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INTERIOR OF BRICK KILN (PAGE 208).

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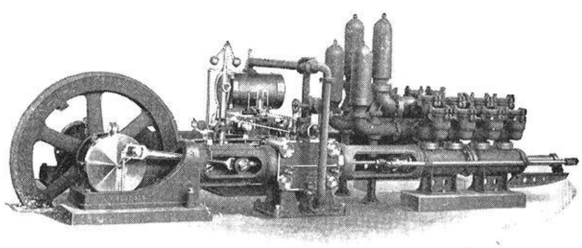

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The Wisconsin Engineer

VOL. XV FEBRUARY, 1911 No 5.

ORGANIZATION AND DISCIPLINE.

A Paper Read at the University of Wisconsin, Madison, Wisconsin, March 18, 1909, by M. C. Rorty.

In running through my own working experience to find what might be of most interest and value to a class of university students on the eve of graduation, nothing has seemed to me more significant than the rapid advance of specially trained college men from positions of purely technical character to positions requiring general executive and business ability. In saying this I do not mean to convey the impression that the college man has ever been, as regards the filling of positions of breadth and responsibility, at a disadvantage in comparison with the non-college man, for I do not think that, in any general way, this has ever been the case, but wish rather to bring out the fact that, today, the college man, as a college man, is purposely being selected for these larger positions.

So, during the hour at our disposal, I will try to give you an outline of the general principles of organization and discipline, together with some notions as to detailed methods of handling men.

Let me begin by drawing a parallel between the development and handling of an organization and the design and operation of a steam engine.

In the case of the engine, the designer who made the plans would provide a cylinder and piston, a piston rod and cross-head, and a connecting rod and crank. He would select the material for each with an eye to its special qualities, and would give each part dimensions proportionate to the demands to be made upon it. He would adso give each part special functions, and would define in his own mind, down to the smallest detail, the duty that each should perform in the operation of the engine as a whole. He would never throw a tangle of material together, and turn steam into it, in the hope that it would grow into an engine.

And when the engine was completed and turned over to the engineer to run, (this, in my parallel, representing the change from the development to the routine handling of an organization), the engineer would not say, if a bearing began to squeak and grow hot, "Good bearings do not squeak," for he would know that it was the nature of bearings to squeak, but would set to work at once with wrench and oil can until things ran smoothly again. He would know, too, that the more power the engine was developing, and the harder piston rod pushed against cross-head, and cross-head against connecting rod, and connecting rod against crank, the more chance there would be for friction. But he would not, for that reason, shut off steam. He would realize that if quiet and rust were all that were wanted, a turn of the throtle would secure that.

And if, in some way, the piston rod should begin to grow, and should say, perhaps, that the connecting rod was weak and that it would be better for the piston rod to take hold of the crank directly, the engineer would not say, "Very well, fight it out." He would know that that would probably result in injuring or wrecking the machine. As a sensible engineer, he would say, more probably, "Very well, that may be so, but the designer and I will have to consider the question before any change is made. In the meantime, remembr that you are still only the piston rod." And if the piston rod did not take the hint, he would find a new piston rod that believed in organization, and that he could safely trust alone with the rest of the machine. He would do this even if he believed that the connecting rod *was* weak and *was not* required in the engine.

Leaving this parallel as it stands, let me next state briefly certain fundamental principles of organization and discipline.

These are:—

1. Each position in an organization should have assigned to it definite responsibilities and definite authority. These may, and, in most cases, should be reduced to writing.

2. Active responsibility should always be coupled with corresponding authority.

3. No change should be made in the scope or responsibilities of a position without a definite understanding to that effect on the part of all persons concerned.

4. No dispute as to the authority or responsibilities of a position should be considered too trivial for careful adjudication. The knowledge that this adjudication can always be obtained will tend to reduce friction and to promote amicable adjustments of differences.

5. An official in charge of any work, whether competent or incompetent, must insist upon his decisions as to methods of handling work being respected and followed out by his subordinates. A good man will give all possible weight to the opinions of his subordinates and, as he gains confidence in their judgment, will leave many points entirely to their decision. He will thus retain good men in his service. A poor man, on the other hand, will decide arbitrarily and will not delegate definite responsibility to his subordinates. He will, therefore, be unable to retain good men in such positions.

6. The work should create the position rather than the reverse. When questions of personnel make arbitrary divisions of responsibility necessary, unusual care must be taken accurately to define the limits of authority.

7. A sure appeal to men for extra exertion can only be made on the basis of their self-interest. To this end the organization should make full provision for filling, from its own ranks, any vacancies that may occur. The security of position which a good organization gives to its officials makes them ready and willing to give their subordinates full information of a kind to fit them for advancement.

Appeals to the loyalty of subordinates to superiors, or to "stock holders," will soon prove futile if accompanied by no prospects of advancement or increased remuneration.

8. The most certain guarantee of a loyal and enthusiastic working force is the adoption of a definite and logical policy, consistently carried out. The opportunist may occasionally achieve success for himself but he acquires few followers.

The principles that I have just enumerated apply equally well to all organizations without regard to the nature of the work involved, whether this be the making of steel rails, the selling of groceries, or the maintenance and operation of telephones. When, however, we come to study the characteristics of particular organizations we find that, in addition to these general principles, there are many other special factors to be considered. Among these might be named the geographical distribution of the working forces, the possibility of minute subdivision and specialization of the fundamental work of the organization, the presence or absence of broad natural lines of cleavage extending throughout the work of the organization, the character and extent of facilities for transportation and communication, the necessity or absence of necessity for local one-man authority, etc.

Leaving now the broader problems of organization, I will try to give you a few points as to detailed methods of handling men.

In the first place you have all heard of the old recipe for cooking a rabbit, in which it is specified that you must first catch your rabbit. So in handling men you must first learn to hire them.

Now I firmly believe that experimental psychology in time will develop to a point where it will be of definite value in selecting men for particular lines of work, and incidentally in determining courses of school and college instruction for individual students, but during your time as executives it will, I imagine, be necessary as today, to rely for such purposes largely upon the cruder psychological processes of personal judgment.

In my own selection men, I first consider the work I have in mind and, if possible, choose a man, who, while specially qualified for the particular work in view, is of so well balanced a make-up that he can, if necessary, be shifted to other work. This is important even in large organizations, and is doubly important where only a few men are employed.

In the second place, I am as careful not to pick too intelligent a man for a job as I am to secure a man that is intelligent enough, and, in determining this point, it is necessary, particularly in hiring young and ambitious men, to know with a fair degree of accuracy what, and how many, lines of advancement are open in the organization. As a general rule, the men you employ will have a rather fair minded view of their own capabilities, and of what is a proper rate of advancement, and you will secure best results by having neither a surplus nor a deficit of talent. I sometimes think that it is better, on the whole, occasionally to be forced to advance a man to a position a little beyond his natural capacity, than regularly to have an excess of highly intelligent men working in low grade positions.

And finally I never, when I can avoid it, rely entirely upon my own judgment either in hiring or in promoting a man. I have found, and you will find, that every man, consciously or unconsciously, measures his intelligence against the intelligence of those with whom he is thrown in contact, and he does not do this fairly, point by point, but chooses his own strongest points as the basis of comparison. This principle is exactly the same as in trials of muscular strength, where the one proposing a test selects always some trick in which he is particularly skillful. So, in selecting an employee, I have him judged, whenever I can, by a number of persons of known and varied mental characteristics, and from their combined opinions find it possible, in the majority of cases, to make up a very accurate analysis of the man under consideration.

The determination of mental characteristics is, however, only a part of the proposition. I am inclined to think that my first instinctive measure of a man is based upon his appearance of health or ill health, and that I make judgment next for general normality or abnormality of makeup, and finally look for facial and other outward signs of perseverance and good tempered firmness, which are positive qualities and signs of strength, as distinguished from obstinacy which is a purely negative quality and a sign of weakness. And, unless an applicant measures up satisfactorily as to the points I have mentioned, I do not concern myself at all with the absolute degree of his intelligence.

With the proper man hired for a job and with the job properly laid out, two-thirds of the work is done, and the balance is simply a question of proper handling and discipline.

I specified near the beginning of this talk certain general principles for the handling of an organization and will supplement those principles now by describing more detailed and more personal methods of securing results.

To start with, there are as many kinds of men as there are of horses and, just as different horses require different handling, so the skillful driver of men will vary his touch for each individual. However, in all cases, you can make no mistake by keeping the personal interests of your subordinates in mind fully as much as your own, and, when you find your interests in conflict with the best interests of an employee, you will do well in the majority of instances to give precedence to his interests, and to secure your returns in the long run from the loyalty to you on the part of your subordinates that will follow the consistent carrying out of this policy. You must also treat your own authority as a thing so well established that you can afford to ignore minor breaches of discipline and to bear patiently with the argumentative man. Yet, on the other hand, when the time comes that the needs of your work call for definite and decisive action, and you have given all possible consideration to the suggestions and opinions of your subordinates, you must be prepared to enforce your decisions to the letter and without mercy to the obstruction. In such cases do not make the mistake of saying that you personally require certain things to be done, but say, rather, that the work requires certain action and that you, as the appointed agent of the work, will fire every last man on the job if necessary to get results. And in all your talk with your subordinates speak everlastingly of what the work requires and scarcely at all of what you personally desire.

In dealing with intelligent and sensitive men you must be an allopath in encouragement, instruction and judicious praise, and a homeopath in criticism. With unintelligent and shiftless employees, on the other hand, you must combine with these a wholesome fear of consequences, while to both types of workers you can apply, perhaps better than anything else, the stimulus of comparative figures as to results.

Now what I have told you may seem cold blooded and brutal, and it would be so, except for the fact that, when you have once demonstrated your entire willingness to perform a surgical operation on a crowd, if required for the cure of diseases of discipline, you will find that they will respond promptly to milder remedies. And, when you have brought this condition about and have tuned your organization up to concert pitch, you will be in the fortunate position where before removing a man, you can safely wait until his own associates are firmly convinced of his unfitness. Furthermore, by the judicious use of pace makers and comparative figures, you can readily develop a speed that will cause the majority of the unfit among your forces to drop out of their own accord into positions more nearly suited to their natural capacity.

I have told you now something of business organization and something of the ways in which men may be handled, but I have said nothing of what, to you as individuals, is a greater problem—the problem of self-development and self-handling. The average university graduate, when he begins his college course, has a productive value of perhaps $7.00 or $8.00 per week, and when his course is ended this value may have increased to $12.00 or $15.00 per week. In four years, therefore, the increase has been at the rate of less than $2.00 per week per year. Yet during the following twenty years of practical day by day experience, this increase for the ordinarily successful college man may continue at the rate of from $3.00 to $5.00 per week per year. This fact can in plain terms mean only that the effective man, each year after leaving college, learns more of productive value than he learns during the corresponding years of his college course. So when your time for graduation comes, do not think that your student days are over. You are simply changing schools and school-masters, and the peculiarity of Prof. Hard Experience, who will be your chief instructor, is that he teaches not so much what to do, as what not to do—and teaches the latter with a club.

To know what the college man should study after graduation, particularly if he hopes in time to take up executive work, it is necessary to know his special weaknesses. In respect to these I am quoting not only from my own experience, but from the experience of many others, when I say that the recent graduate is of an over-analytical turn of mind, has too much confidence in the goodness and honesty of human nature, and in general lacks absolutely the ability to see all sides of a proposition and to drive things to a conclusion without the turning of unnecessary corners.

These faults are in part the natural faults of youth and inexperience, but, to a greater extent, are due directly to certain perhaps unavoidable peculiarities of college training, and it is in one way not entirely fair to describe them as faults, for they continue as faults after graduation only when untempered by proper observation and study. Nevertheless, it is a frequent and thoroughly distressing experience, when assigning a recent graduate to a definite line of work, to have him seize upon some comparatively insignificant feature of the job and analyze it to death, while at the same time, neglecting utterly a dozen more important features.

The college man, first of all, needs perspective and breadth of view, and, following that, needs a knowledge of men, and, to become strong in both of these directions, it is necessary, not only that he shall study his job from the bottom up by personal experience in his daily work, but that he shall also study it from the top down by reading and by taking every opportunity to talk of the work with those who are in position to see the broader aspects of it. Also, in studying men, it is necessary for him to know and study not only the men with whom he is thrown in daily contact in his work, but also to meet and know the men who are what he hopes some day to be. It is, of course, impossible, in a large organization, for the higher officials to meet and know all or even a large proportion of the subordinate employees, but, in the various engineering societies and business associations that the college graduate may readily join, he will find, if not his own superior officers, at least men occupying positions of equal responsibility, from whom, if he goes about it in the right way, he can readily obtain invaluable information and often direct personal advice. In his own line of work, too, he will ordinarily be suprised to find how willing his superiors are to give him a chance to become acquainted with branches of the work other than those in which he is directly employed. Requests for opportunity to acquire such information may occasionally be refused, but I doubt if in one case in a thousand they will ever be resented.

In addition to the information that may be obtained in this manner, it is important that the college graduate shall avoid the reaction from the reading of books that seems, in ninety-nine cases out of one hundred, to follow the completion of a college course. In this I refer not alone to a failure to read books applying to the particular line of work in which the graduate is engaged, but more particularly to a failure to read those books that are of assistance in knowing men. The man who hopes to become an executive and to handle business problems, must, above all things, know the nature of mankind in general, and I believe that this knowledge can best be secured by a proper proportioning of time between the direct study of men and the indirect study of them through books.

If you become aware of a certain peculiarity of human nature through direct observation and, later, read in some book, and particularly in some book that has stood the test of time, a description of similar peculiarities, you feel confidence in your knowledge and have confidence to act upon it. Or, if, in the reverse way, you first read of some human peculiarity and then, later, observe that same peculiarity in your daily experience with men, your previous reading gives double value and weight to your personal experience.

Now, as to books that you should read, I can name only a few that apply directly to the point in question. However, one that you all will appreciate is the "Meditations of Marcus Aurelius." Another is the "Autobiography of Benjamin Franklin." While among short papers and essays you will find Huxley's "Evolution and Ethics" and Philips Brooks' sermon on the "Courage of Opinions" full of sound common sense. And if you desire stronger medicine, to be used carefully and with discretion, you may try Michiavelli's "Prince."

Continuing from these you may, in any library, pick and choose at length and to advantage, provided you read always with a definite purpose.

I have found, and I think that you will find, that every writer, at some time, in a short essay or in a personal letter, rather than in a formal production, yields himself up to a moment of self-revelation and writes down the gist of his experience with, and his philosophy of life. So one course of reading may well be directed toward the discovery of such passages in the writings and autobiographies of men who have lived useful and active lives.

You will find, too, that intellectual birds of a feather flock together and that, in making the intimate acquaintance of a man through his writings, you will discover the books that he has read with appreciation and the men he has admired and may thus continue an almost endless cycle.

In my own reading I have made use of this principle perhaps fully as often for the purpose of avoiding as of selecting books, for, as some one has said, there is no hatred equal to that of a second rate mind for a first rate mind and, conversely, the admiration of second rate minds for other second rate minds is a thing to be marveled at.

I am not entirely sure, however, that the actual books you read are as important as the way in which you read them. One of the cleverest men I know, a keen judge of human nature and an executive in charge of several thousand men, tells me that he deals for the most part with ordinary people and that, in spite of their crudeness as literary productions, he finds the every day trashy novels most useful to him in revealing how the ordinary men of today think and feel.

Shakespeare probably sums up the whole situation for the practical executive when he says of one of his characters, "He reads much. He is a great observer, and he looks quite through the deeds of men."

But, whatever your reading or your personal experience may be during the first ten years of your outside work, they will both be of value or of detriment to you largely as they affect your ideals and philosophy of life.

In all that you have studied here at Madison, and in all that I have said to you so far today, the most obvious point in view has been the securing of material dollars-and-cents success. Yet I might quote both Huxley and the "Declaration of Independence" to you to show that this material success is but a means to an end, which end is the securing of a rational happiness for yourselves and your neighbors. And, in analyzing the means whereby this rational happiness may be arrived at, you will find that it is expressed by the product of your co-efficient of appreciation of the sanely good things of life, into your opportunities for the enjoyment of them. And you will find, too, that happiness is as contagious as melancholy, and that your opportunities for the sane enjoyment of life are measured mainly by the friends you make, and the leisure time you have, and in least part by the money you have to spend. So, if you arrive at a sane philosophy of life, you will recognize that, if your co-efficient of appreciation is zero, and if your friends are zero, and your leisure time is zero, the value of your life, as a whole, will likewise be zero, whether you multiply the preceding factors by tens of dollars or by millions of dollars.

And this question of ideals is not an academic one, even from a purely business standpoint, for I have repeatedly heard men in responsible executive positions say that, in selecting a man for important work, they always felt safer if they knew that he had fixed and sane views of his purpose in life, and that they distrusted men, however capable, who looked upon their work solely as a means for personal advancement, and had none of the artist's satisfaction in good work for its own sake well done.

Now, I have, perhaps, taken an unfair advantage of you by talking of the philosophy of life, after giving my paper the business like title of "Organization and Discipline," so I will conclude and, at the same time, will try to square accounts by turning over to you a ready made philosophy from Marcus Aurelius, who says—"Besides you will quickly go the way of all flesh * * *. Therefore, whatever the dignity of human nature requires of you, set about it at once, without 'ifs' or 'ands', and speak always according to your conscience, but let it be done in the terms of good nature and modesty and sincerity."

REFRACTORY MATERIALS.

F. T. Havard,
Assistant Professor of Mining.

Materials used in the walls, hearth and roof of reverberatory furnaces, in the shafts, boshes and crucibles of cupola and blast furnaces, in retorts, in crucibles, in coke ovens, fire boxes, boiler settings, flues and in all those parts of metallurgical, chemical or other industrial plants exposed to the action of heat must have the property of sustaining high temperature, the abrasive action of dust, often the corrosive action of slag, matte or metal and the chemical action of furnace gases without suffering sudden physical or chemical change. They should have a low heat conductivity, small modulus of expansion or shrinkage and be reasonable in price.

The range of refractory materials has become wide since different processes demand different properties in materials. While one may give high satisfaction in a furnace using a particular process, it would be of no use in resisting the very different actions ensuing on making a different kind of smelt or fusion in the same furnace. In general metallurgical establishments a special type of furnace is always adapted and used for a particular process and we may find three or four furnaces in the same works of the same shape and size, every one having a different lining and doing each its particular and individual work only.

Generally speaking it has been found that the character of the slag and gases produced in a particular process determines the type of furnace and the kind of material that should be used. It is taken for granted that the refractory material must in first essential be able to sustain the effect of the temperature of the operation without suffering such physical change as cracking, splitting or pealing. While some materials resist the attacks of a furnace process at a temperature of, say, a thousand degrees C. these would have to give place to other materials, perhaps of similar chemical composition which would resist higher temperatures if it were necessary to employ these.

Dividing our list of refractories into classes, we find that reactions producing acid slags demand refractories of an acid character; basic slags call for furnace materials of a basic character; neutral materials are often used in both basic and acid processes, but as a rule may be regarded as replacing basic materials when the highest demands to resist chemical action are made on the furnace lining.

It is plain that when a slag is acid, that is, when its basic content is more than satisfied with silica or with silica and alumina, there will be little danger of this slag extracting any more silica or alumina from an acid brick lining. As "acid" when applied to refractory materials, we understand a material having for its chief constituents both silica and alumina or silica alone. In the same way a slag containing more ferrous oxide than is required to slag the silica will not be likely to attack a basic furnace lining containing calcium and magnesium oxides in the form of burnt dolomite. And neither a silicious slag nor a basic slag would have any ill effects on a refractory neutral lining such as ferrous chromite.

The principal acid refractories are first of all the silica bricks and mass such as the ganister brick, then the low aluminous silica brick such as the better class of red brick and the lower grades of fire brick. The high aluminous silica brick, such as the best grade of fire brick, may be classed as semi-acid. The basic refractories are the bauxite, the dolomite and magnesite bricks; of these the magnesite is becoming the most popular and widely used. The neutral bricks and mass are made of graphite (a mixture of plumbago and fire clay), chromite (chrome iron oxide), steatite (magnesia-alumina silicate), marl, cement, bone ash and carborundum and similar artificial carbon silicon material. The most refractory for general purposes is probably chromite (sesqui oxide of chromium).

ACID REFRACTORIES.

Sandstone and less often pudding stone and granite were used extensively in furnace construction before the recent developments in the manufacture of fire brick had been achieved. They are decidedly more refractory than the old common red brick, particularly when placed so that their line of cleavage was parallel and not at right angles to the slag line. The making of Dinas bricks was commenced in the beginning of the 19th century by a Mr. Weston Young who succeeded in evolving a process by using as a bond the limestone upon which the silex lay. This fire brick proved to be very infusible but expanded at high temperatures, disintegrated when cooling and was readily eaten by lead oxide and hot alkaline substances. The silicious material used by Young was found in the vale of Neath and was called Dinas rock and is similar to the millstone grit of the carboniferous system which we know as ganister. Ganister has now become the trade name for all highly silicious fire brick. This is used extensively in iron smelteries where pig of low phosphorous content is treated by the acid open hearth process; in ring furnaces, in cement kilns, in malleable furnaces, coke ovens, crucible steel melting furnaces; in the roofs of furnaces with basic lining, and in copper reverberatory furnaces, gas retorts and producer linings.

HIGH GRADE SILICA ALUMINA BRICKS.

These are commonly known as fire clay brick and the mass from which they are made as fire clay. Fire bricks are most widely used in all manner of furnaces, boiler settings, flues, stacks, dust chambers, while the best type of mass is used in fettling and for mortars. The most refractory of all clays are used in making crucibles and porcelain fire proof ware. Even in those furnaces which employ a basic or neutral lining about the bath of metal or slag, fire brick is used above the slag line of the walls and in the roof. It is the most commonly used refractory material in all parts of iron, copper and lead shaft furnaces, in innumerable types of furnaces in the general industries and in household grates.

BASIC REFRACTORIES.

Magnesia or burnt magnesite has in recent years been replacing the old standard dolomite. Magnesia is generally used in the form of bricks, while burnt dolomite was used as mass The highly refractory qualities of magnesite were realized as far back as 1870 but effort after effort to use it was frustrated on account of the poor physical properties of the burnt mass and bricks. It is only in the comparatively recent years that we have developed the art of making these burnt bricks firm and sufficiently tenacious to stand pressure when hot. The magnesite to be refractory must be low in iron, silica and alumina. The deposits which are sufficiently pure to use in furnaces where the highest demands are made come from the Isle of Enbœa in Greece and from Styria and other parts of Austria-Hungary. The deposits are most carefully mined, the mineral sorted from impurities, ground and mixed with a suitable bond such as tar or in some cases with little refractory plastic clay, dried and burned several times at a high temperature. These are the most useful bricks for the modern practice of metallurgy.

In lead-silver smelting practice they make the most economical lining in softening and cupelling furnaces. In the metallurgy of antimony they are used in both shaft and reverberatory furnaces, in tin and arsenic furnaces magnesia is equally satisfactory and it makes an economical lining in copper and steel practice. The linings of the bath of open hearth copper and steel furnaces are now almost invariably made of magnesia brick. To the copper metallurgist this means the saving of time, money and the physical energy expended on the weekly clayings of the lining, which are costly, and retard work in plants using the fire brick lining. Since the large modern furnaces and fore hearths are placed out of commission on account of their lining being eaten rather than on account of the fore hearth "freezing up," it has been found profitable in the long run to line these with magnesia. We are just entering on the era of basic copper converting when the linings of our copper converters will be of magnesia instead of silica clay. These magnesite lined converters are already in use and give great satisfaction in several of the large western works. Magnesite is the most satisfactory material to use in electric furnace work and makes a particularly good crucible.

Of the neutral refractories chromite is of the greatest importance to the iron, copper, antimony and tin metallurgists. It is used as a buffer lining between the bath lining of magnesite and the wall lining of fire clay, preventing any reaction between the basic and acid bricks. In the French antimony works it is used as lining in the reduction hearth furnaces and in the metallurgy of tin, it is, and should be still more, used for the bottom and sides of the hearth. In open hearth iron and copper furnaces which use a magnesite bottom,

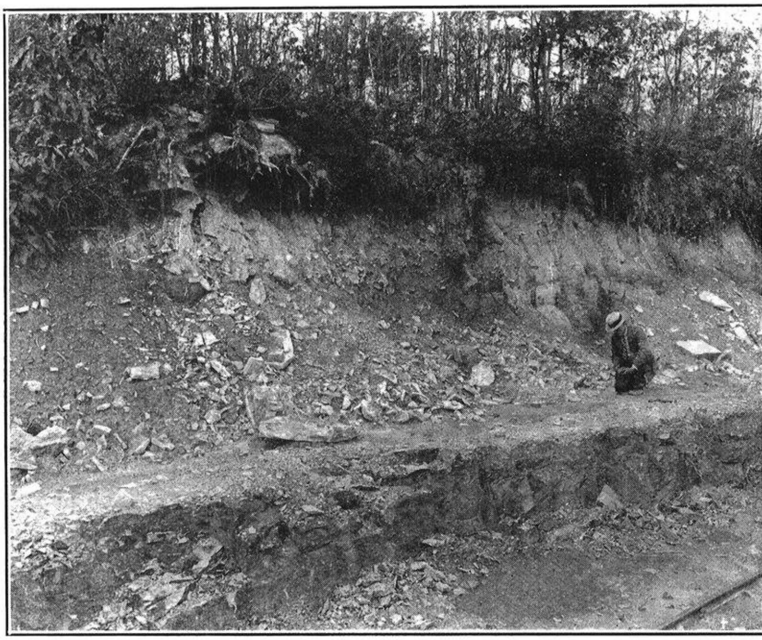


Plate 1. A seam of hard flint clay.

chromite is laid in between the hearth and the foundation of fire brick. Chromite is found in its greatest purity in New Caledonia, some is found in California. It should be fairly low in iron and with only sufficient clay content to enable it to bond.

THE PREPARATION OF REFRACTORY BRICK.

The general process for the general manufacture of all kinds of refractory brick consists in four operations: 1. selecting and grinding the raw material, generally with a bond, such as lime or clay; 2. pressing into forms; 3. drying in ovens at a constant low temperature; 4. burning in kilns at a temperature somewhat higher than that used in the process in which the brick will later be employed.

Naturally, the details of manufacture vary with the different kinds and quality of brick produced. For instance, the ganister brick is made by selecting and grinding such pure quartzite

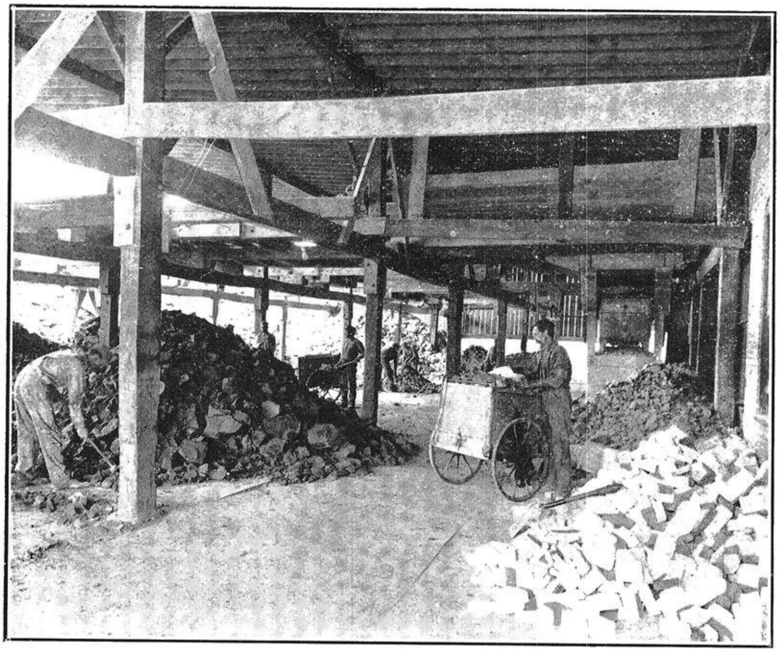


Plate 6. Selecting and loading clays.

as that of Devils Lake with a bond of lime or plastic fireclay; magnesia would be bonded with a consistency of tar and ground magnesia; chromite and graphite might be bonded with plastic fireclay. The fireclay-brick industry is most extensive, and the methods of manufacture of high grade aluminous brick are seen from the pictures which we exhibit.

SELECTING AND GRINDING OF CLAY.

Plate No. 1 shows a seam of hard flint clay. This is a chief constituent of fireclay brick, and is bonded with a less refractory plastic clay. The man in the picture is standing on the seam of desirable refractory lean flint clay. Most fireclays are ground raw but clay containing limestone is calcined in kilns before being sent to the factory.

Plate No. 6 shows the method of handling lean plastic and calcined clay at the factory. The clay is broken by hammers and selected. The buggies are divided by partitions, and each

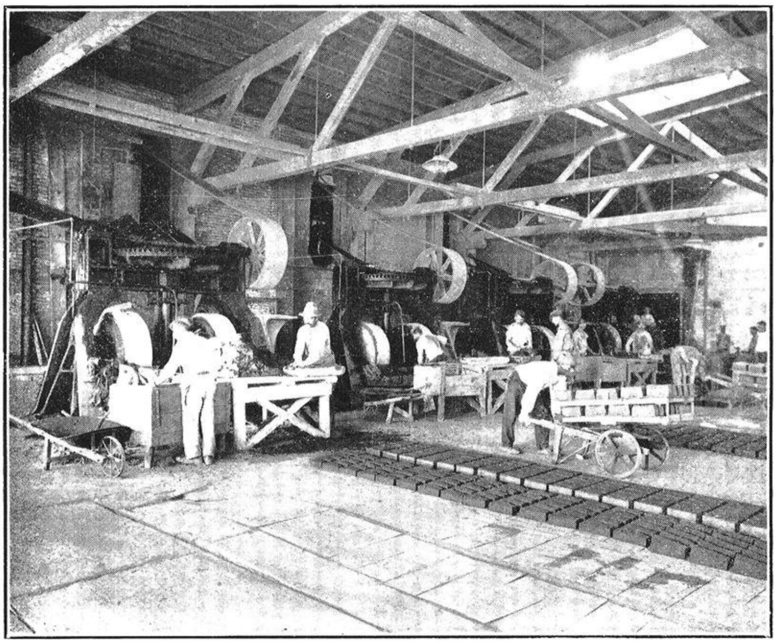


Plate 31. Wet-pan grinding.

part is filled with its quota of lean clay, plastic clay, calcined clay, as desired for the manufacture of particular kinds of brick.

PRESSING AND DRYING BRICK.

Plate No. 31 shows the method of wet pan grinding. This particular plate is of a magnesite works, but the wet pans used in fireclay brick manufacture are similar. Lime milk is rarely added to the pans for grinding fireclay in which coherence is obtained by mixing plastic clay with the lean refractory clay, but is almost invariably used to bind silica, and is intimately mixed in the pan with the ganister rock during the process of grinding.

Plate No. 32 shows a drying oven heated by hot air. These particular bricks in the plate are magnesia and chrome. Fire-clay and ganister are dried in the same way.

Plate No. 16 shows a lot of difficult shapes drying on the

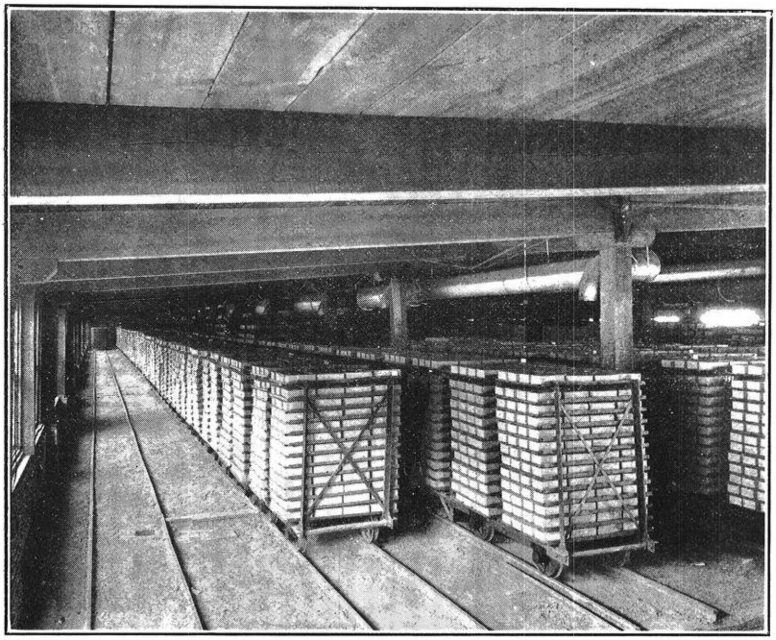


Plate 32. Drying oven.

"hot floor." The material in the foreground is for Bessemer converter bottoms; in the background are a number of hexagons for hot blast stoves.

Plate No. 17 shows the inside of a rectangular updraft kiln and the method of laying bricks and shapes for burning.

Plate No. 27 shows the kilns for burning Silica brick at Mt. Union. These kilns are of the down-draft type with "Parsons" firing. The heat from the fire boxes is drawn from the bottom to the top and then down and out from the center of the floor of the kilns. The waste heat drawn from the center of the bottoms is used for raising steam in the boilers, as shown in the Plate.

BURNING BRICK IN KILNS.

Burning brick in kilns. Two kinds of kilns are used;—the old fashioned up-draft kiln, in which the heat rises straight through the kiln and is drawn off near the top, and the down-draft type already mentioned. The process of burning is divided into three stages: 1—dehydration or water smoking; 2—oxidation; 3—vitrification. In all these stages the draft and temperature must be carefully regulated with a view to obtaining the best possible distribution of heat throughout the whole kiln and an even and gentle rise in temperature. These operations are controlled carefully by water pressure gages and Seger cone pyrometers.

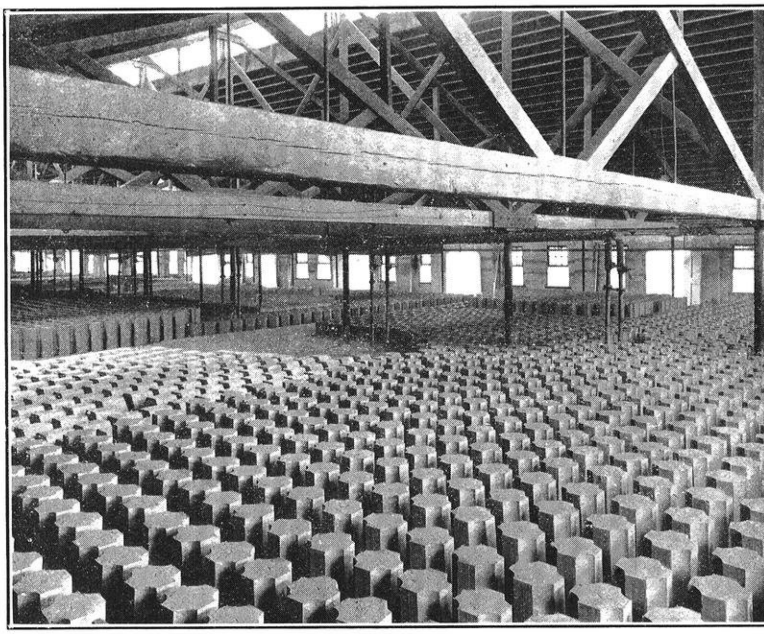


Plate 16. Difficult shapes on hot floor.

Water smoking period. The first stage of the burning is that of the removal of the hydroscopic water. While it is necessary that the rise in temperature should be slow during this period, too muct time spent in water smoking may seriously reduce the capacity of the plant. Slow evaporation within insufficient draft may produce scum upon the brick, particularly if the fuel contain sulphur or if the clay have much potash, soda, lime or magnesia. A moisture-testing rod should be used to determine the rate of dehydration. This is simply an iron rod which is inserted in the kiln. If water is still present, it will be visible on withdrawing the rod. A large excess of air is needed during the period of from three to four days which are spent in water smoking. The temperature rises to 500° F. and the draft to 4 mm.

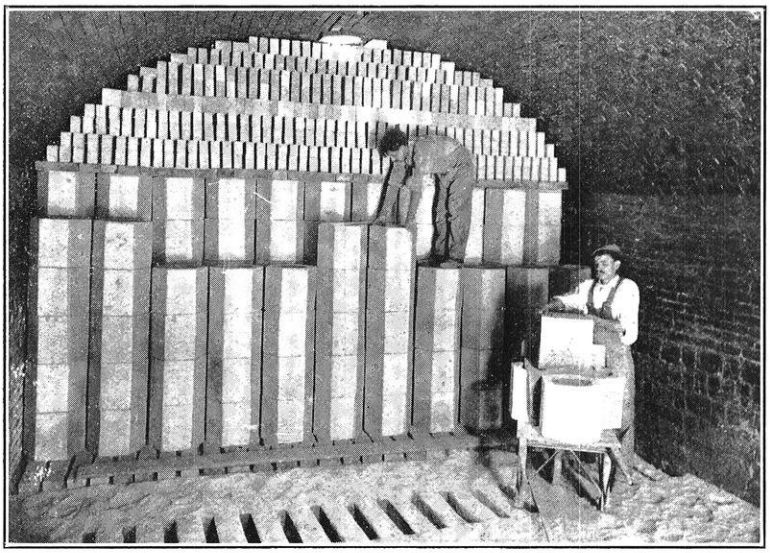


Plate 17. Setting shapes in rectangular kiln.

The oxidation period. This period extends from the stage at which the hydroscopic water has been completely driven off to that at which the shrinkage of the clay, or settling of the brick, begins. Lower oxides of iron and manganese are oxidized to the higher forms: Carbon in the clay is burned to carbon dioxide and this and the carbonic acid of the lime and iron of carbonates is expelled, while dehydration of chemically combined water in the kaolinite is effected. The brick obtains a bright color, generally buff, some time before the temperature of 1500° F., which marks the limit of the heat of the oxidation period. The fourth, fifth, sixth and seventh days are employed in the oxidation period, the

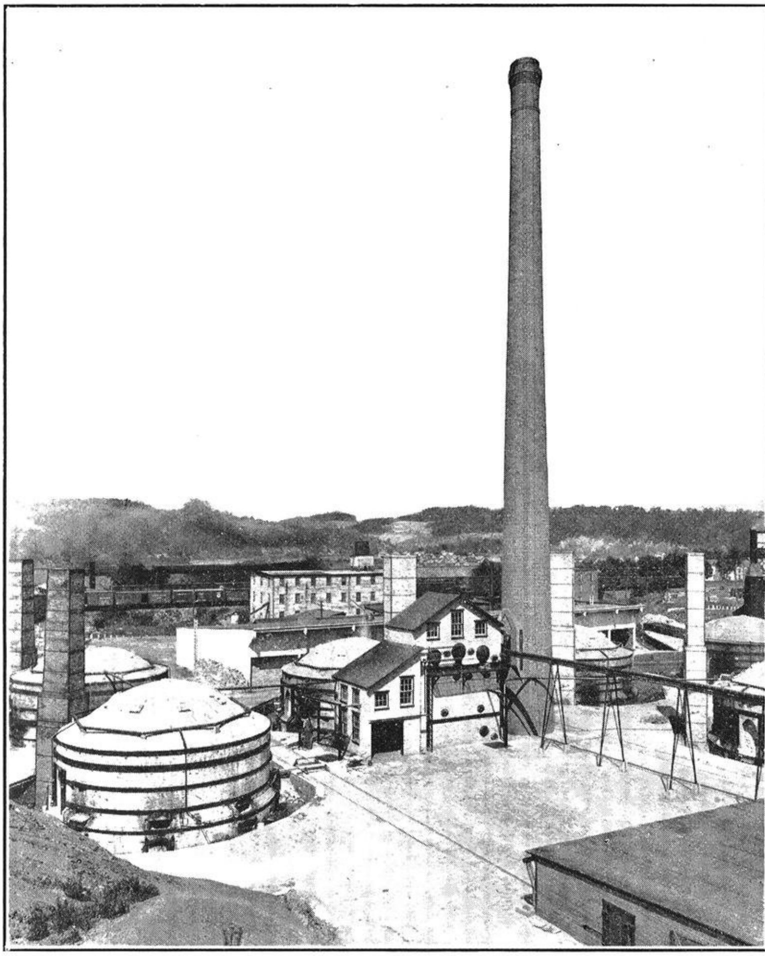


Plate 27. Kilns at Mt. Union

tempeature rises from 500° to 1500° F. and the draft sinks somewhat (from 4.2 mm. to 3.7 mm.).

The vitrification period. During this period the clinker is formed. By this we understand the particles of slag which are made by the basic oxides combining with silica and alumina throughout the brick. These hold the particles of the burned clay together and in shrinking make the brick porous and produce the effect of clinking, that is to say, the brick becomes hard and rings when struck with a hammer. At the close of the oxidation period the brick should be uniform in color, will have begun to harden but is too soft for any useful purpose. The kiln doors are now kept tight, but little excess air is allowed in the kiln, and the temperature is driven up to 2700° F. or even 3000° F. The finishing temperature can be determined by the Seger cone, but the progress is best ascertained by measuring the amount of settle; that is to say the number of inches on the bricks have sunk in the kiln owing to their shrinkage. Vitrification commences with the beginning of the eighth day as a rule, and is completed at the end of the twelfth day. The draft is reduced gradually from about 3.7 to about 2 mm., and the bricks settle from an inch, which is recorded at the end of the oxidation period, to ten to twelve inches at the end of the twelfth day. When the proper settle has been obtained and the proper cone has melted in the kiln, firing should cease. The damper should be closed when all the fuel has been burned out, so that the bricks may be allowed to cool slowly and evenly. The harder and more dense the brick, the more liable they are to be damaged by uneven cooling. In fact, the brick must be annealed during the process of cooling. When the kiln has cooled to a temperature of from 300° to 500° F., a fan may be attached and cold air blown into the furnace to enable the workmen to enter and remove the bricks.

When the kiln is opened and the bricks are removed, examinations are made as to the conditions of oxidation and the distribution of temperature in the kiln. The amount of settle is measured and the poor bricks rejected on removal of all from the kiln.

Temperatures Employed in Burning Brick and Clay Wares.

	Cone.	Temperature F.	Temperature C.
Porcelain colors and lusters....	022 to 010	1094 to 1742	590 to 950
Common building brick, drain tile, stove tiles and the like, iron and lime-bearing clays..	015 to 01	1472 to 2066	800 to 1130
Roofing tile..................	010 to 1	1742 to 2102	950 to 1150
Art pottery { Biscuit..........	05 to 1	1922 to 2102	1050 to 1150
Art pottery { Glaze — Glossy...	010 to 2	1742 to 2138	950 to 1170
Art pottery { Glaze — Matt....	05 to 4	1922 to 2210	1050 to 1210
Sewer pipe from shale.........	05 to 1	1922 to 2102	1050 to 1150
Common cream brick from limey clays......	03 to 2	1994 to 2138	1090 to 1170
Paving brick from shales......	1 to 4	2102 to 2210	1150 to 1210
Sewer pipe from fire clay......	1 to 8	2102 to 2354	1150 to 1290
Whiteware pottery { Biscuit...	3 to 10	2174 to 2426	1190 to 1330
Whiteware pottery { Glaze....	010 to 10	1742 to 2426	950 to 1330
Face-brick from fireclay.......	3 to 10	2174 to 2426	1190 to 1330
Floor tiles { Encaustic.........	4 to 7	2210 to 2318	1210 to 1270
Floor tiles { Vitreous..........	7 to 10	2318 to 2426	1270 to 1330
Paving brick from fireclays....	4 to 8	2210 to 2354	1210 to 1290
Stoneware, with salt or slip glazes......................	5 to 10	2246 to 2426	1230 to 1330
Fireproofing.................	1 to 88	2102 to 2354	1150 to 1290
Fire brick, cement and porcelain	10 to 20	2426 to 2786	1330 to 1530
Glass tank blocks............	10 to 20	2426 to 2786	1330 to 1530
Gas retorts..................	15 to 20	2606 to 2786	1430 to 1530
Silica brick and hard-flowing glazes......................	20 to 26	2786 to 3002	1530 to 1650

Drying shrinkage of clays....................... 1 per cent to 10 per cent
Burning shrinkage of clays..................... 0 per cent to 8 per cent

The writer expresses obligations for information received to Messrs. The Harbison Walker Refractories Company, to Mr. W. D. Richardson and to Dr. Bischof. The illustrations are from photographs supplied by Messrs. Harbison Walker.

TRAVEL ON HUDSON BAY.

EXTRACT FROM AN UNPUBLISHED NARRATIVE.

C. K. LEITH.
Professor of Geology.

GULF HAZARD.

Our exit from Richmond Gulf was by way of Gulf Hazard, a narrow passage connecting Richmond Gulf with Hudson Bay. From the time we had reached Hudson Bay we had heard of the danger of this passage, which is only three hundred yards wide at the narrowest point, with high cliffs on both sides, through which the tides of Richmond Gulf discharge. It is passible to any sort of a craft only for a few minutes near change of tide. When the tide is running full, it is extremely dangerous, for great whirlpools are likely to form anywhere, and they are powerful enough to pull down the largest available boats. Many accidents have happened here and lives have been lost. We were warned again and again to be careful in making this little two mile passage into the gulf, and as we reached the passage going north our guide seemed to be afraid to attempt it with the sail boat under any of the conditions which we met, constantly postponing the attempt until better conditions of wind. He dreaded the possibility of being able to get only part way through with the sail boat during the few moments of safety, and then being caught with the rush of the tide. Coming out, therefore, with our light canoe and kayaks the passage was approached with some little trepidation. We put ourselves entirely in the hands of our husky guides. As we hovered near the mouth of the gulf awaiting the right moment, they suddenly gave the word to go through. One of them took the lead to point the way, we came next, and the two huskies followed. The conditions were ideal for safe passage but we were not without uncomfortable qualms as minor whirlpools, big enough to twist the canoe out of its course in spite of our best efforts, would suddenly develop immediately under us.

EDITOR'S NOTE.— The extracts from Professor Leith's narrative were begun in the January number.

TENDERFEET.

The natives seemed to have an unusually well developed sense of responsibility for our safety. It was impossible to venture even on short side trips without having one or more of the natives volunteer to look after us. Indeed, they came whether we wanted them or not. At first we rather resented being treated like tenderfeet, but after realizing the uncertainties of travel and the necessity for accurate knowledge of local conditions, we were glad of all the help of this kind we could get. We had travelled on Richmond Gulf for nearly a week with the huskies before we found out that each morning as we started out on our work sealskin bags (used for markers to harpoon lines) had been blown up, put into the kayaks, and fastened with long sealskin tongs, to be used for our benefit in any possible emergency. For that matter, we were regarded as tenderfeet from the moment we struck the Bay until we left it. The Hudson Bay Company, post managers, the natives, and even the missionaries treated us as if we were forlorn wanderers without any previous experience in travelling, for whom they must necessarily take responsibility. The Canadian used to travelling through his interior woods assumes as a matter of course that he is able to travel on Hudson Bay, and it is only by bitter experience that he learns the contrary. Even the hardy French and English voyagers from the Ottawa and Temiskaming country, who occasionally come to the Bay, are treated likewise by the natives. On the way out we saw three of these men who had attempted to join a party on the bay, and after working for three days on the south shore, gave up in despair in the attempt to meet the unusual conditions, and were promptly trundeled off homeward by the Hudson Bay people. A half breed Frenchman in charge of the party said he had spent a life time in travelling through the wilds of Canada, but he had not yet found anything like Hudson Bay and would not again venture there for a thousand dollars.

THE START FOR HOME.

The sailboat was waiting for us at the mouth of Gulf Hazard with a small group of huskies who had accompanied the boat in their kayaks this far south simply because they had nothing else to do and enjoyed the company of strangers. Notwithstanding the fact that we had eaten a warm breakfast before we started through the gulf, when, two hours later we found another breakfast ready, with salmon, we promptly forgot the first breakfast and ate another.

We had then finished the principal part of the geological work which we came to do. Our results had been satisfactory, and notwithstanding the many vexatious delays in our trip, after all the start for home was made in what seemed ample time. On August 27th we set sail for the south in high spirits, with every reason to believe we would be out to the railway track within a month or five weeks. But our troubles were not over, the Bay was still "holding out on us." After beating around all one day with a light wind, we landed on an island two miles across from our camping place in the morning. The next day we sailed around all day in the fog and at night landed at our old camping ground of the day before, tired out with the long hours in the boat, cold and hungry, tired of each other's company, so discouraged and ugly, in fact, that talk of any kind was uncomfortable.

THE WRECK OF THE SAILBOAT.

The third day the start was made with little better prospects. In some ten hours' work we made nearly fifteen miles south. When within four miles of the harbor late in the afternoon, a cool breeze came suddenly out of the northwest, our huskies called attention to it long before it struck us. One could see a little streak of blue in the distance. It came first as a light breeze, but we all seemed to feel that there was something more beyond. The husky guide promptly pulled the hood of his coat over his head, took a firmer grip on his pipe, and looked so frequently in the direction of the harbor four miles ahead and out to sea where the breeze was constantly rising, that we begun to recognize the situation as one of danger. Little was said, therefore, as the boat scudded toward the harbor near Little Whale river. Within five minutes the boat was in the midst of a howling gale, with the waves constantly rising. By the time the mouth of the harbor was reached the billows were as high as our thirty foot boat could stand. From the bottom of the trough our view was up along slopes positively terrifying to contemplate. The boat shot through the narrow opening of the harbor, the crew in their places waiting orders from the pilot, one man at each of the three sails, and one at the anchor. As we rapidly crossed the narrow harbor the guide shouted something, which we could not hear distinctly in the storm, about the harbor not being properly protected, and about the necessity of getting out again, probably having in mind the narrow escape of the boat in a similar harbor two weeks previous. He apparently was considering the possibility of getting out again and running to a safer harbor. In the meantime the boat had almost reached the surf. We shouted and pointed out the danger, and even started to drop the anchor, only to be stopped by the vociferous orders of the pilot not to drop it. The guide then attempted to jibe around with the wind, but his decision to act came too late. A great sea picked up the boat and crashed it on the rocks.

The next few minuts were wild ones. With each wave hurling the boat, crunching and rocking its heel, against the rocks, waves going in solid sheets over the boat, and sails cracking dangerously over our heads, we were uncertain whether the boat would last a few seconds, a few minutes, or a few hours. At any rate we were one hundred miles from the nearest source of food supply, and it was necessary to get to shore if possible with food. The canoe was promptly cut from its stays. Two of the men went overboard in the surf, the canoe was passed out to them. and they pulled it to shore. Two other men went in the forward hold to pull out pork and flour. These were passed back in the boat to others, thence over the sides of the boat to the men, who came plunging again and again over the slippery rocks to get things we put overboard. That no man was drawn into the undertow or lost his feet in the surf indicats the remarkable skill of the huskies under surf conditions. After a few seconds the boat lodged firmly on the rough ledge, making it certain that we would have at least a few minutes to get our things out. Time was then taken to empty the boat.

Darkness found us all on shore, all our supplies and equipment, food, tents, blankets, and personal clothing, thoroughly wet, with a cold northwest gale penetrating our very vitals. But at any rate we were safe and had plenty of food. The rest was not essential. After some difficulty, a fire was started, tents were put up to afford shelter from the wind, a strong, hot cup of tea and a pailful of rice soon put us in a cheerful frame of mind, and I do not exaggerate when I say that that night we went to bed reasonably happy in our wet blankets and clothes.

ON FOOT TO GREAT WHALE RIVER.

The next day was spent in preparations for our overland trip to the nearest Hudson Bay post at Great Whale River, nearly one hundred miles to the south. Our canoe was too small for the party and the bay too rough. A fire was built behind a rock precipice where we were protected from the wind and there everything we possessed was spread out to dry. Drying was a slow process at any time on Hudson Bay, and at the end of the day the best we had done was to get reasonably dry some of the articles of clothing we wore next to our skins. Packs averaging fifty pounds apiece were made up for the southward trip; the rest of the supplies and equipment were made in bundles and put on to a raised platform against the precipice and covered with sales from the boat, to preserve it from marauding animals. To the natives a cache is sacred even in cases of dire need. In the afternoon a husky family suddenly appeared from out of nowhere. Across the great bare rock wastes it is possible to see for miles, but distances and sizes are very deceptive. No one had noted the approach of the huskies until they were within a few yards of the camp. While at first glance it would seem impossible that a human being could stand anywhere in the landscape without being seen, it is difficult to distinguish large objects even a few hundred yards away because of the large size of the elements of the topography. Ridges which seem near and smooth on investigation are found to be far off and composed of many rough elements. This husky family happened along providentially for them and for us. We were able to give them many things we had to discard. The man of the family in turn was able to aid us in the first stages of our packing trip to the south.

On a Monday morning we set off in high spirits to follow the extremely rough rocky coast south to Whale River. There was no trail. It was necessary constantly to climb up and down. The rocks for the most part were wet and slippery, so that we had to earn every yard of our advance. The fifty pound pack made it certain that no one would go too fast. Whale river was reached safely in five and a half days. This bald statement, however, does not do justice to the trip. The reader who has had some experience in the short portages of the northern woods country will perhaps appreciate what it means to travel over a country without trail from daylight to dark, carrying a fifty pound pack.

PACKING.

A few days' packing—it is difficult to convey the significance of this phrase. This day is a sample. We arose about five from a bed on the bare ground or rock, perhaps without no other shelter than a tree. No time was lost in dressing or washing for we slept in all our clothes (and wished for more), and washing under such conditions in that cold is a disagreeable operation at best, is not absolutely necessary, does not directly aid in covering distance, in fact takes time from it, and therefore is usually discarded for something more effective. The party squatted shivering around the fire and ate a hot breakfast consisting of fried salt pork, bannock (baking powder bread cooked in the frying pan), tea, sugar (if we had any), and rarely some additional luxury in the way of jam or rice or oatmeal. All were more or less stiff and cold, and had little to say, nor little patience to listen. As the hot tea or coffee made themselves felt, the spirits of the party rose, and conversation was begun without personal danger. About twenty minutes were required after breakfast to pack up food and dishes (let not the plural bring up a picture of any imposing array), to arrange bedding and tent in packs, to light pipes, tighten belts, to see that boots were properly tied (sealskin boots usually require ties above and below the knee and around the ankle), etc. There was usually some repacking and some rearrangement of contents of packs to get the proper weight, to see that there were no corners to project into one's back, and above all to make it "hang right." There are a great variiety of methods of carrying, by the tump line which one carries by the head alone, by pack sack with shoulder and head straps carrying from the shoulder and head, and by a wonderful contrivance used by the huskies, consisting of an intricate lacing of the pack with a thirty-foot sealskin thong, so arranged that when complete, there are about five strands used together as a head band and about three stands to pass around the arms and chest. This looks clumsier than the other methods and is more difficult to tie. In fact throughout our trip, we did not solve the mystery of the tying or learn to carry such a pack with comfort. The huskies, however, handled their loads effectively and expeditiously by this method. The Indians use the tump line alone, carrying from the head. This is the method followed in nearly all of Canada, and it may be noted in passing that the carrying is done on the head in nearly all parts of the world where packing is necessary on any large scale, as in China, or the Andes, or in the Himalayas. The pack sack with shoulder straps is used extensively by the white man. The pack bag is more convenient for filling and arranging of loads than the other packs, which are merely bundles wrapped in canvas sheets. Each method had its advocates in our party and many and vigorous were the discussions as to the best method, but without in the least modifying the view of any man in the party. I have perhaps taken an unfair advantage by noting the prevalence of the custom of carrying on the head, my own preference.

Then the start was made, in file, with Bill, our husky guide, in the lead. We had anticipated no difficulty in keeping up with him is our legs gave us a consderably longer stride, but we soon found that we had our work cut out to do this, for Bill, in common with all the other huskies we had anything to do with, travelled a gait resembling a shuffling trot, not modifying it for hill or flat, and he had also some advantage in being more surefooted over the slippery rocks with the sealskin boots which we had not yet learned to manipulate so skillfully. As a result after the first ten minutes most of us were breathing heavily, and when the weather was not too cold, perhaps perspiring. But not to be outdone by the diminutive huskies no one called for a rest until the leader stopped. Stops of five or ten minutes came every hour, and sometimes at longer intervals. The stop usually came when some of us at least had about decided that we could never keep up this gait all day, that there was no use killing ourselves anyway, in short that we were nearly "all in." Would the man ahead never stop? Surely he must have less than his share of the load,—it is sure that he cannot be loaded as heavily as I am, or he would not be moving along so jauntily. As soon as we stop I will lift his pack and see. Surreptitious lifting of the pack afterwards revealed the fact that the load was actually heavier, and as the man was breathing quite as heavily as I, one became quite ashamed of his suspicions.

But almost the instant the pack slipped to the ground, one's troubles were forgotten, and after a few whiffs from a pipe, the grind was resumed with something approaching good spirits. The second hour was like the first. One became even more convinced that he could not last all day. The third hour was better for there was promise of something to eat at the end and this furnishes something satisfactory to think about. Lunch over, we started cheerfully, but soon to relapse into the same hopeless state of mind. As the day wears on we became less sensitive of our bodies, our minds worked but sluggishly, and one's movements became more automatic. When asked one afternoon if he were tired, one of our party expressed the feelings of most of us when he replied: "Oh, I don't know how I feel." It is this condition that really brings one through the day. Too keen an appreciation of the body or a too active intellect that rebels at monotony are not desirable prerequisites for the work. A saying current in Canada is that a good packer must have a strong back and a weak head.

After eight or twelve hours of this sort of thing (we were not a labor union), stop was made for the night, usually at some river selected in the morning as our objective. The approach to this objective furnished another incentive to keep up our flagging spirits at the end of the day. While really too tired to travel, it would be really too bad to stop short,—it could not be more than three or four miles away, and if we stopped there would be so much more to do tomorrow, if we were to keep our schedule. It is surprising how long considerations like this keep a party plugging along, without murmur. But the work was not finished when the camp ground was reached, for a fire must be built, supper cooked, perhaps a tent pitched, or a place cleared for a bed under some stunted spruce. Usually within an hour or hour and half after finishing supper, we were sitting around smoking our pipes in the best of spirits, with the day's drudgery all but forgotten. The morrow looked easy. Little time was lost in getting to bed, and all too soon the next day's grind was on, with its cycles of cheerfulness and depression. While the hours were interminably long the days followed each other rapidly. The events of the preceding days became merged into one blur and differences of opinion arose as to preceding events, or as to the number of days we had been at it. Twice during the summer at our arrival at a Hudson Bay post after a long grind, we found ourselves a day off in or calculations of the day of the week.

If one could fix on paper all the burning thoughts on packing which pass through his mind during a day of packing, he might convey some notion of what it means. But perhaps it is fortunate that we are so constituted that our joys, not our troubles, are best remembered. The man who has had to pack will perhaps concur in the general conclusion that packing is the crudest and hardest means of travel that man subjects himself to. An assistant in one of my Canadian parties once expressed this idea tersely when he defined a portage as the longest distance between two points.

My brother adds: "To specify further it is a place where you start at one end with one hundred pounds on your back and put down two hundred at the other. It is a place where the laws of the Universe are reversed. The shortest portage is always the longest and the longest still longer; the good portage is always bad and the bad still worse; it is never where it should be, but invariably where it should never be; it begins wrong and ends bad, and vice versa; it runs straight up a steep cliff, and along the level is so crooked that you can't tell whether you are going forward or back; one half the time on a portage you are losing yourself and the other half finding yourself and getting lost again; muscle is here supreme over intelligence; fine talents are useless, ingenuity of no avail, anger and emotion futile; a bull neck, a hardened back and large thighs beat all science and knowledge; it cures headache or sickness, blots out grief or love, checks all ambition and destroys any aspirations by causing the senses to become numb and the heart cold."

It may be hard to convince the reader that there is any real enjoyment in this kind of travel, but there is. As the body becomes accustomed to it, and especially as the neck and shoulder muscles become strengthened so that the strain is not felt there, one comes to feel a solid satisfaction in the physical fitness which enables him to stand the work with impunity. Then the wonderful appetites so developed, and the still more wonderful digestions, are no small considerations. Not the least of the beneficial effects is the elimination of nerves. One can safely recommend it as an infallible cure for the nervous patient,—if it does not kill him first.

BY KAYAK.

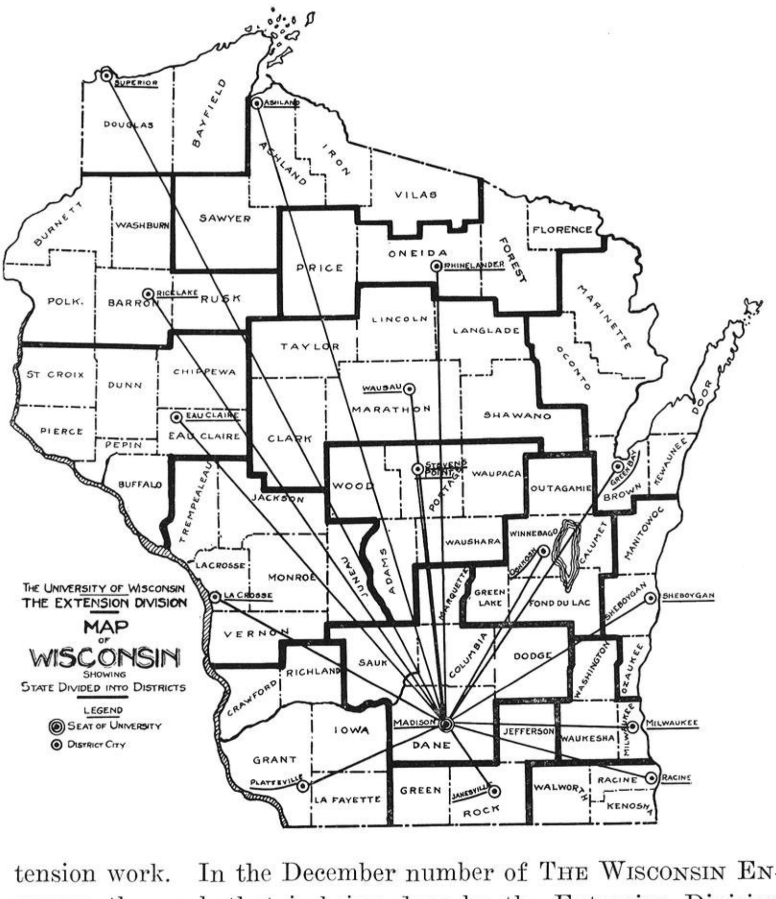
With this digression, we may return to our opening remark that we reached the Great Whale Hudson Bay post one hundred miles to the south, after five and a half days of packing. The only variation from the above daily routine was caused by the slight wrenching of my knee by slipping on a slippery rock, followed by a sharp attack of rheumatism in the weakened member, probably due to wading the icy streams. This made travel difficult and on the fourth day I had to utilize a kayak with husky paddler, fortunately located on Manitounuk Sound by an advance scouting trip of our guide. This experience was interesting,—afterwards, though not to be recommended to the pleasure seeker. By taking off my coat, I was barely able to crowd feet first under the forward deck of the kayak. My head came just to the edge of the cock-pit, giving me opportunity to stare at the sky. The paddler crowded his knees on both sides of my head. When thus secured it was literally impossible to shift position, not even to raise my hand to my face to wipe off the drops of water which fell onto my face from the paddle. The smell of the interior of the sealskin boat and of the husky's person did not add to my comfort. This on the whole was one of the hardest trails of the trip. The close confinement seemed almost intolerable. It seemed as if flesh and blood could not lie still for long under these conditions. But as there was no alternative, with the condition of my leg as it was, the only thing to do was to forget so far as possible that one could not move, or persuade oneself that after all he did not care to move, or to think so hard about something else as to become oblivious to his condition. Three-quarters of a day of this was quite enough. I was then prepared to walk the rest of the way, if it meant hopping on one foot. The next day I was able to hobble along most of the day, but got rests at intervals by paddling the kayak, while the husky owner walked along the shore. The paddling of a kayak is not difficult, though long practice is necessary to acquire anything like the skill or speed shown by the huskies. One faces forward and enjoys the easy control of the graceful little craft. Barring a stiff head wind, especially unfortunate for a novice in a kayak, this part of the trip was really enjoyable.

THE UNIVERSITY EXTENSION DIVISION.

E. B. Norris,

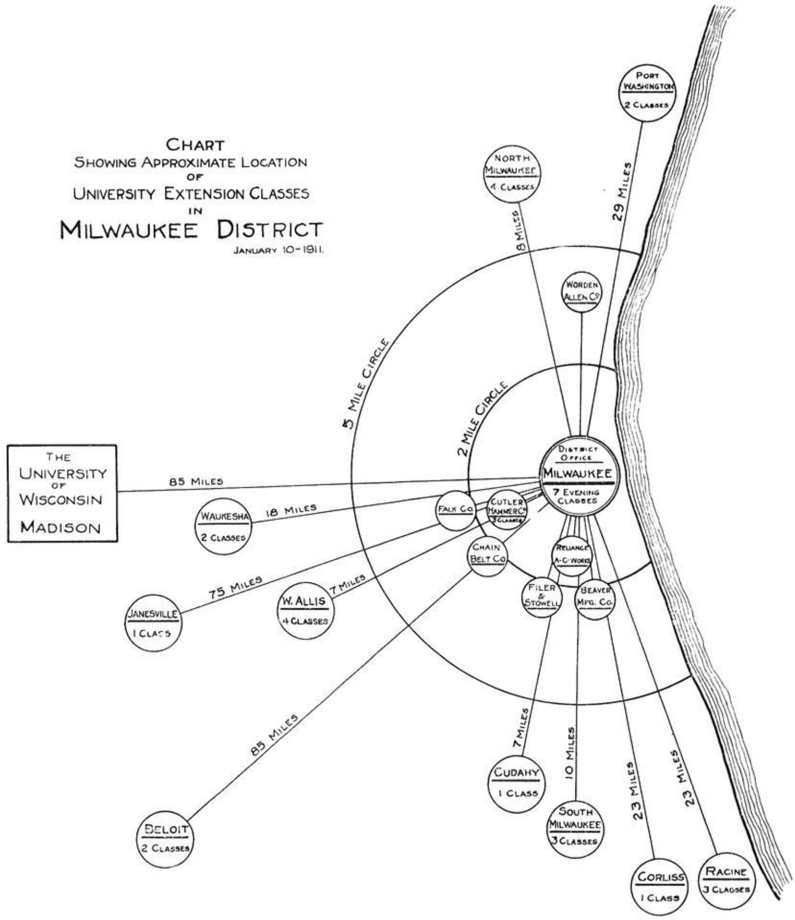
Assistant Professor of Mechanical Engineering.

We welcome the opportunity of using The Wisconsin Engineer to tell our readers something about the organization of the Extension Division and the methods of carrying on the ex-



tension work. In the December number of The Wisconsin Engineer the work that is being done by the Extension Division in engineering and industrial education was explained. It will be the purpose of this article to describe briefly the methods and the organization by which this work is accomplished.

As will be seen from the accompanying map of Wisconsin, it is proposed to divide the state into sixteen districts, in each of which a district city is selected as headquarters for the extension work of that district. In each will be located a district organi-



zation, consisting of a district representative with field organizers, instructors, and such other men as the needs of the community may require. The duty of this force is to ascertain the needs of the people of the district that can best be supplied by the University.

At the University in Madison are located the central offices from which correspondence instruction is carried on, lectures are sent out, and information furnished on matters of public interest or welfare. Here are the offices of the dean, of the secretaries of the different departments, and of the professors and instructors in charge of the courses of study and other activities.

At present there are district organizations in but two districts, those having headquarters in Milwaukee and in Oshkosh. The extent of the correspondence instruction carried on in these two districts is shown on the accompanying charts which show the classes that are at present organized. Not all of the extension students are fortunate enough to be in one of these classes, and there are, therfore, hundreds of others both in these districts and throughout the state who are receiving instruction by mail alone. These charts show only the development of the correspondence-study work which is but one of the functions of University extension. Most of the Milwaukee classes are organized in the manufacturing institutions of that city, and these classes meet in class rooms that have been fitted up in the plants. For those not fortunate enough to be in one of these institutions, evening classes have been organized which meet in the class rooms at the district offices. At West Allis the evening classes meet at the high school; in Racine, at the Y. M. C. A.

The work of forming these classes is done by the field organizers, who are trained to give advice as to the proper courses to be pursued by the students. The applications for courses are then forwarded to Madison where they are passed upon by the instructors. If accepted, the student is apprised of the fact and instruction papers are forwarded from the University. The classes are then met at regular intervals by the field instructors, but all the students' work is mailed to the University for examination and correction. When a class is obtained in a subject, the demand for which is not sufficient to warrant having a field instructor in the district, the class is met by an instructor from the University. At the present time there are in the Milwaukee district three engineers who give instruction in engineering and industrial subjects, and one instructor in business courses. In addition there are other instructors and assistants who have been engaged to help the regular instructors in the larger evening classes or to conduct special classes. In the Oshkosh district there are three instructors at present conducting classes in business subjects, shop mathematics, mechanical drawing, and educa-

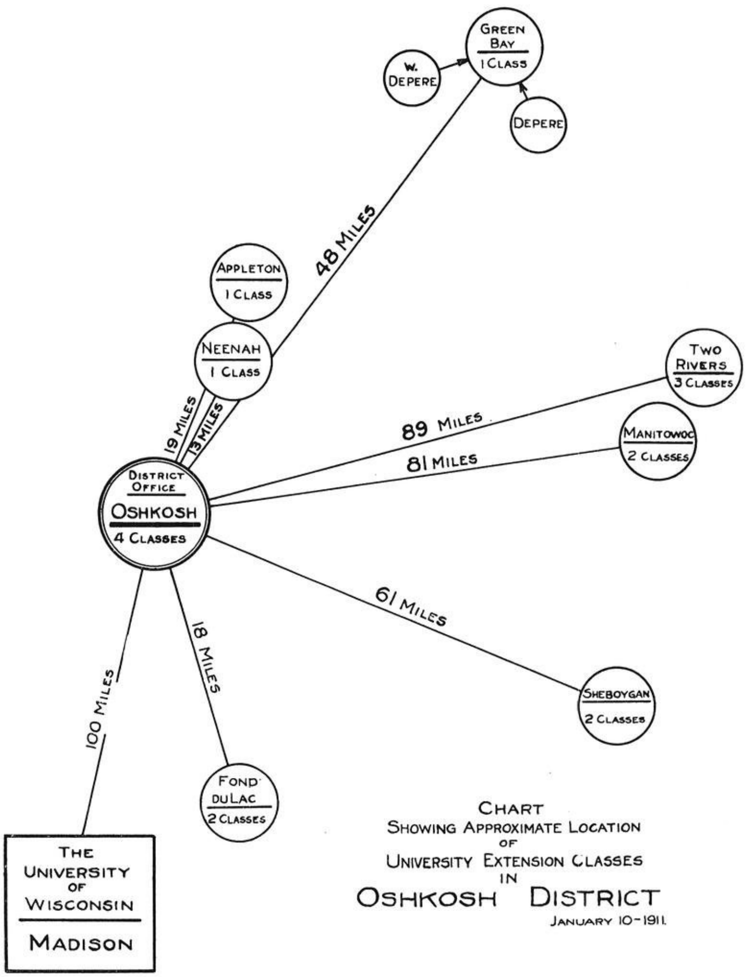


CHART
SHOWING APPROXIMATE LOCATION OF UNIVERSITY EXTENSION CLASSES IN
OSHKOSH DISTRICT
JANUARY 10-1911.

tion. There are also in both districts many students who are taking courses in which there are not enough students to warrant forming a class. To many of these the instructors can be of much assistance, and office hours are maintained for the benefit of such of these as wish assistance.

It will be noticed that, owing to the lack of district organizations in other than these two districts, classes in cities outside these districts are being conducted at present by these field instructors. As fast as means will permit, organizations will be effected in the other districts so as to make University extension available in all its forms to all the people of the state.

* * * *

A class in structural engineering meets the last Friday evening of each month at the Extension headquarters in the City Hall at Milwaukee. The subjects taught are of an advanced nature and include Elements of Structures, Roof Trusses, Plate Girder Bridges, Bridge Trusses, Timber and Combination Bridges, Masonry Structures, Reinforced Concrete Construction, Steel Building Construction, and Structural Drafting. Many of the students enrolled in this work have degrees from some of the leading universities of the country, including the University of Michigan and the University of Wisconsin. A number of architests are availing themselves of the opportunity to study Reinforced Concrete Construction and all the sturctural firms in Milwaukee have employees studying some special line of work.

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The paper on "Industrial Schools and Apprenticeship" in the American Machinist of Nov. 24, 1910, should be read by every engineer and shop man.

* * * *

Considerable difficulty is encountered in trying to solder aluminum by the usual methods. The following formula for aluminum solder has been recommended to several shop men who report very satisfactory results:

Aluminum Solder:—Tin 64 parts, zinc 30 parts, lead 1 part, rosin, a small amount. Melt, mix and run into bars. Clean the surfaces and apply in the usual manner but without any chemicals.

The Wisconsin Engineer

EDITORIAL.

In this issue we publish the paper on organization and discipline which was read before the students of the College of Engineering by Mr. M. C. Rorty, of the American Telephone and Telegraph Co. Mr. Rorty has unique experience in the character of the work he discusses. He also presents the results of his observations in an unusual style. His gift of wording is enviable, his exposition of the subject succinct and fascinating. His comparison of the handling of an organization with the operation of a steam engine will find ready sympathy with all Engineers. The individual parts must do their work quietly and regularly so that the whole machine may realize the best possible results. He would not say, for example, to a piston rod which had begun to grow and was demanding the removal of the connecting rod, "Very well, fight it out;" that would endanger the whole machine; but he would inform it that the designer and himself would consider the question; "Meanwhile remember you still are only the piston rod."

The eight principles of organization and discipline which he epitomizes might well be learned and digested. They will apply to all organizations, from grocery stores to steel mills. They are definite, and yet tritely enunciated. Witness No. 6: "The work should create the position, rather than the reverse." And 8: "The most certain guarantee of a loyal and enthusiastic working force is the adoption of a definite and logical policy constantly carried out." But the whole eight are of equal importance, of the greatest value. They bear to the great business of the world the relation which our Geometric axioms have to the books of Euclid.

Mr. Rorty has studied Psychology with excellent results in the hard school of handling men. His notes on the selection of men make us realize how we all, more or less subconsciously, act and think in employing labor. Few of us could reduce our irregular mental meanderings to the direct rules of action which Mr. Rorty formulates.

Mr. Rorty transcends all his previous wisdom, however, in his discussion of the problem of self-control. The college man is too analytical, he needs perspective and breadth of view, knowledge of men. He should not only study from the bottom up, but from the top down, by taking every opportunity to meet those with the broader knowledge and to discuss his work with superiors. He must also look to the development of his intellectual resources by reading—by becoming acquainted with the great souls of history and with their kin, the men who have helped to make these same men immortal. Know the great man by his writings, and know those books which have inspired his work, and the young man is admitted to the Great Club of the Intellectuals, and at the same time develops for utilitarian purposes a useful knowledge of man and mankind. Then when money has been made to the end that he may have the good things granted by the gods, the man of business will not choose the mean, the fleeting, or the material to satisfy his leisure hours, but will select, before all, friends who will come to him because he has made himself worthy, in the best and greatest sense, of enjoying all that their society may purvey of culture, of wisdom, of artistic and intellectual expression.

* * * *

THESIS WORK.

The educational value of thesis work has recently been the subject of close scrutiny in a number of universities as well as our own. In individual cases the value of such work may be questioned, but upon the whole a well executed thesis is a most useful experience in the training of any engineering student. It is perhaps a just criticism of class room work that the material presented by texts and lectures is so selected and predigested that the student does not sufficiently realize what elements are involved in the working out of problems in the field. The aim of the text books is, as a rule, to present the principles which underlie the infinite variety of composite practical problems which arise in an engineer's experience and which could not possibly be covered by texts even were it desirable. A student who has mastered the principles but has not developed his analytical faculties sufficiently to resolve the composite problems to the fundamental principles is still lacking in a most important element of a well rounded training.

It is the usual experience of students starting their thesis work that they do not know how or where to begin, especially if the problem be of the nature of research work. This of course is not surprising but emphasizes the desirability of training of this kind during the college course. Perhaps for the first time the undergraduate finds it necessary to consult the original literature of a subject. Valuable information will frequently be disclosed in a search of the literature of other departments of knowledge seemingly remote. Perhaps, too, the student will first meet contradictory statements and opinions and it becomes necessary to judge for himself of the accuracy of the opinions or observations of others. The necessity for doing the work in such a way that he can safely draw correct conclusions is an additional incentive to careful and painstaking effort on the part of the student. He probably more fully appreciates the great effort which must often be made to actually gather together the relevant material, and to obtain consistent experimental results. One who can actually accomplish things in experimental work in the face of the difficulties always to be met must and does have grit. A grim determination to win in spite of all obstacles brings success to the experimentalist as well as to those engaged in other lines of work. The thesis training which develops initiative self-reliance, patience and perseverance is certainly worth while.

To properly plan and supervise thesis work requires considerable time upon the part of the instructor and in so far as it brings student and instructor into closer relationship, the advantages are all those pertaining to individual instruction. It is fully as true, or more so, of thesis work as of class work, that the value to the student is commensurate with the effort that the student puts into it to help himself, to plan and to really think for himself. It is probably safe to say that the cases in which thesis work has not been regarded as satisfactory by both student and instructor have been those in which it was necessary for the instructor to do all the thinking and then drive the student to do the work. If a student is ever to be genuinely interested in a study for its own sake it should be the thesis and a genuine interest is not first in how many credits are to be received for the work. When the thesis requirement has been regarded simply as a requirement to be met and disposed of in the easiest way, the instructor may well feel disappointed because of his wasted time and the student may well have fears as to his probable measure of success in the stern business of making a decent living.

Another aspect of the matter is that it is possible for a student to accomplish something worth while, that is to obtain results which may be regarded as a useful contribution to knowledge.

We present elsewhere in this issue of THE WISCONSIN ENGINEER a list of the theses being carried on this year. It will be the aim of THE WISCONSIN ENGINEER to present to its readers from time to time the results of thesis work completed and in progress, which may be of interest. We welcome at all times suggestions relating to problems which may profitably be carried on by the College of Engineering.

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U. W. MINING CLUB.

The U. W. Mining Club, although just entering upon the second year of its existence, has, thus far, enjoyed a most healthy existence. Drawing its members from the three upper classes in the course in mining, and geology students interested in mining topics, it maintained an active membership of twenty-two last year and the roster contains exactly the same number of names at the present writing.

The club has been addressed this year by Profs. Holden and Havard of the faculty and Messrs. Wolff, Corner, and Schilling of the student body. In addition it has become an affiliated student society with the American Institute of Mining Engineers, gaining many valuable privileges by such affiliation.

While primarily a scientific club, the social activities have not been neglected. On December twentieth a most delightful informal evening was enjoyed at the residence of Professor Holden. A banquet in the near future and a picnic later on in the spring are planned.

The officers retiring at the end of the present semester are: H. E. Schmidt, President; W. G. Pearsall, Vice-President; W. V. Bickelhaupt, Secretary-Treasurer; W. P. Wolff, Mucker.

THESES SUBJECTS FOR ACADEMIC YEAR 1910-1911.

BRIDGE ENGINEERING.

1. Design of a Reinforced Concrete Coaling Station of a Capacity of 400 Tons.
2. Design of a Reinforced Concrete Water Tank and Support.
3. A Study of Reinforced Concrete Retaining Walls.
4. Design of a Reinforced Concrete Trestle at the Harrison Street Crossing of the Illinois Central.
5. Design of a Reinforced Concrete Ribbed Arch at the Harrison Street Crossing of the Illinois Central.
6. Comparison of Cost and Maintenance of Concrete and Wood Pile Trestles.
7. Design of Steel Trestle at the Harrison Street Crossing of the Illinois Central.
8. Design of a Steel Ribbed Arch at the Harrison Street Crossing of the Illinois Central.
9. Design of a Steel Arch Bridge to Cross C., M. & St. P. Tracks at Agricultural College Barns.
10. Design of a Double Track Railway Viaduct, Comparing Cost of Structures with Various Ratios of Tower and Suspended Spans.

MINING ENGINEERING.

1. Three on the Development of Copper Mines in the Butte District under Varying Conditions.
2. Three on the Equipment and Operation of Silver Lead Mines in the Couer d'Alene District, Idaho.
3. The Development and Equipment of a Gold Mine in the Cascade Mountains.
4. The Development and Operation of a Coal Mine in the Trail Creek Coal Field, Montana.
5. The Development of an Iron Mine on the Mesabi Range.

MECHANICAL ENGINEERING.

1. Test of Capitol Heating Plant Engines.
2. Test of Capitol Heating Plant Boilers.

3. Test of Low Pressure Steam Turbine and High Pressure Steam Engine, Appleton, Wisconsin.
4. Investigation of Efficiency of Line Shafting and Variable Speed Transmission Gears.
5. Test of New Steam Turbine and Boilers, Madison Gas and Elec. Co.

ROADS AND PAVEMENTS.

1. A Study of the Commercial Feasibility of Operating a Stone Quarry at Burke, Wisconsin.
2. The Present Status of Permanent Road Construction with Special Reference to Dust Problem.

RAILWAY ENGINEERING.

1. The Valuation of the Joint Terminal of the C. & N. W. and the C. St. P., M. & O. Railways at Sioux City, Iowa.
2. The Apportionment of Maintenance of Way Expenses Between Passenger and Freight Traffic.
3. A Study of Northern Pacific Locomotives with Reference to Tonnage Rating and Grade Revision Problems.
4. Investigation of Ruling Grade Conditions for Freight and Passenger Trains in the Proposed Milwaukee Track Elevation Work.
5. A Field Study of the Resistance of Single and Double Truck Electric Railway Cars on Straight and Curved Track.
6. The Valuation of the Milwaukee Water Works System.

HYDRAULIC ENGINEERING.

1. Irrigation from the Weser River, Idaho.
2. Power Development on the Presque Isle River, Michigan.
3. Hydro-Electric Development on the Colorado River at Austin, Texas.
4. Power Development on the Spokane River, Washington.
5. Investigation of the Power Available on the Illinois River at Peoria.
6. Hydro-Electric Development on the Upper Twin Falls, Menominee River, Michigan.
7. Investigation of the Effect, on the Discharge and Efficiency of an Air-lift Pump, of Variations in Its Percentage of Submergence.

8. An Investigation of the Loss of Head in Pump Valves.
9. Test of an Over-shot Water Wheel.
10. Test of a Fall Increaser.
11. A Study of Valve Action in Reciprocating Pumps.
12. A Determination of the Relation of Length of Drive Pipe to Supply Head for the Hydraulic Ram.
13. Experimental Investigation of Centrifugal Pumps.

ELECTRICAL ENGINEERING.

1. Investigation of Hysteresis with an Irregular Pressure Wave.
2. Reduction of Voltage upon Direct Current Circuits.
3. Speed Regulation of Induction Motors.
4. Tar Settling by Electrostatic Discharge.
5. High Efficiency Incandescent Lamps.
6. Study of Wireless Detectors.
7. Insulation Tests.
8. Illumination Design.
9. Design of Water Rheostats.
10. Effect of Inductance in the Armature Circuit upon the Acceleration of Direct Current Motors.
11. Design of Power Plant for University of Wisconsin.
12. An Electric Railway Design.
13. Electrolysis of Reinforced Concrete.
14. Dependence of Magnetizing Factor upon the Material of the Rod.
15. Appleton Plant Test.
16. Capitol Plant Test.
17. Madison Plant Test.
18. Comparison of Methods of Determining Efficiency of Transformers.
19. The Disruptive Failure of Air.
20. The Production of High Frequency Alternating Currents from a Direct Current Supply.
21. Relation Between Direct and Diffused Light in Interior Lighting.
22. An Investigation of Some Insulation Problems Encountered in the Design of a 500 Kilo Volt Transformer.

DEPARTMENTAL NOTES.

STEAM AND GAS ENGINEERING.

The work of fitting up the extension to the laboratory is nearing completion. The new Forster superheater is erected and the piping for superheated steam will soon be ready to connect up with the steam loop around the main laboratory. The new Foos gas engine is being equipped with the necessary brake and other appliances for testing, and will be used in an extensive series of thesis tests during the coming winter. Thesis tests are now in progress at the new capitol heating staton, and also at the plant of the Madison Gas and Electric Company where a new Allis Chalmers Steam Turbine has been installed.

A series of tests will be made in the Steam and Gas Laboratory this year to determine the relative efficiencies of various types of ball and roller bearings, and also to compare the efficiency of bevel gears with that of some of the "right angle transmission" systems now in use.

RAILWAY ENGINEERING.

The railway location project undertaken by the Junior Civil Engineers during the present semester consists of a line approximately two and a quarter miles in length on ground selected with especial reference to value of practice as regards topography, curve work, cross sectioning and the other essential details of railway location field work. The entire line has been cross-sectioned and portions repeated for further practice. The work this year is unusually well advanced, the field work having been practically completed some two weeks previous to the Thanksgiving recess. The class this year consists of some fifty students handled in three sections.

U. W. ENGINEERS' CLUB.

A marked awakening of interest in all the lines of activity offered by the U. W. Engineers' Club has been noted during the current semester. An active campaign for new members has resulted in the addition of a goodly number of names to the roll.

Of special interest have been the talks given before the club since the opening of the semester. A. G. Christie, Assistant Professor of Steam Engineering, spoke of his travels in England and J. G. D. Mack, Professor of Machine Design, spoke of the work of the Mechanical Department of the Rate Commission. The talks given by students have also been very interesting and instructive.

On Jan. 18, a smoker was given at the Union. Music, cider, apples, smokes, and speeches helped to make the occasion an enjoyable one.

CIVIL ENGINEERING SOCIETY.

The semester has been an active one for the Civil Engineering Society. Beginning the year with 24 old members, the membership has been increased by 50 new names. All of the members have taken a marked interest in the society and the meetings and a number of good talks have been given by the student members. Those who have addressed the society are: Kroening, Griffith, Scudder, Blake, Ludberg, Goeke, Blodgett, Hughes, Curwen, Whitney, Reber, and Torkelson from among the students, and L. F. Boon, '10, from the graduate membership. E. R. Jones, Assistant Professor of Soils in the College of Agriculture, spoke on drainage problems at one meeting.

On October 21 a smoker to all civil engineers was given at the Union by the society. Cigars, punch, sandwiches, music and a number of impromptu speeches enlivened the occasion. A banquet with an elaborate menu and music was given at Schwoegler's on January 21.

An orchestra composed of members of the society has furnished music for many of the meetings. The personnel of the orchestra is as follows: Pianist, C. L. Eastman; Cornet, C. M. Scudder; Violins, A. E. May and G. W. Trayer.

The officers retiring at the end of this semester are: President, F. A. Torkelson; Vice-President, S. H. Ankeney; Secretary, A. E. May; Treasurer, F. J. Hoffman.