of the Shredded Wheat Biscuit Co. Although somewhat out of our line, this factory presented several points of interest, chief among them being the great care which was exercised in keeping the product manufactured pure and clean. In this respect the building is probably one of the most ideal in the world. Pure air was maintained throughout by a system of fan blowers carefully placed, by means of which the air which was taken in at the top of the building, strained, warmed or cooled as the case may be, was sent to every part of it. By this means the air was renewed in each room every fifteen minutes. Another commendable feature was the great care which was taken for the comfort and intellectual improvement of the employes. The building and equipments cost in the neighborhood of a million and a half dollars, while the plumbing alone cost $60,000.

Saturday was spent in the city of Buffalo. The party divided according to their respective lines of work, the mechanicals visiting the pumping stations, etc., and the remainder going to some of the electric power stations.

The electricals went first to sub-station No. 1 of the Niagara Falls Power Co. Here we were met by Mr. Alverson, U. W. '93, who is the superintendent of the Buffalo end of the Niagara Falls Power Co.'s lines. It is owing to his kindness and courtesy that we saw what we did on Saturday to such good advantage. At this sub-station are located seven large water-cooled transformers of 2,250 K. W. capacity for transforming the Niagara Falls pressure of 22,000 volts down to 11,000 for distribution in the city. One of these is held in reserve and the rest are arranged in delta connection, two groups of three each. At this modern up-to-date station we had an excellent opportunity of inspecting the various instruments and appliances used in high tension work.

The next place visited was the Boston Traction Co.'s power house. Although this company buys 7,000 H. P. from the Niagara Falls Power Co., it isn't enough to supply the demand, hence the necessity of this station. The power is generated by several large direct connected units, and a storage battery of 270 cells carries the peak of the load.

From here the party went to the city pumping station. That this was a municipal station could be told by the number of idle men. The two sections of the class met here and went to the Buffalo Forge Co.'s works together. This is quite a large concern—engines and fan blowers being the chief articles manufactured.

The last place visited by the electricals was the Boston General Electric Co.'s station. Just outside of this building is one of the sub-stations where the 11,000 volts is transformed down to 352 volts for use in the station. The mechanical power, 3,000 H. P. altogether, is derived from A. C. motors, these motors vertors, with their direct current ends across the three-wire sys- for the incandescents is supplied on the Edison three-wire system, part being supplied by two 100 K. W. 125 volt rotary convertors, with their direct current ends across the three-wire system and the rest by a 425 K. W. 3-phase revolving field motor, direct coupled to two 200 K. W. shunt wound 150 volt generators. The 28 125-light arc machines are driven by 14 150 K. W. motors, two arcs being direct connected to each motor. At this station also the peak of the load is carried by a storage battery of 150 Chloride Accumulators. Direct current is supplied also for 500 volt motors and A. C. for some of the incandescents. Notwithstanding the large capacity of this station, only two attendants are required.

The mechanicals, under Prof. Bull, left on the evening train for Cleveland, where they spent Sunday, going from there to Pittsburg. The electricals, with few exceptions, spent Sunday at Niagara Falls and left for Buffalo at 1:00 a. m. Monday morning for Chicago.

At Pittsburg the party visited first the American Locomotive Works. This is a large concern, eight complete locomotives a day being the output. In the afternoon the Compressed Steel Car Works were inspected. This is also a very large concern, something like 15,000 men being employed. Many interesting points in connection with hydraulic presses, etc., and the application of high pressure were gained here.

On Tuesday two plants were visited, the Westinghouse in Pittsburg, and Carnegie's at Homestead. At the former they manufacture a great variety of machinery both electrical and mechanical. Here were seen presses of 4,000 tons capacity for pressing plates into different forms while cold. Last year the party on its trip saw the 12,000 H. P. engine at the Allis company's works in Milwaukee, for the New York Manhattan station. Here the party saw the 45,000 K. W. generator which is to be run by that engine. Some of the many sights of interest were the steam turbines of 3,600 R. P. M., the large gas engines which this company builds, and the 5,000 girls which it employs.

The afternoon was spent at Homestead. Twenty thousand men are employed here, it being the largest steel works in the world. Perhaps the most interesting features were the rollinig of the I beams and armor plate. This plant is similar to the Illinois Steel Co.'s except as to its size and the greater variety of products manufactured.

The party left for Madison on Wednesday. The electricals stopped over in Chicago to visit the Illinois Steel Works at South Chicago. Here we saw some of the most interesting sights of the whole trip. We were given a guide and shown the chief points of interest. First we visited the large pumps, air compressors and blast furnaces; then to the Bessemer converter house where three large converters were in operation. The display of fireworks here would beat a 4th of July celebration. From here we went to the rail and roller mills where rails and plates were being rolled. All the iron is handled by machinery, electro magnets being used to a considerable xtent for picking up the rails, etc. The company has several pumping stations and an electric power plant of its own, the plant running day and night, 365 days in the year.

The party left for Madison Tuesday night, feeling just a little tired. Thus ended one of the longest and most successful trips taken by any senior class. We probably will forget most of what we saw, but the important points gained in witnessing the practical application of the theoretical methods studied in the classroom will always remain with us. I take this opportunity also, on behalf o fthe class, of thanking the Professors who accompanied us, and the gentlemen who so kindly aided us on our trip.

J. W. WATSON, E. E. '02.

FACULTY CHANGES.

The vacancy caused by the death of Prof. N. O. Whitney, has been filled by Prof. W. D. Taylor, of Chicago. Mr. Taylor who was first assistant engineer of the Chicago & Alton R. R., is an engineer of wide, practical experience, having been connected with several systems as chief engineer. He recently completed one of the most difficult tasks in railway engineering—that of rebuilding a road without interrupting its operation. He was also engaged recently in "taking stock" of a certain northern railroad. This work necessitated thorough knowledge of all the details connected with railroad work. Mr. Taylor was for seven years professor of civil engineering at the Louisiana State University at Baton Rouge.

Prof. E. R. Maurer has been promoted from the position of assistant professor to that of Professor of Mechanics.

Mr. Albert S. Merrill, M. I. T., '00, has been appointed Instructor in Mechanical Engineering.

Mr. J. F. Kable, U. of Illinois, '99, is Instructor in Descriptive Geometry, having held a similar position at Champaign for two years.

Mr. J. W. Shuster has been appointed Instructor in Electrical Engineering. He is a graduate of the class of '99.

Mr. A. B. Marvin, U. W. '00, has charge of the electro-chemical laboratory. He spent the year following his graduation with the General Electric Co., of Schenectady, N. Y.

Mr. B. S. Anderson, Ex. '02, is an assistant in the shop.

Mr. R. Hartman, '01, is instructor in the testing laboratory.

Mr. Edgar Buckingham, Ph. D. of Leipsic, Wellesley Hill, Mass., has been appointed Instructor in Physics.

R. W. Hargrave, '98, has resigned his position as instructor in the shop.

C. E. Mendenhall, Ph. D. Johns Hopkins, has been appointed Assistant Professor of Physics.

Dr. Longden is Professor of Physics at Knox College.

PERSONALS.

H. T. Plumb, E. E. '01, celebrated the completion of his college course by getting married. He had to go clear to Washington to get his bride, (which, by the way, accounts for some of those interesting talks that Mr. Plumb used to give about trips through western states). Mr. and Mrs. Plumb (nee Mida Lorton) are at home to friends in Brooklyn, N. Y., where he has a position in Pratt Institute as assistant professor of mathematics and physics.

Arthur H. Ford, '95, is professor of electrical engineering at the Georgia School of Technology.

Arthur R. Sawyer E. E., '96, is professor of electrical engineering at the state college of Kentucky.

C. B. Mutchler, C. E. '02, is in the employ of the C. M. & St. P. R. R., as civil engineer, with headquarters at La Crosse.

W. H. Williams, '96, is professor of electrical and mechanical engineering, Montana College of Agriculture.

Howard S. Webb, EE. '98, is professor of electrical engineering, University of Maine.

Ernest F. Legg, EE, '01 and A. A. Nicolaus, EE, '01, are employed in the testing department of the General Electric Co., at Schenectady, N. Y.

Roy A. Sanborn, '01, and Miss Lorena Freeborn, '02, were married at Richland Center, the home of the bride's parents, July 11, 1901. Mr. Sanborn is in the employ of Weston Bros., consulting and contracting engineers, Chicago.

C. H. Bachelder is in the employ of the Chicago Telephone Company.

Dr. E. R. Buckley is director of the Bureau of Geology and Mines and State Geologist of Missouri. He is located at Rolla, about sixty miles from St. Louis.

Professor W. H. Hobbs spent the summer in the east, on work connected with the United States geological survey.

Fritchiof J. Vea, '01, is Superintendent of the Stoughton Wagon works.

Le Roy Salsich is an assistant engineer at Duluth for the Rockefeller branch of the United States Steel Corporation.

Mr. Edward Freschl, '99, is at present on a recreation trip in Japan.

Leo Granke, C. E. '00, has been appointed division engineer the Chicago & Alton R. R., between Kansas City and St. Louis. His headquarters are at Slater, Mo.

R. E. Heine, '98 is assistant professor of electrical engineering, University of Washington.

A. A. Radke, '00, is instructor in electrical engineering, Rhode Island College of Agriculture.

THE U. W. ENGINEERS' CLUB.

The U. W. Engineers' Club began its yearly work October 5 in a very flourishing condition. There is every promise of a successful year.

At this meeting Prof. J. G. D. Mack gave an opening address which was well received. He pointed out some of the advantages to be derived from the engineering societies and hoped that with the continued growth of the College of Engineering there might be developed a great enthusiasm along the line of literary work.

Owing to the suggestions received from Prof. Mack's address, as well as from other sources, the club decided to take steps toward the formation of another engineering society. Accordingly Dean J. B. Johnson, Prof. J. G. D. Mack, Mr. O. B. Zimmermann and others were consulted and through their efforts such enthusiasm was aroused that two new societies were formed: The J. B. Johnson Engineering Association, and the N. O. Whitney Engineers' Association.

The installation of the following officers took place at this meeting:

President—W. L. Thorkelson, Racine Junction, Wis.

Vice-President—A. J. Quigley, Lake Geneva, Wis.

Secretary and Treasurer—O. C. Atkinson, Chicago, Ill.

Censor—F. W. Huels, Madison, Wis.

Mr. Atkinson has since resigned his position which is now held by S. J. Lisberger, Danville, Va.

The papers which have been given this year have been of uniform excellence. Some of those deserving mention are the following:

"Rotary Engines," by E. A. Ekern.

"Buffalo and Niagara Falls," A. J. Quigley.

"Santos-Dumont Air Ships," J. N. Cadby.

"Manufacture of Glass," J. A. Walker.

On November 15 a joint session was held in the auditorium by the U.W. Engineers' Club and the N. O. Whitney Club. Mr. O. B. Zimmermann read a paper on "Industrial Literature" which was well received.

New members are constantly joining and there is still room for men of the Freshman Class. Anyone intending to join is urgently requested to come around at once.

THE N. O. WHITNEY ENGINEERS' ASSOCIATION.

On November 1 "The N. O. Whitney Engineers' Association" was organized under the direction of Mr. O. B. Zimmerman. After some discussion a constitution was adopted and signed by a large number of sophomores and freshmen. The following were elected as officers:

President—Harry D. Keerl, (Mason City, Iowa).

Vice President—Herbert J. Kuelling, (Shullsburg).

Secretary and Treasurer—William Bradford, (Stevens Point).

Censor—Charles L. Eustis, (Fort Atkinson).

At the present time there are fifty-nine members, of whom two are seniors, thirty-three sophomores and twenty-four freshmen.

No regular programs have been given. Arrangements have been made so that a thorough reviewing of current engineering periodicals will form a very large part of the work of the association.

THE J. B. JOHNSON ENGINEERING ASSOCIATION.

This association was organized on November 8 by a large gathering of engineering students. A constitution was drawn up and signed by thirty members.

The following men were elected to serve as officers:

President—Joseph P. Burns, (Watertown, N. Y.).

Vice President—Ira C. Sunderland, (Hartford).

Secretary and Treasurer—William Spaulding, (Oshkosh).

Censor—William J. Gibson, (Hartford).

The association has held no programs up to this time. The meetings, which have thus far been for purposes of organization, indicate that the men hope to make their work worthy of him whose name they have taken for their association.

NOTES.

With this issue, No. 1, Vol. VI. of THE WISCONSIN ENGINEER makes its appearance. It would be fitting at this time to give a historical resume of the "ENGINEER'S" varied career, but the material for such a sketch is not now at hand and instead it will be reserved for our next issue. At present suffice it to say that your journal again comes before you as a quarterly after a two year's period of hard times on half fare as a semi-annual. Your board of editors makes this change with the full confidence that the increased work and expense will be rewarded by a more liberal and enthusiastic support from all sides. With this confidence to urge us onward we hope to make your journal fill a larger sphere of usefulness, and that in so doing it will keep pace with the rapid strides of progress which the Engineering College is now making.

We are also glad to embrace this opportunity to thank the Regents and Professors as well as the students and friends whose aid and encouragement has helped in so many ways to make it possible for us to restore THE WISCONSIN ENGINEER to its original form.

Owing to the inaccuracy of last year's Alumni directory and the time required to get authentic data on that subject, it was deemed advisable by the board, to defer its publication until the next issue.

There has been plenty of football spirit in the University this fall, and several class teams have been organized as a result. On November 2 the electricals played the mechanicals and won by a score of 10 to 0. On November 7 the electricals played the civils for the championship, again winning by a score of 17 to 0. Ware and Levisee were the star players for the electricals.

The University boiler house has been undergoing some improvements this fall. The two boilers have been taken out and a new 260 H. P. Babcock and Wilcox boiler is being installed instead. Like the rest, it is supplied with a mechanical stoker. The coal-handling apparatus is also undergoing repairs. A new air compressor has been put in to supply compressed air for Prof. Snow's lecture room, and for the heating apparatus in the University buildings. The air is compressed to 40 pounds for the lecture room and reduced to 18 pounds for the other. The work is under the supervision of Professor Bull.

Co-ed.—"Who is that football player over there making so much noise?"

Escort—"That's Pierce, the captain of the Civils."

Co-ed.—"Well, he don't look so *very* civil."

The new physical laboratory is located in the northwest corner of the first floor of Science Hall, in the large room formerly occupied by the engineers as a drafting room. It is well lighted naturally, and will soon be artificially by means of numerous incandescent lights on walls and ceiling. New apparatus is being constantly supplied. Without doubt this is the largest and probably the best equipped physical laboratory in the country. The old one is being used as a "heat" and "light" laboratory. Our physics department has grown so that it now occupies practically all of the basement and first floor of Science Hall.

Prof. Maurer—"What is "working stress?"

Junior—"Two finals in mechanics, 1 quiz in dynamos, 3 armature connection diagrams, all in the same week of the Minnesota game."

At a meeting of the freshman class Oct. 31, held for the purpose of electing officers, the usual struggle for supremacy took place between the engineers and hill students. The engineers, as usual, came out ahead. The following were elected: President, Adolph Meyer, Cedarburg; first vice president, G. D. Kershaw, Wauwautosa; second vice-president, Ralph T. Craigo, Monroe; secretary, M. G. Hubbard, Kilbourn; treasurer, H. K. Weld, Elgin, Ill.; sergeant-at-arms, T. H. Dorner, Milwaukee.

Tau Beta Pi, the honorary engineering fraternity, held its semi-annual on October 15 and elected the following new members:

Guy E. Diehl, C. E., Elroy.
Patrick J. Kelley, E. E., Manitowoc.
Harry W. Cole, M. E., Milwaukee.
Stephen Gardner, E. E., Madison.
William Thorkelson, M. E., Racine Junction.
Felix W. Boldenweck, M. E. Chicago.
Frederick C. Stieler, E. E., Stevens Point.
Martin W. Torkelson, C. E., Black River Falls.

All are members of the senior class excepting Mr. Torkelson, who is a junior. At this election, the first eight of the senior class were eligible and one junior who ranked highest in his class. Tau Beta Pi is a purely honorary fraternity, but to be elected a member one must have both good scholarship and good fellowship.The initiation banquet was held on November 6.

August 29 of last summer was a gala day for the engineers who attended summer school. About 25, including Professor C. I. King, Henry Kratsch, Mr. Lattes, Mr. Hargrave and "John" Conahan went on a picnic across Fourth lake. After inspecting the asylum a game of baseball was engaged in. "Henry" and Prof. King acted as captains. Features of the game were the rooting by the Episcopal choir boys who were in camp at the time, and the batting and catching of Prof. King. Although the score was close it would not look well in print, but credit of winning must be given to the followers of "Henry." After lunch the party adjourned to the camp grounds and attended the vesper services of the choir boys. The trip home on the boat brought to a close a most enjoyable "half-day off."

During the early part of the semester a petition was drawn up and signed by the senior engineers, petitioning the faculty to make senior theses optional. It was presented at the first meeting, but before deciding definitely they wished to hear the arguments on both sides of the question. For this purpose a joint meeting of the faculty and senior class was called by Prof. Bull. Dean Johnson presided. All the possible arguments in favor of an optional thesis were ably presented by the class, and those against it by the faculty. Although it is certain that the petition will not be granted, yet this meeting was of the utmost benefit for it gave the students a clearer insight into the true character of a thesis, perhaps, than could have been obtained in any other way. It also demonstrated that they were not actuated by any selfish motive, but that they desired to get the greatest possible good from their college course.

"Why doesn't the clock strike thirteen?"
"Because it hasn't the face to do it."

Shopwork—"When are you going to cut your gears?"
———"I've got through cutting teeth."

B. L. (debating) Just for argument, suppose that a trolley line *could* be operated so as to compete with the transcontinental steam flyer. What will you do sometime when you get three or four hundred miles out on a *prairie* and your current suddenly stops coming? What are you going to do about it? Why, you'll sit there and wait—no knowing how long. Whereas, with a locomotive if your power gives out all you have to do is to go out and cut down a few *trees* and go ahead. Applause.

Last year's crew at Poughkeepsie was well stocked with engineers, as usual. They were:
W. J. Gibson, captain, at No. 5.
D. C. Trevarthen at bow.
L. H. Levisee at No. 3.
A. J. Quigley, port substitute.

To take the place of Dean Johnson's "Saturday evenings at home," which were so greatly enjoyed last year, a series of four socials are to be given this year in the Engineering building. The increasing popularity of the Dean's "at home's" last year made this step necessary. The arrangements are in the hands of the following committee: From the faculty, Dean Johnson, Prof. Maurer, Prof. Mack, Prof. Burgess, Mr. Zimmerman and Mr. Kable; from the students: M. R. Bump '02, H. W. Dow '02, James Goudie '03, J. P. Burns '03, W. H. Hauser '04, B. H. Borreson '04, J. E. Boynton '05, Herbert Cole '05. These socials will be given in the Engineering building on Saturday evenings from 8 to 10. Special programs will be arranged, including music, etc., after which the evening will be spent in a social way. Owing to the limited accommodations of the building it will be necessary to limit these socials to the faculty and students of the College of Engineering and their lady friends. A great interest is being taken in them and their success is assured.

The attendance in the College of Engineering this year is about 490 as against 411 last year. The great increase has been in the freshman class, and if each year sees a proportionate increase, the remaining sections of our Engineering building will soon have to be built, so popular is our college becoming.

BOOK REVIEWS.

ELECTRIC LIGHTING. A practical exposition of the art for the use of engineers, students and others interested in the installation or operation of electrical plants, By Francis B. Crocker, Ph. D., 2 Vols., 8vo., $6. D. Van Nostrand Co., New York.

Electric lighting is an art, the thorough cultivation of which has heretofore been given over to the contractor and central station manager on the one hand and the college lecturer on the other. Literature upon the subject has consisted of scattered articles and superficial or antiquated books. Professor Crocker's book therefore enters a gap heretofore unstopped. The book found a demand and filled it with reasonable satisfaction to readers as is shown by the second volume having already reached a reprint though it is still in its first year of publication, while the first volume has been reprinted thrice since its original publication in 1896.

The two volumes treat of two fairly independent branches of the art dealt with, namely, "The Generating Plant," in volume one, and "Distributing System and Lamps," in volume two. The first volume, when considered alone, is disappointing on account of its incompleteness and at times popular and even superficial tone; but this is perhaps an unavoidable result induced by an effort to compress the description of the principles of central station machinery, and the practice in central station design, construction and operation into one octavo volume of 438 generously leaded pages. As a semi-popular introduction to the second volume, it serves its purpose, however, and one is inclined to forget the evils induced by an effort at brevity and the production of readable characteristics.

The second volume contains so much of the admirable and so little of the discordant that the reviewer has little to say but praise. The first six chapters of this volume, covering 108 pages, comprise as fair a presentation of the principles relating to conducting systems for electrical distributions as may be found or need be desired. The five following chapters, which deal with the principles of alternating currents and the characteritics of alternating current circuits are also well planned and excellently executed though their brevity has somewhat interfered with the unity and curtailed the completeness of the treatment.

The descriptive chapters relating to the construction of overhead and underground circuits may here and there cause experienced contractors to express dissent, but, on the whole, equal praise must be accorded to them. Certain of the later chapters, however, do not show the results of the same careful judgment in the presentation of experimental data and drawing deductions. This is especially true of the chapters relating to the electric arc (Chap. 14) in which doubtful data is presented and contradictory deductions are drawn. Mr. Ayrton's extended investigation of the physics of the arc is not given a passing notice, while the data from Blondel's wisely conceived and thoroughly executed tests on enclosed arcs are apparently ignored.

The chapter on incandescent lamps (Chap. 17) revives the better characteristics of the earlier parts of the book, and its thirty-two pages are wholly admirable. In common with several others this chapter includes a short bibiography; but in respect to bibliographical or historical references and the assignment of individual credit, the second volume is below the level of the first.

The vast field of the book could not be treated perfectly within the compass of its pages, as may be recognized when it is remembered that besides covering a certain proportion of introductory theoretical ground, the volumes purport to deal at once with all those branches which are treated in the courses on Central Stations, Electric Light and Transmission of Power, and Illumination and Photometry as they are presented by our electrical engineering department. But Professor Crocker's book must be marked "excellent."

It is a satisfaction to find in the author of this book another convert to the use of the letter f to indicate the frequency of alternating current, and to the use of $2\pi f$ (instead of abused ω) in reactance and impedance formulas.

Electromagnets; Their Design and Construction. By A. N. Mansfield, S. B., New York. D. Van Nostrand Company; 115 pages; 36 illustrations. Price 50 cents.

This little volume takes the place of Number 64 of "Van Nostrand's Science Series," i. e. "Electromagnets, the Determination of the Elements of their Construction," by T. H. Du Moncel. It is the outgrowth of an attempt to revise Du Moncel's work, which the author found impossible to revise without completely rewriting.

No originality is claimed and acknowledgment is made of indebtedness to the works of Du Bois, Jackson, and Thompson, reference to these and other authors being made throughout the text.

As a work upon Magnetism the book would not be a success, as there is nothing upon the theory of magnetism, and the explanations of the fundamental values and definitions are not very thorough and in many cases not entirely clear. Unless one is quite familiar with the theory of magnetism and the general principles involved, a rather superficial knowledge of these matters would be obtained.

However, the aim seems rather to have been to collect, in a convenient form, formulae and data which are essential to the design and construction of electromagnets used for various purposes. In this respect the work has some considerable value and the discussions as to materials of construction, form of cross-section of core, winding of coils, heating, etc., are very good. Various types of electromagnets are considered, such as those for lifting purposes, those for action over a distance, alternating current magnets, and polarized mechanisms. The Appendix contains tables showing the properties of copper wire, temperature coefficients, and weight of insulated wire.

A B C of the Telephone, By James E. Homans, A. M., Theo Audel and Company, New York, 1901.

The task of supplying the popular demand for a good book on telephony, and a difficult task it is, still remains to be performed, and the book here referred to instead of relieving, emphasizes the need of such a book.

With the rapid development in telephony, which in some communities has placed one telephone at the disposal of every ten of the inhabitants and is making the use of this instrument indispensible to everyone, there is naturally a popular demand for a book which will enable the non-technical reader to obtain an understanding of the general principles and details of the operation of the telephone. It appears that the book above indicated was written with the purpose of supplying such information. The book is attractively gotten up and the graphical information afforded by the copious and well selected illustrations is all that might be desired in a work of this sort.

Unfortunately, however, the publication of this book still leaves much to be desired in the way of a comprehensive treatise on telephone construction, installation and management for the use of the non-technical reader.

We have received a vest pocket copy of "Electric Sparks," by Prof. James A. Beaton, A. M. and published by Laird & Lee, Chicago, pertaining to electricity in all its branches and applications, with 116 illustrations. In addition there are tables of units, etc., and a short vocabulary of technical terms. It treats the subject of electricity in a very compact yet clear and simple manner.

How to become "A Good Mechanic," is a pamphlet intended as a practical guide to self-taught men, telling what to study, how to begin, etc., It was written by John Phin, and published by the Industrial Publication Co., of New York, being now in its second edition.

UNDERGRADUATE DIRECTORY.

SENIORS.

Mechanicals.

Adams, Bertram F., Chicago, Ill.
Anderson, Gustave A., West Salem.
Baxter, Frederic C., Mansfield. O.
Boldenweck, Felix W., Chicago, Ill.
Cole, Charles M., Appleton.
Cole, Harry W., Milwaukee,
Dow, Herbert W., Milwaukee.
Gibson, Wm. J., Hartland.
Grey, John C., Madison.
Hammerschlag, Jas. G., Milwaukee.
Hippenmeyer, Irving R., Madison.
McEvoy, Geo. E., Milwaukee.
Saunders, Arthur B., Milton.
Schapper, Kurt, Powers Lake.
Smith, Robt. T., Jr., Baltimore, Md.
Starks, Sanford P., Madison.
Stillman, Carl F., Milwaukee.
Thorkelson, Wm. L., Racine.
Whittemore, Herbert L., Madison.

Civil.

Balsley, Eugene A., Madison.
Be rg, Wm. C., Ft. Atkinson.
Diehl, Guy E., Elroy.
Ehrnbeck, Anton D., Appleton.
Greaves, Arthur R., Spencer.
Jensen, Carl W., River Falls.
Mabbett, Walter F., Edgerton.
Moore, Sherman, Brodhead.
Olsen, Arthur C., Madison.
Olsen, Sidney, Madison.
Polley, Geo. A., Albertville.
Schroeder, John T., Hartford.
Smith, Jas. E., Sharon.
Stevens, Chester H., Mason City, Iowa.
Stockman, Louis R., Milton Jct.
Sunderland, Ira C., Hartford.

Electricals.

Balding, Henry A., Milwaukee.
Bump, Milan R., Spokane, Wash.
De Lay, Frederick A., Madison.
Earle, Roy R., Darlington.
Ehreke, Gustave W. R., Wausau.
Gardner, Stephen, Madison.
Kelley, Patrick J., Manitowoc.
Kohl, Oliver B., Madison. ,
Lathrop, Wm. F., Madison.
Lea, John M., Waupun.
McKee, Louis A., Sp., Madison.
Pengra, Preston W., Madison.
Scott, Geo. A., Oshkosh.
Stieler, Frederick P., Stevens Point.
Terven, Lewis A., Columbia, S.C.
Watson, Jas. W., La Crosse.
White, Chas. M., Delafield.
Young, Henry W., Prairie du Sac.

General Engineering.

Grindell, Arthur B., Platteville.
Lennon, Hawley D., Decorah, Ia.

JUNIORS.

Electrical.

Adams, Benjamin C., Madison.
Atkinson, Oliver C., Sp., Chicago.
Bailey, Hiram E., Sp., Madison.
Belling, John W., Mondovi.
Bertke, Wm. J., Milwaukee.
Borden, Fred G., Plainfield.
Brobst, John E., Mondovi.
Brown, Lewis R., Oshkosh.
Cadby, John N., Madison.
Chamberlain, Frederick A., Madison.
Crandell, Willis E., Plainfield.
Crowe, Edward L., Marinette.
Crumpton, Wm. J., Sp., West Superior.
Ekern, Emil A., West Superior.
Elliott, Howard S., Mazomanie.
Friend, Jack H., Antigo.
Gapen, J. C., Monroe.
Goudie, Jas., Ironwood, Mich.
Hadfield, Ray H., Chicago, Ill.
Haman, Morris, E., Milwaukee.
Hejda, Chas. J., Manitowoc.
Hejda, Chas. W., Manitowoc.

Hill, Minot J., Almond.
Hopt, Robert V., Sp., Madison.
Huels, Frederick W., Madison.
Krumrey, Robt. G., Plymouth.
..Lathrop, Leigh H., Madison.
Lea, Harry L., Iron River.
Levisee, Lester H., Clintonville.
Lisberger, Sylvan J., Danville, Va.
Marvin, Frank C., Zumbrota, Minn.
Mott, Wm. R., Decorah, Ia.
Mueller, Edgar B., Manitowoc.
Neef, John H., Sp., Portage.
Potter, John C., Sp., Wauwatosa.
Pugh, John, Jr., Racine.
Quigley, Arthur, Lake Geneva.
Rowe, Wm. J., Warren, Ill.
Schmidt, Wm. F., Manitowoc.
Seaman, Irving, Milwaukee.
Spalding, Wm., Oshkosh.
Walker, Jas. A., Rockford, Ill.
Ware, Julian V., Madison.
Weber, Frederic C., Fond du Lac.
Woy, Frank P., Sparta.
Zimmermann, Jas. A., Milwaukee.
Zimmermann, Clarence L., Milwaukee.

Civils.

Adams, Walter K., Oneonta, N. Y.
Brandt, Hugo E. C., Watertown.
Burns, Joseph P., Sp., Watertown, N. Y.
Carter, Perry J., Sp., Mauston.
Cowie, Harry J., West Superior.
Cummins, Frank S., Des Moines, Ia.
Dessert, Howard L., Mosinee.
Foster, Rollins N., Shullsburg.
Frendberg, August F., Ashland.
Frick, Orlando H., Antigo.
Garvens, Gustav W., Madison.
Gilman, Jas. M., Madison.
Haase, Alvin, Milwaukee.
Hahn, John F., Tyndall, S. Dak.
Hawley, Ed. J., Sp., Green Bay.
Hotchkiss, Wm. O., Eau Claire.
Keachie, Geo. R., Cedar Rapids, Ia.
Laurgaard, Olaf, La Crosse.
Mannington, Jos. A., Madison.
McDonald, Leroy L., Rochester.
McNown, Wm. C., Mauston.
Peirce, Elmer A., Madison.
Perry, Claude H., Madison.
Saunders, Henry J., Madison.
Savage, John L., Madison.
Saxton, Wm. R., Berlin.
Stevens, Harold L., Madison.
Terrell, Edward E., Lynchburg, O.
Torkelson, Martin W., Black River Falls.
Warner, Henry M., Baltimore, Md.
Watson, Chas. T., Baraboo.
Wilson, John, Dodgeville.

Mechanical.

Alexander, Archie F., Milwaukee.
Anderson, Arthur E., Janesville.
Dean, Garrison C., Eau Claire.
Dean, John S., Madison.
Douglass, Courtney, Fontana.
Geerlings, Henry J., Jr., Milwaukee.
Holloway, Don C., Janesville.
Howland, Henry P., Springfield, Mo.
Johnson, Arthur L., Chicago, Ill.
Lyons, Benj. F., Appleton.
Morrison, Rowland H., Morrisonville.
Page, Harry W., Baraboo.
Rowe, Leonard L., Madison.
Rueping, Louis H., Fond du Lac.
Wedemeyer, Adrian A., Sheboygan.
Woodruff, Leslie B., Milwaukee.

General.

Goodenough, Chas. F., West De Pere.
Jorstad, Osmund, La Crosse.
Horsfall, Lloyd P., Prairie du Chien.
Trevarthen, Dwight C., Madison.

SOPHOMORE.

Civil Engineering.

Anderson, Aden W., Columbus.
Bennett, Wm. B., Mineral Point.

Borreson, Borge H., La Crosse
Brown, Wm. E., Racine.
Bull, Eyvind H., Madison.
Bunn, Samuel A., St. Paul, Minn.
Burkart, Herman F., Eau Claire.
Burns, Louis A., Watertown, N. Y.
Coon, Royden J., Plainfield.
Dering, Chas. M., Portage.
Dressendorfer, Ferdinand, Arcadia.
Epstein, Philip C., Portage.
Ewald, Robert F., Fairchild.
Fisher, Ernest J., Beaver Dam.
Gardner, Harry, Monroe.
Grout, Horace C., Wausau.
Hall, Merton G., Reedsburg.
Hall, Robert S., Ripon.
Hopper, Chas. V., Eau Claire.
Kahn, Gustave E., Milwaukee.
Keerl, Harry D., Mason City, Ia.
Keith, Geo. G., Johnstown.
Killey, Edward G., Geneva, Ill.
Kinne, Wm. S., Winona, Minn.
Kleifeld, Henry, Kenosha.

Civil Engineering.

Lynch, John H., Madison.
Martin, Hal E., Fond du Lac.
McCrossen, Ralph, Wausau.
McDonald, Harry N., Fond du Lac.
Moritz, Ernest A., Yankton, S. D.
Nicholaus, Arthur W., Beaver Dam.
O'Mara, Edwin, Chicago, Ill.
Owen, Ray, Footville.
Peterson, Carl A., Racine.
Ripley, Paul M., Oak Park, Ill.
Smith, Clyde C., Bangor.
Staack, John G., Middleton.
Tubesing, Wm. F., Milwaukee.
Van Hagen, Leslie F., Chicago, Ill.
Whitby, Willis, Jericho.
Wild, Edward C., Mayville.
Wood, Chas. L., Jr., Oshkosh.
Ziegeweid, Anton B., Arcadia.

Electrical Engineering.

Barber, Edwin L., Lenexa, Kas.
Biegler, Philip S., Madison.
Bleser, Arthur J., Bleser.
Blood, Frank H., Kenosha.
Bradford, Wm., Stevens Point.
Caskey, R. R., Chicago Heights Ill.
Conger, Raymond T., Elgin, Ill.
Crehore, Lawrence, Milwaukee.
Erwin, Olando R., Milwaukee.
Eustis, Chas. L., Ft. Atkinson.
Fairweather, Edgar W., Sheboygan.
Foster, Leslie G., River Falls.
Frost, Donald K., Winona, Minn.
Greisser, Victor H., Madison.
Hall, Edwin M., Chicago, Ill.
Hanson, Frank H., Stoughton.
Haugen, Chas. M., Chicago, Ill.
Heath, H. Marvin, Waupun.
Heidemann, Walter R., Waterloo.
Henry, Robert R., Anchorage.
Hillemeyer, Joseph E., Shullsburg.
Hills, Fred P., Menomonie.
Klinkert, Geo. P., Racine.
Krippner, Arthur F., Ft. Atkinson.
Lee, Norman, Cambridge.

Electrical.

McMullen, Vincent, Dodgeville.
Merrill, Zadock, Madison.
Murphy, Francis H., Balmoral.
Musil, Louis F., Manitowoc.
Musser, Jas. M., Madison.
Nicholas, Wm., Footville.
Noyes, John D., Baraboo.
Peters, Chas. S., Dodgeville.
Petura, Frank H., Racine.
Post, Geo. G., Madison.
Rosenstock, Louis G., Warsaw, Ind.
Rowe, Wm. A., Eau Claire.
Rowley, Frank, Evansville.
Saunders, Walter B., Madison.
Schwendener, Harry G., Milwaukee.
Servis, Frank A., La Crosse.
Shealy, Edward M. Columbia S. C.
Steenson, Burt E., Whitewater.
Stewart, Arthur T., Los Angeles, Cal.
Stewart, Jas. A., Van Kleek, Hill, Ont.
Townsend, John R., Waupaca.
Treber, Albert P., Deadwood, S. D.
Turner, Paul B., Stoughton.
Ungrodt, Geo. F., Medford.
Whiting, Max A., Watertown.
Zinke, Paul F., Fond du Lac.

Mechanical Engineering.

Allen, Jean M., Marinette.
Benedict, Wallace J., Milwaukee.

Cahoon, Ora B., Madison.
Cheney, Seymour W., Fond du Lac.
Elvis, G. H., Medford.
Evans, Robt. E., Madison.
Galloway, Edward W., Whitewater.
Gore, Warren W., Beloit.
Griswold, Robert G., West Salem.
Hagenah, Rudolph E., Reedsburg.
Haskins, Harold, Meadville, Pa.
Hauser, Wm. H., Fargo, N. Dak.
Hodge, John S., Waterloo.
Kales, Francis H., Chicago, Ill.
Kimball, Frank W., Janesville.
Koch, Walter J. Milwaukee.
Lachmund, Bruno, Sauk City.
MacArthur, Donald, West Superior.
McEachron, Edgar J., Green Bay.
McIntyre, Ivan M., Ft. Atkinson.
Morehouse, Louis B., Elkhorn.
Naramere, Floyd A., Mason City, Ia.
Olin, Edgar A., Waukesha.
Redman, Shelby W., Racine.
Saridakis, Frank J., Milwaukee.
Schoelkopf, Louis F., Welcome.
Thayer, Lyman F., Everett, Wash.
Tullock, Geo., Rockford, Ill.
Uihlein, Wm. B., Milwaukee.
White, Herford, Delafield.

General Engineering.

Drake, Eden W., Jr., Milwaukee.
Goetz, Edgar A., Milwaukee.
Lee, Allan, Cambridge.
Marshall, Albert L., Rensselaer, Ind.

FRESHMEN.

Ames, Daniel F., Clinton Jct.
Anderson, Lawrence A., Deerfield.
Austin, James L. Milwaukee.
Balch, Leland R., Neillsville.
Beebe, Matthew R., Woodruff.
Belden, Frank A., Kaneville, Ill.
Blackman, Horace L., Pleasant Prairie.
Blossey, Albert F., Cadott.
Bolles, Edgar J., Randolf.
Boone, Charles, Warren, Ill.
Borchert, Ernest, Jr., Milwaukee.
Borgers, Philip P., Neillsville.
Boynton, John E., Jr., Jerseyville, Ill.
Bradshaw, John W., Jr., Superior.
Breitkreutz, Emil W., Wausau.
Brennan, Bernard C., Cato.
Brown, James A., Madison.
Bruemmer, Arno C., Kewaunee.
Bucklin, Winslow W., Brodhead.
Burke, Thomas J., Winona, Minn.
Burling, Lancaster D., Freeport, Ill.
Burnett, Earle S., River Falls.
Burton, Maxwell L., La Crosse.
Casserly, James F., Madison.
Clark, Sherman B., Elgin, Ill.
Cole, Herbert S., La Crosse.
Conrad, Nicholas J., Port Washington.
Corbett, Lester L., Ladysmith.
Craig, William H., Chicago, Ill.
Craigo, Ralph T., Monroe.
Cratty, Paul, Oak Park, Ill.
Cronk, Forbes B., Madison.
Crugar, Edward L., Glasgow, Mo.
Dearborn, Philip C., Stoughton.
Derge, Matthias L., Eau Claire.
Dorner, Fred H., Milwaukee.
Duckett, Walter E., Burlington.
Dummert, Frank G., Milwaukee.
Dyer, George H., Milwaukee.
Edwards, Evan C., Appleton.
Elmore, Samuel E., Milwaukee.
Evans, David J., Baraboo.
Falconer, Donald P., Corry, Pa.
Findlay, William W. H., Kansas City, Mo.
Fisk, Andrew J., Helena, Mont.
Ford, Ralph H., Tomah.
Forrester, Abraham C., Racine.
Froehlich, John A., Madison.
Fruit, Clarence H., La Crosse.
Fuller, Eugene, Madison.
Furer, William C., Sheboygan.
Gates, Howard B., Milton Jct.

Gauger, John C., Manitowoc.
Gierow, Otto A., Chilton.
Goodman, Isaac, Marinette.
Goodner, Ivan E., Pierre, S. D.
Gould, Fred C., Council Bluffs, Ia.
Graff, Christian F., Seattle, Wash.
Graham, Guy A., Reedsburg.
Grant, Robert L., Milwaukee.
Green, Daniel, Whitewater.
Green, Joseph A., Cherokee, Ia.
Grier, James H., Lake Geneva.
Haertel, Carl F., Portage.
Haley, George H., Watertown, N. Y.
Halverson, Oscar T., Milwaukee.
Hamilton, Charles W., Plainfield.
Hankinson, Ray L., Evansville
Hansen, Charles A., Milwaukkee.
Harlacher, Lloyd, Freeport, Ill.
Harvey, William R., Madison.
Hawkins, Louis W., Waukegan, Ill.
Hawley, Royal D., Chicago, Ill.
Hebron, Raymond, Sparta.
Helmholz, Arthur W., Madison.
Hiestand, Clarence L., Oregon, Ill.
Hill, Leon A., Fish Creek.
Hoag, Lee S., Waukesha.
Hoefer, Chester A., Freeport, Ill.
Hoefer, Elmer G., Freeport, Ill.
Hofmann, Lothar, Fort Wayne, Ind.
Hosig, Irwin B., Hartford.
Houghton, Howard W., Milwaukee.
Howland, Marvin W., Eagle Grove, Ia.
Hoyt, Ray S., Bellvue, Neb.
Hubbard, Maynard G., Kilbourn.
Hueffner, Otto J., Racine.
Hunner, Hale H., Eau Claire.
Inbusch, Herbert S., Milwaukee.
Inbusch, Walter H., Milwaukee.
Irving, Thomas J., Watertown.
Ives, William E., Amboy, Ill.
Jacobs, Ernest R., Aurora, Ill.
Jaeger, Rudolph J., Dubuque, Ia.
Jenkins, Frank B., Grand Tower, Ill.
Jones, Richard, Waukesha.
Jones, William N., Astoria, Ore.
Kayser, Edward M., Green Bay.
Kershaw, George D., Wauwatosa.
King, Max W., Madison.
Kirkland, Harry B., Janesville.
Klatte, Alfonzo J., Milwaukee.
Kuelling, Herbert J., Shullsburg.
Larkin, Fred V., Verona.
La Roy, Herbert A., Jr., Waukesha.
Larsen, Albert, Milwaukee.
La Rue, George A., Reedsburg.
Latta, Warren H., Clinton.
Leary, James H., Monroe.
Legreid, Herman N., Stoughton.
Leins, Oscar J., S. Germantown.
Linquist, Ira F. A., Marinette.
Long, Fred A., Davenport, Ia.
Lowry, Elton C., Menomonee Falls.
Lyons, Emmett G., Madison.
MacMillan, Harold S., Wauwautosa.
Mainland, John, Racine.
Manegold, Robert A., Milwaukee.
Mann, Franklin H., Shullsburg.
McWethy, Frank H., Aurora, Ill.
Meadows, Orley J., Oconomowoc.
Meyer, Adolph F., Cedarburg.
Millar, William J., Milwaukee.
Miller, Arthur H., West Salem.
Morgan, Walter D., Reedsburg
Morrison, Harry I., Eau Claire.
Morrissey, Patrick W., Mauston.
Muir, Roy C., Arcadia.
Nash, Robert L., Grand Rapids.
Nedeleff, Paul P., Madison.
Nelson, George W., Manitowoc.
O'Brien, Leo L., Sparta.
Olmsted, Lewis W., Boone, Ia.
Olsen, Rossie G., Arcadia.
Olson, Harry M., Madison.
Orbert, Edwin G., Green Bay.
Pavy, Edward F., Wauwatosa.
Perkins, Willis D., La Crosse.

Persons, Archie L., Arkansaw.
Peterson, Harry, Phillips.
Peterson, Henry W., Waldo.
Pfahler, Fred S., Mason City, Ia.
Porter, Julian C., Lake Mills.
Potts, Frederick A., Rural.
Price, John R., Cambria.
Purple, Cullen D., Galesville.
Pyatt, Horace S., Oak Park, Ill.
Ramstad, Albert G., Eau Claire.
Ramstad, George H., Eau Claire.
Reed, Carl S., Canandaigua, N. Y.
Reich, Albert I., Tunnel City.
Rice, Leverett E., Madison.
Ritger, Arthur, Appleton.
Robinson, Benjamin A., Kenosha.
Robinson, Ray F., West Superior.
Rodenbaeck, George A., New Holstein.
Rood, Charles M., Reedsburg.
Rosstead, Oliver B., Eau Claire.
Russell, Claude V., Portage.
Sampson, Henry A., Grand Rapids.
Samuels, Collins W., Darlington.
Schattschneider, Sylvester, De Forest.
Schmidley, William R., Janesville.
Schoengarth, Edward H., Neillsville.
Schoephoester, Albert J., Reedsburg.
Schumacher, Arthur H., Chicago, Ill.
Selbie, William E., Deadwood, S. D.
Seyton, Harry J., Richmond, Ill.
Shepard, Colin R., Depere.
Sherron, Frank J., Monroe.
Sinz, Edward F., Johnsonville.
Smith, Homer H., Chicago, Ill.
Smith, Joseph R., Milwaukee.
Snow, William M., Mineral Point.
Soper, Charles P., Darien.
Stack, James R., Madison.
Starr, Edward M., Washburn.
Sterling, Ely D., New London.
Stock, Harry, Madison.
Stroud, Samuel L. L., Oshkosh.
Sunderland, Clarence S., Hartford.
Swan, George D., Burlington.
Tenner, Otto F. C., Green Bay.
Thon, George L., Aurora, Ill.
Vinson, Albert W., Milwaukee.
Walter, Roscoe G., Mazomanie.
Ward, Hugh C., Madison.
Warner, Jesse W., Mason City, Ia.
Warren, Ray C., Waupun.
Washburn, David C., Racine.
Weatherlow, Guy P., Madison.
Weaver, Ernest R., Sussex.
Weld, Harold K., Elgin,Ill.
Wharry, Major E., Elkhorn.
Wheeler, William S., Chicago, Ill.
Whinery, Ralph H., Marshalltown, Ia.
White, Fred G., Waterloo.
Whyman, Robert H., West Aurora, Ill.
Willison, Charles D., Fennimore.
Winger, Carl, Grand Rapids.
Winkley, George R., Clinton.
Wray, Edward, Janesville.
Wright, Allen E., Perrysburg, N. Y.
Wright, Oscar W., Lancaster.
Wulfing, Harry E., Viroqua.

SENIOR THESIS.

Civil Engineering Course.

Clade Berry, Madison—A design of a drainage system for the swamp areas in east Madison.

William Courtenay Burdick, Milwaukee—An experimental study of the properties of terra cotta.

Russell John Hawn, Stevens Point—A design of a drainage system for the swamp areas in east Madison.

Walter Paul Hirschberg, Milwaukee—A design of a bascule bridge at Grand avenue, Milwaukee, Wisconsin.

John Thomas Hurd, Stoughton—The purification of sewage by means of the septic tank and bacterial beds.

Harry Ashton Severson, Milwaukee—Timber preservation.

Frank Edwin Washburn, Sturgeon Bay—The purification of sewage by means of the septic tank and bacterial beds.

Lester Denison Williams, Fox Lake—Metal railroad ties.

Mechanical Engineering Course.

Clare Herbert Bachelder, Madison—An efficiency test of the Boscobel electric light plant.

Louis Henry Barkhausen, Green Bay—Design of a triple expansion engine.

Frederick William Buerstatte, Manitowoc—A friction test of the University of Wisconsin compound steam engine.

Charles Lyman Dean, Seymour—A friction test of the University of Wisconsin compound steam engine.

Nathaniel Leslie Hurd, Chippewa Falls—The separation of losses of the Gisholt Machine Company's plant.

Arthur Charles King, Madison—Power plant and sub-station test of the Oshkosh street railway system.

Fritchiof Johnson Vea, Stoughton—The separation of losses the Gisholt Machine Company's plant.

Henry Harrison Wood, Stebbinsville—The separation of losses of the Gisholt Machine Company's plant.

NOTICE TO SUBSCRIBERS.

The business manager wishes to enter a protest which is hoped will bring returns.

It refers to the thoughtlessness of all our subscribers in regard to that little note at the bottom of each ad. page.

MENTION THE WISCONIN ENGINEER WHEN YOU WRITE! We know that our journal has a large enough circulation to bring returns to advertisers. But those who advertise don't know it nor will they believe it without tangible evidence. A little care in this respect will do much toward keeping THE ENGINEE in the front rank of college journals.

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Ernest Friend Legg, Wausau—A study of the illumination of interiors.

Alvin Meyers, Verona—A comparison of electrical losses on aluminum and copper lines under pressure of 20,000 to 60,000 volts.

Merritt Norton Murphy, Twin Lakes—Indirect illumination with application to the Engineering building of the University of Wisconsin.

Albert Adam Nicolaus, Beaver Dam—Power plant and sub-station test of the Oshkosh Street Railway system.

Hylon Theron Plumb, Milton—Electrolytic corrosion of iron by alternating currents.

Ray Palmer, Madison—Power plant and sub-station test of the Oshkosh street railway system.

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Hubert Isaac Townsend, Poynette—A study of the illumination of interiors.

General Engineering Course.

Clarence Eugene Abbott, Madison—Microscopic investigation of alloys.

Mechanical Engineer.

Halsten Joseph Berford Thorkelson, B. S. (University of Wisconsin), Racine—Some phases of manufacturing shop methods and management.

ELECTRICAL ENGINEER.

Carl Hambuechen, B. S. (University of Wisconsin), Milwaukee—Electro-Chemistry and Organic Chemistry. The aluminum cell as a rectifier of alternating currents.

Bernard Victor Swenson, B. S. (University of Illinois), Madison—Electrical Engineering. Calculations for a light and power plant.

ALUMNI LETTERS.

It is our purpose to keep in closer touch with our Alumni than has been the case formerly and to this end letters, were written to our Alumni who graduated in mechanical engineering, requesting a short account of their experiences after leaving college. Some have complied and we publish their letters. We will publish those of the electrical and civil engineers in our future numbers.

Walter Alexander, U. W. '97 has charge of the Mechanical Engineering Department of the University of Missouri at Columbia, Mo. The University is a state institution and is made up of the following departments: Graduate, Academic, Education, Law, Medicine, Agriculture, Mechanic Arts and Engineering, all located at Columbia and the School of Mines at Rolla.

The Engineering Department is housed in a General Engineering building and a shop or Mechanic Arts building. The total number of students is about 2,000, about 10 per cent. being engineering students. The M. E. course is about the same as at the U. of W., except in laboratory work. In another year the laboratories will be enlarged by the addition of a wing on the Engineering building and $30,000 worth of new equipment. Mr. Alexander's work consists of instructing in steam engineering, machine design and mechanics.

Byron B. Carter, consulting mechanical engineer and designer of machinery, Chicago.

I graduated with the class of '83. Following that time I spent the years until fall of '85 in various places and kinds of work, mostly in the line of my education, but of no particular importance except as to gaining experience. The fall of '85 I secured a position as draughtsman with the M. C. Bullock Mfg. Co., Chicago. In the following summer of '86 I was appointed chief designer and acting assistant superintendent for the same firm. I remained with this firm until September, '91, when I opened an office of consulting work and machinery design here in Chicago.

The years from '93 to '99 were very lean for professional men, particularly in engineering lines, and I suffered with the rest. But I held on as best I could and am at the same work now, located at 1644 Monadnock building, Chicago.

I have followed machinery designing as a specialty, especially that of automatic and special machines, and have secured something of a reputation in these lines. About the most difficult yet successful example is a very delicate but massive machine for cutting and forming "expanded metal" lathing. Perhaps, however, my best work has been in the line of machinery for operating bridges, and other structures in the line of civil engineering. In these I have been associated with civil engineers, and have had professional connection with many bridges in Chicago and vicinity. The largest and most important was the government bridge between Rock Island and Davenport, of which I was appointed mechanical engineer by the government.

Later I have been connected with other large works, the latest having just been finished, but am not at liberty to state what it is.

Most of my consultation work is connected with mechanical devices for civil engineering works. My residence is at Hinsdale, Ill., seventeen miles out of the smoke, dust and noise, where I have a wife (nee Cora Walbridge, U. W. '84) and three girls as a family.

C. H. Hile, '94.

Boston Elevated Railway Company, 522 Harrison Avenue. Office of Superintendent of Wires.

Replying to your favor of the 23rd inst. asking for a brief sketch concerning the personality of, and niche filled in this great work-a-day world by one of Wisconsin's Alumni, I would say you are more than considerate in making a point on a "brief sketch," for there truly seems little to say.

I have been with the management of the Boston Elevated Ry. Co., since 1894, starting in as engineer in charge of underground conduit construction. At present my title is as given above and the position is that of the head of the Department of Wires and Conduits.

The duties of the position involve the care and supervision of all overhead trolley and feeder wires and all underground conduits and wires, also the planning and construction of all new work in this line and all electrical calculation and investigation connected with the building and maintaining of our distribution system. As the road operates something over 400 miles of track, has about seven miles of elevated construction and nearly a mile of four-track subway and seven power stations to furnish the power, you can understand that there is plenty to occupy my time. The department requires from 200 to 250 men, made up of engineers, inspectors, foremen, linemen, clerks and laborers. The work is thoroughly congenial to me, full of variety and experience, and at no time do I ever find time hanging heavily on my hands. I have been married since 1897, have a fine young engineer about 16 months old to make our home happy, and am more than satisfied with Boston as a place to live.

I shall always be glad to have any of old Wisconsin's boys hunt me up when they come to Boston.

W. H. Kratsch, '97.

Have been for the past three years engaged with The Geo. Challoner's Sons Co., as their desingner and am at present combining this position with that of general superintendent of shops.

XENOPH/N CAVERNO, '90.

Every once in a while I get a letter from Prof. Frankenburger asking me to fill out the accompanying postal card with my name and address and also give a list of higher degrees conferred on me and of offices or positions of distinction to which I have been elected or appointed. At such times my eyes involuntarily wander to the wall of my office where a neat oak frame encloses the following:

To all to whom these Presents may come, Greeting: Know Ye, that having made due inquiry into the mechanical skill, character and ability of

XENOPHON CAVERNO
in the
SCIENCE OF SANITARY PLUMBING

and having thereby acquired special trust and confidence in his ability and having found him to possess every qualification, etc. etc. We, the Board of Examiners of Plumbers of the City of Peoria, Illinois, do hereby cheerfully issue this certificate, etc.

So far as I know I am the only graduate of the U. W. who has attained this high honor. I am greatly indebted to my university training for the ease with which I passed the arduous examination leading to this honorable degree. As I recollect it the examination in "mechanical skill" consisted in calculating the capacity of a tank of given dimensions while the examination in "character and ability" consisted in demonstrating the capacity of my own.

I wish here to make public acknowledgment of my indebtedness to Prof. Van Velzer and Joe Hausman for the training which enabled me to rise to this occasion.

In strictly mechanical lines I have developed some proficiency in running the local political machine, having held the distinguished offices of chairman of the Third ward Central Committee and Secretary of the City Central Committee. I was also elected church trustee for one term only.

In science I have distinguished myself by raising a full-

blooded octopus which developed so rapidly that in a few months it fell upon and devoured the local gas and electric light companies, each of which had octopus ambitions of its own.

I remember that, when I left Madison, Prof. Frankenburger prophesied that I would not stick to engineering but would take up some form of "thought expression." This has proved true. I am a poet. The following lyrics have appeared anonymously in the local papers. Being modest I have made no claim of authorship here but I wish to show my U. W. friends how well Prof. Frankenburger's prophesy has been fulfilled.

A man who lived up at Spring Grove
Bought his wife a new gasoline stove
    And the very first night
    She was blown out of sight
And she hasn't come down yet, By Jove!

A woman who lived in Kewaunee,
Was healthy, athletic and brawny,
    But her coal stove they tell
    Kept her house hot as—well
She's now lean and ill-favored and scrawny.

The base insinuation has been thrown out that these gems are not strictly humanitarian and altruistic in their aims but are designed to boom the gas stove business for the octopus.

I am glad to inform my friends that, in spite of my "higher degree," it is not my ambition to be a proud and haughty but soulless plumber rolling in my ill-gotten wealth, but that I intend from now on to carry light into dark corners of the world in this vicinity and hereafter as an humble monopolist and president of a trust I shall spend my declining years in idyllic simplicity, laying up treasures in Heaven and on earth.

P. S. I reserve the right to vary this program by knocking off occasionally for a caucus or a football game.

A. L. Goddard, '96.

I am at present chief draftsman of the Mechanical Engineering department of the New York Shipbuilding Co., of Camden, N. J. My work here for the past two and one-half years has been the design of special machines for shipyard work, and the maintenance of equipment. This requires a drafting room force of eight or ten men and boys. We use individual two-horse motors on most of our machines and the motor connections for most of these have been designed and made here. We use direct current for our electric cranes. We have hydraulic power at 1,500 pounds per square inch and compressed air at 100 pounds per square inch pressure. The adaptation of these various forms of energy to modern methods of manufacture is very interesting work, and the results of such efforts now so extensively being made in the shipyards throughout our country will, before long, permit American shipbuilding to rank with American bridge construction in the engineering and commercial worlds.

E. S. Luetk, '97.

At present I am employed by the Brown Corliss Engine Co., now erecting large modern shops near Racine, for which I have drawn up plans for their power house, heating plant and forge shops, including all piping, both steam and water, for the entire plant. Have located all of their heavy machines for the machine shop proper and drawn up foundation plans for rereceiving the same, as well as designing the electrical gearing by which the large machines are connected to motors. The principal work for the summer has been on the general arrangement of the machine shops; but in addition have done considerable designing on Corliss engines which the company intends to build in the near future. The company will be prepared to build engines up to ten thousand horse-power per unit, either horizontal or vertical design.

J. A. Farris, '00.

In reply to yours of Oct. 23rd will say I hardly know what you want, but will try and help you out.

I am at present assistant foreman in the piece making department of The Cutler-Hammer Manufacturing Co., Milwaukee.

XENOPHON CAVERNO.

In reply to your favor of the 23rd, will state that since my graduation in June, 1900, I have been employed as special apprentice with The Chicago, Milwaukee & St. Paul Railroad at West Milwaukee. This special apprenticeship consists of two years' work in the machine shop repairing locomotives, and two years in the draughting room.

The work in the shop is divided into gang work, such as the "floor gang," which does all the general erecting and repairing about the locomotive, or the "guide gang," which performs all the work to be done on guides, or the "wheel gang," which gets out all the work to be done on wheels, etc.

The draughting room work, of course, consists of tracing, draughting, and a little designing which the special apprentice is given.

Besides shop work and draughting room work, the apprentice is often called upon to go out upon the road with the dynamometer car to test locomotives, or to make coal tests, or any other such tests as will be of servic to th company.