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The Wisconsin Engineer

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BY-PRODUCTS OF AN ENGINEERING EDUCATION

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Instructor in Mechanics

When a manufacturer wishes to increase his profits through improvements in the factory he may study the methods of manufacture to eliminate waste and loss of energy due to misapplied effort in handling materials and tools, or he will study the waste itself to see whether all the valuable elements have been extracted.

If he is satisfied with the thoroughness of extraction, he may examine it for ingredients of other valuable products. As a result of such investigations, blast furnace gas, formerly allowed to escape and burn in the air, is now diverted to gas engines, where it becomes the motive power driving all the machinery of a great industry. Similarly, coal, once burned either only for coke or coal gas, now furnishes ammonia for refrigeration, aniline dyes for the textile industries, and anesthetics for surgery. Innumerable instances may be given in which the residues and offal of manufacture have been converted into valuable by-products, sometimes even of more importance than the principal products. They may become the primary output of a factory originally erected for an entirely different purpose. Whether primary or secondary, it cannot be questioned that the by-products have often been the small additional ounce on the delicate balance of business fortune necessary for success. Not even efficiency itself, that wonderful panacea of Doctor Engineer, has been the manufacturer's salvation as often as has the utilization of waste in the production of by-products.

Like every industry which has its definite function in the production of one or more manufactured articles, technical schools have as their definite purpose the training of properly qualified men to become engineers. Like industries, they have their waste, but unlike industries, the waste in training mental faculties is very intangible. If the detection and elimination or utilization of waste were left to the student, even though he be entirely serious and capable, the results would probably be quite a catastrophe to training. The man of affairs would probably insist upon practical information to such an extent that the student's efforts would be employed exclusively in the harvesting of facts. Each group would give prominence to create formulas and well defined methods that give immediate results, casting aside as useless all studies that do not point to visible and direct benefits. Because there would be no by-products, the educational institutions equipped to prepare men only in the applied sciences, would and should go under.

What, then, are the by-products of an engineering education? I shall not attempt to specify them, and will only say that from the definition of the term they are additional results of a college technical training that have very little direct bearing upon the immediate requirements of the engineer's profession. They may be manifested in ideas, in enthusiasms or aversions, in the predilections or prejudices. As to their cause, it may lie in a few selected friendships, in the inspiration of an experienced and mature instructor, in a book, in the laboratory, even in a lecture. Usually they do not treat of practical things, but point to distant achievements. They demand sacrifices and often the relinquishment of many cherished habits; consequently they may occasion some of the disagreeableness caused by readjustments in our attitudes and customs. Often they occasion the drawing up of entirely new lists of values.

THE MECHANIC AND THE ENGINEER

The invoicing of values requires a sensitive self-consciousness enabling a person to see himself in perspective and to choose surroundings that are beneficial, and to react against deleterious influences. The self-conscious engineer tries not only to see what he would like to be, but through comparison with other men he determines what he would not like to be. He may compare himself to men whose work is somewhat similar to his. He differs, for example, from the mechanic in that the latter works under constant supervision and direction upon some small part of a larger machine which he does not understand, while the engineer, through the higher faculties of imagination and reasoning, conceives the machine or structure as a whole. He sees the function of each part and the co-ordination of all the parts. He will observe that his linen collars carry more prestige than grimy overalls, but do not differentiate him from the mechanic. Nor does mental labor in contrast to manual labor necessarily raise him to higher rank. Only when the engineer can see his work, not as end in itself, but as a means to other higher goals, can he claim any superiority over the unthinking mechanic. When he realizes that the work of his profession is a very potent force in civilization, that for more than a century it has been the moulder of history, and the immediate future at least appears to be destined by the machines and structures he builds; and when to the realization of the consequences of the engineer's work he adds his approval or disapproval depending upon his philosophy of life, only then does the engineer elevate and distinguish himself from the more unreflective mechanic.

To the vision of a greater and better future determined by the *Weltanschanung* formulated as a by-product while in college, possibly, the non-mechanic engineer will sketch a better and more humane present. To give direction to the future and bring into being the desirable present calls for manhood. Action alone, it is said, can develop character. However, it will develop it according to a pattern, and it is the drawing of the pattern that may be done in student days.

In continuing his self-analysis, the engineer must see that while the mechanic is regarded as a man who uses tools, there are unfortunately many engineers who are only tools that use men, and the engineer, superintendent, or foreman working for an unscrupulous employer can recognize himself as a tool only when he has well developed principles of right and wrong. A lack of clearness may debase the engineer below the meanest pickaxe subordinate. Ethical standards are usually unconsciously absorbed, but a "college education" demands that they be the product of deliberate reflections.

QUANTITATIVE AND QUALITATIVE ANALYSIS.

Given a few handbooks of tables and formulas, a set of drawing instruments, and a slide rule, the orthodox engineer believes he has at his command all the essentials to give him his place in the world. They furnish the means for measurement and calculation that he will need in his daily work. He can measure and compare power, force, distance, volume, mass, area, depth, height, in fact everything that can be expressed in terms of units. Everything that has quantity can be analyzed and standardized.

The more thoroughly practical he is, and the more absorbed he is in his daily grind, the deeper the engineer drifts into the rut of believing that he is skillfully performing the duties of his profession. Eventually he begins to calibrate every object he sees and every deed he witnesses in terms of his adamantive units. Like the atoms of Democritus they serve to build up the entire universe in all its parts. "The mind," said Democritus, "is made of very fine smooth round atoms." "The mind," says the modern materialist, "is brain. It is man's power to invent and organize. Its value depends upon its capacity to produce articles that can be sold. A roaring waterfall equals so many thousand horse-power only. Magnificent pines equal so many thousand feet of lumber, nothing more. The beauty of a rose bud varies with the price per dozen. The value of a bock is indicated by the sales the publisher can verify. Even an act of heroism can be measured by the cost of the Carnegie medal. Everything has its price per."

In diverting the drift of his profession toward this new materialism, the college trained engineer who has come under the influence of the "humanities" as these are cultivated in the university, is doing a distinguished service. Unless he wilfully surrounds himself with an insulation that protects him from the sparks of wisdom, and refinement that can hardly be avoided in four years of almost continuous exposure to scholarship, the freshman and the embryo senior are different men. One has visions of an education, the other visions of a future. In the picture of the future are hidden the subtle influences of many persons, books, and lectures. It is not a dimensioned mechanical drawing but a harmony grouping of those values the tape cannot touch nor the balance belittle. Four years in a college which has its by-products, should take him a step beyond childish estimation of quantity to an appreciation of quality.

Of course, an invigorating atmosphere also has its suffocating constituents. In an atmosphere of learning there is the carbon dioxide of many inane "student activities" and the all-engrossing amphitheater athletics, emphasizing popularity rather than individuality. We may trust, however, that persons of real mind will be able to withstand their influence.

INEFFICIENT EFFICIENCY

"The elevation of man," says Wm. Oswald, "from a working beast on a level with the ox to a higher being having free sway over endless quantities of energy is an ethical gain which we owe exclusively to technical progress." Such statements from one of the world's greatest scientists should fill every engineer with pride, and deepen his respect for his profession. He urges that modern men take for a motto his energetic imperative, "Waste no energy." In other words be efficient.

The philosophy of efficiency has been so deeply engrained in our thinking that we are prone to speak of efficiency in most ridiculous connections, forgetting that there are many life processes that do not involve changes of energy and consequently cannot be subjected to an efficiency test. Steam engines may be efficient because heat units are taken in at the cylinder, and their equivalent, power, is delivered at the fly wheel. Men may study efficiently because definite lessons must be covered, and this can be done in a certain period of time and with a degree of excellence that may be compared with a standard set by the most capable minds. Oswald's energetic imperative holds here. Waste no energy. But we are not always working changing energy from one form over into another. Sometimes we live. How can we admire efficiently, aspire efficiently, hope efficiently, hate efficiently?

Merely try it, and immediately it becomes mechanical; we become "enthusiasts by rule."

A balanced understanding of the meaning of efficiency, then, should be aimed at by every engineer. Here, again, proper friends, and reading done under the guidance of broad minds can aid. And where can such direction be found better than in college?

THE PROGRESSIVISM OF BEING OUT OF DATE

Few remarks are as certain an indication of superficiality in persons as those which condemn a view or an attitude in another person because it is out of date. Stamping our approval on an idea because it is modern means either that we consider every innovation good because it is an innovation, or that we have no ideas of our own with which new ideas may conflict. Young children like candy because it is sweet, old children like fads and proprieties because they are new. Or, if we are not blessed with childish simplicity, and yet blindly worship styles and fashions, it may because we live on the surface of the ocean of ideas and are unable to ascend or descend. A man without clear goals is like a piece of drift wood tossed by circumstances up and down in endless confusion—like a point in a plane he has position but no direction. He can stem no influence because influence gives direction and he has none. Certainly, being out of date because we are unable to recognize change, is no more shameful than being up to date, simply to be up to date.

Progress implies a moving forward. In the terminology of physics it may be called a vector quantity in that it is a change that has both direction and magnitude. It is velocity, not speed. A speed of forty miles an hour does not tell us where we are going; it is merely the rate at which we are changing position. A factory may speed up its production to a thousand automobiles a day, but where does such frenzied production bring the machinist who make it possible? Why improve factory organization, reduce expenditure and overhead charges, eliminate unnecessary motion, standardize methods of manufacture, and introduce automatic machinery? Can it be possible that larger incomes, bank accounts or homes resulting from efficient production constitute progress? Few as the men who see in wealth an end in itself, those who see a use for it that will enrich or in any way enable their lives are still less numerous. Because they imagine progress to be a scalar quantity, a growth which has magnitude only, the results of their lives are meaningless.

A manner of living that agrees with our ideals of justice and beauty furnishes a goal for progress. Again, where are the opportunities greater for establishing standards of character and nobility than in a college? There the heritage of all the ages of literature lies at our disposal, there the wonders of the sciences are best revealed to us, and the history of human endeavor is most accessible. A selection of standards or ideals from poetry or drama written long ago may be the basis for real progress, and the by-products which they represent may prove of inestimable value.

When the engineer will lose his fear of quoting verse because it is unengineerlike to do so, when he is not afraid of expressing convictions others do not share with him, when he will dare to show enthusiasm for knowledge for its own sake, when he will act under the direction of the deep feeling caused by a violation of his ideals of justice, then he has raised himself out of the mire of nonentity, and he bids fair to elevate his vocation from a profession a step towards superprofession. Goethe, the immortal master of the arts of living, bids us

"Let noble Man
Be helpful and good;
Ever creating
The Right and the Useful—
Type of those loftier
Beings of whom the heart whispers."

THE SALT INDUSTRY OF CENTRAL KANSAS

Charles I. Corp
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Kansas ranks fourth among the salt producing states, being led by Michigan, New York and Ohio, in the order named. Of the thirty-four and one half million barrels produced in the United States in 1913, twenty-eight and one-half million was the output of the above named states. Something over two and one-half million barrels of this came from the Kansas field.

In pioneer times, settlers obtained their supply of salt from the "salt plains." These plains or marshes are covered with water, in the spring of the year, highly saturated with salt. As the season advances the water is evaporated, leaving a crust of crystalline salt upon the surface.

The pools of brine left on these marsh areas were frequently utilized by hunters to cure their "jerked" buffalo meat.

The first salt commercially produced in Kansas came from salt marshes and saline wells. The only plant of importance to use this source of supply was the Solar Salt Company of Solomon City. This plant was erected in 1873 and was operated intermittently until six or eight years ago.

Brine was drawn from drilled wells eighty to one hundred feet in depth and passed through a series of reservoirs where the sun evaporated the water, concentrating the brine, and causing a deposit of salt to form. Frames which supported a removable canvas covering were used to keep out the rain. This primitive method first caused Kansas to be recognized as a salt producing state.

From 1880 to 1890 was a "boom" period for central Kansas.

During this time money was plentiful and could be readily obtained for almost any sort of enterprise. In numerous localities companies were formed for the purpose of drilling for oil, gas, coal or other valuable mineral products. In 1887 a stratum of rock salt was struck at several places, from five hundred to a thousand feet below the surface. Its discovery was not at first considered of any great moment; on the contrary, it produced disappointment, and it remained for eastern salt men from New

York state to erect the first plant for the production of salt from this source.

Fig. 1 shows the part of Kansas under which the salt bed is known to extend. Its full limits have not been definitely determined. The strata is from two hundred and fifty to over four hundred feet in depth, made up of veins of almost chemically pure rock salt separated by shale deposits. The vein being mined at Lyons is eighteen feet in depth and is pure rock salt.

METHODS OF OBTAINING

Since 1888 to the present, salt has been obtained from the strata both by mining and by the evaporation process. Costs prevents the mining process from competing with the evaporation process for the finer grades of salt.

The product of the first is special, being used by packing houses for such purposes as the curing of hides and packing of meats, by stockmen for ''salting'' cattle, by makers of ice cream for the freezing process, and by shippers for charging refrigerator cars.

At Lyons, Kanapolis and Kingman the salt is mined in a manner very similar to that used in obtaining coal. The pillar and room system is used. A layer from one to one and one-half feet of the salt is left below and above in order to keep the salt which is mined free from shale.

After the salt is hoisted it is run through crushers and screens, and boys and girls pick out the shale and discolored lumps by hand.

The Lyons plant, with a capacity of 2,000 tons per day, is the only one which is in active operation throughout the year. The Kanapolis plant, which is under the same management, is operated only as need arises.

The overhead buildings of the Kingman mine were burned, a few years since, and the mine soon filled with water. This has caused it to be abandoned.

The evaporation process calls for a well, a settling vat, a series of evaporation pans, a process of raking, and storage and shipping rooms. The largest center for the production of salt by this means is in Hutchinson, Reno County, where is to be found

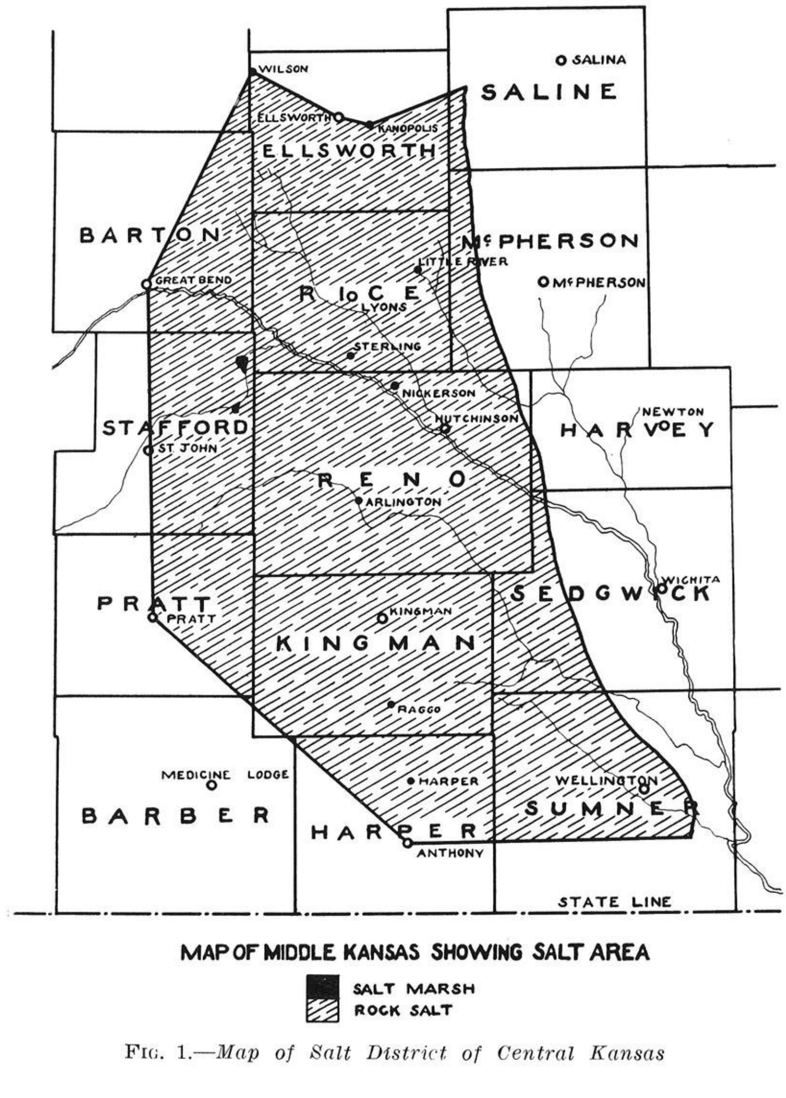

Fig. 1.—*Map of Salt District of Central Kansas*

the Joy-Morton plant, one of the largest, if not the largest salt plant in the world.

Wells are drilled with an oil-well drilling outfit, the procedure being in every way similar. An 8 in. casing is put down through the water bearing stratum, which is from 150 to 200 ft. deep. A $5\frac{5}{8}$ in. internal diameter pipe is then lowered into this and the well cased with this smaller pipe to the top of the salt stratum. The second pipe ends at this point but the drilling is continued until the bottom of the salt bed is nearly reached. A $2\frac{1}{2}$ in. pipe is then lowered into the well to within 10 or 12 feet of the point where the drilling was stopped. Fresh water is then pumped into the well through the $2\frac{1}{2}$ in. pipe and is gradually forced back to the surface between the two pipes. In rising through the salt bed it becomes partly saturated with salt and returns to the surface as brine. As a well ages, the excavation caused by the dissolving salt remains filled with water which becomes practically saturated with salt. Thus the capacity of a well will increase rapidly, and provided no cave-in occurs to destroy it, will improve with age. In several instances where wells have been placed near each other they have formed a subterranean connection and it has been possible to pump fresh water down one well and have the brine flow from the other.

The brine flowing from the well is run into a large rectangular wooden vat built from ten to fifteen feet above the ground so that the brine may flow by gravity from this basin to the evaporating pans. This vat has the double purpose of furnishing a certain amount of storage for the brine, and of being a settling basin in which earth carried along in suspension may be separated by sedimentation. In the more modern plants this vat is followed by a second vat in which steam filled coils are placed for the purpose of warming the brine to a temperature of about 180° F. before it enters the evaporating pans. This is to avoid the cooling effect of the unheated stream of brine.

Several different kinds of pans have been and are being used. Fig. 2 illustrates the type of evaporating pans employed in the first plants. The pan was of sheet metal, about 25 ft. by 90 to 110 ft. and from 12 in. to 18 in. deep. The sides were sloping, the slope being continued by the wooden drain board, D, shown in section A–a. Beneath one end of the pan a furnace was built.

The flue gases passed back under the pan and up the steel smoke stack at the other end. Just above the fire a fire-brick arch was built between the grate and the pan to prevent over-heating. This had openings at intervals near the rear end. The brine from the settling vat entered the cool or stack end of the pan. Fig. 3 is an interior view of one of these old pan rooms showing this rear end of the pan. It can be noted that the first one quarter of the pan is separated from the rest by means of a baffle and the stream of cool brine is thus spread out entirely across the pan. Steam is rising from the hotter portion of the pan clouding the picture. The salt was precititated in the form of crystals as the evaporation continued and at two hour inter-

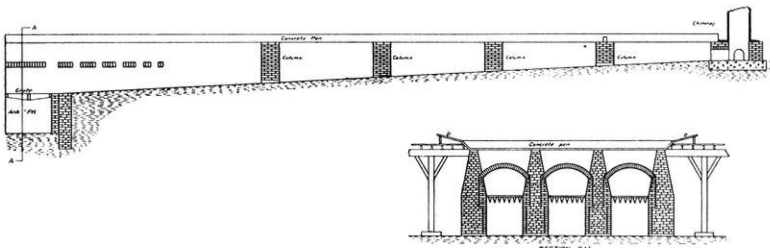

Fig. 2.—*Original Direct-Heated Evaporation Pan.*

vals was raked out by hand upon the slanting drain boards. The rake used for this purpose consisted of a steel blade hinged to a long handle. In raking, on the outward stroke, the blade doubled back toward the operator, skipping over the water. On the beginning of the return stroke it straightened out at right angles to the handle as it sank to the bottom. After draining the salt was loaded into the two-wheeled carts (Fig. 3) and wheeled into the storage or curing rooms.

Following these original direct heated pans, there was introduced what was known as the Grainer Process, in which, instead of placing a pan over a furnace, steam coils were placed in the body of the brine itself. These pans were at first raked by hand but were later equipped with an automatic raking device which carried the salt to one end, up an incline, and upon a cross conveyor. Fig. 4 is a drawing showing one example of this type of raking device, and Fig. 5 is a view taken at the rear of one of these pans. The rakes consisted of steel blades which were suspended from a frame work which was hung on axles over the pan. The sides of the pan were used as a track for the supporting wheels of the rake. The front section was hinged so that it could travel up the incline and deliver the salt to the cross conveyor. The rake had, in most cases, a sweep of nine feet three inches, and made a complete cycle in four and one-half minutes. The blades were placed at eight foot intervals and were so arranged that they would swing forward as the rake travelled toward the rear, in a manner similar to the hand rake

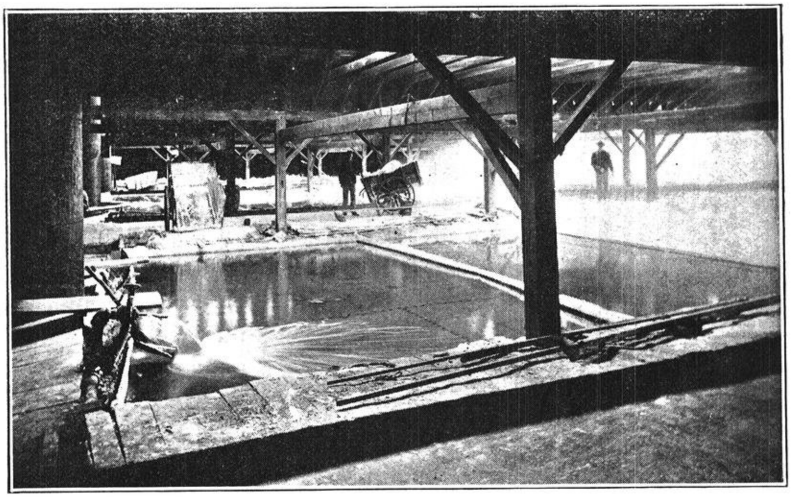

FIG. 3.—*Interior View of Pan Room of Furnace Heated Pans*

described above. Since the stroke of the rake was nine feet, three inches, the salt was pushed forward by each blade fifteen inches beyond the point to which the blade immediately in front travelled on its backward stroke. The salt was thus picked up by each blade and carried forward to the next, ultimately reaching the incline and the cross conveyor.

These rakes have been operated by several different mechanical devices, one of which is shown in Fig. 4. The first device used in the Kansas fields consisted of a pair of heavy chains passing over sprocket wheels spaced the requisite distance apart. At one point on each of these chains was a connection for a long wooden pitman rod, which was hinged to the rake about one-third of the

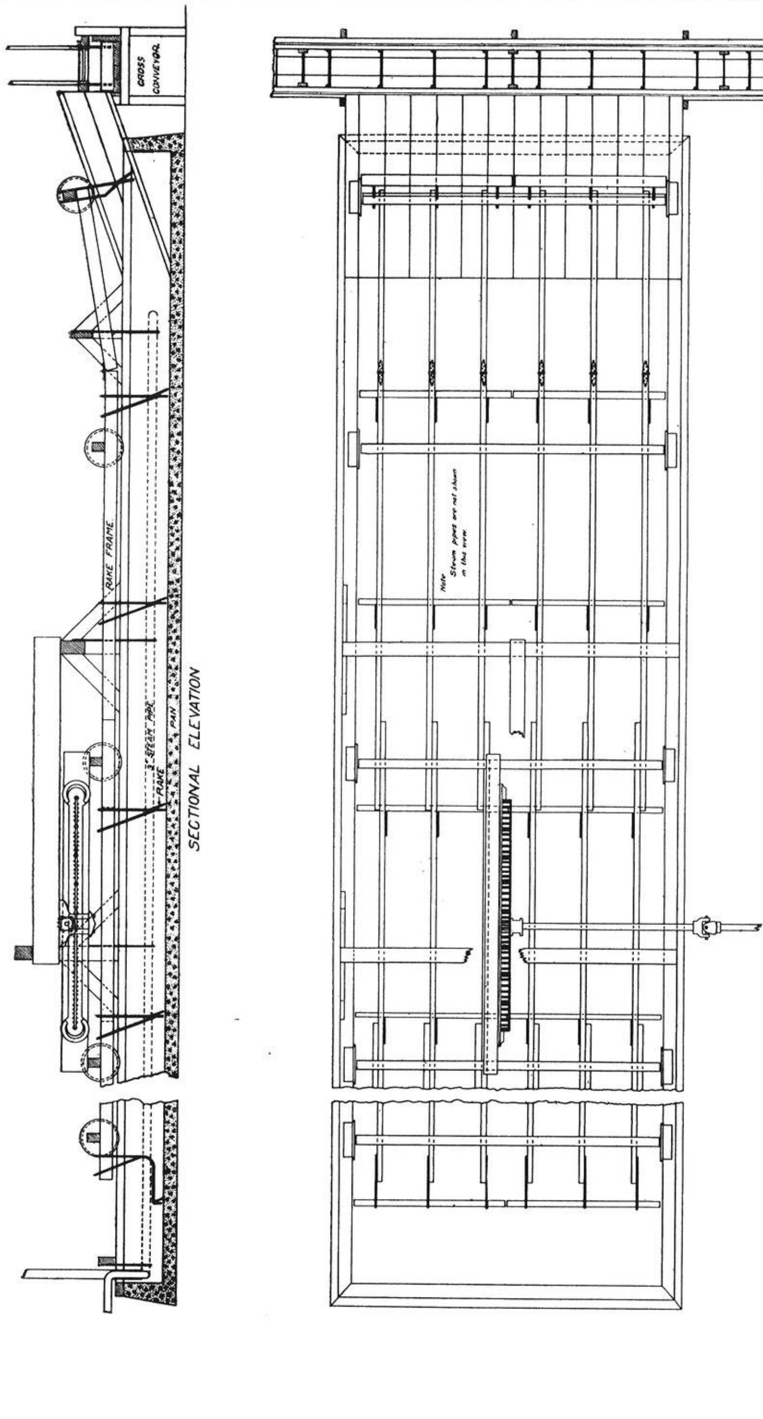

FIG. 4.—*Automatic Raking Device Used in Grainer Process*

way back from its front. The sprocket wheels were power driven and thus furnished the force to drive the rake. A second device consisted of two cranks 4 ft. and 7.5 in. long, which were connected to a pair of pitmans in the same way as the device above. The cranks were on either end of a heavy shaft which was rotated by a system of gears. A third driving device consisted of a long water cylinder operating a piston which was connected to the rake. The device shown in Fig. 4 consists of a double rack on which a pinion travels. The shaft which drives

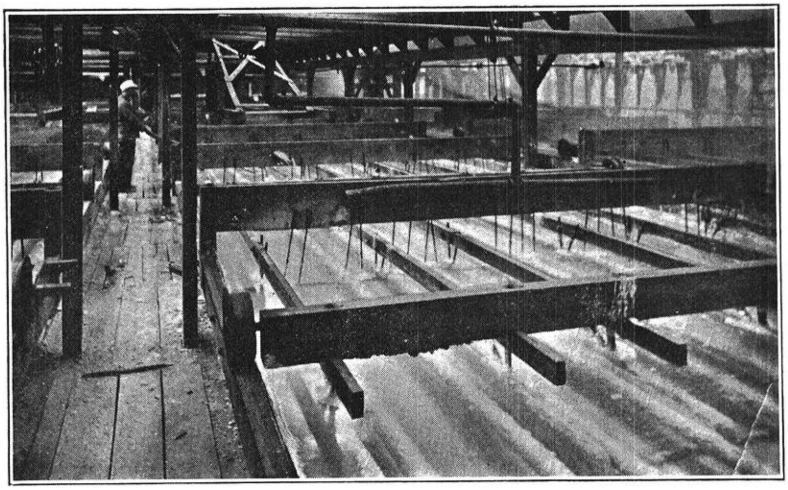

FIG. 5.—*Interior View of Pan Room of Grainer Process Showing Automatic Rake and the Piping in Pans*

the pinion has a universal joint so that it can travel on the top of the rack for one stroke and on the bottom for the return. In still another device, pans about 5 ft. in depth, narrowing in at the bottom, hopper fashion, were used with an endless chain raking device. The chain returned at an elevation above the section carrying the salt forward along the bottom. Besides steel, concrete pans were used in some instances and in other cases the pans were lined with glazed tile about 0.5 ft. square.

VACUUM PROCESS

One effort to evaporate brine under a vacuum did not succeed. The apparatus consisted of an immense sheet iron drum, about

30 ft. in diameter, and fully 60 ft. high. The upper and lower ends were conical in form, the lower cone connecting with a rectangular shaped elevator tube which ran off at an angle of about 45° and rose to a point above the water line within the pan. The upper cone was connected to a jet condenser which produced the vacuum. Within the outer drum was a second

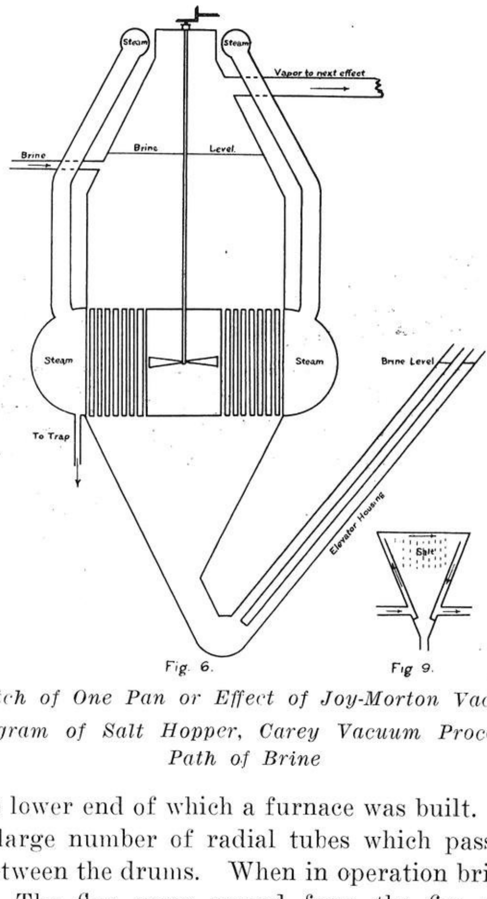

FIG. 6.—*Sketch of One Pan or Effect of Joy-Morton Vacuum Process*
FIG. 9.—*Diagram of Salt Hopper, Carey Vacuum Process, Showing Path of Brine*

drum in the lower end of which a furnace was built. The upper end had a large number of radial tubes which passed through the space between the drums. When in operation brine occupied this space. The flue gases passed from the fire up and out through these tubes into a smoke passage which conveyed them to the chimney. Unequal expansion caused the short tubes to break away from the drums causing almost constant leakage and consequent loss of time to repair. The plan was finally abandoned.

The Jay-Morton plant now uses a pan modeled somewhat after this original idea (See Fig. 6), but substituting a steam belt with vertical tubes for the inner drum. This belt consists of an upper and lower disc of copper connected with a number of short copper tubes, 4 ft. in length and 2.5 in. in diameter. There are, in all, 2,500 to 2,600 of these tubes. The brine is within these tubes and the brine level in the pan is in the upper section well above the steam belt. Steam is in the space surrounding the tubes and furnishes heat for the evaporation. In the central

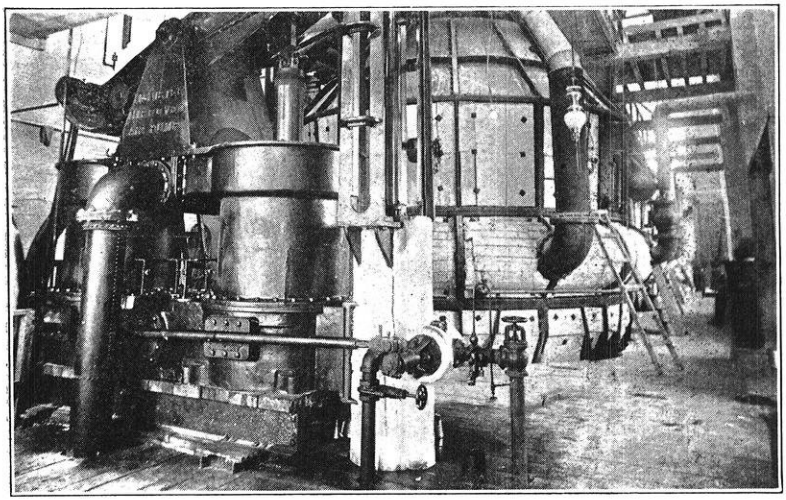

FIG. 7.—*View in the Vacuum Pan Room of the Joy-Morton Salt Co. at the Elevation of the Steam Belts*

portion of the steam belt is a space in which a propellor is placed which drives a current of brine continuously downward in the center of the pan. The return current passes up through the tubes, tending to prevent the formation of scale on their interior. As the salt is precipitated it is driven down by the central current and collects in the elevator boot at the bottom of the pan, from whence it is taken by an endless chain conveyor up the incline leg and is delivered into carts on the second elevation.

The Joy-Morton plant includes three such pans or effects as they are termed. Live steam is run into the steam belt of the first effect at about 3 pounds pressure. The steam evaporated from the brine of the first effect under a vacuum of 11 in. to 12 in. Hg. is passed into the steam belt of the second effect. The evaporated steam from this effect is in turn passed into the third effect under a vacuum of about 18 in. Hg., and from this effect the steam passes to the condenser under a vacuum of 25 in. to 26 in. Hg. The pan is operated twelve hours, and is then shut down, drained and filled with fresh water, which is heated to remove the deposit from the tubes and the sides of the pan. It is then filled with brine and evaporation continues. It requires one hour and twenty minutes from the time the pan is shut

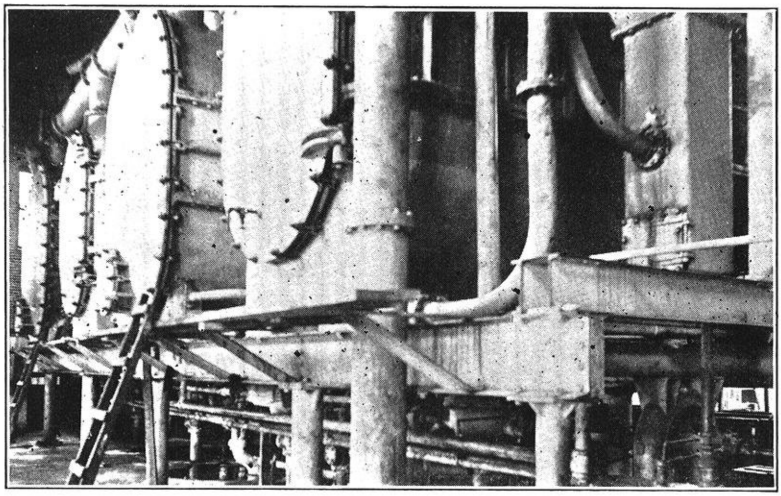

FIG. 8.—*Vacuum Pans of the Carey Salt Co.*

down until it is again producing salt. Once a week the pans are shut down and the tubes scaled out with a tube cleaner. Fig. 7 is a photograph taken on the floor at the elevation of the steambelts. The vacuum pump is in the immediate foreground. The picture is taken from the end of the room nearest the third effect.

The most recent type of vacuum process is the one used by the Carey Salt Company of Hutchinson. It consists of four effects, or pans, which are elliptical shaped, with axes horizontal. Fig. 8 is a photograph of one of their plants. In these drums a short portion of one end is separated from the rest of the interior by a tube sheet. From this tube sheet or partition, copper tubes project horizontally into the body of the drum. They are closed on the free end. Steam is admitted into the end partitioned off, and fills the copper tubes. Brine is run into the main part of the effect and surrounds the tubes. Steam is run from one effect to another in a manner similar to that of the Joy-Morton plant. The Carey plant is so arranged, however, that the direction of flow may be reversed periodically, so that the end effects alternate in receiving the hottest steam. The brine is rapidly circulated through the four effects by means of a centrifugal pump. The scouring action of the salt is sufficient to prevent the formation of scale on the tubes. Between the effects are placed hoppers (shown diagrammatically in Fig. 9, p. 162) through which the brine must pass on its way from one effect to the other. The brine is forced up one side of the hopper and flows across the top and is led away down the opposite side. Salt settles in the hopper as the stream of brine flows slowly across the top.

STORAGE AND PACKING

In practically all the plants the store room consists of a large wooden structure, having a floor of heavy boards, laid with $\frac{1}{4}$ in. to $\frac{3}{8}$ in. cracks. These floors are built about 3 ft. from the ground, thus providing a means for draining the damp salt. The salt as it is produced by the pans is elevated in a dripping condition and deposited in a large hopper at one end of the storage room. From this it falls into two wheeled carts similar to those in Fig. 3. Runways are built 16 ft. above the floor, and on these the salt can be carted up any part of the building and dumped on the floor. Here it remains to cure for about two months.

From the curing room the salt is packed directly into sacks or barrels and loaded by hand into railway cars ready for shipment. Salt intended for table use is taken from the curing room to the dairy mill. Here it is passed through a machine for crushing the lumps, and thence through a revolving steam-heated kiln, where it is thoroughly dried. From here it is elevated into hoppers from which the salt is filled into the ordinary table-salt sacks.

OIL FLOTATION AND COPPER LEACHING AT THE WASHOE SMELTERY

FREEMAN D. LOHR, '16

The Washoe copper smeltery at Anaconda, Montana, with a capacity of two thousand tons of ore a day, is probably the largest copper smeltery in the world. It is also one of the most modern in its equipment. One of the most striking features of the plant to a visitor is the apparent unconcern with which millions of dollars are invested in new processes which, at the first glance, seem to result in but a small saving on each ton of ore handled. It is, of course, the large amount of ore treated that makes these savings add up to an appreciable sum. Two of these installations are the oil flotation and the copper leaching plants. In the case of the former it has meant the scrapping of all the old water concentrating machinery, a loss which must be enormous in a plant of this size.

The old concentration plant was divided into eight sections, each of these being run as a separate unit. They are now being replaced, section by section, with the new oil flotation machinery. Thirty days are allowed for the complete destruction of an ore-demonstrating plant capable of handling two thousand tons a day, and for its replacement by a plant of a different type and an even larger capacity. The first of the oil flotation sections was put into operation about the first of July, 1915, and it is thought that the eight sections will have been entirely reconstructed by the first of January, 1916.

The equipment of each of the new sections consists of the following machines: Dorr Classifiers; Hardinge Conical Ball Mills; four Minerals Separation Company machines, which consist of fifteen agitators, fourteen flotation compartments, six Callow cleaning cells, Dorr thickeners, and Oliver continuous filters.

The ore from the Dorr classifiers is run through the ball mills and ground. All the mineral under two millimeters is reground. The mills were operated at first using stone balls, but these have been replaced by balls of chilled steel. The ore, in water of course, is run to the agitator. This is simply a rectangular wooden cell in which a stirrer rotates at a high rate of speed.

Here the ore is mixed with oil and air. The oil is a mixture of sulphuric acid, kerosene sludge, and creosote oil; six to eight pounds of acid, two to three pounds of sludge, and one-half to one pound of creosote being used per ton of ore treated.

The agitating cell is separated from the flotation compartment by a wall; there being an opening between the two which can be varied in size thus giving a means of regulating the flow from one cell to the other. The thoroughly beaten mixture of water, oil, air, and ore flows from the agitating compartment to the flotation compartment. In the comparative quiet of this tank a thick heavy bubbley froth forms on the surface, varying in depth from three to ten inches depending on the conditions of operation. This froth contains practically all of the copper ore. The earthy material settles to the bottom of the tank. It is drawn off and used for the manufacture of fire brick in the new brick plant which the company has just built. The concentrate from the first three machines goes to the thickeners, the rough concentrate from the next five cells is cleaned in the Callow cleaners, and the middlings from these and the remaining five cells are run through the separating machines again. The concentrate from the thickeners is run through Oliver continuous filters, and the product from the filters which contains about ten per cent of moisture is then carried on belt conveyors to the roasters. It is seen that the oil flotation process is just the reverse of the old water separation mehod, where the metallic particles are settled out and the earthy material or gangue as it is called, is floated off and thrown away.

By the old separation process there was always a large amount of copper lost, but the tailings from the oil flotation process are free from even traces of the ore. When a plant is treating twelve thousand tons of ore a day, the saving in copper saved soon mounts up to a large sum.

The actual facts of the process have already been stated. In short: the finely ground ore is mixed with a large amount of water and a small quantity oil by thorough agitation; a thick froth of oil, metallic particles and air forms; this froth contains all of the copper sulphide; and the gangue sinks to the bottom of the flotation cell. But in an explanation of why the oil so kindly selects the metallic particles and so utterly rejects the earthy material, difficulties are encountered. The growing importance of the oil flotation process and the number of legal disputes which have accompanied this growth have brought out a good many theories as to why and how the results mentioned are obtained. As yet none of these explanations have gotten beyond the theoretical stage.

[1] The first and most natural theory was based almost entirely on surface tension phenomena. It is impossible to get a froth of any permanence by beating pure water. So the object of the oil was, by lowering the surface tension of the water, and increasing its viscosity, to give the bubbles formed a greater permanence. And the further and equally important function of the oil was to entrap metallic particles with the air bubbles, since the oil seemed to have the property of adhering to the bright surfaces of the sulphides in preference to the earthy particles. No reason for this selective power, which is after all the basis of the new process, was attempted, it being merely assumed to be a property of the oil which was proving of great practical value in this particular case. The function of the acid was to clean the surfaces to aid the oil adherence.

[2] Another of the theories based the flotation of the metal on the combination of the gases dissolved in the water with the gases held on the surfaces of the metallic particles or "occluded" in the particles themselves. It was claimed that the gas occluded in the particle was liberated in the agitator due to a saturation of the liquid in the cell with air, and this liberated gas united with some of the dissolved air, forming a bubble which grew in size until large enough to float the particle which was the nucleus. The object of the acid was to facilitate the liberation of the "occluded" gas, while the oil was necessary merely to strengthen the bubbles, and give them the desired permanence.[3] This theory met with objections on the grounds that while there was no doubt that there were gases occluded in the sulphide particles, there was a great deal of doubt that this gas would be liberated by the treatment in the agitator, in sufficient amounts or with a great enough speed to accomplish the flotation in the

1 Mining and Scientific Press, Sept. 11, 1915.

2 Mining and Scientific Press, Sept. 18, 1915.

3 Mining and Scientific Press, Oct. 23, 1915.

relatively short time that is actually required. It was also pointed out that a previous boiling of the mixture which would remove all of the dissolved air and a good deal of the occluded gases would hinder flotation, if this theory were correct. Experiments in the laboratory of the General Engineering Company have shown that this is not the case, the flotation taking place with practically the same speed as if the pulp were not previously boiled.

[4] The latest theory to be proposed is based on the electrification of the particles of the mixture by the friction incurred in the beating process of the agitator. It is known that this friction gives the air bubbles and oil particles negative charges, while the sulphide particles are positively charged. Thus the air and oil are attracted to the metallic particles forming a bubble which floats the pyrite. The oil has as its function insulating the mass, preventing the bubble from losing its charge and decomposing. The earthy material is also negatively charged but the charge is so small in comparison with the weight of the particles themselves that it cannot hold the earth and sulphide particles together. The acid in the water increases its conductivity and since the gangue loses its charge more quickly than does the gas or oil the chance of the gangue being attracted to the metallic particles is decreased, and in this way a cleaner separation is obtained.

By its effect on the surface tension of the water, which has already been mentioned, the oil has the further function of aiding in the formation of small and permanent bubbles. So, after all, the last theory is really a combination of the earlier ones with the addition of the consideration of the electro static effects.

The truth of the matter is probably that all of the properties mentioned are factors to a greater or less degree in the separation, and there are probably other factors yet to be discovered, for this line of investigation is comparatively new. And in inverse proportion to the number of facts really known of the reason for the results obtained are the numbers of theories or guesses proposed.

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[4] Mining and Scientific Press, Nov. 27, 1915.

The great loss of copper in the old water concentration process made the recovery of the copper in the tailings necessary. It has proven difficult however to find a process which would handle the relatively large amounts of tailings necessary for the recovery of a small amount of copper and at the same time yield a profit. The Washoe smeltery must have found such a means for they have just installed a large leaching plant capable of treating two thousand tons of tailings a day. Even though the new oil flotation gives a tailing free from copper, there have been enough tailings collected in the years the plant has used the older process to keep this leaching plant running for twenty years.

The tailings from the dump are roasted in McDougall furnaces. On account of the low sulphur content it is necessary to heat the lower three hearths of the furnaces. The roasted material is treated in large leaching tanks, fifty feet in diameter and fourteen feet deep. A sulphuric acid leaching solution is used, the solutions being run from one tank to another until the desired concentration of copper sulphate has been obtained. The solution is then run into long concrete tanks filled with scrap iron. As the solution runs over the iron the iron replaces the copper. As the copper is deposited it drops to the bottom and as the tanks fill up it will be removed and refined. While the plant has been in operation but a short time it has been found that the metallurgical part of the process is sound. Though of course mechanical details were found that need further working out, there is no doubt that the process will prove profitable, especially while the war prices on copper continue.

The smeltery has just built a large sulphuric acid plant. The chamber process is used, there being six chambers in the plant. A fairly coarse concentrate is roasted, the sulphur dioxide gas being used for the acid manufacture, while the roasted ore is sent back to the smeltery and treated with the rest of the ores.

ENGINEERING EXPERIENCE, HOW GAINED

Albert M. Wolf, c '09, C E '13
Principal Ass't Engineer, Condron Co., Structural Engineers, Chicago

The idea seems altogether too prevalent among engineering graduates that once out of school their study days are over. Nothing can be farther from the truth; as some of the older men have learned to their sorrow.

Naturally, after completing a difficult course of study, covering a period of four years, the desire to slight study has a real basis, and a short rest from such work will not be at all detrimental. There is danger, however, of getting out of the mood of study and research, into which many find it hard to re-enter. The average graduate, after obtaining a position, is likely to believe that practical engineering practice will afford him all the experience and knowledge necessary to insure his advance in the professional work. As a result, instead of spending some of his spare time reading good technical magazines and reference books, and thereby increasing his knowledge regarding methods pursued in other lines of work than the particular one he may be following at that time, he will most likely enjoy social and club life, to the utter neglect of his technical work. By this I do not mean that the social side should be neglected altogether, for it forms a very important part in any man's life, if not carried to extremes.

Almost any position which the young graduate can fill, must of necessity, after a time become a sort of routine, and unless the man pushes himself forward and seizes every opportunity to advance his standing, his experience will be limited, and his worth will be measured accordingly.

For example: I have in mind two men working in the same office at practically the same kind of work; one quits on the dot at closing time and is out of the door before the others have thought of quitting for the day, and from that minute on until the next morning, his work is entirely forgotten. The other man is generally so interested in his work that he is the last to leave, and when he reaches home he studies up on matters with which he is not familiar, not being satisfied with routine work only. There can, of course, be no doubt as to which man is the more valuable to his employer. As to experience, it is safe to say that the latter has in the same time accumulated twice as much experience as the former, since this valuable asset is not so much an element of time alone, as it is of the proper use of time.

The man who does not trouble himself about things until the occasion arises, will generally spend a day or two of his employer's time studying up on a problem which is suddenly thrust upon him; while, if he had previously improved his time, he would no doubt have been able to handle the problem readily, much to his own credit, and to the benefit of his employer. The fellow who is not satisfied to trudge along in the same old rut, and who keeps himself informed on current practice in all lines related to his own, is the more experienced, and when a difficult problem arises, he, rather than the "plodder," will be looked upon as the man capable of handling it. His experience is thereby increased still more.

Perhaps one of the most effective means of broadening and developing the technical mind, is the writing of technical descriptions and expositions of engineering works. To be able to write well, one must have a good vocabulary and the ability to pick out and emphasize such points as will interest the reader. To do this, requires an intimate knowledge of the subject at hand, such as can be gained only by careful study of plans, photographs, and data, or of the particular structure itself. The experience gained in this way is sometimes more valuable than that gained from daily work.

One may ask, "How is one to know what will interest the reader?" In answer to this I would say: Take a technical article on a subject with which you are entirely familiar, and note the features emphasized; also note those points on which you desire information, and which have not been touched upon. In some articles you will find many such points. Then, when writing an article, put yourself in the place of the reader, and write so that one not familiar with the subject will be given a good idea of those important details which are so often omitted in technical articles, because they seem to the writer to be mere matter-of-fact details, too common to be of interest.

Engineering experience in any line, can be gained in three ways: By intimate connection with the design and construction of the work in question, by reading, and by writing technicel articles on engineering works. The man with knowledge gained from all of these three sources is without doubt better than the man who has had only the actual working experience, for he receives benefit both from his own work and from the work of others. No engineering firm can boast of such vast experience as not to be able to learn something from another. The case of the individual is the same.

* * *

There has just been issued by the Bureau of Standards, of the Department of Commerce. a paper dealing with the factors which influence the resistivity of the soil and with the effects of soil resistance on the leakage of currents from street railway lines using the rails as return conductors. Three methods of determining the specific resistance of soil are given and the results of a large number of measurements are tabulated.

The principal factors which influence soil resistance are described and their effects on the results of electrolysis surveys and on the escape of currents from street railway tracks are discussed.

Copies of the publication, Technologic Paper No. 26, entitled "Earth Resistance and Its Relation to the Electrolysis of Underground Structures," may be obained free of charge upon application to the Bureau of Standards, Washington, D. C.

SUCTION DREDGES IN RAILROAD CONSTRUCTION

E. R. STIVERS, c '15

Since 1910 the Chicago, Burlington, and Quincy Railroad has been reconstructing and double-tracking its line between Savanna, Ill., and St. Paul, Minn., a distance of nearly 300 miles. The line for the entire distance follows the east bank of the Mississippi River, and is closely limited by the river on the west, and the high bluffs on the east. The old line, built in 1885, had a maximum curvature of 3 degrees, and a maximum grade of 0.7 %. The reconstructed line is reducing the maximum curvature to 1 degree, and the maximum grade to 0.2%.

Reconstructing the line with the curvature thus reduced left the alternative of cutting heavily into the bluffs or crossing the many sloughs along the river. The latter course was adopted and is being carried out. The numerous embankments across the sloughs, and many of those along the river, are being constructed with suction dredges. These embankments are not infrequently 6,000 or 7,000 ft. long across open water. Nearly all of this work is being done with three company dredges, having respectively 15-, 18-, and 20-in. suction pumps.

Since fine sand or mud washes away and does not deposit readily, the material required is coarse sand or gravel. To locate the deposits of heavier materials, the river or slough is first sounded. When the best material has been located, the dredge is brought into place. This is done by means of flat-bottomed, stern-wheeled tows that push the dredge ahead of them. The cutting edge on the end of the suction pipe in a normal mixture will stir up about 20 per cent solids. This dredge can reach to a depth of 37 ft. below the surface of the water, and pump within a radius of 250 ft. at one set-up. When these limits are reached, pumping must be temporarily suspended until the dredge is moved to another location.

Preliminary to, or immediately after, locating the dredge a pipe-line is built to the place of the proposed embankment. The pipe is either floated on pontoons or supported on a line of driven bents. Where the line is unusually long and the current strong the latter method is generally used. Two types of pontoons are used, those shown in the first illustration, in which the pipe lies on the pontoons in rigid supports, and those, which are not shown, where the pipe is carried in slings from the top of the pontoon. In all cases driven bents carry the pipe along the embankment where the material is being deposited, and these bents remain in the embankment when it it finished. The pipe line is kept under 2,000 ft. in length whenever possible, although the 20-in. dredge has worked with a 4,000-ft. pipe line.

The sand is deposited along the line of the proposed embankment until the fill appears above the water. At this point a

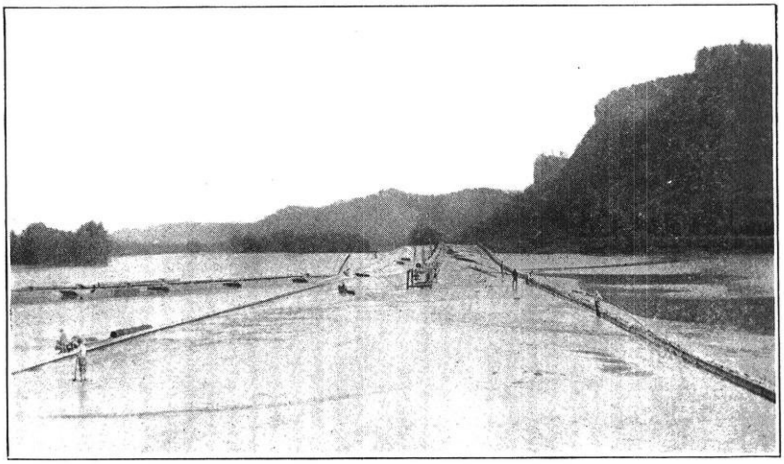

FIG. 1.—*Pipes Rigidly Supported By Pontoons*

shield line is erected. These shields are ten ft. long and twenty-four in. high, and are overlapped and placed in lines on each side of the embankment, being built as shown in the second illustration. Referring now to Fig. 3, which shows portions of sections taken at right angles to the center line of the embankment, the operation is as follows:

When the fill first appears, the shields are placed as in *a*. The sand is allowed to deposit until it is filled in as at *b*. Sand from inside the shield line is then shoveled over against the backs of the shields on the desired 2:1 slope, and the shields are jacked up as in *c*. When the fill again nearly covers the shields, the operation is repeated, and again a third time when the fill is about 3 ft. deep as in *d*. The whole shield line is then moved in about 6 ft., and similar operations follow until the completed embankment has reached grade with a top width of 34 ft. for double track. One foot is the usual allowance for shrinkage, although in some cases more has been deemed necessary. As the bank builds up, the pipes are carried ahead so that the top of the bank will build at about an 8.1 slope.

About 35 per cent of the working time of the dredges is consumed in necessary delays. Of these, moving the dredge and reconstructing the pipe line are usually the most serious, two or

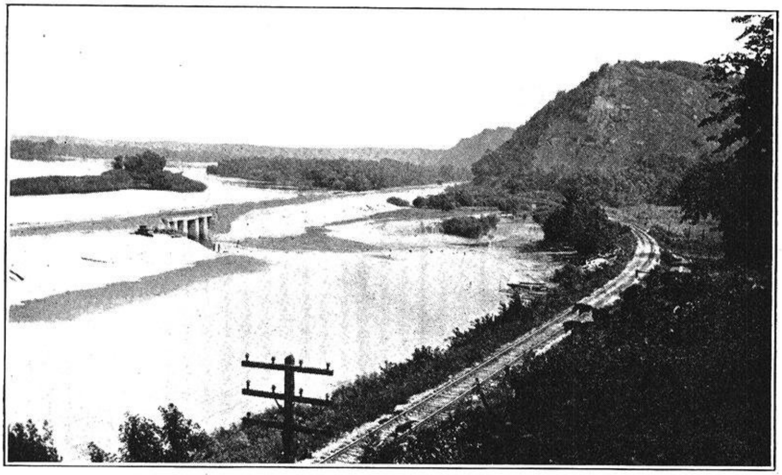

FIG. 2.—*Completed Cut Off and Old Line*

three days sometimes being required. There is a delay each time the shield line is changed, and operations must also cease while new bents are built and additional sections of pipe added. Minor repairs to the dredge will take one or two hours a day. These dredges are operated on two eleven-hour shifts, electricity generated on the dredge lighting up the work at night. The regular force on each shift consists of a foreman, six men on the dredge, and fifteen men on the bank.

Two sets of yardage figures are kept—net and total. While the side slopes above water are 2:1, where the bank strikes the water the sand deposits on about an 8:1 slope. Referring to the cross-section in Fig. 3, that quantity contained in section 1–2–3–4 is considered the net yardage, and all the sand pumped, the total. The latter normally exceeds the former by about thirty per cent. Three dredges each pump from 2,000 to 3,000 cu. yds. net per day.

The main advantage of the dredges is the low cost per cu. yd., which is from 35 to 50 per cent cheaper than steam-shovel work.

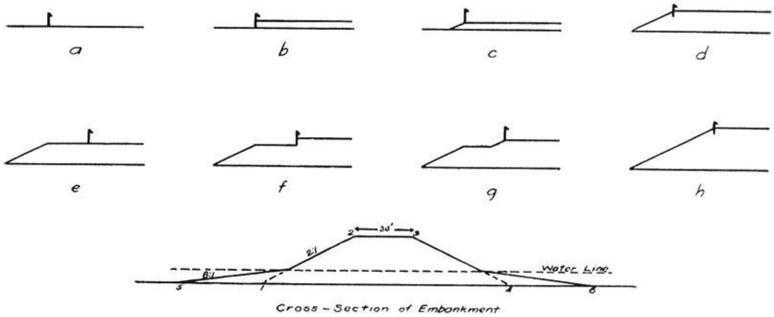

FIG. 3

To have done this work by train fills would have made the cost prohibitive, or would have caused the line to be located nearer the bluffs, thus defeating the main purpose. Another advantage is the elimination of work trains on the main line; and, lastly, more yardage can be deposited in a given time in this way than by steam shovels, while the shrinkage is very small.

CONSERVATION AND PRESERVATION AT NIAGARA

Dean Francis C. Shenehon of the College of Engineering of the University of Minnesota spoke to the junior and senior classes of the student body of the College of Engineering in regard to the problem at Niagara, the utilization of some part of the water at the Falls for power purposes and the preservation inviolate of the scenic grandeur of the cataract.

While this is viewed by some as a conflict, the conclusion reached by the speaker is that in a measure these two uses of the water of Niagara River are reconcilable.

It appears that five great companies, two on the American side and three on the Canadian side of the river, are withdrawing water for power purposes, which in a state of nature passed over the rapids and cataracts. In addition, the Chicago drainage canal is withdrawing from the Great Lakes System seven or eight thousand second feet of water naturally tributary to the Niagara River and sending this down the Mississippi Valley instead. The loss coming from these great diversions led Congress in 1906 to pass the Burton act, limiting the amount of water which power companies on the American side might use to 15,600 second feet and limiting also the importation of the electric current from Canada to the United States. This latter limitation was imposed with a view of retarding Canadian water diversion.

The great importance of the Niagara River in connection with the navigation of the Great Lakes system, which is the most important inland navigation in the world, and the probable desirability of building regulating works to maintain Lake Erie Levels caused the Federal Government to make most extensive and intensive investigations on the hydraulics of the river. Later, the great property interests of the power companies at Niagara Falls and the great civic interest in the maintenance of the scenic grandeur led to further hydraulic investigations. Altogether the Niagara has received more attention from hydraulicians than any other river in the world.

While the economic and civic question involved in the use of the water in the falls are of great import to engineers, the river hydraulics are of particular interest. The discussion led to an inquiry as to the precision with which the flow of a great stream, like the Niagara River, may be measured and the conclusion reached is that the precision obtained is within one or two per cent. In support of the precision of such measurement, many detailed observations were cited.

Aside from the precision with which the volume of flow of a great stream may be measured, emphasis must be laid on the delicate adjustment with which a river of fixed regimen maintains its surface relationships. A river is simply a chain of pools linked together by narrower retrictions or rapids, and the outflow from these various pools is regulated by these contributions or rapids, and made law-abiding in much the same way that artificial weirs or sluices regulate and prescribe the flow of water.

In the series of pools on the Niagara River, Lake Erie is the initial or parent pool. As the water raises in this lake the volume of overflow is greater by a very definite increment. At an ordinary level of Lake Erie the outflow in the Niagara River is 219,000 second feet, and when the lake rises one foot 21,900 additional cubic feet per second are discharged. These two elements, a base volume of flow at some fixed elevation of Lake Erie above sea level, and the rate of change per foot of change in lake level, permit the writing out of the law of discharge. The law of discharge of the Niagara River is:

Value of flow = 219,000 + 21,900 (Lake Erie level — 573.00).

It seems axiomatic, when an engineer has placed in his hands this equation, that if Chicago should divert into its drainage canal an amount which is one-half of 21,900 cubic second feet, that Lake Erie must have surface levels six inches lower than it would have in the absence of this diversion. As lake freighters carry about 80 tons of freight for each additional inch of draft, the hurtful effects of lowering the levels of the lake channels are apparent.

In the chain of pools in the Niagara River, starting with Lake Erie as the initial pool, the second pool is that above the rapids at the cataract. Here the river is wide and the natural weir is long, so the movement of the water is only 56 per cent of that in Lake Erie. That is, when Lake Erie rises one foot the water in this pool above the rapids will rise only 56 hundredths of a foot, or 6¾ inches. With this relation known it is easily seen that if power companies at the Falls withdraw from the pool above the rapids an amount of water aggregating 21,900, the level of the water here will be lowered 6¾ inches, and that any other diversion here will be in the same proportion.

This lowering of the navigable water of the Niagara River places the diversions of the power companies of the Falls within the grasp of the Federal Government to limit and control them.

Continuing down the river, the third pool is that in the gorge below the cataract. This is held in check by the whirlpool rapids, which form a third weir. Here the movement of the water is 2.29 times that of Lake Erie. The fourth weir is that in the Whirlpool with its outlet the lower rapids, and here the movement of the water is 2.47 times that of Lake Erie.

Each of these four pools, when once calibrated, become a water-meter or measuring instrument of great precision and is of great value in determining the river flow, and river changes.

The total available water power at the cataract would amount to 4,000,000 electrical H. P., if the whole flow should be developed with maximum efficiency. With a view of getting some conception of how much power this means, it is readily computed that this represents the muscular energy of 120,000,000 able bodied men working eight-hour shifts every day of the year. Of course only some fraction as 20 to 25 per cent of the river flow will ultimately be used, otherwise the scenic spectacle of the cataract may be diminished. If 25 per cent is ultimately used this gives a round million electrical horse-power as a possibility.

The speaker gave in some detail the methods used to ascertain the exact effects of water diversions on the cataract and the lessening of its grandeur. He stated that in the end the obvious conclusion, that if the amounts of water flowing over the cataract is less, the grandeur is diminished, is involved in the definition of grandeur. But the lessening of the impressiveness of the fall is not anywhere near proportional to the volume of the flow. The American Fall, for instance, has only one-nineteenth the amount of water of the Horse Shoe Fall, but as a spectacle it still ranks among the great cataracts of the world.

The conclusion reached in the effort to reconcile some power uses of the water with the maintenance inviolate of the scenic grandeur is, that certain compensating measures are practicable which will converse the water at times when the cataract is not on duty as a spectacle. Regulating works in the Niagara at Buffalo may store up during the night hours 20,000 cubic seconds feet or more of water so that the flow over the cataract during the daylight hours will be exactly as full as if the power companies were not withdrawing 20,000 cubic second feet.

In the end, it is doubtful if a chance visitor at the Falls can detect by eye a difference in volume of flow of 20,000 second feet. This fact and the possibility of very considerable impounding in the great reservoir of Lake Erie makes practicable the use of considerable volumes of water for power purposes. The energy so exacted from the water must lessen human burdens and serve to make better men. The enrichment of the lives of men, women and children in material things growing out of manufactories, transportation and light must be the end in view in the use of this great power resource.

Under the treaty with Great Britain the amount of water to be taken from the Niagara at the Falls is now limited to 20,000 cubic seconds feet on the American side, and to 36,000 cubic feet on the Canadian side. These limitations will doubtless not be exceeded in our generation.

THE WESTERN INSPECTION TRIP

J. Frederick Gross, '16

In the last four or five years there has been a change of selection with senior engineers in regard to their inspection trip. The western trip which at one time was the premier, is apparently giving way to the more popular eastern trip. The number of men who took the western trip this year was a little smaller than usual, but this handicap did not dampen the enthusiasm of the western party. The party, numbering ten in all, was properly chaperoned by Mr. B. E. Miller, who surely deserves congratulations for his week of noble work. It was "Bert's" own schedule, and this is how he led us.

Chicago was selected as the base for the first series of inspections, because it affords many opportunities for inspections which are of special value to the engineer. On Monday morning the party left for Buffington, Ind., to visit the plant of the Universal Portland Cement Company. Here, for once, we realized the magnitude of cement manufacture and production. The details were numerous and few will remember all, but it is safe to say that the impression of such a plant will be lasting and beneficial. The afternoon was spent at Gary in the plant of the Indiana Steel Company. Our guide here was "some boy." We were never sure of an answer, but why worry, because each man came away knowing more about iron and steel, and further, just what a big scale production plant means.

The trip to Hawthorne Electric Works of the Western Electric Company on Tuesday morning was exceedingly interesting. The plant is strictly modern and each phase of production highly developed, demonstrating the efficiency which can be attained in manufacturing. Some of the party were more interested in the girls at times than in the inspection, but none can deny that it is some feeling to have the eyes of all the "fair ones" centered on "you."

We were the guests of the company for lunch, during which we got an idea as to what welfare work really means and attempts to accomplish.

The afternoon was spent in visiting the Fiske and Quarry Street plants of the Commonwealth Edison Co. and the main exchange of the Chicago Telephone Company. It was a revelation to see the great development in telephone work. To understand the wonders of the modern switchboard was beyond most of us, but we managed to look wise and keep our mouths closed.

On Wednesday morning the party left the Dearborn Street Station to visit the hydroelectric plant of the Sanitary District of Chicago at Lockport, Ill. When we got off at the station we found that the plant was about two miles down the track. Walking railroad ties was not on the schedule, and therefore nobody was keen about it. There were no regrets, however, because each minute of the allotted time was filled in seeing some of the real problems of design that confront the hydraulic and electrical engineer.

Bert felt at home when we visited, in the afternoon, the locomotive and repair shops of the Northwestern R. R. Co. at Chicago. He was popular in his apprentice days. The superintendent acted as our guide. The shop presented a splendid example of what good improvement can be made for modern practices of an old shop layout and equipment. The unique feature was the inspection of the locomotive equipped to burn powdered coal. This work is in the experimental stage at present but bids fair to become of practical use.

Thursday morning we bade farewell to Chicago, and arrived at Waukegan at 9:00 a. m. We checked our grips at the station and took the automobiles furnished by the company to the plant of the American Steel and Wire Company. The first impression of the plant was a good one. We were told to expect to see in continuity the manufacture of steel and copper wire products from the billet to the finished product. This we did without retracing any steps. We reluctantly left the plant in order to catch the train for Racine, Wisconsin.

When we reached Racine, we were met by the representative of the J. I. Case Company, an engineering college grad with the characteristic Wisconsin welcome. We cannot say too much in appreciation of the company's interest and the entertainment it was able to give us for our short trip. We were the guests of the company for lunch. In our travel through the town we were furnished with automobiles. The town plant of the Case Co. is an old one, but no reasonable expense has been spared to make it modern. The new plant about two miles out of town is little short of a wonder. It is hard to conceive that a foundry could be made so attractive. This splendidly equipped foundry and the elaborate pattern storage vault adjacent gave an idea as to the best there is at present in foundry practice.

The party reached Milwaukee on Thursday night. Most of the members had engagements, so nothing eventful happened to break up a night of much needed rest. On Friday morning we started for the Allis Chalmers Company. This plant was one of the largest visited. The location of the buildings is very carefully arranged, so as to provide for easy and continuous passage of the work through the different shops, and allied with this plan, so as to have rapid production, is the shop equipment, complete in every detail. We met several Wisconsin alumni in the shops doing some real work. They didn't wear the same style of clothes they did when they used to promenade the campus. This did much to impress us with what we will have to come to after our glorious days at college.

In the afternoon the party inspected the plant of the A. O. Smith Co. This plant is devoted to the manufacture of special automobile parts. Much attention was given to details which are interesting but too numerous to mention. Our reluctant spirits were aroused when we reached the Commerce Street Plant of T. M. E. R. & L. Co., and saw some of the interesting practices of power plants.

On Saturday morning we started out with "lots of pep" on the last leg of the trip. We were met at the plant of the Cutler-Hammer Co. by a former president of the U. W. Engineers' Club, G. E. Laue. Laue, with the other representative of the company explained in detail the intricate and automatic operations of switchboard and electric starting and stopping mechanism. The Falke foundry was visited next, but the time was limited and we were content with a hurried inspection.

The party broke up in Milwaukee at noon. Most of the members took the first train back to Madison. In general the trip was an unqualified success. The fellows not only grew to know each other better, but the impressions of the personality of the engineer, as reflected in the plants we visited, make the profession of engineering appeal to us even stronger than it has ever done before.

THE INSPECTION TRIP OF THE CHEMICALS

H. A. GOLLMAR '16

The seniors in the chemical engineering course were on their annual inspection trip during the first week in November, officially chaperoned by Dr. Mann and Dr. Watts.

Most of the bunch left for Chicago on Saturday morning (all that could) showing their loyalty at the Chicago game. The inspection trip proper did not begin until Monday morning. Early that morning (i. e., early for most of us) at nine o'clock, we were hustled away from the big city of Chicago to Whiting, Ind., the home of the Standard Oil Co. Even a casual observer would be impressed by the immense number of pipes and storage tanks crowded together in their one square mile of ground area. Of course, being Chemicals, we pried into the methods of manufacture of all articles from gasoline to Stanolax. By courtesy of the company, each left with a square meal and we had a liberal-sized bottle of Stanolax among us.

Of course, all concerns could not be expected to be of Standard Oil size, but this concern deserves to head the list. Back at Chicago, we saw how the Barrett Manufacturing company makes large quantities of asphalt, road oils, and roofing.

The day's work being over, our worries had left us. All were in Chicago, and our time was our own. But the conventional unexpected happened in the form of a round-up at the Union station. We were taken to Joliet to spend the night. (Anyone wishing to be impressed with the tragedy of this inopportune removal from Chicago will please consult Canaar, who reports the hardest luck of all.)

The plant of the American Steel and Wire Co. was the object of our morning expedition. From Joliet we went to La Salle, where we spent an exceedingly busy afternoon. The Illinois Zinc Co. had a very interesting plant to show; The Western Clock Works illustrated the modern type of factory; and the German-American Portland Cement Co. had a plant provided with the machinery of a modern mill. In connection with the last named plant is a well-equipped testing laboratory.

The next day we were again back in Chicago, and spent half a day at the Corn Products Refining Co. plant. There was little here to interest any engineer but the chemicals—the industry being almost exclusively chemical. We found that a half-day was none too much for our inspection. The Sherwin-Williams Paint Co., another chemical product concern, was given a half day.

The rest of the week was spent in Milwaukee. While, as a rule, the plants were not so large as those previously visited, all were interesting, and we were shown every possible courtesy. The Pfister Vogel Leather Co. had a number of evil-odored processes within its buildings, but the time passed here was profitably spent. Next we went through the Patton Paint Co., and afterward the Goodrich Linseed Oil Co.

The Mann-Watts shift was now working. First, Mann set the pace, and we all followed. Then Watts assumed charge, while Mann rested. The result was that we were going along rapidly, and with no decrease of efficiency in our leaders.

At the Milwaukee Coke and Gas Co. we were shown a good example of the Semet-Solvay process, so general in the United States. The National Distilling Co., although not a large plant, furnished entertainment for a half day. To follow the liquor process, we then went to what might well be an auxiliary of the distillery—The Northern Glass Co., where the well known brown bottles are manufactured. A visit to the plant of the Illinois Steel Co. wound up our trip.

A tinge of blue beneath the eyes was a common feature to all—with the exception of the Mann-Watts combination, whose superior endurance may be attributed to their wonderful shift, which was their exclusive privilege. The party left for Madison and more sedative labor.

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EDITORIALS

Readers of The Engineer will remember Mr. Elmendorf from his article "The Engineer as a Cultivated Man," which appeared last March. In the present number he has an article which we feel will be found to be just as interesting as, and perhaps more interesting than, the former. He pleads for a broader view of life by the engineers; an engineer should be more than a mere Mechanic, he should be a MAN. The best place to acquire the broader view, to get the requisite understanding of things, is in college and hence—but read the article if you want to really appreciate what he means.

The article by Mr. Wolf is somewhat different from that by Mr. Elmendorf; one pleads for a broader education, for the appreciation of other things than engineering, while the other warns against the idea that an engineer can neglect his technical studies after he graduates. Both men are arguing against too much specialization, and by heeding both, we can all profit.

Mr. Wolf is editor of a new monthly bulletin, "The Technician," devoted to the interests of technical men. He offers to send this bulletin to any subscriber to THE ENGINEER.

* * *

The beginning of a new school year, of a new calendar year, or of a new semester is always an opportunity for the giving of much editorial advice. Often such advice seems rather out of place when given by a fellow student, for we feel that he has had no more experience than we ourselves, and is simply taking advantage of his position to preach. In place of this attitude, can we not feel that the editor is voicing the kind of advice that he feels would help him, or which has helped him before?

* * *

Four weeks is a rather short time, but it may mean a great deal. The next four weeks will complete another lap in our race for education. Some of us are coming into the stretch with our heads up, while others are beginning to think of dropping out. With the fresh endurance resulting from our short vacation, let us all make another try, come down to the wire not beaten, even if we are behind, and resolve to make the pace-maker hustle on the next lap.

Successful Wisconsin Engineers.

J. G. WRAY e '93

Among those who have graduated from the College of Engineering of the University of Wisconsin, and who are now connected with large companies, or with some of the more important commercial engineering enterprises, very few have attained more prominent positions than Mr. J. G. Wray, class of '93.

Mr. Wray was born in Janesville, May 19, 1872, and, after attending the public schools, and graduating from high school there, entered the College of Engineering of the University.

He became an employe of the Bell Telephone Company in 1893, soon after receiving his degree of Bachelor of Science in Electrical Engineering. Since that time he has served as Superintendent of Maintenance, Superintendent of Equipment, Chief Electrician, Chief Engineer of the Chicago Telephone Company, and is at present Chief Engineer of the Central Group of Bell Telephone Companies, with headquarters in Chicago. This group of companies includes the Chicago Telephone Company, Wisconsin Telephone Company, The Cleveland Telephone Company, and The Michigan State Telephone Company.

Some idea of the magnitude of Mr. Wray's work in the field of engineering may be gained from the fact that the construction work of the various companies which has been carried on under his charge aggregates more than $100,000,000.

In addition to this work just mentioned, Mr. Wray has been active in the field of invention, and now has a number of patents relating to the telephone business, all of which are in current use throughout the United States and foreign countries.

Mr. Wray is an honorary member of the Tau Beta Pi, and has been elected to the Hall of Fame of the University of Wisconsin. He has been a member of the Board of Visitors of the University and was on the Executive committee of the Alumni Association for nearly six years. He also holds several positions of trust and honor in a number of the clubs and societies of which he is a member. He has been recently elected as one of the membership committee of the University Club of Chicago, is Secretary-treasurer of both the University of Wisconsin Club of Chicago and the Wisconsin Society of Chicago, and is a fellow of the American Institute of Electrical Engineers.

In addition to his offices in these clubs, he is also a member of the City Club of Chicago, Wilmette Country Club, Chicago Jovian League, University Club of Madison, Association of Commerce of Chicago, Electric Club of Chicago, Western Society of Engineers, Illumination Engineering Society, American Society for the Promotion of Education, and American Economic League.

Aside from his engineering practice and club work, Mr. Wray finds a considerable amount of time to devote to the church and Sunday-school, and to missionary work. At present he is superintendent of the First Congregational Church of Wilmette, and Director of the Chicago City Missionary Society.

In this article we have only touched upon Mr. Wray's principal activities. Even were the additional data available, lack of space would prevent a detailed discussion of these activities, or mention of all the minor ones of his life.

Mr. Wray is one of those few truly valuable men who have, in addition to their close connection with a great company, found time frequently to step aside from their strictly professional career, and keep in touch with the interests and activities of the outside world.

He is indeed a man in whom the University of Wisconsin may justly have a feeling of pride.

CAMPUS NOTES

It is hardly necessary to inform the students of the University, especially those of the Engineering College, that the Engineer's All University Dance was a success. The engineers showed their loyalty to their college by the way in which they supported this affair.

Not only did the students lend their support, but the faculty members were present, and again demonstrated their ability to leave the technical lecture platform behind and mix on a level with the lesser lights. Professor and Mrs. D. W. Mead and Professor and Mrs. J. G. Callan, who chaperoned the dance, assisted materially in the mixing.

Since the dance the engineers have had a warmer feeling, if possible, toward their "slip-sticks." They realize the aesthetic as well as the utilitarian value of the instrument. Mistakes in the keeping of dance engagements were easily explained as "slide rule errors."

Too much cannot be said for the creditable manner in which Mr. Walthers and his assistants on the committee handled the dance. They have helped to establish, even more firmly, the fact that the Engineer's Dance has become a recognized annual All-university affair.

* * *

The U. W. Engineers' Club recently held an election of officers for the next term. As president J. U. Heuser succeeds J. F. Gross. The other officers are: W. K. Walthers, vice-president, J. E. Mackowski, secretary-treasurer, R. A. Baxter, censor, and J. F. Johnson, assistant censor.

* * *

The following seniors were recently elected to Tau Beta Pi, honorary engineering fraternity:

Harry A. Doeringsfeld	Robert J. Mensel
Erwin W. Fisher	Harry C. Pollak
William H. Fowler	Stanton Umbreit
Victor C. Hameister	John B. Wilkinson

The minstrel rehearsals are making themselves felt in an increased tendency on the part of the students to "bubble" over in song. The main steps were very popular the last few days before the vacation.

* * *

M. R. Cornish, '15, who is working at Dayton in the Miami Conservancy District, was back for a day or so. He reported that many interesting results are being obtained in the course of the experiments under way. We have been promised some articles on this work for an early issue.

* * *

C. T. Wiskocil, who was here a year ago doing research work in Hydraulics, is to return and resume his experiments next summer.

* * *

The U. W. Engineer's Club has been recently strengthened by the acquisition of 15 new members. The initiation was held December 3, and terminated, after the reading of some highly interesting and entertaining papers, in a costume party at the Orpheum. The whole affair might be well described as a "howling success."

* * *

Basketball is again the sport of the day. We are all hoping for a "comeback," and we have a fine chance to show our interest by getting out and ROOTING.

The Minstrels were given by the Seniors in 1912 and they were good. This year all classes take part. Will they be good?

ALUMNI NOTES

We are in possession of a very interesting article entitled "Good Headwork Rather Than Huge Machinery Outfit Tells In Cedar County," which was published in the Iowa State Highway Commission Service Bulletin. James C. McLean, C. E. '13, has shown the Iowa Highway Engineers what little money, together with good headwork, will do. An extract of the article will authenticate this fact:

"Cedar County, compared with some counties, hasn't a very big bunch of equipment. Not putting a money value on the county engineer, she certainly has less than $5,000 worth, all told. But, she is getting results that are making a decided showing in every corner of the county. All which indicates that it is not necessary to make the road building machinery factories 'work nights' to have good roads and bridges in any Iowa county.

"Ask the supervisors what part of their road and bridge building equipment they could get along without. 'Yes,' you will hear them say, 'we could get along without the wheelers, the scrapers, the drill, the plow, the graders and the culvert form, but the engineer? Well, no, not the kind of a county engineer we've got.

"There are a great many Iowa counties that have been fortunate enough to secure highly capable energetic men as managers for their road and bridge building business and Cedar county with J. C. McLean is one of them. With McLean as engineer, backed up with a fine bunch of supervisors as a board of directors, she is fortunate, too, in this respect, she could dispense with her plow, her drill, her culvert form, etc., and still get good roads and bridges built. Cedar is living proof that $100,000 worth of machinery, or even half that much, is not necessary for effective road and bridge work.

"Engineer McLean and his two assistants have kept close tab on the building. 'We are paying for first class work and we propose to have it,' is the way the engineer puts it. The work inspected indicates that he has got it. One foreman insisted that he was 'doing the best he could.' He was bluntly informed that 'the best you can do is not good enough for Cedar county.' "

In a letter accompanying the bulletin Mr. McLean writes: I have been in my present position since leaving the University and enjoy my work here very much. Few Wisconsin men are engaged in highway work here in the state, but we're always loyal to the old school.

* * *

Carroll O. Bickelhaupt writes us the following communication. Mr. Bickelhaupt is Commercial Engineer for the American Telegraph and Telephone Co.

I should like to write you at length upon the matters touched in your request, but the limitations imposed by my arduous duties and by the fact that I must conduct myself with extreme activity if I would retain my position in the ranks of the bread winners, prevent. I note from time to time, in my perusal of the professional papers, that as a class, engineers do not advertise enough. Therefore this seems to be a golden chance to catalogue, enumerate and epitomize the various items of personal achievement which I feel should properly be included as reflecting in a measure the degree of success to which I want my friends to think I have attained. However I find a fundamental deterrent operating to keep me from availing myself of the opportunity here offered—lack of time. This is not as it should be, yet as a condition it exists. Some day I shall take time out and crack myself up in all manner of eulogy, encomium and panegyric. When that time comes, I hope my works will be such as to lend themselves to such laudatory treatment and that THE ENGINEER will give me space in its columns, as it so generously does now.

Please accept my thanks for this opportunity of talking about myself, and allow me to congratulate you on the policy, subject matter, and general make-up of THE ENGINEER. It is a live member and deserves the praise and support of all alumni and students.

* * *

W. V. Bickelhaupt min '11, has been promoted to the position of Contracting Engineer for the Des Moines Bridge and

Iron Works, Des Moines, Iowa. He states that he is looking forward to the 1911 reunion next June.

O. A. Bailey, c '15, who, after graduation entered the employment of the Chicago Bridge & Iron Co. of Chicago, writes that he is at present acting as assistant to the President, and finds his work very intereting and agreeable. His company has now under construction at Baltimore, Md., some 57 tanks and standpipes, and 50 tanks in West Virginia.

J. F. Alexander e '11, salesman for the Wagner Electric Co., writes from the New York office as follows:

"Kenneth Hare e '11, chief electrician for the Northern Pacific R. R., and Glen P. Cowan e '11, of the sales dept. of the National Lamp Works, came in to see me and we had quite a reunion."

* * *

Elmer C. Moots e '11, who was formerly instructor of Applied Mathematics at Whitman College at Walla Walla, Washington, is now in the Department of Civil Engineering in the University of Arizona at Tucson. In a letter recently he writes the following:

"I feel that your plan for the alumni section this season will serve to loosen the rust from the hinges of many old time friendships and set them once more in good working order.

"This year my wife, baby, and myself are enjoying the summer climate of southern Arizona. We are at Tucson where I am teaching at the University in the Dept. of Civil Engineering.

"Arizona is semitropical in climate. The atmospheric humidity is very low in the summer as attested by the common occurrence of dry rains, or the so called 'horse tail' showers, a phenomena at first striking to one from the east. These showers form at an altitude of a few thousand feet and are entirely evaporated before any part of them reaches the ground. The average yearly rainfall of about 12 inches, would, if available nearly all be evaporated during the month of June which shows, incidentally, the folly of any attempt at dry farming.

"Arizona has an area of nearly 73 million acres and if all of the water in the United States diverted for irrigation purposes, could be used here it would place 1/4 of this state under cultivation. There are now between three and four hundred thousand acres irrigated, which acreage no doubt will be increased a considerable in the future, but, according to the best irrigation engineers, never to exceed one million acres for intensive farming. This amount would utilize the water available for the state from all sources including its probable apportionment of the Colorado River."

* * *

John A. Hoeveler e '11, has been promoted to the position of Assistant Chief Engineer of the National X-Ray Reflector Co., of Chicago. Some time ago he sent us the following news item:

The exterior surface of the immense Woolworth Building, New York, between the 30th and 58th stories, is illuminated from "concealed sources." The installation was planned by a Wisconsin man, "Herb" Magdsick, '10, and the National X-Ray Reflector Company built the special reflectors for the 600 projector units employed.

Albert M. Wolf c '09, C E '13, in addition to being Principal Assistant Engineer of the Condron Co. of Structural Engineers, is now Associate Editor of the "Concrete Cement Age," and also Editor of "The Technician," a monthly bulletin devoted to the professional interests of technical men. An article by Mr. Wolf on "Engineering Experience," appears in the columns of this issue of The Engineer.

H. A. Bauer m '15 is with T. M. E. R. & L. Co. of Milwaukee. He is in the power plant department; most of his time is devoted to heating and heat insulation problems. His present address is 723—40th St. Milwaukee.

H. W. Rusch e '15, is with the Montana Power Co. at Butte, Montana.