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The Wisconsin Engineer

JANUARY, 1913

Volume 17 Number 4

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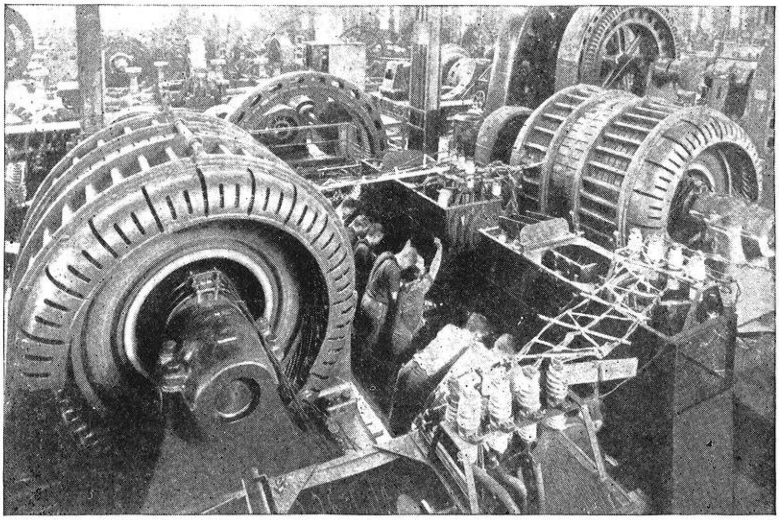
WISCONSIN ENGINEERING JOURNAL ASSOCIATION



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VOL. XVII JANUARY, 1913 NO. 4

THE POWER HOUSE AT THE NEW KEOKUK DAM.

M. F. McFarland, '13.

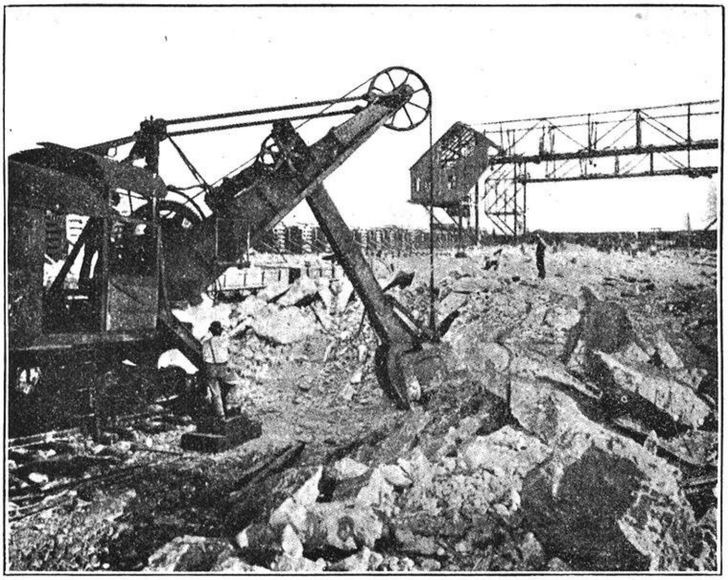
The power house of the Mississippi River Power Company's plant at Keokuk, Iowa, is built with its entire length almost parallel to the channel, several hundred feet from the Iowa shore. The area between this shore and the power house constitutes a forebay, through which the water flows from the lake above the dam to the turbines. The water will run through the power house almost at right angles to the channel, taking the normal direction of the current in the tail race excavated from the upper end of the power house to a distance of about five hundred yards below its lower end.

The power house is 1,718 feet long, 132 ft. 10 in. wide and 177 ft. 6 in. high from the lowest point in the tail race to the highest point of the roof. It is built in two parts, the substructure and the superstructure. Each of the stories of the superstructure has very high ceilings, in order to give clearance for the traveling cranes which are so installed that they can lift out an entire power unit and carry it to the machine shops located at the northern end of the power plant.

The superstructure houses the electrical machinery, a fact which largely governs the architecture. The substructure is a monolith, while the superstructure is built of reinforced concrete. The superstructure is being built by the Stone and Webster Engineering Corporation, but the substructure was designed and built by Chief Engineer Hugh L. Cooper, who is much opposed to the use of the reinforcement in the superstructure. Mr. Cooper believes that reinforcement in the walls and columns of the power house will be weakened by electrolytic action. The superstructure is four stories high, with a trussed roof. The upper floors are used for installation of oil switches and electrical machinery.

Foundation

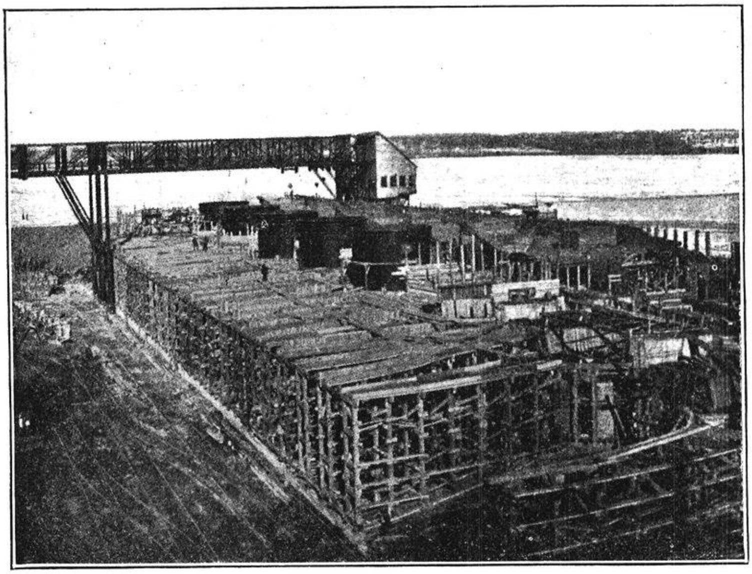
The power house is set down in the bed rock of the river about twenty-five feet below the surface of the limestone bot-



Steam Shovel Lifting Rock from the Bottom of the Mississippi.

tom. The object of this is to gain fall by depressing the tail race. The area of the foundation and tail race was excavated by blasting and steam shovels. The limestone bed was found to be hard and impervious. Test holes drilled thirty feet deeper than the excavation remained absolutely dry, although the water in the river outside the cofferdam, one hundred feet distant, was fifty feet higher than the bottom of the test holes.

The substructure is a monolithic mass of concrete containing the sluices and chambers used to carry the water through the turbines from the upper to the lower level. The forms for this structure were very complicated and were built of wood. Wood was used for this purpose because the cost of steel forms which would be used only fifteen or thirty times was prohibitive. The form lumber is low grade southern pine. The form work was carefully done and shows good results on the finished parts. Very heavy bracing was needed in the draft tube forms, as the pressure of the concrete when being placed is great. The concrete is proportioned and mixed at



About One Quarter of the Power House Area, Showing Basement under Construction.

the mixing plant by mechanical scales and mixers. From the mixers it is poured into dump buckets, standing on flat cars, which are hauled to the work and placed immediately by means of lifting cranes. All cement and aggregate is sampled and carefully tested. Four traveling cranes were used for excavating and placing materials in the power house. These consist of a truss carried on four legs. The truss carries a traveler and operating machinery. The whole crane runs on track laid parallel to the longer side of the power house.

Power Installation

Ultimately, thirty 10,000 horse power single runner, vertical shaft turbines with scroll case settings formed of solid concrete, direct connected to 9,000 K. W. revolving field alternators will be installed in the power house. The substructure for the primary installation of fifteen units, which will be in operation in less than a year, is complete.

The turbines are of the Francis type, especially designed for low heads ranging from thirty-nine to twenty feet and for a speed of 57.7 revolutions per minute, on which the rated capacities are based. From the Holyoke tests of models the efficiency is eighty-six per cent. The over-all dimension of the runner is sixteen feet two inches. A combined oil and roller thrust bearing carries the 275 ton rotor, comprising the twenty bucket runner below, the generator above and the twenty-five inch vertical shaft.

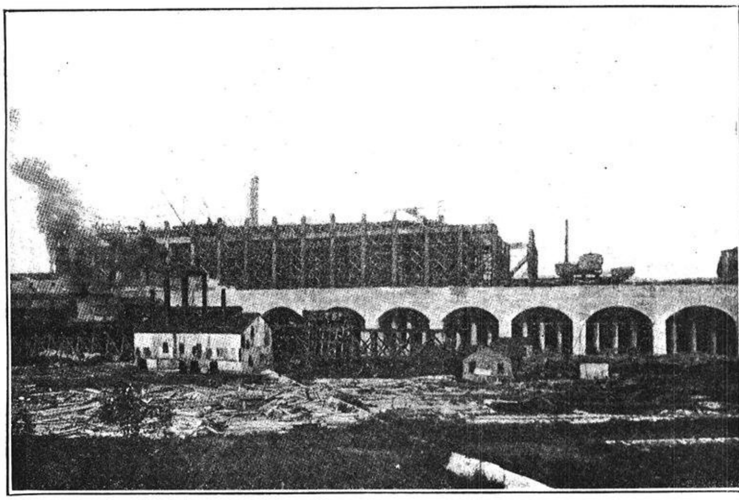
The single runner turbine was chosen after a consideration of the advantages of simplicity, accessibility, bearings out of water, and minimum vertical height against the saving by the use of smaller sized generators which would be possible were a higher speed multiple runner type used. This choice was based on the results of the Holyoke experiments on various models in which high speed and high efficiency were sought.

Course of Water

Passing the sixty foot submerged arches of the ice fender which stretches from the upper end of the power house to the Iowa shore, a distance, including the 300 feet of floating boom section, of 2,110 feet, the practically still water in the forebay reaches a line of submerged arches forming the west wall of the screen room, twenty-two feet four inches in front of the sloping buttresses which support the structural steel screens. Back of the screens and between the four foot buttresses are the stop log grooves, in front of them the deep narrow steel head gates. Each of the four channels passing to the wheels is shaped differently, the one on the right being entirely separated from the other three. Skimmer arches serve to deflect any ice or floating debris from the screens. The crowns of the skimmer arches are submerged two feet at low water.

Intakes

The intakes are designed as near a scroll case as is practical and are formed of solid concrete. The wheels are spaced forty-eight feet apart center to center, each being served by four head gates. Passages from three of these head gate openings merge by easy curves into a common passage which is



Portion of the Power House Viewed from the Forebay.

tangent to the distributor at a point opposite the axis of the wheel. These three passages and the common one are all rectangular in cross section, the floor and the roof being level throughout. Water enters the three passages at a velocity of five feet per second for normal head and is uniformly accelerated to seven feet per second opposite to the axis of the wheel. From this point the design follows that of a scroll case and successive areas around the distributor are such that the velocity of the water is gradually increased. The remaining one-fourth of the distributor is served by a single passage of rectangular cross section, in which the water will be main-

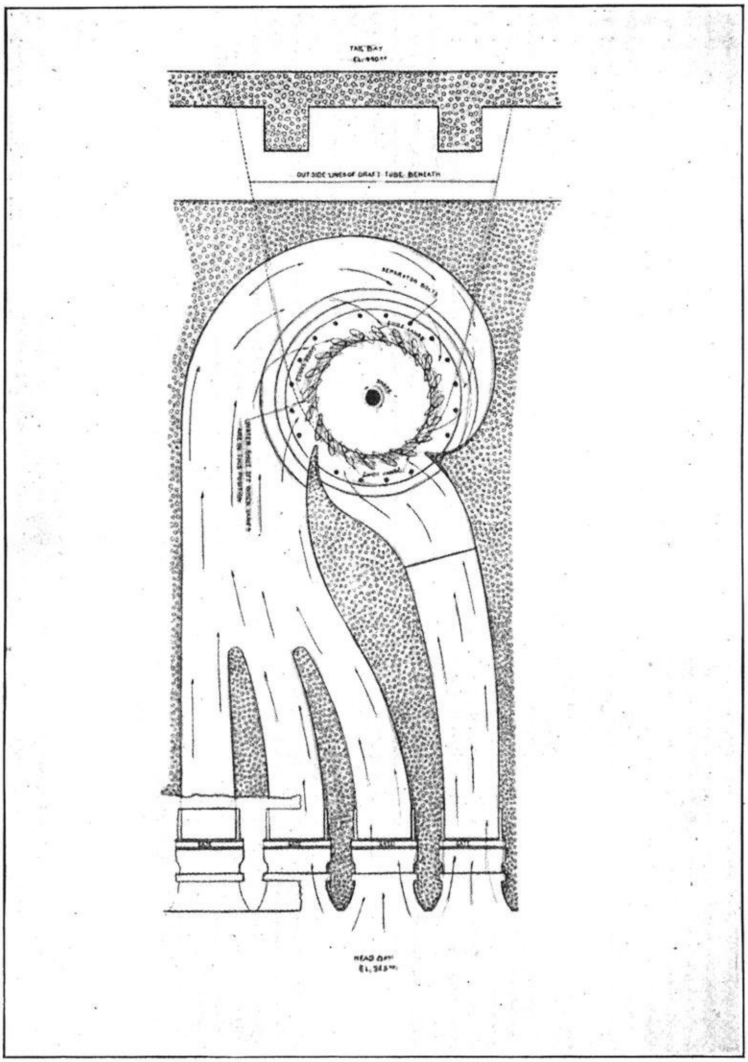
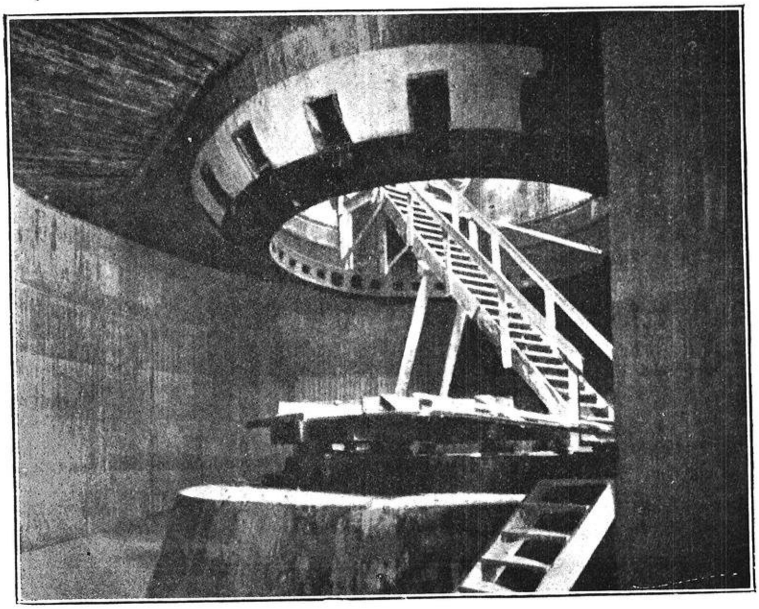


Diagram of the Route by which the Water Reaches the Turbine, Showing the Four Intakes Converging into the Scroll Chamber.

tained at a velocity of five feet per second to a point near the wheel, and from there will be gradually accelerated. Three-quarters of the water serving the wheel is conducted after the manner of ordinary scroll casings, which type of setting has been demonstrated to be the most highly efficient. In open



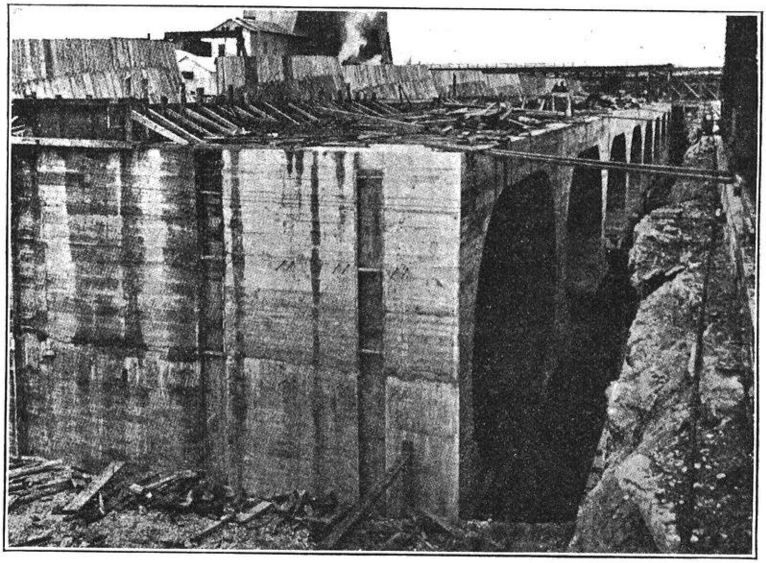
Interior of a Scroll Chamber. Turbine will be Placed in Circle where Stairs Are Seen.

wheel channels serious losses have been encountered due to eddies and swirls in approaching water. In the Keokuk wheel chambers, however, division walls have been so placed as to provide easy curves for the passage of water and to exclude dead spaces with their resulting eddies and swirls.

Though the size of each intake varies throughout its length, the center openings are each seven and one-half feet wide by twenty-two feet high, thus giving long narrow gates sliding in cast iron guides. A traveling crane will operate the gates and screens. The latter are held in place by a cast iron T section bolted on the buttresses. The screens are in four sections, ten feet nine inches high, with three by one-half inch bars spaced six inches apart, giving an opening equivalent to seventy-five per cent of the gateway.

Draft Tubes

On the center lines the draft tubes are sixty feet long. Emerging from the wheels the section is an eighteen foot cir-



Draft Tubes Opening into Tail Race.

cle, gradually opening out to an oblong section at the end with twenty-two foot eight inch half circles connected by seventeen and one-half foot tangents. The velocity is gradually reduced in these tubes from eighteen to four feet per second. The quarter turn from the vertical to the horizontal is an easy curve.

Forms for the tubes were of wood and consisted of a central rib set up for alignment and elevation, on which transverse ribs made in four interchangeable parts were carried and then covered with three inch surfaced lagging. Removal of a single two inch pin at each side permitted the transverse ribs to be removed.

Tail Race

The foundation of the draft tubes at the outlet is twenty-five feet below the natural bed of the river and the rock still in front of the tubes is being removed by quarrying methods to form the tail race. The latter is fan shaped in plan, extending to great width below the downstream end of the power house, beyond which it will disappear into the natural surface of the bed rock.

Pit Liners

A cone shaped casting resting on the supporting ledge of the bottom cast iron ring of the pit liner supports the moving parts of the wheel by a thrust bearing interposed between the top of the cone and the lower side of the spool on the shaft. From the supporting ledge the weight is carried into the pit liners and thence through the surrounding mass concrete to the limestone foundation.

Vane Control and Turbine Shaft

The twenty cast steel guide vanes, six feet eight and three-fourths inches high by three feet four inches wide, are controlled by a specially designed Lombard governor. Cranks at the upper ends of the supporting shafts are attached by links to an operating ring, which is carried on ball bearings and revolves against rollers mounted on eccentric bearings for adjustment. Piston rods from the two high pressure oil cylinders are attached to the ring at diametrically opposite points. The maximum stroke of these pistons is nineteen inches and the twenty-five inch oil cylinders under two hundred pounds pressure will develop 250,000 foot pounds in two seconds.

Each vane may be removed for repair by withdrawing its stem or shaft vertically without disturbing other parts of the mechanism. Each vane is supported and the weight carried on ball bearings at the top of the shaft. The bottom steady bearing is lubricated from the top by a hole through the center of the shaft.

The governor fly balls and the high duty oil pump are driven by a counter shaft geared direct to the turbine shaft.

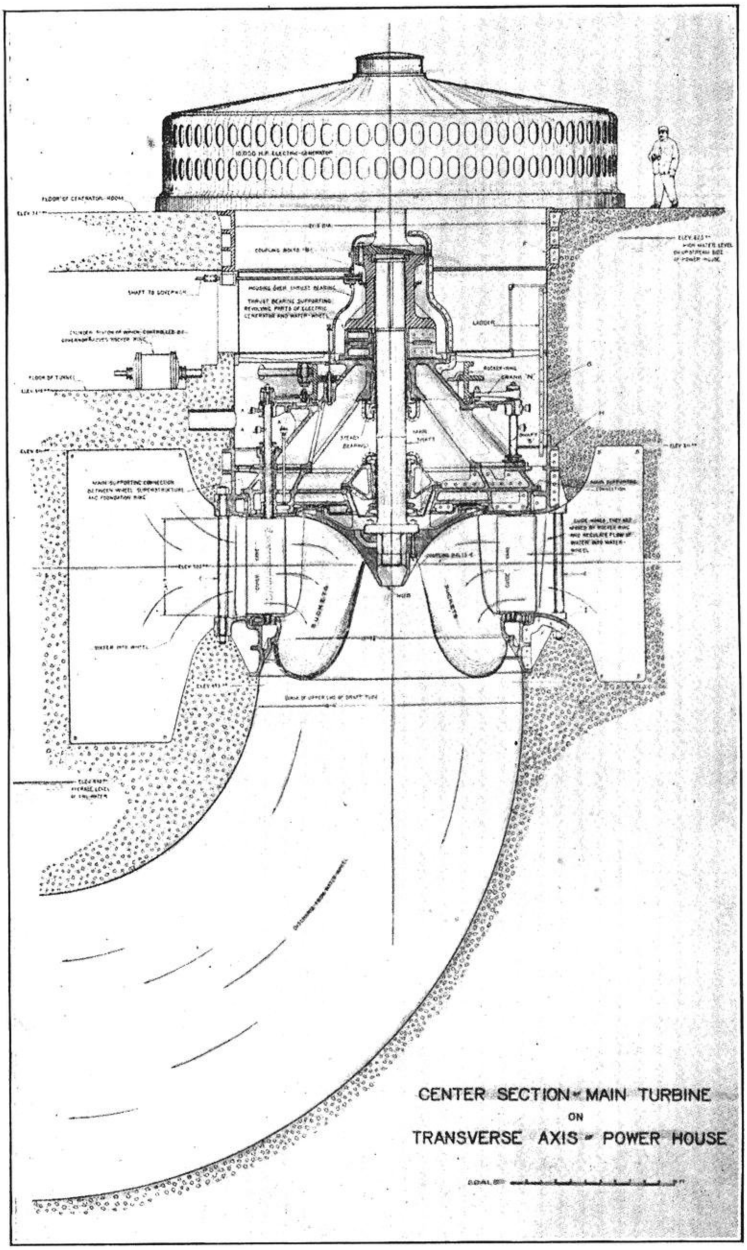


Diagram of the Turbine, Showing the Mechanism above the Wheel in the Pit Liner, the Scroll Chamber Around the Wheels, the Guide Vanes and the Beginning of the Curved Draft Tube Below.

Motor driven triplex oil pumps furnish oil for the governor cylinders under two hundred pounds pressure.

The weight of the wheel shaft and the attached runner is carried to the coupling spool or thrust block by a round-about key at the top, while a vertical key takes the torsional stresses. To the top of the spool is coupled the generator shaft and to the bottom the upper part of the combined oil and roller bearing. Ordinarily the rollers will not be in contact, but any material drop in pressure or quantity of oil will permit the bearing to settle down on top of the rollers which are immersed in oil and ready to run.

Exciters

At present two turbines of 2,200 horse power capacity are being installed to furnish current to operate individual motor driven exciters for each main generator. A full scroll case setting was formed in the concrete for these units, which are served from two seven and one-half foot head gates and discharge into special draft tubes.

* * * * * *

Thanks is due the Publicity Department of the Mississippi River Power Company for bulletins used in the preparation of this article and for the loan of the cuts in connection with it.

NOTES OF A VACATION TRIP.*

Having made no serious study of any particular subject, the following notes of a vacation trip need not on their part be taken very seriously. They may, however, be of some little interest, the football season being over, and I am glad to comply with the request of the *Wisconsin Engineer* for a few notes "by the way."

We sailed early in July on the Donaldson line from Montreal to Glasgow. This is an eight-day, "one class" line of boats which was selected because of its good reputation in Madison and the fact that Toronto and Montreal could be visited enroute to Scotland, where we wished to begin our European trip. I may say in passing that we found everything connected with the ship's service very satisfactory. We had a genuine Scotch crew, including bagpipes and other accompaniments, British ham-and-egg breakfast with Scotch oat meal (porridge) thrown in.

The ocean trip was quite uneventful. We saw a few ice bergs, of course, the nearest one of which I estimated by a rough triangulation to be about 100 feet high and one mile distant (notice the nice round numbers). On this route the use of the wireless is often a great time saver. In our case, for example, messages received from other ships ahead concerning fog and ice caused our captain to take the southern route around New Foundland and so avoid the delay and risk which the northern route would have entailed.

Our summer itinerary included Scotland, England, Paris, Switzerland and Italy. Although not very carefully considered, the order of travel proved to be very satisfactory. The highlands of Scotland are fine but would not be so greatly enjoyed if seen immediately after a visit to Switzerland. It was also quite restful to alternate castles, churches and museums with mountains, lakes and the open country.

From the time of sighting Malin Head on the north coast of

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* A letter written for the Wisconsin Engineer by Dean F. E. Turneaure, who is at present on leave of absence for the semester.

Ireland things became interesting to the traveler, night or day. The trip up the Clyde to Glasgow is a good introduction to the industrial life of the city. This river, naturally a small, sluggish stream at this point, has been transformed by dredging into a ship canal about 500 feet wide by forty-five feet deep, with innumerable docks connected therewith. The Glasgow people "point with pride" to this great river as one made by man, whereas the Mississippi, the pride of some Americans, is a "God made" river for which man deserves no credit. This canal is lined on both sides for two or three miles with large ship building yards; and in passing up the dock the tourist gets a very good impression of the most important industry of the city, an industry in which Glasgow has no rival. One of the largest firms, the John Brown Company, we visited while in Glasgow, and were fortunate in being able to get a view of the partially completed Aquitania, to be the largest ship afloat, and a sister ship to those of similar name (Lusitania and Mauretania). The new ship will be about 900 feet long by 100 feet wide, nearly the dimensions of the Panama Locks. In the ship yard the immense size of the modern ocean passenger ship can be comprehended. The John Brown Company builds the machinery as well as the ship structure and employs about 6,000 men.

Glasgow may be said to have been the birthplace of steam engineering. It was here that Watt lived and did his work, and also where the first steam boat on this side of the Atlantic, the Comet, was placed in service by Henry Bell in 1812. The centennial celebration of this event had been held shortly before our arrival, and it was interesting to note how very little significance was attributed by any of the British papers to the work of Fulton and the celebration held in New York three years earlier. However, it was some compensation to notice that one of the largest manufacturing concerns of Glasgow is the branch factory of the "Singer" Sewing Machine Company, and that the "Bell" telephone is in general use throughout Europe.

Much has been said about the efficiency of the Glasgow city government, especially in its operation of public utilities, and one is indeed very favorably impressed with the manner in which these affairs are conducted. Both here and in Edinburgh great pains are taken to keep the streets clean and free from rubbish. For example, special receptacles are provided at the exits of street cars in which passengers are requested to deposit the little paper tickets instead of dropping them on the pavement as is done in most cities as a matter of course. The uniforms of the street car employees are very neat and seem to be always well brushed.

The "low lands" of Scotland are not really low or level but only relatively so. The topography is about as irregular as that around Madison. The whole country here is pretty well filled up with cities and villages but there remains quite an area for farming purposes, all of which is thoroughly well utilized. I have seldom seen a finer agricultural country than that immediately surrounding Stirling, such as can be seen from the old castle. The old Scotch kings certainly chose a fine spot when they constructed this castle. The chief crops grown about here are wheat, oats and potatoes. Indian corn is ruled out on account of the climate, and in fact it grows very little north of Italy.

The highands are, to a large extent, the pleasure grounds of Scotland and England. The mountains are not very high but they are covered with vegetation of beautifully variegated color and this, continued with the lakes, deep forths and canals, makes the scenery very attractive. The tillable land is confined to narrow strips in the valleys but considerable grazing is possible on the hillsides. To us the mountains seem peculiar, as, owing to the very moist and cool climate and the geological conditions, the soil is generally quite wet and the vegetation consist mostly of moss, heather and bracken (large ferns) with a certain amount of grass, much of it wiry and of no value. Such is the moorland of which we read. Sheep and Scotch cattle are able to get something of a living from this area. The forests were cut off long ago but some efforts towards reforestration are now being made by the government. I saw one fine strip of spruce reaching from the valley high up the mountain side.

The extremely appreciative attitude of some American travelers towards things foreign is illustrated by the remark of an American lady, which I overheard, relative to these bare unproductive hills. She was "so pleased to see that the people here (the Scotch) valued beauty of scenery and had not 'commercialized' the entire country as everybody did in the United States." Her companion, a Scotch gentleman, politely remarked that he thought the land of no great value anyway. In fact it was apparent that the people here were getting everything out of the land that was possible.

England and Scotland are of course full of interest from the standpoint of English literature and history. The land of Scott and Burns and the land of Shakespeare are thronged with English and American tourists. We joined the procession here but I shall not bore the reader with any details of this trip. I will say, however, that these historical associations, the fine scenery, good roads and short distances are such great inducements as to warrant the American college student to spend one vacation period, if possible, on a bicycle tour through this country. Of particular interest to the student are the university towns of Oxford and Cambridge. These famous universities differ greatly from those in America. They are composed essentially of groups of colleges, twenty-one at Oxford and eighteen at Cambridge. Each of the colleges is essentially a study and residence hall, consisting of dormitory, dining hall, and library, and maintains to a large extent its own staff of tutors. Examinations are University functions. Architecturally the buildings are fine, especially the dining halls and libraries, with their fine oak trim and walls decorated with portraits of famous men, former students of the respective colleges. It would seem that here one could become cultured by absorption of the atmosphere, but I dare say that this method is about as effective here as in the climate of Wisconsin. Oxford gives no instruction in engineering but at Cambridge this line of work is fairly well provided for.

To a civil engineer interested in the history of his profession, England is the most interesting of all countries. Owing to its early industrial development, it was here that the pioneer work in lighthouse construction, canal construction, railway and bridge building was done; and the early English engineers, as Telford, Smeaton and Stephenson were, perhaps, the most famous men of their day. Their work was strong and substantial and much of it still stands.

The very earliest of long-span iron bridges were the chain suspension bridges over the Conway river and the Menai strait on the highway leading to the island of Anglesey. These were built of Thomas Telford (first president of the Institution of Civil Engineers), and opened in 1829. Figs. 1 and 2 are snap shots of the bridge over the Menai strait. Adjoining these structures, on the railway line running parallel to the highway, are the old iron tubular bridges built by Robert Stephenson in 1846-50, which were the very first among long span railway bridges. These four bridges are still in service and apparently in good condition. While this speaks well for the efficiency of maintenance, it would hardly be considered in America, a sign of progress in railroading. In the United States, the increase in train loads would long ago have required the replacement of the railroad structures by heavier and stronger ones. It is interesting to know that at the time when the old bridges were built the analysis of bridge stresses was not yet very well developed so that the strength of tubular bridges was determined to a considerable extent by tests on large models. The South Kensington Museum of London contains many things of great historical interest to engineers, notably a collection of the earliest locomotives, among them Stephenson's "Rocket," and "Puffing Billy," Trevethick's original locomotive, and many others less famous. The service of these early engineers is commenorated by four beautiful stained glass windows in Westminster Abbey dedicated to the memory of Robert Stephenson, Locke, Brunel and Trevethick.

For one accustomed to the high office buildings of American cities, the buildings of London present a great contrast. Neither this city nor any other European city, so far as I know, has seen fit to adopt the skyscraper style of construction. Four or five stories (in Paris six or seven) is about the limit of all sorts of buildings, business blocks as well as residences, and this height is of course strictly determined by law. The result of this plan is to force business to spread out over a large area,—to grow horizontally instead of vertically. Off hand, this seems uneconomical but there are some advantages. No such congestion of street traffic occurs as is the case in our

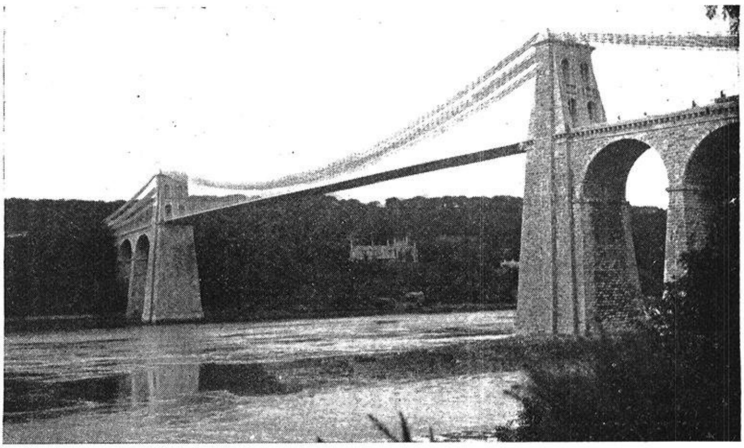

FIG. 1.—*Suspension Bridge over Menai Strait Built by Thomas Telford in 1829.*

large cities, especially at the hours when the immense office buildings disgorge their contents. Where there is no limit to

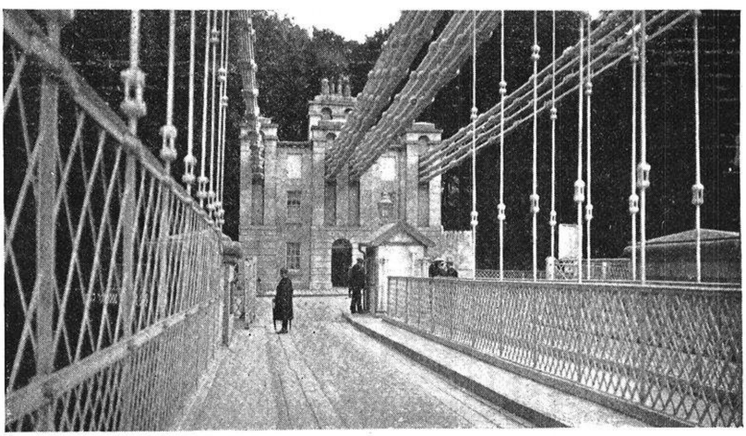

FIG. 2.—*Detail of Bridge of Fig. 1.*

the height of buildings all improvements in the transportation simply tend to increase the congestion and to encourage still greater concentration of business and still higher buildings.

A study of the relative advantages of the two systems in all their phases would be interesting. Evidently each country is well satisfied with its own system and gets along very well therewith. In London and Paris passenger traffic is well taken care of by numerous underground lines, by surface tram lines and motor busses. In the congested districts trams are not allowed, as the motor bus, on account of its freedom of action, is more rapid and satisfactory. On good pavements it appears to be a good competitor of the car line but probably more expensive to operate.

Paris is, in many respects, a city in a class by itself. As a center of art it has probably no equal. From the technical side I think the most interesting feature is the street lay-out and the design and arrangement of its public buildings, monuments and bridges. City planning has here, perhaps, reached higher results than in any other city. It was interesting to note the changes caused by the cutting of a broad street diagonally through a congested district, which, at the time of my previous visit, sixteen years ago, had just been begun. The aid to traffic was remarkable.

In many respects the most interesting part of our entire trip was our visit to Rome and Pompeii. While Rome is also a great center of art it did not seem extraordinarly attractive after visiting the galleries of Paris, but the ancient engineering and architectural monuments and ruins to be seen in Rome and Pompeii are extremely interesting. In visiting the old works one is confronted on all sides with the evidences of the extensive water supply systems of that age. The ruins of the numerous masonry aqueducts, the lead pipes and bronze fittings which are to be seen in many places give one a good idea of the supply systems. Not having the advantage of iron pipe for conducting water under pressure, the Romans were forced to carry the water from the hills to the city in masonry aqueducts, which, in crossing the plains near the city, had to be elevated for a considerable distance on masonry arches. Several lines of such elevated aqueducts were built from about 100 B. C. to 200 A. D. and their remains form a most picturesque and interesting scene. Baths were very popular in these days and in Rome and Pompeii many well preserved ruins may be seen of public and private baths.

In Pompeii the old structures are better preserved than in Rome on account of their having been buried for about 1800 years in ashes. In several of the Pompeian houses the marble fountains in the courts, including pipe and fittings, are practically intact, and in some cases the frescoes on the plaster are still clear and bright. There is plenty of opportunity here

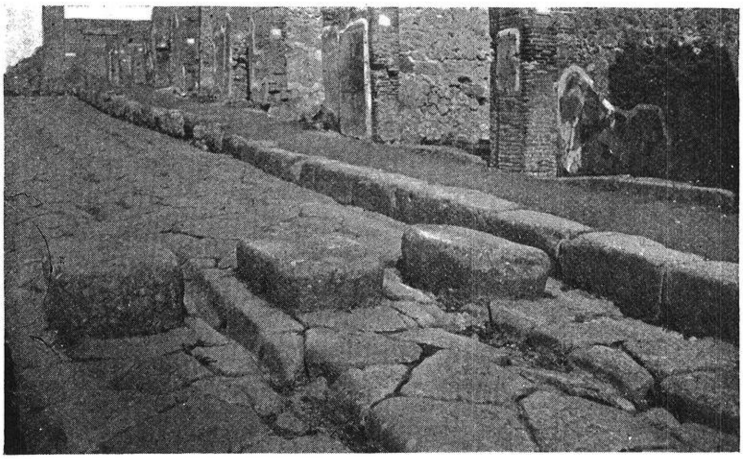

FIG. 3.—*Pompeii. Pavement and Stepping Stones.*

and in Rome of walking over ancient pavement 2000 years old. That they did not keep them always in good repair is shown in Fig. 3. The stepping stones as shown in the figures are common throughout Pompeii. In the street notices of elections and other meetings are still in evidence; and laundries, bake shops and wine shops are easily identified by the stone and bronze utensils remaining.

As Pompeii was our "farthest south" it is a good point for bringing these notes to an end. Perhaps later I may have something to say relative to European technical schools, but at present that sounds too much like work.

Wishing the College of Engineering and the *Wisconsin Engineer* a very prosperous year, I remain,

Yours truly,

F. E. Turneaure.

THE MINERAL INDUSTRY OF WISCONSIN.

By Edwin C. Holden.*
Professor of Mining and Metallurgy.

In the popular mind mining is so invariably associated with the glamor of the precious metals that the average man, if asked to name the mining states of the nation, would, only as an afterthought, include more than the Rocky Mountain and Pacific states in his list, while perhaps a majority of well informed citizens would be surprised or even incredulous on being told that the manufacturing states, New York, New Jersey and Pennsylvania, produce from one to four million dollars worth of ore every year, that the plantation states, Alabama, Florida and Louisiana, are pouring into the lap of the nation from seven to twenty million dollars worth of iron ore, coal, phosphate, sulphur and petroleum each year, that the granger states, Ohio Indiana, Illinois and Iowa, each yield annually from twelve million to fifty million tons of coal, that the annual coal output of Pennsylvania is second only to that of the United Kingdom, and, if we omit Germany and England, is greater than that of all other foreign countries combined.

If, now, we turn to the broader aspects of the mineral industry and include building stone, clays, cement rock and lime, we cannot name a state which does not appear in the mining category, and it becomes easy to believe, as statistics show, that over sixty per cent of the entire freight tonnage of the nation is the product of the mines and quarries. In view, then, of the basic importance of the mineral industry, it is almost amusing that the public should still cling so tenaciously to the Mark Twain conception of a mine as "a hole in the ground. owned by a liar," and that in the popular mind the appropriate seal for any mining company is a wildcat rampant.

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* Revised from an address before the Wisconsin Society of Engineers. The advice and criticism of Mr. W. O. Hotchkiss, State Geologist and Professor C. K. Leith are gratefully acknowledged.

Wisconsin is not obliged to fall back upon her non-metallic mineral products in order to obtain recognition as a mining state, for her output of iron, zinc and lead amply qualifies her. But the actual industry of the state in these and the non-metallic minerals, and more especially her undeveloped resources and possibilities, are appreciated by comparatively few of her citizens, and it is our purpose here to briefly outline the history and present status of this great group of industries, so that the impression fostered by the geographies of our school days, that Wisconsin produces chiefly lumber and dairy products, may be modified.

Lead and Zinc

Wisconsin is, in fact, one of the oldest mining states, for her lead mining industry dates back almost to the time of the earliest French explorations. So far as we can tell, the aborigines made no use of the ore before the advent of the white man, and it was probably not until they became familiar with firearms and lead became an article of barter that the Indians took any practical interest in the deposits.

In this respect the history of the lead ranges differs from that of the copper region, where much prehistoric work was done. Along the Lake Superior shore and on Isle Royale are found numerous shallow outcrop workings, stone mining implements and wrought copper utensils, bearing mute testimony to the industry of by-gone days.

The first mention of the lead deposits of the Mississippi valley was by Radisson and Grosiellier in 1658-9. Thirty years later Perrot established his post about opposite the Dubuque mines for the avowed purpose of working the mines or trading in lead with the Indians, who were by this time producing lead from the Galena or Fever River district. The early Indian methods of reducing the ore, probably all borrowed from the traders, are interesting examples of primitive metallurgy. They worked only the cleanest galena ore, and in the early French days they recovered the metal by throwing high-grade ore on large fires built with thick logs at the base and small holes in the ground underneath. The lead would be found in irregular masses in the cinders or filling the holes, and it was then sold to the traders or cast into bullets. Later, small side-hill dug-out furnaces lined with stones were used, the metal settling in a trench below the charging hopper. These methods were, of course, very wasteful, and large quantities of litharge were left in the ashes. Schoolcraft mentions, in 1821, that the traders were then paying the Indians one dollar per bushel for the lead ashes from these old furnace sites.

The hundred years following Perrot records desultory progress. The Missouri deposits were opened under French auspices, and lead became, next to peltries, the most important export of the upper Mississippi region, and also served as currency. Julien Dubuque in 1788 obtained his grant of the mines near the city which bears his name, and through his popularity with the Indians the principal lead districts of Iowa, Wisconsin and Illinois were occupied by his prospectors and his operations grew in magnitude until his death in 1810. At the time of Major Pike's expedition in 1805, Dubuque admitted that his shipments were from 20,000 to 40,000 pounds of lead per annum.*

In 1819, with the settling of Shullsburg, the permanent white development of southwestern Wisconsin began, and, except during the Black Hawk War, it continued rapidly until the California excitement in 1850.

It is interesting to note in these days of radicalism that the proposed new departure of government leasing of mineral lands is only history repeating itself, for all the Wisconsin mining operations until 1846 were conducted under federal lease. According to a congressional act of March, 1807, the government was to receive a royalty of six per cent of the gross output. The determination of the amount due, and its collection, was left to a superintendent, and, under the primitive conditions then obtaining and the loose method of super-

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* A detailed summary of the early Wisconsin lead mining development will be found in the interesting paper by Dr. R. G. Thwaites in the Wisconsin Historical Collections, Vol. 13, p. 271–292, and a general historical sketch with geological bibliography in Zinc and Lead Deposits of the Upper Mississippi Valley, by H. Foster Bain, Bulletin 294 U. S. Geol. Survey or Bulletin XIX Wisconsin Geol. & Nat. Hist. Survey.

vision, the total return to the federal government under this act was less than $150,000, and its collection had cost more than half that amount in direct expenses and litigation. This early failure of the leasing system is being cited today as an argument against the revival of the policy.*

The lead and zinc production of the different districts of the upper Mississippi valley has until recently been reported together, and it is to be regretted that it is not possible to segregate the figures for Wisconsin for the entire period. From the thirties through the sixties the upper Mississippi region was the important source of lead for the United States, and the production reached its maximum in 1875, when about 25,000 tons, or over five-sixths of the entire production of the country was mined. After the Civil War there was a decline in lead mining, as most of the then known deposits had been worked down to water level, and the lead production gradually dwindled to a minimum of about 1,000 tons per annum. About 1900 the metal market conditions caused a revival of mining activities. Bain estimates the total lead production of the upper Mississippi valley to 1905 at 611,975 tons, but a recent investigation†† indicates that the figures for the period from 1880 to 1904 may have been underestimated, and that the total production was probably over 650,000 tons. To the close of 1911 a round total of 685,000 tons of metallic lead may be accepted as conservative. It is difficult to place a value on this production, owing to the uncertainty of the early prices for lead, but, on the basis of four and one-half cent lead this represents a value of $61,650,000. With the revival in zinc mining, the production of lead as a by-product has again increased, and the production of Wisconsin during the past few years is indicated in the accompanying table.†

* R. W. Raymond, Bulletin 70, p. 1111, Am. Inst. Mining Engrs.

†† O. C. Gillett, Thesis Univ. of Wis. 1911.

† The accompanying tables are compiled, with some corrections and additions, from the U. S. Mineral Resources.

TABLE I

Annual Production of Lead and Zinc In Tons of 2,000 lbs.

	Crude Ore	Concentrates	Metallic Lead	Metallic Zinc	Value
1907	*	54,724	3,499	18,490	$2,552,614
1908	475,689	56,607	4,138	18,206	2,058,956
1909	696,389	75,210	3,694	23,152	2,818,100
1910	1,032,052	100,109	4,413	25,927	3,188,460
1911	1,123,040	103,357	3,353	29,720	3,680,850

* not known

There was no market for zinc ore until the La Salle, Mineral Point, Peru and other smelters were built, in 1860 and later. The early production was largely from carbonate ore, but in recent years it has been entirely blende. The total production in terms of metallic zinc, with five years missing, was 213,000 tons to the close of 1910. The districts within Wisconsin are now almost the exclusive producers of zinc ore north of Missouri, and Wisconsin ranks fourth among the zinc producing states, being exceeded by Missouri, New Jersey and Colorado.

Iron

Iron ore, on the basis of known reserves, is the most important mineral resource of the state. It is found in four well defined districts, the Florence, the Penokee, the Baraboo and Dodge County. The ore of the first three districts occurs in the well known iron formations of the Huronian series of rocks, and the deposits are, in a general way, somewhat similar, while the Dodge County deposits occur in the Clinton formation of the Upper Silurian and are bedded. In addition to these, there are the Spring Valley and other sporadic deposits of bog ore in Pierce county. As it requires a quarto volume of over six hundred pages for the authorities of the Federal Geological Survey to make a general report on these deposits, we cannot attempt to more than mention them in a paper of this compass.

Wisconsin ranks fourth in the list of iron producing states, following Minnesota, Michigan and Alabama, and her yield is now over one million tons per annum.

In figuring the iron resources, it must be remembered that the term "ore" is not absolute; that minerals must be profitably workable on a commercial scale to be called ore; and that with changing conditions the profitable grade changes.

The iron ore statistics show that since 1886 there has been a drop of about .35 of one per cent per annum in the average grade of the iron ore marketed. Each decrease in grade adds rapidly increasing tonnages to the resources, so that this rate of drop cannot be expected to continue, but it is reasonable to figure that in the indefinite future mineral running over thirty-five per cent iron will be classed as ore, and it is on this basis that the reports of the National Conservation Commission figure the iron ore resources of the country. In these reports * Wisconsin is credited with 4,565,000,000 tons of mineral running thirty-five per cent or better in iron which will ultimately be available as ore. These estimates are necessarily crude and have occasioned considerable controversy.† The ore at present actually available as commercial reserves is variousy estimated at from 50,000,000 to 100,000,000 tons.

TABLE II

Production of Iron Ore in Wisconsin

Year	Long tons	Value	Rank of State in Tonnage	Rank of State in Value
1906	848,143	$2,033,217	7	5
1907	838,744	2,665,737	5	5
1908	733,993	2,027,208	4	5
1909	1,067,436	2,727,406	4	5
1910	1,149,551	3,610,349	5	5
1911	559,763	1,386,616	6	5

The serious drop in output shown in 1911 is explained partly by the easy ore market of that year, partly by the approaching exhaustion of some of the older mines, and partly by the

* Papers on The Conservation of Mineral Resources Bulletin 394 U. S. G. S.

† W. O. Hotchkiss in Report of State Conservation Commission pp. 29–30 makes the ultimate ore conservatively ten billion tons, while Monograph 52 U. S. G. S. estimates below three billion.

operation of large Bessemer ore bodies on the Messabi range by the owners of the larger Wisconsin mines, who will naturally work those cheaper ores first.

A few notes regarding the separate districts may be of interest.

Florence.

The oldest of the Lake Superior iron ranges in the order of development is the Marquette, of Michigan, which was discovered in 1848, and has made regular shipments ever since 1856. The Menomonie range followed thirty years later, and in 1880 the Florence district, which is practically the Wisconsin extension of the Menomonie range, was opened.

The deposits in these districts do not occur in the great, flat, easily exploited masses typical of the Messabi range. The outcrops are few, the ore bodies deep-seated, and the ore itself slightly lower grade than the best Messabi, and these conditions have tended to retard the development of this and the adjacent Crystal Falls district, so that the ultimate possibilities are not yet determined. Hayes credits the Florence district with 1,750,000,000 tons of iron formation, and on his ratio of iron ore to total formation of one to 3.8, gives the Florence district 460,000,000 tons of ore ultimately available, while Leith and Van Hise give 215,000,000 tons in monograph 52. The Florence and Commonwealth mines have produced about 6,000,000 tons of ore to date.

Penokee Range or Wisconsin Gogebic.

The Penokee range is the westerly extension of the Gogebic range of Michigan, and was first explored near the western end as the ore here is magnetic and in places exposed. This end of the range, however, is of lower grade and less productive than the central hematite portions. It extends some forty miles or more from the Montreal River at Ironwood and Hurley, across Iron, Ashland and Bayfield counties, and productive mines are developed along the eastern third of this distance. The district has been shipping since 1884, and the twelve principal Wisconsin producers have shipped to date fifteen million tons of ore. The ore bodies occur in steep sided pitching troughs, formed usually by the intersection of tilted quartzites and a series of inclined dikes. The mines are deep, and the ground in places heavy, and as a result the underground problems are at times far more complicated than on the Messabi range, where the deposits are usually flat, comparatively regular, and seldom over three hundred feet below the surface. The Wisconsin portion of the Gogebic is credited with 1,250,-000,000 tons of ultimate ore.

Baraboo.

The Baraboo deposits were discovered by drilling into the Huronian formation near North Freedom in 1903, and such important ore bodies have been found that three shafts have been sunk and first class modern equipments at the Illinois and the Cahoon mines (Monograph 52 U. S. G. S.) credits the district with 910,000,000 tons of formation which will contain over thirty-five per cent iron.

Dodge County.

The Clinton ores are bedded deposits occurring below the Niagara limestone and above the Cincinnati shales. This horizon is persistently iron bearing wherever it outcrops in Wisconsin, Ohio, Kentucky and all down the Appalachians to Alabama. The hematite outcrops in Dodge county and was early discovered and mining began in 1849. The ore beds vary from four to thirty-seven feet thick so far as explored. Owing to the comparatively low grade of the ore, the maximum being fifty-four per cent iron, not a great deal has been shipped by the lakes, but owing to the associated lime the ore is self-fluxing and commands a local market. The aggregate shipments from 1892 to the close of 1909 were 570,886 long tons. In addition, an unknown tonnage was produced previously.

These deposits may become of considerable importance as drilling has proven them much more extensive than at first supposed, and in monograph 52 the district is credited with a possible total of 600,000,000 tons, averaging perhaps forty-five per cent iron.

Spring Valley.

The Spring Valley deposits were worked in a small way until recently, producing from the Gilman and Cady mines from three to six thousand tons of iron ore per year, which were smelted locally. There are several other small local deposits of this bog ore, none of which are at present active.

Copper

The Keweenawan system of rocks, in which occur the great native copper deposits of northern Michigan, crosses Wisconsin diagonally in a great syncline in Ashland, Bayfield, Douglas and Burnett counties. The northern limb of this horizon is deeply covered in the Bayfield peninsula, but in Douglas county the Douglas copper range and the so-called St. Croix copper range occur in the northern limb and the Minong range in the southern. On the Douglas range there are evidences of prehistoric mining similar to those found on Isle Royale, and desultory prospecting has been done ever since 1846. In the sixties and seventies a number of copper mining companies were formed, all of which ended in failure. Professor Irving years ago summarized the situation in one of the early U. S. G. S. monographs, by stating that native copper has been met with all along the course of the Keweenawan belt in Wisconsin from the Montreal River to the St. Croix, that there is much float copper southwest of Bad River and that but for the overlying sheet of drift the indications are that this region would be as productive in copper as Keweenaw Point.* Let us hope that the future will justify this geological optimism.

With one exception none of the operations thus far undertaken, so far as can be learned, have done such thorough exploration work as is justified on Keweenaw Point and it seems, geologically, perfectly reasonable to hope that some day Wisconsin may include a group of important copper producers within her borders. Recently there has been only one copper exploration in operation in the state.

Minor Metals

Wisconsin has had several abortive gold excitements, and the mining department of the university frequently receives

* Monograph V U. S. G. S. See also Bulletin VI Wis. Geol. and Nat. Hist. Survey "Copper Bearing Rocks of Douglas County."

samples from various parts of the state for gold and silver assays. The investigator is usually deceived by finely disseminated pyrite or tarnished mica, and the results have been disappointing. Nuggets and fine gold have been found, however, in the glacial drift and even in stream gravels in Wood, Marathon, Clark, Pierce and other counties, but never in commercial quantities.

Silver is known to be associated with the Keweenawan copper. Occasional rich rock is found and some exploratory work has been done, but no workable deposits have been proven.

There are some indications of the possibility of nickel ore occurring in the north central portion of the state, but no exploration work has been done to justify definite statement.

Non-Metallic Industries

As neither carboniferous nor cretaceous coal formations occur in Wisconsin, the state cannot boast of any coal resources. Oil, and even gas are possibilities, due to the presence of the oil rock at the base of the Galena formation.*

A total area of 1,800,000 acres of peat land averaging six feet of peat, or over 1,200 tons of finished peat per acre, is reported within the state. It is problematical what part of this area will be used agriculturally, thus destroying the peat, but a large proportion will probably be mined as coal becomes more expensive.

No Portland cement is made, and the only natural cement plant in the state has been idle since 1910.

Clay

In clay products Wisconsin has produced over a million dollars a year in brick, tile and pottery for the past dozen years, except in 1908. The brick yards are scattered so numerously over the state that it is not practicable to tabulate them in this paper.

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* See Bulletin XIX, p. 25, Wis. Geol. & Nat. Hist. Survey.

TABLE III

Clay Working Industries of Wisconsin

	Common Brick		Front Brick		Tile	Pottery and Mi-cell	Total Value	Rank of State
	Value	Av'g per M	Value	Av'g per M				
	$	$	$	$	$	$	$	
1906	1,109,386	6.51	52,038	9.67	51,953	13,965	1,227,342	25
1907	1,019,522	6.43	43,387	10.57	50,427	13,483	1,127,819*	26
1908	830,240	6.43	41,569	8.95	74,702	11,875	958,395*	24
1909	956,232	6.47	74,120	9.52	95,899	13,338	1.139,589*	27
1910	1,071,457	6.65	29,900	12.46	64,391	11,653	1,177,401	26
1911	985,824	6.51	100,140	10.09	58,547	11,850	1,159,361	26

* Exclusive of crude clay sold as such.

While the proportion of front brick to common brick shows a gratifying increase in 1911, the proportion of tile and other high grade products is still insignificant. The possibility of further developing this industry and of making better grades of product where the cheaper grades are now made, seem very great, as indicated by some preliminary tests made by Professor Havard in conjunction with the State Geological Survey, and the department of mining and metallurgy of the university, together with that of manual arts, is now installing clay testing and ceramic laboratories in which to teach the ceramic arts and assist in the development of this industry.*

Gravel and Sand

The state produces an insignificant quantity of the finer grades of glass, moulding and fire sand. Building sand and gravel are items in direct proportion to the building and construction activity of the state, and they will naturally grow from year to year. The large increase noted for 1911 was due to extensive road and railway construction work.

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* See Ries Report on the Clays of Wisconsin, Bulletin XIV State Survey.

TABLE IV

Annual Production of Sand and Gravel

Year	Building Sand	Other Sands*	Gravel	Total	
				Short tons	Value
1906	$70,026	$50,041	$51,413	301,610	$171,474
1907	124,122	98,917	98,917	967,659	280,394
1908	152,768	44,532	115,455	860,047	312,755
1909	163,610	114,116	122,427	1,517,433	414,269
1910	256,284	76,528	92,751	1,451,758	425,563
1911	245,879	100,117	385,696	3,676,855	731,692

* Under other sands are included moulding, paving, engine, fire, furnace and miscellaneous varieties.

Lime

Wisconsin has since 1907 held third place in the list of states as a producer of lime, as shown in Table VI. An almost unlimited area of limestone is available in the southern portion of the state for the further development of this industry.

TABLE V

Annual Production of Lime

Year	Rank of State	Short Tons	Value	Average price per ton	No. of Operators
1906	5	225,663	$769,868	$3.41	48
1907	5	219,644	733,966	3.34	46
1908	3	235,538	831,792	3.53	44
1909	3	268,250	1,067,500	3.98	46
1910	3	248,238	959,405	3.86	40
1911	3	250,638	961,558	3.84	33

Mineral Water

Wisconsin has for a long time stood first among the states in the total value of its mineral water sold, although it is exceeded by both New York and Minnesota in the quantity sold. The production in recent years is as follows:

TABLE VI

Production and Value of Mineral Water

Year	No. of Openings	Gallons Sold	Value	Rank of State in Value	Rank of State in Quantity
1906	27	7,702,718	$2,397,694	1	2
1907	29	6,839,219	1,526,703	1	3
1908	28	6,084,571	1,239,907	1	3
1909	34	6,101,882	1,132 239	1	3
1910	37	6,400,712	974,366	1	3
1911	31	5,716,162	955.988	1	3

In addition to the above it may be surprising to learn that, despite what is claimed to make Milwaukee famous, the state produces far more mineral water for the manufacture of soft drinks than any other state, or about one-third of the total so reported for the entire country.

Pyrite

Pyrite is in demand for its sulphur content for the manufacture of sulphuric acid, the resultant cinder being suitable as an iron ore. Sulphuric acid is the backbone of the chemical industries, and it is necessary to the manufacture of artificial fertilizers and of high explosives, so that Humbolt was justified in saying that the civilization of a country can be judged by its consumption of sulphuric acid.

Fortunately for our reputation, the acid consumption of the United States has grown by leaps and bounds in recent years, so that, despite the utilization of the waste gases from smelting furnaces for acid manufacture, we are still obliged to import three times as much pyrite as we produce at home. European fifty per cent sulphide sells on the Atlantic seaboard at from ten to twelve cents per unit sulphur, or five to six dollars per ton. Sulphuric acid is a cheap commodity, but because of its disagreeable character it is charged a high freight rate, so that it must be manufactured within a short distance of its market. The importance of this to the Wisconsin miner is that sulphide ore in the Mississippi Valley must ultimately command the seaboard price as we follow Humbolt's prescription and become civilized.

The lead and zinc ores of southwestern Wisconsin have associated pyrite and marcasite in abundance as gangue minerals, and the magnetic and pneumatic methods of separation have turned these formerly objectionable impurities into marketable products. The output within the past two years has doubled, as indicated by the accompanying shipment figures. This commodity promises, therefore, to ultimately become a very important source of income to the Wisconsin zinc miners.

TABLE VII

Annual Pyrite Production

	Short Tons	Value	Rank of State
1907	231	$797	....
1908	2,536	8,740	9
1909	7,970	27,337	7
1910	14,081	49,467	4
1911	14,470	50,025	4
1912	20,134	70,450ca	?

Stone

Wisconsin ranks ninth among the stone producing states, her average production during the past five years being over $2,500,000 per annum. She is exceeded only by the New England states in the value of her granite output, and her production of limestone and sandstone is also important. Quarrying either for crushed or for dimension stone requires systematized, large-scale work, with the best of modern equipment, if the best commercial results are to be obtained. The quarrying industry of the state, flourishing though it is, is absurdly small when one considers the beautiful monumental and building stones which are available,* and the fact that Wisconsin is the nearest source of granite to Chicago and other large cities. A map and directory of the quarries of the state are given in the report for 1911 U. S. Mineral Resources.

TABLE VIII

Annual Production of Stone

Year	Granite	Sandstone	Limestone	Total	Rank of State
1906	$798,213	$181,986	$891,746	$1,871,945	11
1907	1,228,863	236,183	1,027,095	2,492,141	9
1908	1,529,781	219.130	1,102,009	2,850,920	9
1909	1,442,305	204,959	1,047,044	2,694,308	9
1910	1,475,342	189,654	979,522	2,644,518	9
1911	1,382,309	144,430	848,563	2,375,102	9

CONCLUSIONS

A summary of the mineral output of the state is attempted in the following tabulation:

TABLE IX

Total Production of the State

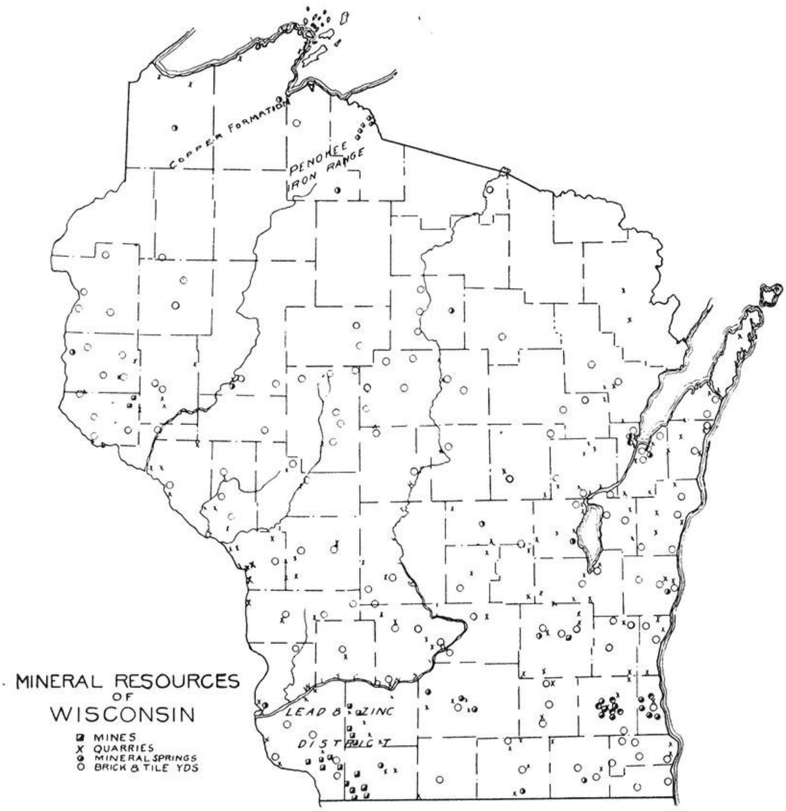
	1910		1911	
	Value	Rank	Value	Rank
Clay Products	$1,177,401	26	$1,159,361	26
Iron Ore	3,610,349	5	1,386,616	5
Lead	388,344	5	301,770	6
Lime	959,405	3	961,558	3
Mineral Waters	974,366	1	955,088	1
Pyrite	49,467	4	50,025	4
Sand and Gravel	425,563	15	731,692	8
Sand Lime Brick	29,399	12ca	68,312	4
Stone	2,644,518	9	2,375,102	9
Zinc	2,800,116	4	3,388,080	3
Miscellaneous‡	3,497,478	....	3,328,798	....
Total	$16,556,406	....	$14,707,302	....

‡ Miscellaneous items are:—Graphite, ground gypsum, quartz, paint and mortar colors and pig iron, less the value of the ore included above.

* See Report on the building and monumental stones of Wisconsin by the late Dr. Buckley. Bulletin IV Wis. Geol. & Nat. Hist. Survey.

The decrease in 1911 is accounted for by the iron ore. Indications are that the grand total for 1912 will more than make up this loss, thus breaking the state record.

While the figures for the separate crude products are fairly accurate, they do not indicate the full significance of the industry because almost all of the manufacturing and structural industries of the state are directly dependent upon them and the line between production and manufacture cannot be sharply drawn. It must also be remembered that a large proportion of our mineral production is not consumed as are agricultural products but becomes permanently a part of the physical wealth of the race.


COPPER FORMATION
PENOKEE IRON RANGE
LEAD & ZINC DISTRICT
MINERAL RESOURCES OF WISCONSIN
MINES
QUARRIES
MINERAL SPRINGS
BRICK & TILE YDS

THE MANUFACTURE OF ELECTRICAL CONDUIT FROM A CHEMICAL ENGINEERING STANDPOINT.

OLIVER W. STOREY.
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Conduit used for electrical purposes may be divided into three general classes: flexible, semi-rigid and rigid. The chemical engineer is concerned chiefly in the manufacture of flexible and rigid conduit, while there are a few problems of interest to him in the manufacture of the semi-rigid conduit.

The methods of manufacture of electrical conduit are partially controlled by the conduit specifications of the Board of Fire Underwriters, whose requirements are very rigid. To meet these requirements on a commercial basis calls for the solution of some difficult problems that have not been entirely satisfactorily solved.

Flexible conduit is used for the protection of wires passing through partitions or around beams, where abrasion is likely to take place and at outlets. The requirements of such a tube are that it shall be moisture repellent, fire-proof, shall fish easily, resist abrasion, be flexible in cold weather and not soft enough to flow at 150 degrees F., have a tensile strength of 200 pounds, shall not break down easily, and that it shall be an insulator. These restrictions narrow the selection of materials used in its construction to a small number. With the exception of the manufacture of the tube base, the manufacture of such a flexible tubing is distinctly a chemical engineering proposition.

To secure a flexible inner tube as a foundation through which wires may be fished, it has been found that cotton and paper must be used, either in the shape of a tubular piece of canvas wound with paper or as a weave of cotton and paper made on a circular loom, similar to the circular knitting machine but on a large scale. As cotton and paper are inflammable materials the covering over these must be of a fire-proof nature, yet water-proof and flexible.

Tars, while in some respects suitable, cannot be used owing to their inflammability. Certain pitches are fire-proof and the addition of a large amount of these to tar will make it fire-proof. Borax, alum, and other inorganic materials might be added, but these are not as effective and cheap as is the pitch. By covering the inner tube with this compound it is rendered fire-proof, almost water-proof, and is flexible, but is not strong or stiff enough to meet practical requirements.

The strength and stiffness is obtained by laying a cotton braid over this compound coating, then applying another coating of compound and finishing with ground mica to prevent tackiness in handling and to give a good appearance. The interior of the flexible tubing is also soap-stoned to make the fishing easier.

The designing of machinery to handle these various materials also presents some interesting chemical engineering problems, since the largest percentage of this tubing is one-fourth inches and is handled in 1,000 ft. lengths. The compounds used are hot, sticky, slow setting pitch and tar mixtures that must be handled while in a fluid and semi-fluid condition and must be applied evenly and as a very thin covering.

In the manufacture of semi-rigid conduit, or the so-called armored cable, the chemical engineering problems are not as important as those in mechanical engineering. In insulating the wire the chemical engineer must decide upon the ingredients necessary to properly water-proof and insulate the wires and here he is again limited by the underwriter's specifications. He must also design machinery for properly applying these materials.

Since armored cable is made by covering the insulated cable with an interlocking series of galvanized steel strip, the galvanizing of this steel strip either by hot galvanizing, electro-galvanizing or sherardizing methods, must be worked out. This involves a system for doing this galvanizing continuously.

Probably the most varied problems for the chemical engineer in the manufacture of conduit are those arising in the manufacture of conduit pipe, such as pickling, galvanizing and enameling.

The pickling of conduit is a big problem and one that has proven a stumbling block. To remove all scale from the interior and exterior of conduit pipe is the most important operation of rigid conduit manufacture. This problem cannot alone be solved in the pickle room but must depend partly on the tube mill.

Conduit pipe is classed into two general divisions; galvanized and enameled. The galvanized, or white pipe, may be made by one of the three galvanizing processes. The enamel pipe is known to the trade as black pipe, since a black enamel is used as the protective coating. The white or galvanized pipe is a more recent development in conduit manufacture.

In the galvanizing of pipe a coating is desired that will be a protection to the iron base and also be very resistant to corrosive influences; it must be easily and cheaply applied, look well, and be elastic enough not to crack or flake when put under stress, as when the conduit is bent.

In the hot galvanizing process the chief difficulty has been the wiping of the interior of the conduit. Both the interior and exterior must be wiped sufficiently to obtain a thin enough coating to withstand bending without flaking.

In cold galvanizing the problem of zinc coating the interior of the pipe has not been solved, while the usual exterior coating of several brands is very thin and not uniform. The threads are usually finished with a scant amount of zinc or none at all.

In sherardizing the difficulties of the two other methods are not present, since the thickness of the coating is under control and the interior and threads can be coated as easily as the exterior.

The relative merits of the protective properties of these various kinds of zinc coatings are subject to a large amount of discussion and the claims and tests of the different companies make interesting reading.

To provide a smooth run-way to facilitate the fishing of wires and in electro-galvanized conduit to also give an insulating and protective coating, the conduit is given an interior coat of enamel. In the hot galvanized and sherardized pipe, this enamel is a very thin coating, as the zinc furnishes the protective coating and the enamel merely aids the fishing. Since in cold galvanized conduit the interior is not zinc coated it must be given a heavier coating of enamel to provide protection to the wire against corrosive influences.

The compounding of these enamels and the design of enameling devices and baking ovens are problems open to a large amount of improvement.

The making of black enamel pipe is one very similar to the enameling of the white pipe, except that an enamel of more body and more elasticity is required to give a heavier coating both on the interior and exterior of the pipe. To obtain a uniformly heavy enamel over the entire conduit requires a great deal of skill in the compounding of the enamel and later in the design and manipulation of the baking ovens.

The manufacture of conduit is in general one in which the chemical engineer should be able to do effective work. Owing to tremendous competition in these lines, any improvements that will cut the cost of manufacture only slightly, or that will improve the product slightly, will mean a greatly increased sale and consequent cut in cost of manufacture. Conduit manufacturers have not realized the importance of the chemical engineer in these lines in the past. With such a recognition improvements in the conduit manufacture, especially in rule of the thumb operations are bound to come.

THE METRIC CARAT IN DIAMONDS.

The systematization and unification of weights has become a by-word in all the chemical and metallurgical industries. Accordingly, it is not surprising to read that the various nations have decided to recommend the adoption of the metric carat for weighing diamonds. The carat is a very interesting unit of weight. The American Jeweler, on page 456 of the present issue, has an interesting account of the origin from which we derive the following:

"The Greek weight 'keration,' and also the Roman 'silique' were equivalent to 1-114 ounce, or 3⅓ grains of our present weights; that is only slightly more than the present value of the carat (about 3⅙ grains).

"The carat weight had its origin in the use of certain hard leguminous seeds, fifty seeds of Ceratonia Siliqua taken at random and weighed together, gave an average weight of 197 milligrams per seed, thus approximating very closely to the present value of the carat weight, which is 205,304 milligrams.

"The above mentioned Ceratonia Siliqua is the carob or locust tree, the fruit of which is the well-known locust-bean, or St. John's bread. The Greek name 'keration,' refers to the horn-like shape of the fruit pods; and carat is an obsolete English name for the seed. The seeds are remarkably constant in weight.

"An international carat of 205,000 milligrams was proposed in 1871 by the Synlical Chamber of Jewelers, etc., in Paris, and the Association of Diamond Workers in Amsterdam adopted on October 17, 1890, a carat weight of 205,128 milligrams.

"The German N. A. G. in 1905 or 1906 petitioned the German Reichstag, in order to get official permission for the use of the carat weight for diamonds and precious stones, but did not succeed.

"The first country to introduce the new carat of 200,000 milligrams was Spain; Italy shortly afterwards followed, then

Bulgaria and Denmark (1910), Norway (1910), Japan (1909), Portugal (1911), Roumania (1911), Switzerland (1909), Sweden (1911).

"France adopted the new carat by the Act of June 22, 1909, and it was destined to be used from January, 1911. At the request, however, of the jewelers and dealers in diamonds, and because the manufacturers of weights could not supply the trade quickly enough with the new weights, the reform was postponed until January 1, 1912, since when the metric carat is the only legal weight for precious stones in France.

"Belgium and Holland, two countries equally important for the diamond trade, have not yet officially adopted the reform, but the suggested acts or laws are already being discussed by the authorities, and ere long they will be brought before the legislative chambers, and there is no doubt that they will be adopted, as the trade of both countries have declared themselves in favor of the reform.

"Germany has been the last country to introduce the new weight for precious stones, a new Act for weights and measures having been operative since April 1, 1912, by which all old weights (including the old carat) were strictly abolished, the metric system enforced, and the denomination of carat allowed for the unit of 200,000 milligrams.

"The movement for the general adoption of the metric carat receives little support in England. It may be added, that the English carat is not a legal unit of weight under the weights and measures act of 1878, but the metric carat would be covered by the weights and measures (metric system) act of 1897.

"The National Association of Goldsmiths in annual convention at Scarborough, has unanimously resolved that the metric carat should be the standard weight.

"The difference between the old and the new units is only slight, the metric carat being approximately 2½ per cent less than the present carat."

The Wisconsin Engineer.

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EDITORIAL.

We have all frequently heard discussions as to the ultimate and true value of our actual class-work at college,—how good scholarship is or is not essential to a successful professional future. We have heard the title, "grind," scornfully bestowed upon the good student, and in return have heard boastful assertions as to the composition and physical quality of the head of the poor student.

On the one hand it is true that a mediocre student, when brought face to face with the difficulties of life, will oftentimes by effort, ability or the element chance, attain an enviable rank, while a good student will prove to be an unexpected failure. On the other hand the reverse situation is likewise of frequent occurrence.

How are we to reconcile these opposite conditions? What is the true value of good scholarship? Simply this,—the good student deserves much credit for his patience and application, and the poor student deserves some reprimand for his lack of these qualities; but, beyond this, neither good nor mediocre scholarship is a true criterion of a man's absolute worth. That intangible element, personality, enters at this point, and enters with considerable force. The ability to create a favorable impression, to go out and meet strangers under the variety of conditions met with in modern society, and maintain a comfortable atmosphere, to carry on an intelligent conversation along any reasonable line; this is just as requisite to a man's success in this strange world of ours as the ability to integrate for the length of the catenary.

We are supported in this belief by a statement recently made by one of our foremost faculty members at a gathering of engineering students, when he said that in the analysis of the value of a college training he would not assign a greater weight than fifty or sixty per cent. to class-room work. And we quote no less a man than Emerson when we say,

> "What boots it thy virtue,
> What profits thy parts,
> Whilst one thing thou lackest,
> The art of all arts.
> The only credential,
> Passport to success;
> Open castle and parlor
> Address, man, address."

With the beginning of the second semester we start upon a new lap, for some of us the last, in the race for an education. The work will not be so hard at the start. There will be plenty of things which can be put off to a later period in the semester. But let us remember that later in the semester there will be many more things to distract us from our work. Leisure time in the spring is doubly valuable. A firm resolution to get everything done on time or a little before time will help to do away with that mad pre-examination rush. It is a hard thing to do, this looking ahead and working ahead, but it is, in the end, well worth while.

* * *

The letter from Dean Turneaure in this issue is well worth reading as an entertainment, whether the reader is an engineer or not. We appreciate greatly such a personal and informal note from one whom too many of us have known only from the assembly platform. The letter half-way promises another of a more technical character to follow. If it accomplishes in instruction what its predecessor does in entertainment, it will be doubly welcome.

* * *

A great deal is being accomplished this year in the line of getting better acquainted with the faculty. The senior engineer smoker, the mixer given for the seniors by the engineering faculty, and the proposed junior-senior smoker, are doing much to remedy the unfortunate condition which must to some extent exist in a university of this size. The lack of attention to the individual is the point upon which opponents of centralization in education base their chief arguments. Everyone seems to be trying to destroy the traditional barrier between student and professor. Very few of us now regard our instructors as slave drivers to be evaded and circumvented. But there is still some spirit of reserve which prevents our getting the best results from our work. We often do problems after a model form, using formulas because they are in the book, getting the right results perhaps, but failing utterly to grasp the principles behind. We know that we do not quite know why we substitute in a certain equation, but it brings the answer and it is easier than looking up the professor and finding out.

That is the spirit which we should try to break down. Fifteen minutes in the office will often teach more than a semester in the lecture room. It is up to us to take advantage of the opportunities we have at hand.

* * *

While we are speaking of getting things done early, it might be well to explain why the *Wisconsin Engineer* has not been as prompt as might be. The December number was delayed until after the beginning of the Christmas holidays by a shortage of paper at the publishers. That kept us back on this issue, which will probably reach us during examinations, a poor time for distribution. We hope, however, gradually to work back to the middle of the month as our time of issue.

DEPARTMENTAL NOTES.

The second of this year's series of lectures given to engineering students by outside lecturers was given on Thursday morning, December 12th at 11 o'clock, by Professor Eugene Kuehnemann, who chose for his theme, "Some Aspects of Modern Germany." Professor Kuehnemann, who is on the faculty of the University of Breslau, Germany, is this year's Carl Schurz memorial professor to the University of Wisconsin.

Prof. Kuehnemann, after analyzing the position of Germany among the nations of the world, brought out clearly the social and political forces which have produced this position, mentioning especially Germany's system of education, compulsory military service, and national pensions. He contrasted educational conditions of Germany with those in America, and intimated that we lack the thoroughness, and resulting competency, which is secured there.

Even though the subject was somewhat foreign to the ordinary items of interest to engineering students, the lecture was well attended and well received.

* * *

The senior engineers' smoker—the first of its kind—which took place in the Union parlors on the evening of Thursday, December 5th, proved not only popular but successful from all viewpoints. It was attended by almost a hundred students, and a number of faculty members. Acting-Dean Mack, Dr. H. C. Bumpus, business manager, and Prof. F. T. Havard of the mining department, gave short addresses. The interest with which this first smoker of its kind was received promises goodly success for future events of its kind.

* * *

A rather interesting departure from the ordinary routine of the Civil Engineering Society is to be noted in the debate that was held at their regular meeting on Friday, December 6th, at which the question, "Resolved, that the city of Madison should acquire by purchase and thereafter operate, the property of the Southern Wisconsin Railway Company," was argued. The affirmative side was held by Davis, Jacobs and Ockert, while the negative was held by Cahill, Bloecher and Larsen. The popular vote taken at the close showed the negative to be the winners.

* * *

An interesting experiment is being conducted in the hydraulics laboratory. Many years ago the right to a very indefinite amount of water was sold at one of the northern Wisconsin dams. Now, when power is more at a premium, a question as to the exact amount of power sold has been brought up. A millwright who had a sketch of the old wheel was found and a reproduction was under the direction of Mr. C. B. Stewart, who is conducting the test. The wheel is an old wooden one like a scroll wheel without the draft tube.

The tests have not yet been finished but the wheel seems to give from twenty-five to thirty per cent efficiency.

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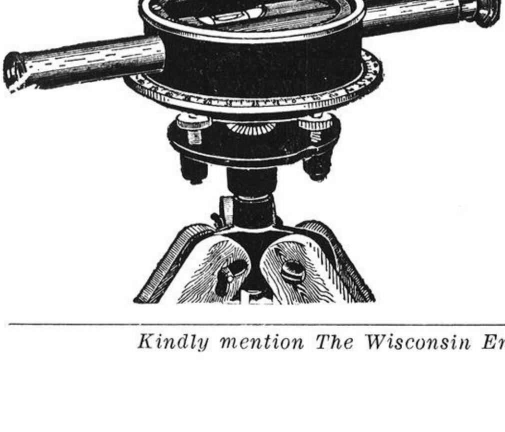

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