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The Wisconsin Engineer

NOVEMBER, 1911

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The Wisconsin Engineer

VOL. XVI NOVEMBER, 1911 NO. 2

INDUSTRIAL CHEMICAL RESEARCH.

CHARLES F. BURGESS.
Professor of Applied Electrochemistry.

Industrial chemical research has been given a tremendous impetus in the country during the few years just past. Numerous research laboratories have been organized during the last decade, and there is an unsatisfied demand for men qualified to direct and to carry on investigative work.

This development is due to certain industrial conditions. England and Germany long ago appreciated that industrial supremacy does not necessarily depend upon control of natural resources, but that the development of the human mind with the resultant increase of knowledge and invention is of greater importance than is the abundance of cheap raw material. This country is beginning to think along the same line, and with the withdrawing of unfair transportation advantages, the prohibition of various monopolistic advantages, and the prospective reduction or removal of protective tariff the industrial managers are looking more and more to cultivating that supremacy which comes through superior knowledge.

In addition to feeling the necessity for study of improvements, the industrial fraternity has begun to learn the possibilities of scientific study. While there are very few managers who will ask for a large appropriation for scientific work involving a certain temporary reduction in dividends with an uncertain guarantee of commensurate advantage, there are nevertheless a few managers who have demonstrated in a striking degree the business wisdom of the proposition of making appropriation for research.

Then, again, our educational institutions are giving more attention to the training of men fitted to go into industrial development work, and it is not now so necessary as it was a few years ago to look to Germany for scientifically trained research men.

It would be difficult to name a half dozen laboratories devoted exclusively to industrial research in existence in this country fifteen years ago, but now this number is greatly exceeded and is steadily increasing. These laboratories include those privately endowed, those supported by government appropriations, others forming a part of some of our larger educational institutions, those operated by industrial concerns and others maintained by manufacturers' associations.

Scientific research was greatly benefited in this country a decade ago by the founding of the Carnegie Institution of Washington. A large sum of money was appropriated annually, major grants being applied to a few important departments of scientific work, and a great number of small grants being made to numerous scientific workers throughout the country. The investigation of a great variety of problems was thus made possible. The overshadowing importance of the larger projects, the somewhat disappointing results of the minor grants, and the limitations on the resources caused the management to withdraw support to the numerous investigators through the country who could devote but part of their time to the work. Although the kind of work fostered by the Carnegie Institution was that which is more strictly scientific the results have been in large part of industrial importance, and much of the work of the Geophysical Laboratory operated by the Carnegie Institution is of importance to the chemical engineer.

Among the United States government laboratories in which important scientific work of industrial importance is being carried on are the Bureau of Standards, and the Bureau of Soils, at Washington; also the Laboratories of the Bureau of Mines at Pittsburg, and the Forest Products Laboratories at Madison and Wausau, Wisconsin, and the Watertown Arsenal.

In reviewing some of the notable results already achieved and the important work under way at these laboratories we cannot help but be impressed with the profound influence which they must have on industrial development of the country. The investigation of electrolytic corrosion of underground structures, the study of efficiency of illumination, the standardization of practice, the improvement in safety devices, the investigation of efficiencies of fuel, the discoveries of how to prolong life of timber, the discovery of new sources of timber for paper manufacture, the utilization of what were formerly the waste products of the forest and mill are illustrations of the important lines of work in these laboratories.

There is probably no one man in this country who has done more to stimulate interest in industrial research, and especially to point out the wonderful results which can be achieved through the application of chemical knowledge to the industries than has Professor Robert Kennedy Duncan of the University of Kansas and the University of Pittsburg. Through remarkable literary ability which he combines with his knowledge of chemistry he has aroused tremendous interest through his book entitled "The Chemistry of Commerce," and other publications. In appraising the progress in industrial chemistry we cannot overlook the important influence which Professor Duncan has exerted not only through discovery, but in arousing public interest in and enthusiasm for research. Large sums of money have been placed at his command by industrial people, whereby he is enabled to scour the country, employing those who are qualified to carry on research, putting them at important problems, and achieving honors not only for himself but for the educational institutions with which he is allied, and for those men who are working under his direction.

Another important educational laboratory is that at the Massachusetts Institute of Technology and styled the "Research Laboratory of Applied Chemistry," which under the able direction of Professor W. H. Walker has achieved notable results.

In naming the important educational laboratories which are doing work in industrial chemical lines modesty should not forbid our naming the chemical engineering laboratories of the

University of Wisconsin where much research aside from that necessarily a part of regulation instruction has been carried on. The Engineering Experiment Station of the University of Illinois has also been calling for men of ability for industrial research.

The most notable example of research laboratories supported by the industries is that of the General Electric Company of Schenectady, N. Y. Any one of a large number of important discoveries has amply repaid the management for the hundreds of thousands of dollars which have been spent on this laboratory, and the results have been such as to benefit not only the stockholders of the company but the country at large. In analyzing the reasons for the great success of this laboratory it is impossible to determine how much is due to the liberal policy under which the laboratory has been organized and how much is due to the remarkable man at its head, Dr. W. R. Whitney.

Among other industrial research laboratories may be named that of the Welsbach Company, the National Carbon Company, the DuPont de ne Mours Powder Company, the United Gas Improvement Company, etc. Perhaps the only laboratory devoted entirely to research concerning iron and steel is that of the American Rolling Mill Company, of Middletown, Ohio, under the direction of Mr. W. J. Beck. A few years ago this company placed upon the market a grade of iron of exceptional purity. To determine all the properties of this new industrial material required much investigation, and the policy of the company to place quality above quantity made research so important as to warrant the establishment of a laboratory from which routine work is excluded and in which the workers have unrestricted opportunity to investigate. While there are but a few laboratories of this type in existence at the present time, there is reason for predicting that the number must of necessity multiply in the near future.

When it is appreciated that the maintenance of research laboratories involves large expense, for high salaried workers, for materials, etc., expense which is usually classified in accounting practice as "unproductive," we can appreciate the hesitation which is frequently exhibited by managers who may in fact be friendly to research work. By co-operation among various manufacturers such expense may be shared, and as a result we have laboratories such as that of the National Electric Lamp Association, and of the Scientific Section of the Paint Manufacturers Association.

Among the important influences promoting research must be included the various technical and engineering societies who have numerous special committees appointed to investigate industrial problems. Among these societies are The American Gas Institute, and the American Society for Testing Materials.

The preceding paragraphs will indicate something of the investigative spirit which is pervading American industry, and will show why it is that there is a larger demand for skilled investigators than there are for men to supply vacancies or to undertake projects which have been delayed simply because of the lack of available workers of the right qualification.

INDIRECT ILLUMINATION.

J. A. Hoeveler, '11.

Physiological Reasons Why Indirect Illumination Is Desirable.

It is quite generally admitted that great injury to the human eye results from the common methods of exposed lighting. Medical authorities agree that since the brilliant lamps of the last half century have made artificial illumination practical for long continued work, the number of eye troubles directly attributable to this source has greatly increased. The increase in the numbers of tall buildings crowded closely together in our cities is rapidly increasing the number of persons required to work by artificial light during part or all of the day. The realization of the shortcomings of the ordinary direct lighting has led to an extensive study of illumination methods, with the general aim of meeting the physiological requirements of satisfactory lighting.

The eyes of the people who are compelled to work by artificial light are subject to a continuous strain due primarily to three harmful effects. First of all, they are exposed to a pure heat effect. Light radiation is a form of energy, and therefore, when intercepted or absorbed, is converted into heat. The light which enters the eye is thus converted into heat; and, if its power is considerable, it may cause harmful effects like inflammation and burns. Our common illuminants, such as arclamps, gaslamps, incandescent carbon, tantalum and tungsten lamps are rich in yellow, orange, red and infra-red rays. For a given lighting effect on the eye these rays represent vastly more power than the diffused daylight of a room. While ordinary illuminants are not of sufficient intensity to cause burns, they do cause eye fatigue and serious inflammation. The second harmful effect is due to the strain which the eye continually encounters when trying to perceive equally well both dark and lights objects in a room. The bright objects, as for instance the lamp filaments, cause the contraction of the pupil, in order that just sufficient light may fall on the retina of the eye to give a clear image of the filaments; therefore, the light reaching the eye from the more dimly illuminated objects, is not of a sufficient intensity to form a clear image of these objects on the retina. No doubt most persons are familiar with this phenomenon. A good example is the difficulty encountered in trying to read the figures on a blackboard when an exposed light is interposed between the reader and the blackboard. This is very often the case in classrooms which are still illuminated by old systems installed before much attention was given to the proper spacing and location of artificial light units. The magnitude of the strain on the eye of accommodating itself is greater or less, depending upon the position of the light with reference to the eye; but nothing except the removal of the light from the range of vision will relieve the eyes of this strain. The third harmful effect of exposed lighting is the fatigue due to annoying shadows. If the room is lighted by a single unit, there will be only one deep shadow, which, though avoidable, is nevertheless of considerable annoyance. If, as is more often the case, a number of light units are distributed throughout the room the eye is confronted with a multiplicity of light shadows, all of which can not be avoided, no matter how the position of a person is shifted. These shadows are very harmful, rapidly causing fatigue of the eyes and bodily nervousness.

To overcome these shortcomings of the common methods of illumination, numerous methods are in use. Sometimes, diffusing and diffracting globes are placed around the light source to reduce the intrinsic brilliancy. In order to give a better diffusion of light, and to eliminate shadows, as much as possible, a number of distributed light units are used where one large unit might have been used. Again, light units are often placed high up, out of the range of ordinary vision. This necessitates the use of light sources with a downward distribution, and gives rise to the use of various scientifically designed reflectors. Finally, with indirect illumination, the light source is completely hidden. By means of reflectors of scientific design the light is thrown to the ceiling, and from there is reflected back into the room below. The resulting illumination protects the eye from direct heat rays, reducing this effect as much as possible. Since the light source is completely hidden, the pupil of the eye may expand freely and so easily distinguish all objects equally well. Furthermore shadows are eliminated to a more marked degree than is possible by any other of the present systems of illumination.

That indirect illumination is a very desirable system of lighting for many interiors is by no means a new idea. As early as 1881, an indirect illumination system made its appearance at the Paris Electrical Exhibition of that year. Jasper, its inventor, used arc lamps with conical white reflectors of nickel iron placed beneath the lamp. A Germañ engineer, Schuckhert, adopted the same idea and installed Jasper's system in two drawing schools in Leipzig in 1885. Later he also installed the system in the Industrial School, in the Anatomical School of Vienna, and in the Architectural School of Nürnburg. Erissmann, of Moscow, first introduced indirect illumination in Moscow, using petroleum lamps. Professor Rank, of Halle, used arc lamps with opaque white reflectors of a hemi-spherical shape in his lecture room. In 1893 he substituted white milk glass reflectors and obtained an efficiency 10 per cent higher than that obtained with the opaque reflectors. F. Kermaner and W. Prausnitz used Welsbach's incandescent gas lamps with conical milk glass reflectors for school room, lecture room, and work room purposes in 1897. One of their most notable installations was the "Hygienic Institute," of the University of Graz. In 1908, an indirect system was installed in the waiting room of the Union Depot, Washington, D. C. In this system arc lamps were used. Since the recent introduction of a new system of indirect light, which employs tungsten lamps and specially designed silver-plated reflectors in centrally located fixtures, indirect illumination is coming into more and more extensive use, and a choice between direct and indirect light has become a real engineering problem.

Indirect illumination unfortunately requires the fulfillment of a number of conditions which are not so essential in the use of direct light. Each installation must be planned and laid out in a scientific manner. Hit or miss guess-work in the planning of an indirect system of lighting for a given installation may result in a failure. It is this feature which retards the growth of this system of lighting.

First of all the nature of the ceiling and the walls of the room, together with the purpose for which the room is to be used, must be taken into account, and it is this factor which usually determines the advisability of installing indirect illumination. A room to be equipped with indirect light must be free from skylights and overhead structures, such as roof trusses and

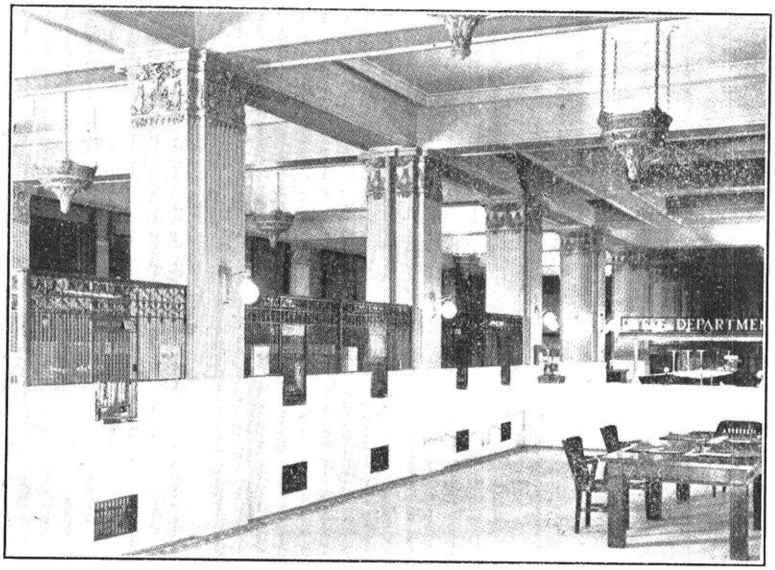

FIG. 1.—*Title and Savings Trust Company, Kansas City.*

line shafting, which will seriously affect the reflection of light. Beams may or may not be a hindrance, depending on the conditions of each individual installation. They become a serious hindrance only when they are placed close together and are fairly deep. In order to insure illumination at reasonable cost the ceiling must be an efficient reflecting surface. A dull white ceiling is the best reflecting surface obtainable. Its efficiency—about 80 per cent—approaches that of white blotting paper. It is essential also that the ceiling be of a dull rather than of a glazed finish, since the former will give a better diffusion of the light than the latter. For best efficiency the ceiling ought to be white, but because of the flat appearance of a dead white, a light cream is preferable. The efficiency of cream is nearly that of white. For highest efficiency, the walls also ought to be white, but since they then have an irritating effect on the eyes, it is best to finish them in a darker color. Such colors as gray, green, blue and red absorb a large percentage of the incident light, whereas light buff, dark buff and brown do not absorb such a large percentage. The latter colors are to be preferred for wall tinting, since they subdue the light sufficiently with a lower loss of efficiency. The purpose for which a room is to be used must be such that the ceiling and walls will remain clean for a reasonable length of time, and that the fixtures will not catch up unusually heavy quantities of dust, and dirt in a short time.

It is evident that the indirect system is not suited to interiors in which skylights or dark ceiling decorations are used, as in some churches, and especially in interiors of antique architecture, or in which there are large overhead structures, as in shop buildings. Even though a shop is free from overhead structures, it usually would prove too expensive to put in and maintain a good reflecting ceiling. Indirect illumination is, however, particularly adapted to the following uses: school rooms, churches, theatres, auditoriums, reading rooms, stores, billiard halls and club rooms, offices and residences. In most of these places a number of persons are usually assembled; and for this reason a well diffused light becomes necessary. Furthermore, conditions are usually satisfactory, or can be made satisfactory, for the successful installation of indirect light. The ceilings and walls remain clean for considerable periods, and the fixtures need not be cleaned any more frequently than direct light fixtures. If the illuminating engineer and the architect work hand in hand, ideal results in illumination can be produced; and when this becomes a universal custom the field of usefulness of indirect illumination will be greatly enlarged.

The endeavor to obtain good efficiency also requires the use of a highly efficient light source. There are a number of illuminants that might be used, but a number of reasons present themselves which show that the tungsten lamp is the best suited. Arc lamps can not be considered for the same reason that they are not used extensively for interior illumination with direct lighting. Incandescent gas lamps are difficult to light, especially when hung high up from the floor. If a pilot light is used, the efficiency is necessarily decreased. The carbon and tantalum lamps are not efficient enough. The tungsten lamp is very efficient, and is now almost universally employed where indirect light is used. It can be obtained in 40, 60, 100, 250, 400 and 500 watt sizes.

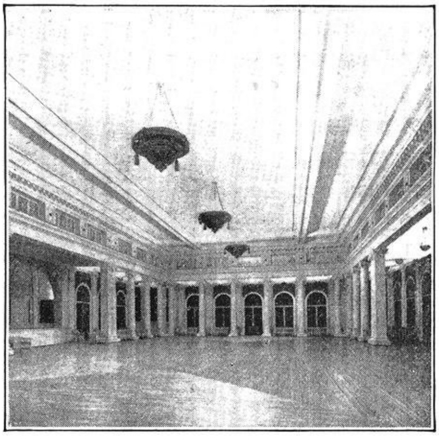

FIG. 2.—*South Shore Country Club, Chicago.*

Of scarcely less importance is the necessity of a correctly designed reflector of high efficiency. The reflector must be designed particularly to the use for which it is to be put, since it is obvious that a reflector designed for direct lighting purposes can not be expected successfully to meet the conditions imposed upon it by indirect illumination. Furthermore, it is of prime importance that this reflector shall be of high efficiency, for the same reason that the illuminant must be of high efficiency. A corrugated, one-piece, silver plated glass reflector is used extensively and proves very satisfactory for indirect illumination purposes. It has been scientifically designed by capable engineers to meet the needs of successful indirect illumination and has a very high reflecting efficiency.

The correct arrangement of lighting units is very essential, requiring illuminating engineering skill, if good results are to be obtained. While it is possible to install direct illumination in a room by guess, and get fairly good results, if the same thing is done with indirect illumination, the illumination may be a complete failure. Therefore, it becomes extremely necessary to consider carefully the purposes for which the system is to be used in order that the arrangement of the units may be the best possible.

At first sight, it would seem that indirect illumination is inherently inefficient. The reason for this is that in most indirect installations only about 30 per cent of the total light flux emitted from the source is available on the working plane. Furthermore, a considerable amount of this fraction is wasted because of the necessity of providing illumination everywhere on the working plane approximately the same as the high illumination required at some points. Although it is true that for indirect illumination the ratio of the light flux available on the working plane to that emitted from the source (called the utilization factor) averages about 30 per cent, this is exceptionally high when compared with a great many of the existing direct light installations. Direct light at its best seldom has a utilization factor higher than 50 per cent, so that even in this case indirect light has an efficiency 60 per cent that of direct light. Under very favorable conditions, a utilization factor of 40 per cent has been reached for indirect illumination. In most instances where indirect illumination is adapted, a uniform intensity of illumination is necessary, so that in most cases light is not wasted by supplying it where it is not needed.

So far the comparison of efficiency has been made only on a basis of the utilization factor, or absolute efficiency of the light. However, this may not be a fair comparison. The reason we desire and need illumination is to see, and therefore it is only fair that the different systems of illumination be compared by noting how well the eye can see when working by the light of each system. Theoretically, a lower intensity of illumination should be required with indirect illumination than with direct. The usual method of testing this experimentally is as follows: A room is first lighted by an ordinary direct system of lighting. At first the illumination is very dim. It is then gradually brought up to an intensity, which the observer, thinks ample for reading. The indirect system is immediately substituted, and the intensity brought up to what the observer thinks is an equal illumination. The observer very often will require higher illumination with the indirect lighting than was required with the direct. This result is very natural, since, unconsciously, the observer looks for the bright spots which were present with the direct light and, failing to find them, waits for the indirect illumination to become equally as bright.

The indirect light is of more uniform intensity, and consequently requires a higher intensity to produce the same physical effect that was previously produced by the exposed lights. Everyone experiences this physical phenomenon in going from a room illuminated by direct light to one illuminated with indirect. After remaining in the room for some time, however, the pupil of the eye gradually expands, the sensation of dimness disappears, and it becomes apparent how easy and restful the illumination is. Therefore, the only criterion for determining the adequacy of indirect illumination is the result of long continued use. Determined in this way, the theoretical proposition that indirect light requires actually less intensity for a given purpose than direct light has been found to be true.

Because of the great improvements made in indirect illumination in recent years, it has come into very extensive use for a variety of purposes. Perhaps its widest field of usefulness at present is the business office, where it is obvious that a well diffused, easy and comfortable illumination of sufficient intensity is highly desirable. Figure 1 shows the offices of the Title and Savings Trust Company of Kansas City. No desk lamps are needed. The fixtures in the center of each bay supply ample illumination to all portions of the bank. One very great advantage here is the ease with which work at vertical filing cases can be accomplished. For ball-room, auditorium, theatre and church illumination, indirect illumination has been found superior to direct illumination. Its great advantage here is the excellent manner in which it brings out the architectural beauty of an interior. Futhermore, the soft and restful illumination is particularly advantageous for such places. Figure 2 is a picture of the South Shore Country Club of Chicago. This picture, as well as Figures 1 and 3, was taken with the indirect light only. In a few instances it has been used for barber-shop illumination.

Figure 3 is a picture of the Blackstone Hotel Barber Shop. This barber-shop is in a basement where artificial light is needed at all times. As is at once apparent, no better lighting could be provided for a barber-shop. Glaring lights immediately above the customers' eyes have been the worst feature of modern barber-

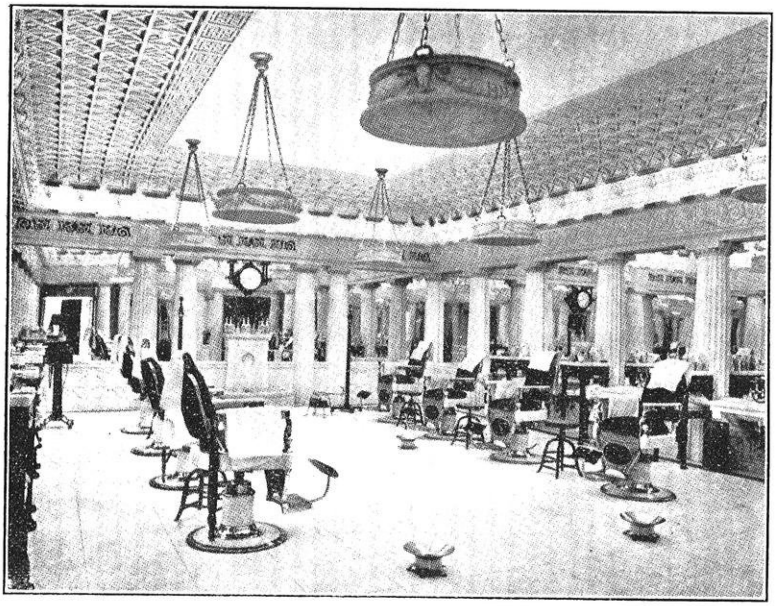

FIG. 3.—*Blackstone Hotel Barber Shop.*

shops. Here, then, is a field in which the superiority of indirect illumination is unquestionable. For show-room and store lighting, indirect illumination is highly desirable. The effect is much the same as daylight. The various signs and placards are easily read.

It is evident that indirect illumination is a long stride towards better illumination, because it saves the human eye from the abuses inherent in other systems of illumination. Its wide adoption for a variety of purposes shows that it has been developed to such a point of efficiency as to make it practical in a growing field of usefulness.

SOME FIELDS OF MECHANICAL ENGINEERING.*

H. J. Thorkelson.
Associate Professor of Steam Engineering.

The engineering field has grown to such an extent, is so well known and recognized by the general public that the title of Engineer is coveted by others not engaged in engineering work. For example, we occasionally see the term "Social Service Engineers" used in describing investigators in the field of social service, whose methods and results are worked out with the care and accuracy that should characterize true engineering work and whose conclusions are supposed to be as free from bias and prejudice as are the conclusions contained in the report of an Engineer whose sole object is to arrive at the truth.

Unfortunately, there is a confusion in the minds of some regarding the field of a mechanical engineer, the extent of this profession and the work of a trained mechanic. There is as much difference between these two as between the man who occupies the editor's chair and the one who is working at the printer's trade, or between the surgeon and the butcher. Both occupy useful and necessary fields and are engaged in honorable labors; but the possibilities open to the one and his responsibilities are vastly greater than those of the other and the education and preparation required by the one are vastly broader and deeper than the training of the other, although there are some points of technical skill and knowledge common to both.

The possible fields of activity for the professional mechanical engineer are growing so fast and becoming so diverse in character that serious thought must be constantly given to planning his preparation and course of studies so as to meet these changing conditions, and the student should have some conception of these plans and of his own responsibilities in fitting himself for his life work.

Let me quote a few remarks from an address by Prof. D. C.

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* A paper delivered before the U. of W. Student Section of the A. S. M. E.

Jackson, formerly connected with this University, now of the Massachusettes Institute of Technology:

"The true conception of engineering may be accepted as comprised within the good old definition, 'Engineering is directing the sources of power' (and wealth) 'in nature to the use and convenience of man.' The man who with fullest success follows the profession defined by this keenly conceived sentence must be a man of science, a man of the world, a man of business, and a man who is well acquainted with the trend of human civilization and human aspirations. To make such a man requires the highest thought and effort of the best teaching influences. Michael Faraday (one of the magnificient men whose lives have been dedicated to the commands of pure science) said that it required twenty years to make a man in physicial science, the intervening period being one of infancy. How much more effort must be carefully expended to make a man not only in physical science, but also a man in business and a man in sociology, all in one! Such men are all of the great engineers, measured according to their times; and to them ought to be accorded in their youth the most careful training."

"Our engineering college men at their graduation should properly be looked upon as apprentices in the engineering profession. The student must be inspired in college and taught to work for himself in the manner adopted by George Stephenson, when instructing his assistants and pupils. 'Learn for yourselves,' said he, 'think for yourselves, make yourselves masters of principles, persevere, be industrious, and then there is no fear of your success.' The students should become *thinkers* in college, capable of usefully applying their scientific knowledge therein obtained; and they should be expected to become thorough engineers through experience in applying this knowledge in a manner which may only be gained in an apprenticeship in the industries, (and other fields) similar to the office and hospital apprenticeships of rising young lawyers and doctors."

It is impossible to predict the future ambitions and lines of work of any of our engineering students. No doubt each has ambitions along certain or specific lines of engineering activities, but few perhaps realize the wonderful possibilities that are available to them providing they are able to meet and measure up to these opportunities. We are all more or less creatures of circumstance; planning today, building tomorrow, and perhaps rebuilding the next, and with the many important and wonderful improvements that are daily being made in science and in our political and economic conditions, newer and greater fields of activity are being constantly opened. These new fields of activity call for originality, constructive, inventive and experimental ability, and very frequently the exercise and development of very unusual technical skill in meeting the many complex financial and economic problems requiring solution.

I wish particularly to call your attention to some of the fields of activity open to graduates in mechanical engineering, and to first speak of the opportunities in manufacturing industries.

Few of us appreciate the position our state occupies as a manufacturing center. Although our mineral wealth is very slight and our lumber resources have been sadly despoiled, still we have north of us rich copper mines and at the northwest the richest iron mines in the world while south of us in Illinois are large coal beds and at the east and north those great highways of commerce and natural rate regulators Lakes Michigan and Superior. Because of this situation our manufacturing centers are very favorably located and the greater number are to be found on the Lake Michigan shore.

The federal census of 1900 showed that the value of Wisconsin's manufactured products exceeded the total value of her agricultural products and her investment in manufacturing plants, stock and equipment exceeded her investment in farms, farm buildings, farm stock and tools.

In 1907 there were over 2700 establishments in the state employing 134,000 persons and having a value of plant, land and equipment of over $309,000,000 and over $370,000,000 worth of manufactured articles and products.

The opportunities for mechanical engineering graduates in these establishments lie very largely along lines of executive management. Many of our graduates have taken positions in factories in this and other states and have arisen through positions as assistant foremen and foremen to positions of factory managers.

In striving for these positions they naturally meet in competition older men who have had many more years of training for such positions, but the managers of these plants feel the advantage of securing technical assistance, and, as a result, this field is gradually increasing.

In the larger plants, a separation is frequently made betweeen the executive positions of superintendents engaged in turning out work as economically and rapidly as possible and those positions which are concerned primarily with design and with methods and materials of construction. Both of these lines offer opportunity for advancement, and in many cases are highly profitable. There are in this state a number of factory superintendents receiving salaries equal to, and in some cases, greater than those paid to the chief engineers of our large railroad systems.

There is always a strong fascination for engineering students in the work of the steam railroad, and there is a large field for mechanical engineers in the Motive Power Departments of our steam roads. We find in the railway systems abundant opportunity for men of this class, not only in operating the rolling stock and equipment, but also in operating the large repair shops maintained by all the railroads. As an evidence of the importance of this work, the work of Mr. Emerson may be referred to. Mr. Emerson was engaged a few years ago by the Santa Fe road to reduce the cost of labor in their repair shops, and by working along scientific principles and systematizing the work he succeeded in cutting the labor bill in half. Mr. Emerson is now writing a series of articles for the *Engineering Magazine* entitled "Twelve Principles of Efficiency." These are well worth reading. In the Motive Power Department problems are continually met in the design and operation of locomotives, passenger and freight cars and other equipment, and in the development of the locomotive and its improvement we see many technical graduates taking part, starting frequently in the Testing Department and being promoted from such positions to positions of higher responsibility. A very brief examination of the details of locomotives of recent construction indicate the improvements that are constantly being made, in compounding, the use of superheat, and the construction of heavier locomotives of greater tractive power.

The principal public utilities requiring the services of engineering graduates are gas works, water works, electric light companies, street railways, heating and telephone companies. Frequently many of these utilities are combined into a single utility, and you will find graduates of the Mechanical Engineering Department in all these different fields of activity.

In the gas companies particularly need is felt for a knowledge of Chemistry and a familiarity with the qualities affecting the illuminating and heating powers of the gas sold. Abundant opportunity is also offered for the design of plants of various kinds, and for the installation of distribution systems adequate to meet all the needs of this department. While electricity is in many cases superseding gas as an illuminant, still the sale of gas for domestic consumption, for the heating of water, for small engines, etc., is constantly increasing.

With water works companies, there is abundant opportunity for engineers trained in the operation of power plants and in the design and construction of distribution systems. The first installation of plants of this kind is usually left to experts trained for that purpose.

There is very little reason for educating mechanical engineers along lines radically different from those of electrical engineers and many of us believe that such differences as now exist will soon disappear. The problems met by both are very frequently of a similar nature and mechanical graduates complain of a lack of preparation along electrical lines and electrical graduates have similar complaints regarding their mechanical preparation.

We have many graduates of one course engaged in the lines of the other and vice versa. This condition emphasizes the importance of a thorough understanding of the fundamental studies of physics, mechanics and mathematics and the necessity of developing the ability to investigate, and become familiar with new lines of work when opportunities in these lines are offered.

In electric light companies the problems usually assigned to mechanical engineers are essentially problems of power plant work, involving the design, installation and operation of the buildings for the main stations and sub stations. The development in this industry is one of the marvels of the century and the improvements made in the past few years have had a very great effect upon the successful operation of such plants. I refer particularly to the development of large central stations, with the resultant improvement in load conditions, the many improvements of the lights, their efficiency and the development of the science of illumination for both streets and buildings. This is a department that is usually taken up by electrical engineers, although there are many mechanical engineers who have gone into electrical work after graduation. Illumination presents so many problems that there are many engineers engaged in this field particularly, calling themselves illumination engineers, and a society was organized a few years ago whose Proceedings give a great deal of material that is valuable when such problems are encountered.

In transportation problems, both urban and inter-urban, there is abundant field for mechanical engineering graduates, in power plants, where problems somewhat similar to those of electric light companies are met, and in problems concerned with the design and operation of cars. In this connection it is suprising to see what results can be obtained from a little study of conditions. I have in mind the operation of one plant in this state where the receipts have been greatly increased by a change in the schedule and in the routing of cars. The problems met in arranging the schedule so as to obtain the greatest revenue for the least expenditure and at the same time meet the requirements of the public, are very intricate indeed. The Engineers of the Wisconsin Commissions have performed a great deal of good work in Milwaukee and Madison in studying these problems, taking data regarding the passengers at different hours of the day, the collection of statistics regarding the loading of the cars, sorting these statistics for crowded cars into those who stand by preference and those who are compelled to stand because of the lack of seating capacity, etc. This will give you but a very faint glimpse of some of the problems in street railway operation which are met by engineers.

The distribution of heat from the central station does not as yet present the opportunities for financial returns that exist in other utilities, for the reason that in the sale of heat the utility must compete with the production of heat in individual buildings. This competition is such that the operation of central heating stations for the sale of heat to various customers is not considered a good investment. In fact, the majority of such companies operate with practically no returns, and many with a positive deficit. However, this field will probably become greater in the future as the public recognizes the benefits to be obtained from such a system and become familiar with methods of controlling heat so as to reduce the cost to them. In selling heat it is necessary usually for the engineers of the utility to make many suggestions to customers to enable them to secure maximum results. This gives a field for engineers which, while rather limited at present, is certainly bound to increase in the future.

In the design and construction of buildings, residences, depots, stores and public buildings, problems met in heating and ventilation are of such a nature that it is customary for architects to refer these problems to consulting engineers, and there is a very great field in this state for men trained for such positions. It is surprising to find upon what empirical rules the design of heating and ventilating equipment has proceeded until within the last few years. Each year sees more data available upon which to base rational designs, and improvements are constantly being made in heating systems and systems of ventilation, so that an engineer engaged in this work finds abundant opportunity for ultilizing all the material he can gather on these subjects.

There are in this state comparatively few consulting mechanical engineers. Perhaps the majority of consulting engineers are civil and electrical engineers, particularly the former. The consulting engineer occupies perhaps the highest field in the profession, and is charged with many important and varied problems for clients of all kinds. In work of this kind the problems met by mechanical engineers are often very complicated, being principally problems in connection with the planning, erecting and operatng of steam power plants and factories for various industries. In this, the qualities required are of the highest order and the work is perhaps as interesting and fascinating as any line of engineering work. The fees paid are usually very good indeed, and as the resources of the state and county become developed the demand for consulting engineers is bound to increase. Many problems formerly met by individual factories and utilities are now referred to consulting engineers, as it is felt that in this way better results are secured, as the consulting engineer has opportunity for a greater breadth of vision and comes in contact with problems of so many different kinds that he is usually able to make suggestions whose benefit more than offsets the additional expense incurred in this method of solving problems. One of the newer fields for consulting engineers is in the line of estimating and appraisal work.

This subject may be divided into two heads, taking up first the field for work of this kind and later some of the details of such work.

The field for work of appraisal engineers has increased to a marvelous extent in the last ten years. This has been brought about by great demands on the part of the national and state governments for estimates regarding the physical valuation of many of the important utility properties of the country. Previous to this demand there was a considerable demand for appraisal work in connection with determining the valuation of such public utilities as water works plants when a municipality desired to purchase such a utility from private owners. In addition to these fields, we find quite a demand on the part of manufacturing enterprises for independent valuations of their property for purposes of determining the value of the plant, equipment and stock once a year, and in this case it is considered as important to have the valuation made by an outside party as it is to make the auditing of books once a year by independent experts. Not only this, but the insurance companies apparently place more reliance in an appraisal made by an independent party than in one made by the owners of the plant, and there are now a number of appraisal companies in existence who make a business of visiting plants of various kinds once every year or two for the purpose of making an inventory of the plant complete, including its equipment and stock in process, and then estimating the value of its equipment and material. In work of this kind a considerable part of the effort is devoted to getting an appraisal of the buildings and equipment. In doing this it is usual to make drawings of the buildings if such drawings are not in existence, and from these drawings it is possible to calculate the amount of material of various kinds entering into its construction and, by securing local data regarding the prices paid for labor in the various trades, it is not a difficult matter to arrive at a fair valuation of the buildings. With equipment, the custom has been to secure an inventory of the various machines entering into the equipment and then, by corresponding with the manufacturers of these machines, obtain data regarding their value when new. The stock in process is taken by usual methods of inventory, its value usually being secured from piece work prices paid by the management, who are in touch with the details of the various processes of manufacture and the cost of each process.

In valuing such utilities as water works, when the valuation is desired for purposes of purchase by a municipality, the usual custom has been for the municipality to secure the services of an engineer, the private company owning the utility also secure the services of an engineer, and these two select a third to act as arbitrator. This method has been fairly satisfactory, although in many cases the final result has only been secured after long and irritating delays while efforts were being made to compromise the extreme differences between the engineer representing the purchasing party and the engineer representing the selling party. Because of the irritation that has frequently grown out of such work, many engineers are reluctant to serve upon any such appraisal committees.

The State of Wisconsin, however, has been very fortunate in its Utilities Law in outlining a method of valuing properties by a board of engineers under the direction of the Railroad Commission, and the services of these engineers have been used in a number of cases, not only for determining the valuation for purposes of selling, but also in determining the valuation for purposes of rate making. In some of the most important cases which have been tried before the Commission, the different parties interested in the case, usually the municipality and the owners of the utility, have each had engineers to look after their interests. The engineers working for the Railroad Commission have no incentive to arrive at either a high or low valuation, but it is very difficult for an engineer engaged by a purchasing or selling party to avoid a bias in his work. This difficulty is almost entirely removed in the case of engineers working for the Railroad Commission, and it is quite gratifying to see how their work has been sustained in the cases which have appeared before the Commission. From the general trend of political matters in the state and country, it is quite evident that there will be in the future quite a demand for engineers to engage in appraisal work of various utilities, such as the water works, gas and electric light plants and the street railway and steam roads of the country.

Another field that has recently opened to graduates of our mechanical department is the field of Auditing Accounts. Expert accountants feel deeply their need of technical training in preparing analysis of costs and in comparing financial statements and quite a few of the graduates of this college are now engaged in this line of work having the advantage of their technical knowledge and training in sifting out items of expense and determining where possible lines of improvement exist. It is surprising to see how quickly and with what great advantage they resort to graphical methods of preparing comparative statements for their superiors. I happen to be familiar with the work of one technical man who now occupies the position of secretary for an engine establishment who can tell from his graphical charts showing material in process and the unit costs under various shop conditions, the price engines must be sold at, one month to yield a certain profit and what price must be asked the next month, etc. He discovered from his graphs the increased machine cost when the foundry production was changed and because of this graphical data was able to introduce improvements in factory operation which resulted in reduced factory costs. This does not constitute a complete list of opportunities and fields for mechanical engineers, but gives you only a partial insight into some of the lines of activity that are open. Many important fields have not even been mentioned.

In selecting a line of work to be pursued after graduation it is a fatal mistake to consider the immediate future. Some of the positions offering the graduates future possibilities, present openings where the initial remuneration is comparatively slight, but the future compensation will more than offset this handicap, and it is the hope of all the faculty that each of you may strive for positions of the greatest opportunity and usefulness not only for yourselves but for the community in which you live. Such positions are usually executive in character, and it is surprising to see how many technically trained men are working for these positions, often going through lines of promotion in strictly engineering work before undertaking positions of greater executive responsibility. This road often leads through the sales department of an industry, and here the engineer has many advantages over his associates not so trained. In the last few years it has been my pleasure to meet a number of such salesmen and I have been impressed with the increasing proportion who are engineering graduates. With other qualifications alike, the engineering graduate has the advantage that he can discuss many technical problems associated with his line intelligently and thus make a better impression upon his prospective purchaser. Take, for example, the problem of selling coal. In this field I find that some of the best salesmen are men who have had years of experience in testing fuels, and, because of this experience, are much better fitted to advise purchasers as to the quality of coal to be selected. to suggest methods to them whereby they may improve the efficiency of their plant, and in this way make such a favorable impression as to secure the sale of their coal in competition often with other salesmen having lower rates to offer. It is to be borne in mind that the highest executive positions as a rule are often reached through the sales department and other departments which come close to the general manager of an establishment or utility. The field is a very good one indeed, enabling those who enter it to obtain an experience that cannot be duplicated in other lines of work. The qualities required for executive positions have been discussed by the President of our university in his address on "The Attainment of Success," in which he lays down three fundamental qualities, punctuality, accuracy and reliability. I wish to quote one paragraph from his address on the last subject:

"All executive officers will appreciate the immense relief one feels when he finds that among his subordinates is one to whom a task may be assigned with the certainty that it will be executed."

"When any of you have attained this position in the confidence of your chief you need have no fear as to your future advancement. But how will you know when you have gained his confidence? The answer is easy—when he no longer questions you from time to time as to the progress of your work. You are asked to get off a shipment of goods at a certain time; you are asked to have an engine ready for the road at a certain date; you are asked to have the plans and specifications of a structure complete at a fixed time; you are asked for a report upon the accounts of a firm at a given day; you are asked to have a brief ready at a specified time. If, when one of the pieces of work be assigned to you, nothing further be said in reference to it, you have gained the confidence of your chief. He knows you are reliable, and the strain in his brain cells is relieved at *one* point. But so long as your chief asks if a task is being, or has been, performed, in order that he may be assured that his large plans may go forward, he lacks confidence in your reliability. Therefore, he must keep the matter in his mind, that is, he must not only do his own work, but must have the responsibility of seeing that you are doing your work.''

I think you all appreciate the fact that life is not made up entirely of rosy and other poetic dreams, but is a constant struggle, which you should strive to make an invigorating one. I feel that success is all the more assured if you can look upon the struggle very much as you would look upon a game. Otherwise you cannot keep your head above the stream of detail problems so as to get the proper perspective for handling the larger serious problems in any calling.

In this connection, and in conclusion, I wish to read a poem from Kipling which states in better language than I can master the qualities and qualifications which I am sure you are all striving to obtain, and which we all wish will be yours:

"If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you
But make allowances for their doubting too;
If you can wait and not be tired by waiting.
Or being lied about don't deal in lies,
Or being hated don't give way to hating,
And yet don't look too good, not talk too wise;

If you can dream and not make dreams your master;
If you can think and not make thoughts your aim,
If you can meet with Triumph and Disaster
And treat those two imposters just the same,
If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools,
Or watch the things you gave your life to, broken,
And stoop and build 'em up with worn out tools;

If you can make one heap of all your winnings
And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings
And never breathe a word about your loss;
If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the Will which says to them: 'Hold on!'

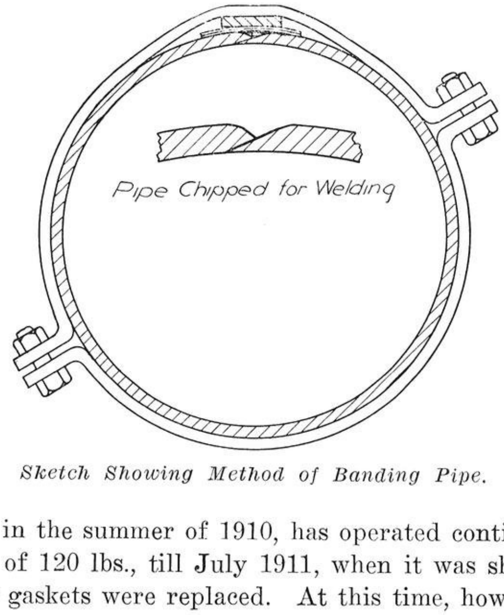
If you can talk with crowds and keep your virtue,
Or walk with kings—nor lose the common touch,
If neither foes nor loving friends can hurt you,
If all men count with you, but none too much;
If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the earth and everything that's in it,
And—which is more—you'll be a man, my son!"

A PECULIAR STEAM MAIN RUPTURE.*

J. M. Smith.

Chief Operating Engineer, University of Wisconsin.

Two years ago the University installed a steam line in a tunnel under Linden Drive to connect the Agricultural Building with the Central Heating Station. This line is a 10″ standard weight wrought iron pipe, connected with forged steel screwed flanges and built for a working pressure of 125 lbs. The line was put into service February 1910, and, with the exception of a short



Sketch Showing Method of Banding Pipe.

shut down in the summer of 1910, has operated continuously at a pressure of 120 lbs., till July 1911, when it was shut off and some leaky gaskets were replaced. At this time, however, there was no leakage in the line aside from the gaskets. The steam was again turned on September 25, at which time a split appeared in one length of pipe.

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* The rupture of the weld in pipes of the size mentioned is an unusual occurrence. The cause for the failure has not been fully determined and a thorough investigation of the pipe will be made upon its removal from the tunnel.—The Editor.

On examination it was found that the weld of the pipe had opened, starting just back of the flange and extending 4 feet along the pipe. It was impossible to leave the steam off entirely until a new length of pipe could be obtained, so to prevent its opening further it was banded with four clamps ½"x4" iron. The steam was then turned on. The clamps held against further opening, but the rupture leaked steam badly. It was decided to try welding the break with an autogeneous welding apparatus. In preparation for this work the weld was chipped as shown in sketch, Fig. (1). The plan failed, however, because it was impossible to get the pipe hot enough in the tunnel to melt the iron. We also tried supplementing the torch with plumbers' furnaces, but this failed by excessive heating of the torch which caused back firing. It was then decided to fill the groove with "Smooth-on." This was put in, allowed to set over night, and a gasket of Permanite sheet packing 3 inches wide was then placed over a patch. On this was placed a ½"x2" iron extending the length of the rupture. It was then clamped with ½"x4" iron previously used. Steam was then turned on, and the pressure raised very slowly. The patch held the pressure perfectly, and has been in service for ten days showing no signs of leakage.

A TRIP THROUGH THE INDUSTRIAL PLANTS OF GERMANY.

A. G. Christie.
Assistant Professor of Steam Engineering.

Dusseldorf is the center of one of the busiest industrial districts of Europe. The introduction of the Thomas basic Bessemer process for the production of steel, built up the huge steel and iron works in the Westphalian District, of which Dusseldorf is the center. The city is thus the "Pittsburg" of Germany, though one is the exact opposite of the other in all that makes life worth living. Dusseldorf compels the manufacturers to build in the outskirts of the town, and these men have found that it does not pay, either from a scientific or practical point of view, to make smoke.

One of the most imposing buildings of the town is the new headquarters of the "Verein Deutschen Eisenhuttenloute" or, as commonly called, the Steel Trust, where we went to get letters to the steel works we wished to visit. Here we were cordially received by Dr. R. Schroeder, the chief engineer of the Trust, and his assistant, Dr. Pederson, and were supplied with most generous letters of introduction. The latter gentlemen impressed the writer as one of the finest men met on the whole trip.

Both seemed in very close touch with all that was going on in America along industrial lines. We were given some instruction regarding our visits and were presented with a very complete visitors' guide for the Westphalian District.

The world-renowned Mannesmann tubes for steam boilers are manufactured in Dusseldorf, but, unfortunately, we did not have time to visit these works. There were also other very important manufacturing works which had to be passed by for similar reasons.

On Thursday afternoon we went out through Duisburg to Oberhausen, a city of about 60,000, to visit the steel works of Guttehofnungsshutte. Here we were met by Herr Schultz and were shown every point of interest in the plant. This concern owns and operates properties in several other places. It owns altogether 26,000 acres of coal fields and over 5000 acres of ore lands. Its principal products are coal, pig iron and steel, while its foundries and machine shops build steam and gas engines, steam turbines, turbo-compressors, boilers, machine castings, and all classes of structural and tank work. An idea of the size of this concern may be obtained from the statement that there were 22,300 men on their pay roll in 1909. The expenditure for wages for the same year was $8,289,000 or $340 per capita. This is about half the earnings of the men in a similar plant in America. But of course living is very much cheaper in Germany and excellent provision is made for the care of the old and infirm. This company owns and maintains about 800 houses with 2700 dwellings for workmen and officials in the neighborhood of its works and also owns and rents a large area for agricultural purposes. Baths and wash rooms are provided at all the works, while special dressing rooms are provided at all the pit mouths of the coal mines. The workmen are encouraged to own their homes and loans to the extent of $250 are made by the company to the workmen free of interest, while a further sum is loaned at a very moderate rate of interest. Another common feature in German industrial works is the maintenance of a bureau where legal advice is given gratis to all employees on all matters. This company even maintains maternity nurses free of charge for the workingmen's wives. A step in this direction has been taken in America by the employment of a company doctor at similar large establishments and in some cases nurses have even been employed, but, as a rule, for the workmen only. The Germans go to the extent of applying this service to the workman's family as well. Hence the poor laborer has a chance to raise a healthy family knowing that they will not be denied proper medical attention owing to their want of money. The fact that the American nation allows so many of the children of the poorer classes to grow up with deformities and irregularities which could be removed by surgical attention at the proper age is one of the severest indictments against our civilization.

The plant at Oberhausen consists of eleven blast furnaces varying in capacity from 260 to 400 tons a day, and using ore with only thirty-eight to forty per cent metallic iron—a low grade ore. The charging device for these furnaces was very interesting. A large charging box is loaded on the ground level, carried by a conveyor to the furnace top and on lowering it on the furnace, bell, it automatically opens this bell, discharges the contents of the box into the furnace and closes the bell without allowing gas to escape. The only labor is that of the operator in the conveyor carriage. This device is certainly a distinct advantage where all surplus gas is required to generate power in gas engines.

The furnace gas is first cleaned in a centrifugal dry scrubber and then passes through a wet scrubber to cool the gases. It is next thoroughly cleaned in a Theissen washer. In the various power houses they have twenty-six gas engines in operation on this blast furnace gas, varying in size from 1500 to 2500 horse power. Nineteen of these are blowing engines and are invariably of the two cycle type. Some of these are old style Korting engines with the air and gas compressor on one side like those at Lackawanna Steel Co., Buffalo. There are some Oeschelhouser engines which resemble the Korting and have a wrist plate device and a knuckle lever operating the inlet valves with the governor controlling the proportion of the mixture. The air and gas compressors on the new Korting engines are placed below the main floor, sometime being operated by a bell crank from the rear tail rod, like some of the old types of jet condensers on steam engines.

The engines generating electric power were all four cycle engines. Most of these were Nurnberg engines of type built in this country by Allis-Chalmers Co. We noticed that there was considerable swinging of load between the engines so that their designers have evidently not yet overcome this difficulty. Some of these engines had the rotating field built up in the flywheel itself, thus saving space. One interesting feature was the fact that the cylinder oil was supplied by positive pressure pumps through the holes to which the indicator cocks are attached.

The exhaust pipes from the gas engines are considerably enlarged after leaving the engines and into which a copious shower of jacket cooling water is sprayed in to muffle the exhaust. The end of the chimney for the exhaust gases resembles the discharge of a non-condensing steam engine, so large is the volume of steam.

In one of the blast houses there was installed a 1500 H. P. motor driven turbo-air-compressor, as a relay to the gas plants. This type of machine will be referred to at a later stage.

All the steel mills here operate on the Thomas basic process and include Bessemer and open hearth furnaces. They also have very extensive rolling mills, which we did not have time to inspect. The slag is manufactured into bricks.

We left the next morning for Duisburg by train and had time to see the splendid harbour. Duisburg is situated on the Rhine about nine miles below Dusseldorf, and combined with Ruhrot, from which it is separated by the small River Ruhr, the population is almost 110,000. It is surrounded on all sides by large iron and steel works. The Duisburg-Ruhrot basins form the largest river harbour in the world and not only handle the largest volume of trade of any German port, but is the center of the Rhine shipping trade as well. These basins and docks are jointly owned by the Prussian state and the Cities of Duisburg and Ruhrot. Their total area is about 1600 acres with 460 acres of water surface. They contain 26 miles of quays and 165 miles of railroad tracks. The cost of these improvements amounted to over $10,000,000. The special feature of these docks is the splendid equipment for loading and unloading cargos. This includes coal tipplers, ore handling bridges, steam and electric cranes, grain elevators, loading stages, unloading hoppers, etc. In the neighborhood are a number of private owned basins. In 1909 the shipping in the Port of Duisburg amounted to 28,000,000 tons of 2000 pounds. One must remember that all this material has to be transported on river barges and not on the large steamships common to our lake traffic. Those interested in the question of utilization of our inland waterways will find a study of this port very profitable.

After a brief glimpse at these harbour works, we took a street car to Bruckhausen, a suburb of Duisburg and Ruhort, to the Gewerkschaft Deutscher Kaiser, where we were met by Herr Director Junius and were entertained at luncheon at the fine Casino of the company. This concern is probably the largest of the Germany iron and steel companies and employs 22,500 men. Herr Thysson is the head of the firm, and is second in wealth to the Krupp family only in all Germany. The Emperor William II is also connected with the company.

After luncheon we were shown over the works by Herr Dahl. They seemed to be distinctly up to date in every particular. This company is said to be the leader in scrapping old machinery when an improved type is introduced. The plant includes five blast furnaces of from 400 to 500 tons of iron each per day with ore containing on the average 42 per cent. metallic iron. These compare very favorably with our large furnaces. The ore comes from many lócalities and includes large quantities of Westphalian, Swedish and Lorraine ore together with considerable Spanish ore, and we were also surprised to find a large supply of Canadian ore from Belle Isle, noticeable by its bright red color. This material is all brought in on the Rhine and is handled at a harbour built and owned by the company on their property at Bruckhausen. The coal is not of a high grade and is all washed before using. The dust is all briquetted with tar from the gas works. The furnaces are equipped with two separate hoists for coke, limestone and ore. All the flue dust is collected and briquetted with lime into firm blocks. It is then charged back into the furnaces again. Their coal mines are directly underground at Buckhausen and there are several collieries in the plant itself, while others are within a radius of a few miles. Coke is here manufactured in large coke ovens of the Otto and Koppel type. The coke is cooled when drawn from the furnace, by a water spray instead of submerging it. The gas produced in these ovens is collected and treated in recovery works where tar, benzol and sulphate of ammonia are the by-products. The purified gas is then piped, at about eighty-five pounds per square inch pressure, to several cities within a distant of fifty miles and used as illuminating gas.

The gas from the blast furnaces is first passed through a number of dry cleaners, which are simply large chambers where the direction of flow is changed suddenly but without whirling motion. It is then passed through three sets of wet scrubbers in parallel, each set consisting of three towers. The next step is purification by means of water-sprayed fans of Thysson manufacture, which clean the gas till only 0.011 grains of dust per cubic feet remains in the gas. The gas used in the ovens, etc., is drawn off at this point, while the gas to be used in the gas engines is passed through a second set of fans, which leave only 0.001 grains per cubic feet of dust in the gas. These results were given to us by the superintendent of the gas engine plant, and are much better than those reported by Mr. Freyn in his paper on "Blast Furnace Gas Power Plant" in the *A. S. M. E. Journal*, Jan., 1910. In fact, they were the best results that we noted among the German mills. From this last washer the gas is delivered at a pressure of about six inches of water to a large gas holder, where it is thoroughly mixed and from which the gas engines receive their gas. This washing equipment was very cleverly arranged in a house by itself, which was particularly notable for the cleanliness of all parts. At one end were the pressure indicators and recorders, all built on the float principle, neatly arranged on frame work like the instruments on an electrical switch board. In order to prevent a vacuum forming in the pipes from the furnaces to the fans and thus to start air leaks, motors are provided which automatically close the suction pipes of all the fans when the pressure drops below some set amount, and automatically opens these valves when the pressure has built up again. At this plant they wash on the average of 12,500,000 cubic feet per hour.

In the blowing engine house are seven gas-driven blowing units built by Thysson at Mulheim am Rhiom, and producing about 15,000 H. P. These engines were all four cycle with a separate gas valve and inlet valve as on the old style Nurnberg. The governor simply cuts off the ignition circuit at over speed so that mixture regulation is done by hand. The air cylinders have a means of varying the clearance while running, and by this means a higher discharge pressure can be carried on the engine without overloading it than could be possible on an ordinary air cylinder. This is of great convenience when a higher blast pressure is required on account of a hang-up in the blast furnace. The air tubs are provided throughout with thin steel valves on the discharge. Similar valves were seen on the high speed boiler feed pumps made by Weirs in England.

The electrical gas engine station is the largest in Europe. There were already in operation four units of 1400 K. W. and four of 1800 K. W., while there were two more of 1800 K. W.

almost ready to run and two more of 2100 K. W. just being erected. This makes about 30,000 H. P. in all. The engines were four cycle two cylinder units with cylinders 44 in. x 54 in. on the 1800 K. W. units. The governor varies the amount of gas per stroke according to load conditions. The generators ran at 94 R. P. M., producing alternating current at 50 cycles. These engines were also built by Messrs. Thysson, and were remarkable for the smoothness of operation and the lack of noise and clatter. They made no more noise than a similar sized Corliss engine. Slippers were used on all the valve motions. One unique feature was the use of grease for all joints and bearings on the engine, though of course oil was used in the cylinders. Their engineer claimed it was more reliable, required less attention, made less dirt and was cheaper than oil. Trouble with cracked cylinders is avoided by designing these so that the M. E. P. shall not exceed seventy pounds per square inch. It was also noted that these engines divided the load among themselves better than any previously seen, and there was also less see-sawing. The load factor averages about 85 per cent. We obtained some interesting figures on cost of power at this plant which, reduced to our money, are as follows:

Cost of power without gas cost..................0.125 cents per K. W. hr.
Cost of power with gas cost....................0.200 cents per K. W. hr.
Cost of power with gas cost, interest, depreciation,
sinking fund, taxes, etc.......................0.400 cents per K. W. hr.

The gas cost was figured on the basis of equivalent B. T. U. in washed coal at $2.00 per ton.

We bade good-bye the next morning to the charming city of Dusseldorf and proceeded by train to Dortmund. An electric car then brought us to Hoerde where we vsited the works of Phoenix Hutte.

This concern was formed some years ago by the consolidation of a number of other concerns, and, besides the iron and steel plant of Hoerde, it owns another iron and steel works at Dortmund, a steel works at Duisburg, another at Hamm, and blast furnaces at other places, and a large number of colleries and iron works. Its employees number 33,000, with an annual wage bill of about $12,356,000, or an average wage of $375 per head.

We were met by Herr Direktor Quilfeldt and in the morning were shown over the steel works. All the steel at this plant is made by the Thomas Basic Bessemer process. The steel is worked up into structural shapes, into axles and into car wheels. Steam hammers are used for forging up the shafts. The cogging and rolling mills for car wheels and wheel rims were interesting machines. They also draw considerable wire and make large quantities of wire nails. Most of the rolls are still steam driven, and, as much of the labor is still done by hand, it cannot be said that this portion of the mill is strictly up to date.

In the afternoon we visited the blast furnace plant. They have seven furnaces in all, one of 240 tons and the remaining six of 300 tons per day capacity with the usual low grade German ores. However, we saw considerable Swedish and Spanish ore in stock. The slag from the furnaces is made into sand by pouring into a stream of cold water. This sand is very high phosphorus and is now largely sold as a fertilizer to the farmers. The old slag dumps are now being removed and used for this purpose. It was certainly odd to see these old slag heaps overgrown with such a luxuriant growth of grass. In America with our acid ores, they are usually barren unsightly piles. The iron is poured into long pigs, which are lifted by electromagnets into a carrier and broken by a shear into suitable commercial lengths.

The gas from these furnaces is cleaned and purified in scrubbers and Thiesen washers. There were four Siegener gas engines of about 800 H. P. each in the blowing plant besides some steam driven blowing units. These gas engines are of the tandem two cycle Korting type with a rock shaft to open and close the inlet valves.

In the electric station there were three new Deutz two cylinder four cycle gas engines of about 2500 H. P. each. These engines were interesting on account of their remarkably fine governing devices. There was also a Nurnberg and a small old style Deutz engine.

In another electric station they had steam turbines. These were of A. E. G. manufacture, one being of 2000 K. W. and the other of 4000 K. W. capacity, with surface condensers, air pumps, etc., made by the same firm. We were told that this concern was questioning the economy of the gas driven blowing engines and preferred the steam turbines on account of less repairs and greater reliability. But probably there were other reasons besides, as it appeared afterward that they have an over-supply of gas.

There were large batteries of an improved type of coke ovens with by-product recovery works for tar, benzol and ammonium sulphate, which were the finest and most compact that we had

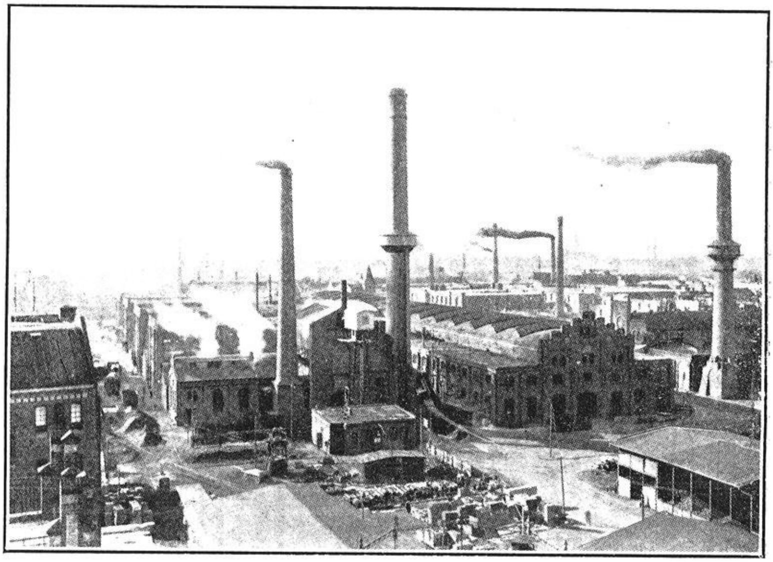

Fig. 1.—*The A. E. G. Turbine Factory, Berlin.*

seen. The tar is removed by water and the benzol recovered; the ammonia is obtained by bubbling the gas through a sulphuric acid solution. The resulting ammonium sulphate solution is evaporated by steam and finally separated in centrifugals as in the process of sugar manufacture.

This company also makes splendid provisions for the comfort and well being of their employees. It will be sufficient to point out that 1.75 acres of their property is devoted to housing accommodation and the gardens of their workmen, while workmen's benefit institutions provide about 1250 houses and 4400 dwellings in addition.

Late in the afternoon we left Dortmund for Hannover and thence to Berlin where a visit was made to the main offices of the

Allgemeine Elecktricitats-Gesellschaft, or, as commonly called, the A. E. G. Here we were provided with letters of admission to the steam turbine works of the company.

We were shown around the works by Mr. Frank A. Scheu, formerly of the Remington Gun Works, Illion, N. Y. Mr. Scheu is a Mechanical Engineer with the A. E. G. and has been engaged in the introduction of system to reduce shop costs. Fig. 1 shows a view of the large turbine shops of this company. The reader's attention is called to the chimney construction common in Germany. A water tank is built around the outside of the chimney and about half way up.

The A. E. G. turbine is of the pure impulse type and as now constructed in the larger sizes, consists of a set of nozzles delivering steam onto a Curtis stage with two velocity rows followed by from ten to twelve pressure stages of the Zoelly type each as shown in Fig. 2, all stages except the Curtis having full peripheral admission.

The bed plates have smooth easy curves that gives a pleasing appearance to the unit. They are of the box type and it is common practice in Germany after erection to fill all the hollow places with cement to give greater weight to the unit.

The cylinder is made in three parts, a cast steel front cover in one piece and the upper and lower halves of cast iron. The nozzles of the Curtis stage are carried in a special part bolted to the front cover. The nozzles of the remaining stages have parallel exit walls and consist of nickel steel blades cast with great accuracy in an inner and outer holding ring. This ring is fastened firmly to the cylinder and remains a part of it. The inner diameter is grooved to fit a corresponding tongue on the diaphragm between stages. The unit has three bearings, one on each side of the generator and the third on the outboard end of the spindle and supported by the front cover.

The spindle carries the blading and also the diaphragms, which are made in one solid piece and put on as the spindle is assembled. The blades are dovetailed at their base and fitted into a dovetailed groove. The outer ends are riveted into a shroud ring. As usual in impulse turbines, there are no close clearances at any part.

The glands where the shaft leaves the cylinder are usually of the labyrinth type, though somtimes carbon packing rings are used. A very simple oil pump is used, which consists merely of two machine cut spur gears meshed together and enclosed in a casing so as to deliver oil by the teeth not in contact. This is geared from the main turbine shaft. The oil strainers and cooler are also of good construction.

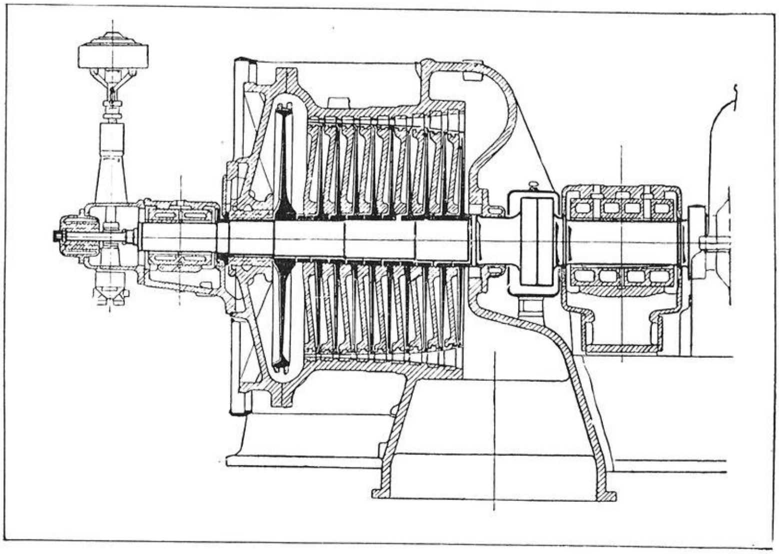

FIG. 2.—*The A. E. G. Turbine.*

Governing is obtained, as a rule, by a compensated oil relay throttle valve as on our Allis-Chalmers turbines. Nozzles are opened as required by hand. For variable load work a different system is used and the governor itself controls by steam relays the number of valves to be opened.

The test floor is quite extensive. At the time of our visit there was a 12,000 K. W. unit under test. This is one of an order of seven for Johannesburg, South Africa.

All turbines up to 3000 K. W. run at 3000 R. P. M., from 3000 to 8000 K. W. at 1500 R. P. M., and above that at 1000 R. P. M. On account of those high speeds the rotors of the alternators are of small diameter and very long. In fact, they seemed of extraordinary length in some cases.

The company also builds a considerable number of large steam turbine driven direct current machines. They also have under construction many low pressure turbines to utilize the exhaust steam of reciprocating engines and other waste steam.

It seems interesting to compare the turbine development of this company, which bought the Curtis patent in Germany, with that of our General Electric Co. The Germans abandoned the vertical type and build only horizontal machines. They have combined the Curtis with the Zoelly so that the best features of each are utilized. The high pressure and temperatures are reduced in the Curtis nozzles, while the most economical expansion is carried out in the low pressure Zoelly stages. They seem to prefer throttle governing whenever possible instead of individual nozzle governing; and still use the Curtis forms of blading and methods of inserting these blades.

This company, in common with most German turbine builders, also constructs its own condensers equipment. As a rule, these are surface condensers with circulating and rotary air pumps on the same shaft and driven by either a motor or a small steam turbine. This air pump is of a modified Leblanc type and certainly is very compact. The condenser shell is usually made of boiler plate. The brass tubes are rolled solid into steel tube sheets instead of being provided with ferules, as is common practice in America. The heads are usually of cast iron. When one faces the end of a condenser the tubes seem to divide into three horizontal strips. In the upper strip the tubes are placed in four banks, each forming an inverted V, thus affording ample distribution of the steam which enters at the top. The second strip is practically solid except for a wide opening down the middle. Between the second and third strips a sheet iron partition is placed to drain all condensation to the sides. This lower section acts as an air cooler on the air pump. As the condensed steam has been led off to the sides, it does not come in contact with these tubes, and hence is delivered by the hot well pump to the boilers at a temperature corresponding very nearly to that of the vacuum. The cooling water enters the condenser at the bottom and leaves it at the top, flowing counter-current to the steam. We saw a large number of these units installed. They seem to be giving excellent satisfaction and are quite popular.

(To be continued.)

The Wisconsin Engineer.

EDITORIAL.

Every year we feel more keenly the need of a clearing house for the technical and scientific press. With the development of the highly technical journals, devoted to special branches of science, and with the growth of bulletin information from public, educational and commercial bodies, published in many languages, it is almost impossible for even a specialist to keep posted in the progress of his conferes.

This condition may be easily improved and be productive of beneficial results to all students in one or two relatively simple ways. The first, and possibly less attractive means, contemplates the formation of a special clearing house journal, which may at the same time perform the functions of critic, arbitrator, codifier and standard maker. The second suggests the plan proposed recently by Mr. H. C. Hoover, of entailing on all serious scientists and engineers the duty of publishing results and criticisms in a few only of the journals which are known as leaders, and in avoiding the wide distribution of material incumbent on supporting many journals of small circulation and slight influence.

In amplification of Mr. Hoover's plan, we would share the joy of many if these great journals were published simultaneously in two or three languages. The trail for this advance in journalism has been broken by the owners of the *Engineering and Mining Journal,* which is now published in English and German. We, in turn, should like to see the *Chemiker Zeitung* and *Stahl und Eisen* among other German journals published in English. Surely this is a feasible way of settling the difficulty. The advertising departments of the small and backwoods press will certainly surrender if contributions are lacking and the establishment of additional local technical journals must be discouraged. There is too much at stake, and we are all too busy, to allow this endless distribution of good material over a wide surface to go on. We want it stored where we may find it when it is necessary for our work. The only people who profit under present conditions are the filing and card-index cabinet makers, and they should not be encouraged to trade their systems for our memories.

* * *

The Great Northwest will again be calling for engineers. Alaska will probably not cry so vehemently for the services of engineers now that it is receiving paternal care as it did under the strange and rough attentions of Messrs. Guggenheim. With the completion of the Copper River Railroad and other railroads in Alaska, the opening of the Panama Canal, and the finish of the connecting links of the Grand Trunk Pacific and the Canadian Northern Railroads, some pretty phantasies may materialize on the Pacific Coast and, in particular, in the Canadian Northwest. We recommend to the ambitious young engineer a serious consideration of the prospect offered by this great continent.

The Grand Trunk Pacific alone claims to be opening a grain country four times the area of the United States wheat belt. Let us discount as much as we like, there can be no doubt of the latent values in mineral, grain, and timber, and of the easily won profits in future industry and transportation in such a country.

Youth may stand a fair strain of trial and privation in pioneer work, and is almost always rewarded by a consciousness of usefulness and power and by ample material success for devotion to the development of new wealth on the frontier.

* * *

The attention of students, and more particularly of mechanical and chemical engineers, is directed to the somewhat peculiar changes which this decade is making in the quality and composition of firebrick. The nineteenth century witnessed the development of the fireclay industry from an insignificant beginning to the stage when several million brick were produced daily in the United States alone. The refractory clays of Kentucky, New Jersey, Pennsylvania, Ohio, Missouri, and Colorado were eagerly exploited, and considerable fortunes were amassed during the great boom in the metallurgical industry in the last two decades of the century.

At the present time, it looks as if the fireclay business might become of secondary importance to the engineer. Its rivals, the silica and basic brick industries, are growing apace and in every year we see the realization of the qualities of the so-called rarer refractories of alumina, magnesia and carbon-silicon. The new refractories plant of the American Refractories Company at Joliet concerns itself only with the production of silica, magnesia, and chrome brick. The new and important by-product coke industry uses almost entirely silica brick.

In Germany the great Koppers ovens were built of quartzite brick, a mixture of fireclay and quartz, but the quality of the American silica brick is so undoubtedly superior that the future installations will use this material almost entirely.

Similar conditions are obtaining in the metallurgical industry. The effect on the fireclay brick makers has been stimulating. The Harbison Walker Company, which manufactures every kind of refractory, is advertising the merits of their Alusil bricks, a fireclay with special additions of alumina, which increases the refractoriness. The Laclede Christy Company claim to have produced a satisfactory bauxite brick, which has none of the physical defects of weakness and shrinkage at high temperatures of the ordinary bauxite brick. The magnesia bricks are being improved in quality to such an extent that the copper and iron smelter no longer complains of their spalling and physical weakness.

In the range of the rarer, or high temperature resisting refactories, the products of the Norton Company, and the Carborundum Company are especially interesting. We draw to the attention of our readers the collection of crucibles and the quick filtering cones, made of the Norton alumina, which are now on exhibit in the laboratories of the Chemical Engineering Department.

These present developments in the firebrick industry seem radical to the student, and, in comparison to the former progress, they are striking. Yet the history of the brick and ceramic industry has been interesting in all its stages. We need not make any further excuse, then, for publishing in our next issue a short account of the growth of this wonderful industry from the time of the ancient brick makers, through the period of the potters' activities to the present developments.

DEPARTMENT NOTES.

THE SENIOR TRIPS FOR MECHANICAL AND ELECTRICAL ENGINEERS.

Arrangements are now under way for the senior trips required of mechanical and electrical engineering seniors. Two trips will be made, an Eastern and a Western. The details of the latter have not been completed, but will include visits to the leading mechanical and electrical industrial plants at Milwaukee and Chicago and will last about a week.

The Eastern trip program, in its present form, may be subject to considerable change as the manufacturers have not been heard from yet. As it stands now, it is proposed to leave Madison on Thursday, November 23rd, and to spend the day at Allis-Chalmers' Company, Milwaukee, going on to Chicago that evening. Friday will be spent in visiting the Cement mill at Buffington and the Steel Works at Gary. On Saturday morning, November 25th, visits will be made to Fisk street and Quarry street Power Plants of the Commonwealth Edison Company. An opportunity will be given to see the Chicago-Wisconsin foot-ball game in the afternoon. Immediately after the game it will be necessary to catch a train for Niagara, where Sunday will be spent in sight-seeing.

On Monday, November 27th, visits will be made to several of the large hydro-electric power houses and to other interesting industrial plants around the Falls.

The members of the party will leave in the evening for Buffalo where they will take a train the same night for Pittsburg. On Tuesday, November 28th, it is intended to visit the great Westinghouse plants and others to be arranged for later. On Wednesday trips will be made to various interesting plants in and around Pittsburg. A train will leave that evening for Chicago so that the party will reach Chicago early Thanksgiving morning.

If the party is of sufficient size, arrangements will be made to have a private Pullman car during the trip. Should a sufficient number of men wish to go on to New York, it may be possible to arrange an additional trip to that city. Hotels will be arranged for whenever the party stays over night.

One will ask, what returns can be expected for the time and money spent? Very briefly, they are as follows: Students will have the advantage of seeing plants they would otherwise possibly never get another opportunity to see. They will receive impressions of machinery and methods of manufacture, and thus be able to appreciate and understand the class work of their senior year. They will realize the magnitude of manufacturing industries and of the small place in the industrial world one must occupy for some time after graduation. They will meet practicing engineers and see their work. They will have opportunity to note the conditions under which men work and live in industrial centers, and these impressions usually figure in decisions regarding employment after graduation. Many men have never traveled to any extent and will thus enjoy the many sight-seeing features of the trip besides the new experiences of living at hotels and in large cities.

The men will find either trip hard work, for one must stand or walk about eight hours a day or more, and sight-seeing is tiring under the best conditions. Each should provide himself with a pair of heavy, solid, well-broken-in shoes, and an extra suit of old clothes to wear around the mills. In order to get into condition all men are strongly advised to start walking around the lake, or doing an equally strenuous exercise for ten days or so before the parties leave.

It may not be out of place to remind the students intending to take these trips, that according to their conduct, strangers will pass judgment on them, and also on their University. Let them, therefore, bear this in mind so that during these trips nothing will happen that will give anyone an opportunity to apply the term of "Roughneck hoodlums" to the engineers and, by all means, let them uphold the honor and dignity of the great University of Wisconsin, of which they form a part.

MINING ENGINEERING.

The Mining Department has been reinforced by the arrival of Mr. F. A. Kennedy, who fills the new position of instructor. Mr.

Kennedy is an old Wisconsin man, having graduated in 1906 with the degree of Bachelor of Science in General Engineering.

Mr. Kennedy comes to us with considerable experience in the field of mining engineering. After completing his school work, up to October, 1907, he was engineer at the Zenith, Sibley and Sarony iron mines of the Oliver Iron Mining Company at Ely, Minn. From October, 1907 to April 1908 he was engaged as assistant engineer for the Oliver Iron Milling Company at Hibbing, Minn. From April 1908 to the beginning of the present month he was Chief Engineer of the Shenango Furnace Company, one of the largest independent companies of its kind in northern Minnesota.

MECHANICS.

The Department of Mechanics has acquired a complete outfit for the cutting and autogenuous welding of metals. The apparatus is of the type known as the Oxhydric, and is being exploited in America by the American Oxhydric Company of Milwaukee, Wisconsin. The process is of German invention, the above named company having the exclusive American rights.

The equipment is complete and consists of a full set of welding nozzles, one two-nozzle and one three-nozzle hand cutting torch, and a cutting machine which may be fitted up with either two or three nozzles.

A series of experiments to determine the adaptability of the process is being carried on in the Mechanics Department, and the College Mechanician is using it in repair work of University equipment.

ELECTRICAL ENGINEERING.

A 300 K. W.-300,000 volt transformer is being constructed by the mechanician department from designs worked out under the direction of Professor Bennett.

The transformer will be installed in an addition to the electrical laboratory and will make possible a wide range of tests and investigations of importance in connection with high voltage transmission.

ALUMNI NOTES.

The Oliver Iron Mining Co. seems to claim quite a number of Civil Engineering graduates. Some of them now in the employ of this company are: E. E. Hunner, '00, F. B. Cronk, '05, W. E. Bates, '06, A. S. Diehl, '07, B. K. Dutton, '09, W. H. Hinn, and Geo. W. Chamberlain, '10.

A large number of C. E. graduates have risen to the position of City Engineer. P. H. Connolly of Racine; G. P. Bradish, '76, of La Crosse; C. W. Boley, '83, of Sheboygan; A. C. Greaves, '63, of Sturgeon Bay; J. F. Icke, '00, of Madison, each hold this position. Three members of the class of 1908 have already reached that of Assistant to the City Engineer. They are L. H. Huntley of Ashland, Ore.; E. P. Abbot of Spokane, Wash., and G. E. Heeink of Janesville, Wis.

Two members of the 1905 class are working on the New York State Barge Canal. Louis A. Burns has charge of contracts No. 53 and 80, Geo. H. Haley of contracts 35 and 79.

Arthur S. Cooper, '81, is working for the government. He is at present in charge of the government work on the Savanna river and harbor.

Leander M. Hoskins, '83, is at present Professor of applied mathematics at Leland Stanford University. Professor Hoskins is the author of several text-books on engineering subjects. Two of these are: "Elements of Graphic Statics" and "Text-book on Hydraulics." Prof. Hoskins taught Mechanics at Wisconsin before going to Stanford.

Two other Wisconsin men who have chosen teaching for their profession are: H. P. Boardman, '84, is Professor of Civil Engineering in the University of Nevada, and J. T. Buser is teaching Mechanics in the Michigan Agricultural College. Mr. Buser graduated in 1909.

From Civil Engineering to Law is a far cry, yet two graduates of that course are now practicing attorneys. H. S. Basset, '71, is in Preston, Minn., and H. S. Bird, '94, is now located in New York City.

F. Cnare, C. E. '10, is with the firm of Cnare & Son, a local firm in the contracting and building business.

Walter K. Adams is in the employ of the government of Mexico, as Bridge Engineer. He is at present stationed at Colonia, Mexico.

Santiago Cerna, C. E. '08, has also located in Mexico. He is the Assistant Engineer for the Monterey Water-works and Sewer Co.

S. R. Sheldon of the class of '94 is at present in Shanghai, China. His occupation is unknown.

P. S. Biegler is now with the Electrical Engineering Dept. of Purdue University. He graduated in 1905.

In the September issue of *Railway Engineering* appears a glossary of track terms compiled by K. L. Van Auken, '09. Mr. Van Auken is the Editor of this magazine.

ENGINEERS

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