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The TECHNOGRAPH

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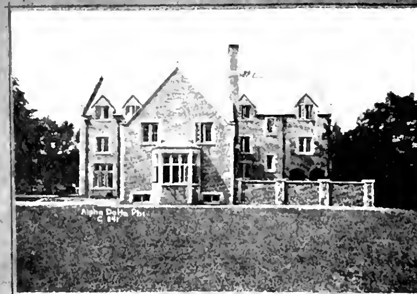
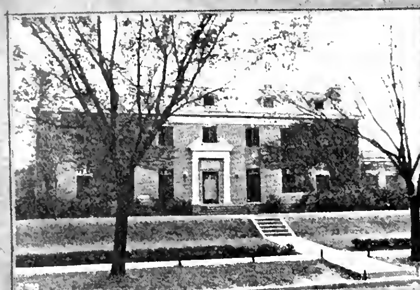
Phi Delta Theta



Alpha Delta Phi



Sigma Nu

Sigma Phi Sigma

Delta Kappa Epsilon.

Chi Psi

Fraternity Architecture at Illinois

FRANK H. HOLMES, a.e., '27

Next to the actual University Buildings the fraternity houses adjoining the campus have become the show places of the Twin Cities. The number and varied appearance of the houses are always interesting to the visitor. In this article the author has endeavored to briefly summarize the architectural tendencies and in a few cases to describe the most important details of some of the houses. No attempt has been made to criticize any of the houses as is customary in such a discussion.

The University of Illinois can boast of as fine a group of fraternity houses as can be found at any university in the country. Fraternities at this school function as more than clubs; they solve an important problem, that of housing students. In a school with an enrollment of over 9,000, providing a place for all of these students to live is a real problem. In some universities, dormitories built and operated by the school take care of the students very well; but at Illinois, and other state universities where the dormitory system does not exist, the fraternities solve not only the housing problem, but the boarding problem as well.

At Illinois there are seventy-one fraternities and thirty-two sororities, the membership of each varying from twenty to forty students. Totaling up these figures it can be estimated that about one-third of the student body live in these houses. In the past three years an extensive building program has been carried on by the fraternities, the total expenditure for new houses being in the neighborhood of $1,400,000. Of this sum $500,000 has been expended during the past year; and, if all the organizations at present having plans to build carry them out, an equal sum will be spent in the next two years.

Although fraternities here have been in some instances guilty of competitive building, they have not, however, gone to extreme. Many organizations have been accused of extravagance, but this is hardly true. Permanance rather than extravagance has been the aim of those fraternities building costly new homes. To build soundly and of enduring materials is costly, but it is a very prudent and judicious way to build. A close scrutiny of any of the fraternity houses at Illinois would fail to evidence any waste of money in prodigal or sumptous decoration. There is no reason why some of the houses that have been built of enduring materials, such as stone and brick, should not be standing in good condition a hundred years from now. In Europe, houses of similar construction have been standing since the fourteenth and fifteenth centuries, and there is no reason why the houses here should not endure as well.

Although, at first consideration, it would seem a difficult problem for college students of limited means to finance a house that costs from $70,000 to $100,000, this is far from being the case. However, it is not within the province of this article to go into a discussion of the methods of financing such undertakings; and the mere statement of the average cost per house is enough to give an idea of the type of the individual project. A very definite type of plan which all the fraternities follow has been evolved from the practical necessities of housing a group of students. In a fraternity house there must be a dining room, living room, kitchen, study rooms, bath rooms, halls, and sleeping quarters. These rooms are essential but in addition most houses have entrance halls, or reception rooms, card rooms, chapter and alumni rooms. The rooms on the first floor must be planned so that they can all be made into one large room in which dances and other entertainments may be held. Although the shape of the floor plans in the various houses is somewhat diversified practical requirements have resulted in all of them containing virtually the same number and kind of rooms.

On the second floor there are two general arrangements in use. One uses a system of single rooms, for study purposes only, with sleeping quarters in a dormitory. Another is to have the bed in the same room with the study desk while the latest plan is to have a suite of two rooms, one for study purposes and the other for a bedroom. This has proven very popular and where carried out, two men are assigned to a room. On the third floor, the dormitory system is generally used. The study rooms are for study only, the men sleeping in a large dormitory. Somewhere in the house is often located an alumni room which is conveniently situated and more elaborately appointed. This room is reserved for guests, and is not used by the active chapter men.

The basements contain, of course, the furnace room, trunk room, laundry, and in some cases the chapter and dining rooms.

As before mentioned all of the new houses are built for permanence, the construction being either fireproof throughout, or semi-fireproof. The exterior walls are of brick or stone, or a combination of them both. Slate has proven such a lasting roofing material throughout the centuries, besides its being a great guard against fire, that almost all of the new houses are using this material. The new Phi Kappa house on Chalmers street, however, has been finished with a copper roof, which should prove equally as serviceable as slate. The copper, in the course of a few years, will acquire a very beautiful mottled-green color. Although copper has had only a limited use in the United States as a roofing for residences, it should prove very popular, since it is quite effective both as a thing of beauty and of utility.

Of the different styles of architecture, those which have found the most favor at the University of Illinois for this purpose are the English Tudor, Georgian, Colonial, one or two examples of French and Italian Renaissance, and a number of houses of the nondescript style which characterizes American domestic architecture.

Of the group that belongs to the English Tudor the Alpha Delta Phi, Delta Sigma Phi, Phi Delta Theta, Phi Kappa Psi, Tau Kappa Epsilon and Sigma Pi are characteristic. Although the architecture of these houses appears quite different at first sight the main difference is in the materials of construction and treatment, not in the essential feature of the design. The distinguishing features of this style of architecture are steep roofs, narrow eave projections, pointed windows and severe simplicity of detail. In the Alpha Delta Phi house the exterior is of red pressed brick with Indiana limestone around the windows and doors. A distinctive feature of this house is the large living room, which occupies a separate wing of the house and extends through two stories. The interior of this room, instead of being plastered, is finished with pressed brick and no attempt is made to conceal the large roof trusses. A balcony from the second floor opens onto the room in one end and a comfortable fire place is located in the other. The whole effect is exceptionally pleasing and makes the room very impressive. In the dining room, which is two steps higher than the rest of the rooms on the first floor, no attempt has been made at decoration other than the simple brick fireplace. The exterior of the Tau Kappa Epsilon house is similar in design and construction to that of the Alpha Delta Phi house. The distinguishing feature of the interior of the house is the low elliptical-arched ceiling of the living room. The Phi Delta Theta house, designed by Howard Van Doren Shaw of Chicago, is one of the most excellent examples of English Tudor style in the United States. The random-ashlar stone walls and the rough cut slates of variegated texture give the house an aged charm and dignity. The interior is very plain, the walls being left untinted and tapestried curtains form the only decoration. The Phi Kappa Psi house exemplifies the English half timber and brick house of this period.

The houses designed in the Georgian style comprise the Delta Kappa Epsilon, Delta Phi, Theta Chi, Theta Delta Chi and Sigma Nu houses. Brick, with scanty stone trim, are the materials that are typical of this style. Doorways are small and simple and invariably stone. The style also demands the use of gabled windows. The cornices are usually ly white and classical in character. The Theta Chi house, which is a fine example of this style, was designed by a former professor of architecture in the University. The front of the house, instead of facing the street, faces the side of the lot. Entrance to the house is through a simple Doric doorway. The Delta Kappa Epsilon house, also designed by Shaw, is excellently proportioned and good taste has been exercised in the spacing and sizes of all the window and door openings. The carved stone doorway on the west side of the house is a splendid piece of design. The Sigma Nu house has an interesting Doric doorway which forms the center of interest of the design.

The Sigma Phi Sigma house is a good example of the Colonial style in brick. The two tall cream colored columns lend dignity and impressiveness to the front and form an admirable color scheme with the red brick. Another example, although similar in character but not much alike in appearance, is the new Kappa Alpha Theta sorority house. The southern mansion is recalled by its large porch with tall columns. An example of the Colonial style in wood is the Delta Upsilon house. Other houses of this type of architecture are the Alpha Tau Omega, Beta Theta Pi and Zeta Psi houses. The main features of this style, since it had its inception in the United States, are familiar to most of us and need no explanation.

An example of the modern English country style can be found in the new Psi Upsilon house on Armory avenue. This house is novel and pleasing in numerous respects. The location of the house, being on the corner, has been taken advantage of, and a front that is circular in plan has been used. The effect is as attractive as it is singular, and the result is quite charming. The brickwork on the ex-

(Continued on Page 40)

Cheating the Mississippi

W. H. Vaughan
Graduate Student

Centuries ago, when Columbus was attaining his conception of the earth's form, and before the coming of De Soto, who was to be the first European to gaze upon that vast expanse of water which stretches with filled banks through the heart of America's great nation to the Gulf of Mexico, the sap coursed through the inner rings of what now are virgin cypress. Along the lower reaches of the Father of Waters, these great cypress stood guard over a wilderness whose wild life thrived beneath a sunless shade. Here disported bear, panther, deer, turkey, and wolf with a wild freedom not unlike the red man who hunted them unmolested, or the great river whose annual deluge of rushing, turbid water disguised the clearness of the Ohio with mud from the slopes of ice covered mountains far up the Missouri.

This great child of nature has left everywhere evidence of its wild strength. South from Memphis the Mississippi spreads into an inland delta varying from 40 to 180 miles wide between the hills of the states of Mississippi, Arkansas and Louisiana. Here, in the past, the spring floods have spent their strength ceaselessly changing from one channel to another, spreading the richest deposit of silt and vegetable humus over a far flung area.

This territory, which composes about one seventh of Mississippi, one eighth of Arkansas and one sixth of Louisiana, may rightly be termed, "the garden spot of the southland," if not the richest body of land of any appreciable size in the United States. It is low lying and flat, being covered with countless sloughs, bayous, and brakes formed when some freak of nature diverted the current from its former channel. It is flat as water, for water made it flat, save for the old river channels which have been over flowed a countless number of times. Each spring brought its history of wood debris and silt deposit in these channels until now they have become graveyards of vegetation and earth surface without drainage save when excessive rains fill them to over flowing. This smooth plain stretches from just south of Memphis to the Gulf with a gentle slope southward as the river seeks its outlet.

Waste Excavation from Ditching Used to Build Roads

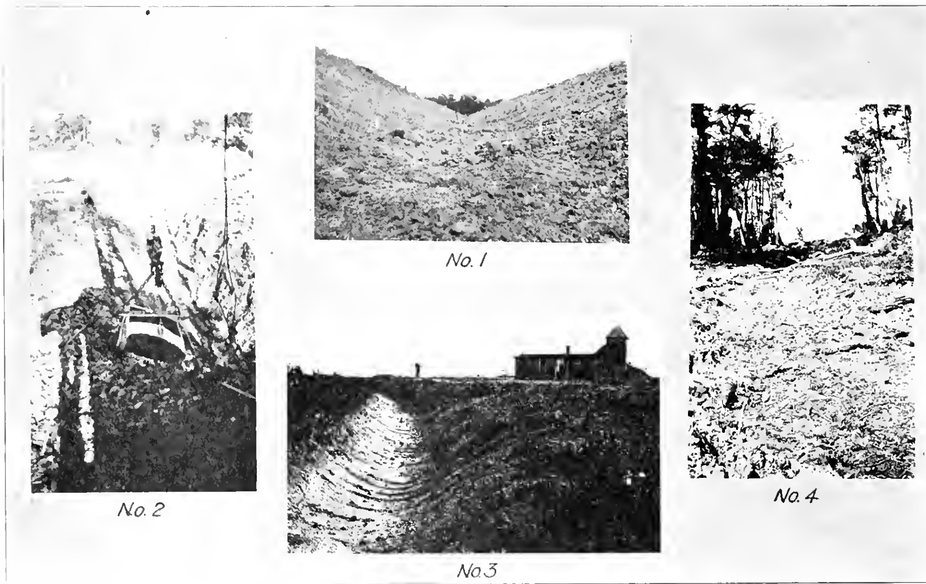
It is now a relatively dry place. No longer does the melting snow on northern mountains drive the river out of bounds to sweep all before it and give in return a richness carried thousands of miles in its bosom. The torrent is held within levees raised on each side at a respectable distance from the river in recognition of the richness of the farm lands between the river and the encompassing hills. These levees are as much as thirty-five feet high and two chain's length across the base.

The advent of the levee has left the country with the drainage problem yet to face. A fair start has been made, but millions of yards of excavation have yet to be done, thousands of miles of hard roads have to follow drainage, and the country must recover from the depression of recent years before it will develop into a home land for the man of small means, the backbone of any stable, prosperous country. Verily it is the place for the engineer, especially the promoting and contracting engineer. Here is an undeveloped plain stretching from Memphis to New Orleans, dotted with brakes and sloughs, harboring mosquitoes, lacking hard roads, farmed by men in large tracts with negro labor, capable of producing half its value in gross returns every year, and yet with its best land lying at the bottom of stagnant stretches of cypress brakes. It must have drainage before anything else can be done for its development. And it is some of the peculiar problems of this met in the reclamation and draining of relatively small districts which the writer wishes to discuss here.

In order to limit the scope of work to some definite location, let us take as our field for investigation the Mississippi part of the Mississippi delta. This may be taken as typical of the other portions, and the writer has had more experience in that particular portion of this large lowland. The Mississippi portion of the delta is higher than the Arkansas, and consequently slightly less rich than the famous St. Francis river bottom land. When

I say higher, I mean from nothing up to thirty feet; and when I say less rich, I mean a difference in quality which would only become apparent when the depth of the surface soil is ascertained. The St. Francis district is characterized by a thicker deposit of silt. The Louisiana delta is, in general, higher and less fertile and perhaps less developed than the other two portions of the lower Mississippi River delta.

A description of the soil will not be out of place here for it is soil that we are reclaiming, soil that produces the bumper crops of this section, and soil that we must excavate before the overflow drains of the district are opened into continuous drains, and the richest land is reclaimed from the sloughs. Underlying the rich silt of the surface, is a yellow clay subsoil which is firm, hard, and almost impervious to water. This soil may be found at any depth varying from one foot on the ridges to fifteen or twenty in the bottom of old slough beds. This was the original soil of the region which was probably washed down from adjoining hills thousands of years ago. Below this a blue hard earth, in places, according to the whim of the current, sand has been deposited in conjunction with the black silt which supports an enormous tonnage of vegetation per acre. At various locations the surface earth is a hard, blue sort of soil which cracks in the late summer to its entire depth. When in this condition it may be broken with an excavating machine into small pebble-like pieces, really a sort of shattering process. Because of their resemblance to "buck shot," this sort of land has become locally known as "buck shot" land. Summer finds the ground cracked and parched, winter finds it moist, and the lower layer of yellow clay almost impervious to water. The result is a low absorption of water during the rainy season which lasts during the months of January and February and sometimes through March. Cotton is what may be termed a dry weather plant, so the spring planting season must find the ground free of any standing water, both for working purposes and the sake of the sprouting seeds which are literally planted on top of the ground. Here is the primary function of drainage as the farmer sees it. Of course the maintenance of good roads is important also, but the planter sees his crops first and his roads second.



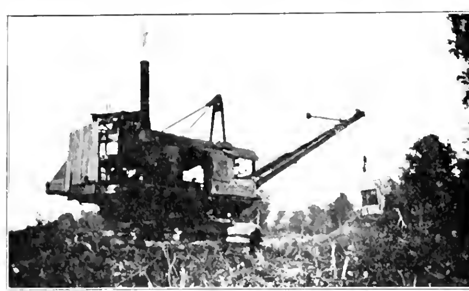
No. 1: Finished Ditch. No. 2: Dragline Excavating Ditch. No. 3: Old Ditching Cleaned Out. No. 4: Light Ditching in the Bottom of an Old Bayou.

Most of the drainage outlets are comparatively close at hand, the main ditch for a project consisting of ten or twenty thousand acres usually not running over six to eight miles. Most of the areas emptying by means of these main ditches are relatively small as drainage districts go. Sometimes the areas of a district may run up to eighty thousand acres and the main ditch may continue for twenty miles or more, but primary drains are usually of convenient distance and size to take care of the water-shed, so the problem resolves itself into one of secondary and tertiary drainage.

The location, design, and promotion of these districts is the first work of the engineer. A preliminary survey is run, usually due to the interest of two or three large land owners involved. Then temporary commissioners are appointed by the courts to act on matters of the drainage district. A final survey and estimate is made, assessments levied by the commissioners according to the benefits of the land, and a petition circulated among the landowners within boundaries of the district. The organization becomes a reality provided three-quarters of the owners, or rather, owners representing three-quarters of the land, sign the petition. Permanent commissioners are elected by the landowners, bids for the work received, and bonds floated to cover the entire expense of the district. This includes the cost of the work which goes to the contractor, salaries for three commissioners, a bookkeeper, a lawyer, and an engineer. The engineer is the backbone of the organization. His work must be faultless; he must sell the proposition to the landowners and get up the petition and estimates; he must aid in the assessments; he must be ready to put forth his opinion on an issue fairly and squarely; and his word is usually final, though he actually has no vote in executive sessions of the commissioners. This, in short, is the organization of a drainage district, with the engineer practically at its head, for all work must be completed under his supervision.

In the face of the above facts is it not astonishing that in a large portion of the cases the engineer's work is faulty? It is a common thing to see ditches stand half full of water the year around justifying the use of the word canal in designating them: projects costing thousands of dollars that do not drain, because the levels were off: clogged drainage costing the farmer large sums annually because the ditches were not designed with the proper side slope or berm width. Only within the last few years a concern not originally drainage engineers put a district through with one-and-a-half to one side slopes throughout, a practice recognized as a standard earth slope in 'made land.' Many waterways are too small because of poor design. In places, long stretches of ditches drain practically nothing at a large expense. What is the matter? A nine-tenths lack of interest, both on the part of the planter and the engineer, and a one-tenth lack of observation. The levee system, done under the supervision of government engineers, was executed by many of these engineers during their early training. This system is perhaps the best in the world in its particular class. But drainage has suffered from a lack of such competent supervision. Such conditions as the above can be avoided by the intelligent engineer who has the inclination to use his eyes and learn to judge by practical observation. With this in mind let us go into details of common-sense ditch design for this lowland region.

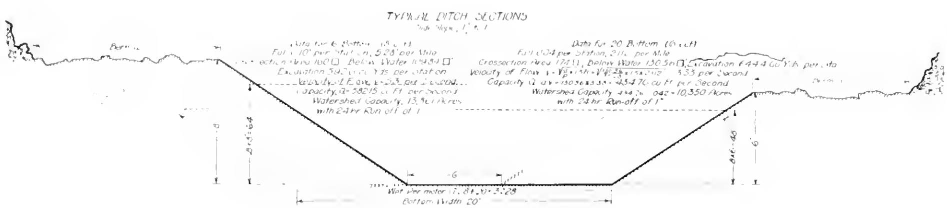
Of course the first question is, "Is there a practical outlet?" This means that it must have the size and fall required for a rapid discharge of water. How much water? This brings us to the second fundamental question, "What is the watershed?" By watershed, we mean the area over which water falls which we intend to carry away with our outlet. Provided the outlet is an assured thing, and it generally is before agitation begins for drainage in a particular section, this question of watershed is the most vital one of all. The cautious engineer will give it the most careful survey in order to obtain a high degree of accuracy. Upon it depent simultaneously the size and grade of the ditches, for these determine the discharge capacity. One would imagine this would be an easy matter. But when it is found that the lands which do not actually stand under water rarely show a difference in level of more than three or four feet in a distance of eighteen or twenty miles, the exact limit of the watershed boundary is difficult to define. Another factor intimately connected with the watershed is



DRAGLINE EXCAVATOR

the twenty-four hour run-off. Here even a survey is likely to lead to too small a design. With experience in this section one knows that the system will be taxed to its utmost capacity during the months of January and February when the ground is soaked to a low absorption factor before this season of rains. And though you will never find a run-off survey in the delta give a twenty-four hour value of one inch, the writer has found that correct design necessitates such an assumption.* The question of berm width and side slope is considered in detail in a drawing (see fig. 1) and slope effect upon the coefficient of roughness of channel is considered in a later paragraph. Assuming all of this work has been done correctly and with engineering precision, the designer may yet ruin the project by being too short-sighted in drawing his specifications for permanence. This phase must be handled by men who have had considerable experience in the delta or similar countries. It must be remembered that here the engineer is dealing with 'made' land, and the erosion of spoil banks and ditch slopes is relatively large. The ditch bottoms and berm widths must be increased to take care of this factor. There is one further idea which will bear stressing in regard to design.

That is the size of the ditches. At present the country has no tile drainage which is effective. Like the open ditch work, the tiling has been done with the idea that any kind of a hole in the ground would work regardless of size, maintainence of grade, and the fluctuating level of the outlets. The result has been that even in the comparatively few places where it has been installed it has not been successful enough to enjoy the confidence of the planter. The fact remains, however, that the future must herald a development of drainage in this direction. And the practical, thinking engineer in that section is today visualizing the time when the entire tertiary drainage will be carried in this product of burned clay. The advantages of this system are well known and do not need enumeration here. The only advantage which I shall mention is the fact that tiling gives a much faster drainage. And the reason I mention it is because faster tertiary drainage means greater maximum run-off, or greater capacity in the secondary ditches or main ditch outlets. This means larger ditches, of course, provided the grade is maintained at the same value. It is true that tiling will afford a compensating factor in that the absorption is increased, but this by no means takes care of the increase in run-off maximum. So the foresighted engineer is designing his ditches a little large for the present and making sure that they will not overflow with the advent of tiling. When water courses have to be enlarged after completion the work is about twice or three times as expensive as when completed correctly in the first place. Then too there is usually the additional trouble of reorganization and surveys of the flooded secondary drainage channels not to mention the dissatisfaction of the land owners.



Let us take an example in design which will bring out these practical points in a specific manner. We have now drawn up a profile of ground level and decided upon the grade which may be maintained in an economical manner. In this section the latter will vary from .03 ft. per station to .15 ft. per station with a minimum at .02 ft. and a maximum at .20 ft. per station. This gives a fall of from 1.056 ft. to 10.65 ft. per mile. Suppose, for instance, we have decided upon .04 ft. per station, or 2.112 ft. per mile, for the grade of the main outlet of a district having a watershed of 10,000 acres. Let us figure the bottom width of the outlet, the profile showing a minimum depth of 6 ft. at a place where overflow of the ditch will allow water to stand on cultivatable land. Allowing a run-off of 1 in. in twenty-four hours, we must, according to a table of run-offs, discharge .042 cu. ft. of water per second per acre.

10,000 x .042 = 420 cu. ft. per sec. the main outlet must discharge. Suppose our ditch to have $1\frac{1}{2}$ to 1 side slopes, which is the best practice in this country of 'made' land. Now,

$Q = a\ v$, where

Q = quantity of water in cu. ft. per sec.

a = area of channel under water.

v = mean velocity of water through the channel.

Then $420 = a\ v$.

Now Kutter's formula, while in general use by hydraulicians to obtain the mean velocity of flow in channels of this sort, is often cumbersome for use where tables are not available. Attention might be called to the fact that the coefficient of roughness used in the above-mentioned formula is often estimated at too low a value by engineers in this section due to the flat slope the natural earth attains and the thick growth of vegetation on the sides and bottom of the drains. Elliott's formula is more simple and will give ample channel size and correct bottom widths for drainage in Mississippi. It is

$v = \sqrt{a/p \times 1.5\,h}$ where: v = the mean velocity in ft. per second; a/p = the hydraulic radius, or the cross sectional area under water divided by the wet perimeter; h = the fall in feet per mile.

Now we wish our channel to run only eight-tenths of its depth in water.

.8 x 6.0 ft. = 4.8 ft., the depth of our channel flowing water. For the sake of speed let us assume a bottom width and try it in the formula for a proper value of Q.

$$Q = 120 = a\sqrt{a/p \times 1.5\,h}$$

We will take a value of 18 ft. for the bottom as an estimate.

Then a = 4.8 [18 + (1.5 x 4.8)] = 120.96 or about 121 sq. ft.; p = 18 + (4.8 x 2 x 1.8) = 35.28 or about 35.3

Then $Q = 121\sqrt{121/35.3 \times 2.112 \times 1.5} = 399.3$ cu. ft. per sec.

This is, as we see, too small. Ditches are usually excavated with bottom widths of some even number of feet. The above figures for a bottom of 20 ft. give Q = 434.9 cu. ft. per sec. This is closer to 420 ft. per sec. than the discharge for the channel with an 18 ft. bottom. Hence our ditch will have a 20 ft. bottom at the outlet end. It must be remembered that as the main is followed toward its source, the bottom width decreases gradually, the acerage being decreased as each lateral enters, new figures for bottom width being obtained.

We have an outlet with a 20 ft. bottom, 6 ft. deep, and with side slopes of 1½ to 1. (See fig. 1.) The width of the berm must now be specified. Due to the high erosion of 'buck-shot' and the sloughing effect of freezing and thawing in the winter coupled with the tendency of this type of earth to stratify along summer cracks, the berm width is not always safe at 10 ft. We might say that 8 ft. is the minimum in this type of earth. The formula used in computing this value by the writer is:

w = (8 ft. + $d/2$) e, where

w = depth of berm

d = depth of ditch

e = erosion, estimated in parts of 1 with an earth which will stand on a 1½ to 1 slope taken as unity.

With this as a basis, earth which will stand on a 1 to 1 slope is estimated at e = .80; earth which will stand on a 1½ to 1 slope is estimated at .70. These estimates are based on existing ditch slopes which have either been in use over five years or have a covering of three year's vegetation. The value for the above formula gives w = (8 + 3) 1 = 11 ft. berm. As berm widths are usually expressed at 8, 10, 12, 15, 20 ft. etc., we will give our outlet a 10 ft. berm here. It is obvious that a cave of six feet off of our berm would now leave us four feet of berm and a 2½ to 1 slope on the side of the ditch, which is beyond question a safe margin for design. It might be noted that soils which will not stand on a 2 to 1 slope are irregular in behavior and would follow no general rule or formula for slope. Among such material you will find sands, some sand loams, a white doughy earth found below the surface in parts of Arkansas and Louisiana, and other special soils sometimes encountered. One other point concerning the outlet deserves attention. Local drainage, such as tiling, hand ditches, and laterals should be lead into the main outlet at the bottom of the ditch, and, so far as possible, without causing undue eddies in the current of the outlet. These eddies will often deposit silt suspended in the current of the main until the entrance of the local drainage is reached. This point is more important than the average engineer realizes, as each small deposit will often decrease the effective grade at that point in the ditch by its

View of Small Lateral

(Continued on Page 48)

The Evidence and Determination of a Fatigue Limit in Metals

H. F. Moore and T. M. Jasper
Department of Theoretical and Applied Mechanics

A paper presented by the authors before the Engineering Section of the British Association for the Advancement of Science at Toronto on August 11, 1924. It gives a summary of the major results of the Fatigue of Metals Investigation which has been carired on at the University of Illinois for the last five years, and which is still in progress.

The conclusion of the paper entitled "Correlation between Endurance Limit and Test Results" has been ommited in this article. It tells of work carried out in connection with the tests for the endurance limit to determine the relation between it with respect to the elastic limit, tensile strength, Brinell hardness, etc.

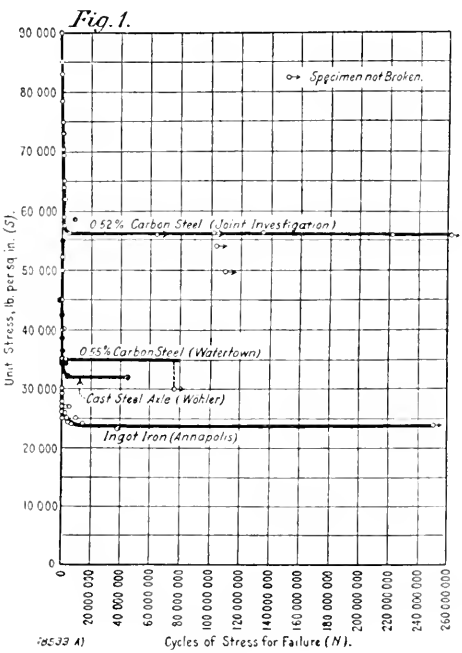
The problem of the "fatigue of metals under oft-repeated loading has been studied for some three-quarters of a century. This is not the place for even a brief summary of the history of this study, but at the beginning of this paper it is desired to call attention to a few of the outstanding developments. Up to about 1895 the study of the fatigue of metals was based on the experiments of Wöhler and the interpretation of his test data by Bauschinger and others. The concept of metal as essentially a homogeneous, isotropic substance was generally current, and it was supposed to have a clearly-defined elastic limit, which if correctly determined would mark the limit below which an infinite number of repetitions of load would not cause failure. There was, however, a vague idea that some kinds of metal "crystallized" under repeated stress and became brittle. About 1895 the study of metal structure by means of the metallographic microscope began to be developed, and about the beginning of the twentieth century the well-known researches of Ewing, Rosenhain, and Humphrey and their discovery of "slip bands" threw light on the mechanism of fatigue fracture, and gradually led metallurgists, materials testing engineers and students of the mechanics of materials to recognize the basic difference between static failure of metal and the progressive failure which takes place under repeated stress.

In 1910 Professor Basquin of Northwestern University read a paper before the American Society for Testing Materials entitled, "The Exponential Law of Repeated Stress." In this paper he examined the data of repeated-stress tests then available and concluded that it was not certain that there was any limiting stress below which fatigue failure would never take place, but that a *safer* view for the user of metal to take was that stress and "life" of metal were given by a relation of the form $S = B/N^m$ in which S is the fibre stress (in lb. per sq. in.), N is the number of cycles of stress to cause failure and B and *m* are experimentally determined constants. Especially in the United States his challenge to the current view has been productive of much discussion with a resulting broadening idea as to the nature of fatigue failure, and together with the growing use of alloy steels, heat-treated carbon steels, and high-speed machinery (especially the internal combustion engine and the steam turbine) has made clear the urgent need for further repeated-stress tests which should be carried to more cycles of stress than were the tests of Wöhler and his successors.

The S-N Diagram and the Endurance Limit.—During the period of the study of the fatigue of metals the machine designer and the structural engineer have always asked the question: "For any given metal is there a limiting stress below which the metal will not fail no matter how often the load is repeated, and if so what is that stress for each of the common stress-carrying metals?" The only positive answer to this question is the answer of direct experiment, and it is evident that in the finite time available for any set of experiments the answer must always be a partial one. To the hoped-for limiting stress the name "endurance limit" or "fatigue limit" is commonly given.

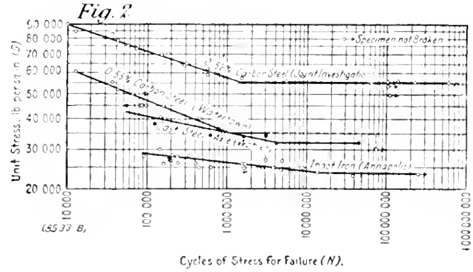
The method of estimating the endurance limit of a metal from the data of repeated stress tests has been practically the same in all extended investigations. A series of tests is carried on on specimens of the metal, using various values of unit-stress (S) and noting for each unit-stress the number of cycles of stress (N) necessary to cause fracture. The test results are plotted with values of S as ordinates and values of N as abcissas, giving what in the United States is called an S-N diagram. This diagram may be plotted either to ordinary (Cartesian) co-ordinates, to logarithmic co-ordinates, or to semi-logarithmic co-ordinates. The unit-stress for which the S-N diagram becomes horizontal is estimated from the diagram, and is reported as the endurance limit of the metal. Typical S-N diagrams for steel are shown in Figs. 1 and 2.

The "Elastic Limit" and its Limitations.—In the days before the development of the metallurgical microscope, when metal was thought of as homogeneous and isotropic, the elastic limit was conceived as having a definite value, and it was very natural that this elastic limit should be regarded as the endurance limit. Most discussions about the elastic limit have been confined to the discussion of methods for determining it, and there has been very little discussion of its significance—and of its limitations. In the light of present day knowledge, the elastic limit seems unreliable as an index of fatigue strength for several reasons; (1) The value determined as the elastic limit of a metal depends on the delicacy of the measuring instruments used,



Cartesian $S-N$ Diagrams

and on the precision of plotting of the stress strain diagram; (2) the value of elastic limit is affected by the initial quenching, rolling or forging strains in the metal, and the amount of mechanical work which has been performed on the metal tending to adjust the initial strains; (3) the elastic limit changes value after a few cycles of stress are applied to a metal; and (4) in determining the elastic limit a minute defect in the metal has no appreciable effect on the value determined, whereas such a defect may have a very considerable effect on the value of any endurance limit.



Logarithmic $S-N$ Diagrams

The elastic limit of a metal depends on the average behavior of a considerable mass of the metal; the endurance limit depends on the behavior of microscopic portions of the metal.

The Mechanism of Fatigue Breakdown of Metal.—Before discussing two proposed "short-time" methods for determining endurance limit, it seems desirable to give some attention to the phenomena of fatigue failure as shown by the metallographic microscope.

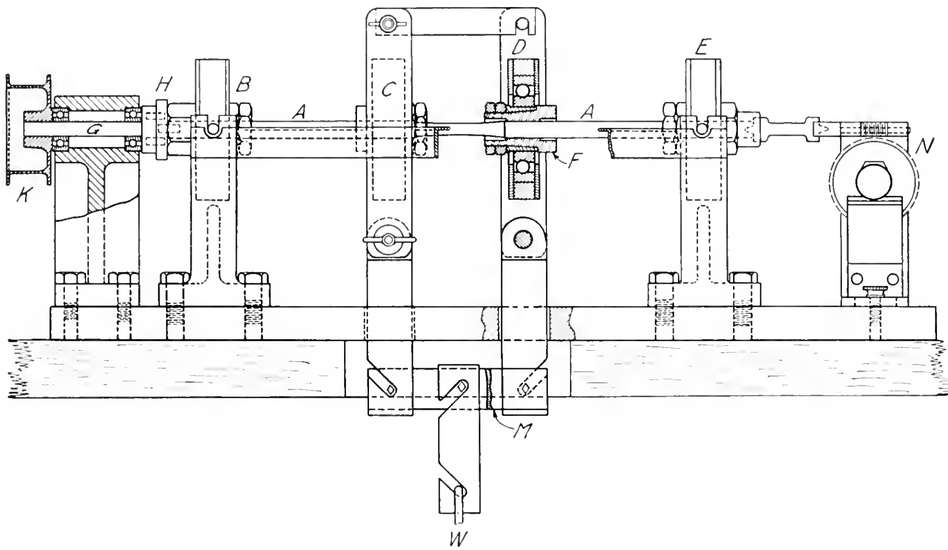
The discovery of "slip bands" has been noted above, and the regular sequence of events in the fatigue failures first studied under the microscope was: (1) Appearance of slip bands within crystals, (2) spread of slip bands, (3) development of cracks, apparently from slip bands, and (4) spread and junction of these cracks to complete failure. Later single-load failures of metal were observed in which failure took place along the crystal boundaries, though this was an unusual failure, and the question was raised whether for such metals slip bands would occur before fatigue failure. Still later several laboratories both in England and in the United States observed distinct evidences of slip in certain ductile metals below the endurance limit as determined by long time tests. It seems today that while slip and fatigue failure usually begins at about the same stress for wrought ferrous metals that they are two distinct phenomena, and that possibly either may ocur in a metal without the other.

The Rise of Temperature Test for Endurance Limit.—Mr. C. E. Stromeyer[1] first used this rapid test for endurance limit, and it has been further developed by Putnam and Harsch, and others. It consists in measuring the rise of temperature which takes place in a specimen after a few hundred cycles of repeated stress. The lowest stress for which a temperature-stress diagram shows a well-defined change of slope is reported as the endurance limit. It seems probable that this test really determines not the beginning of fatigue fracture but the beginning of appreciable slip in the crystals of the metal. This slip causes a cumulative absorption of energy, with a resulting evolution of heat. However, for wrought ferrous metals this slip seems to take place under repeated stresses slightly below those at the endurance limit, and this test seems to give reliable results for sound wrought ferrous metal (up to a Brinell hardness of about 375).

The Running-Deflection Test for Endurance Limit.—Mr. Gough[1] of the National Physical Laboratory first used the running deflection test of a rotating cantilever beam for determining the endurance limit. This test consists in obtaining a load-deflection diagram for a rotating loaded cantilever beam, using successive increments loaded and locating the endurance limit at the point of departure of the load-deflection diagram from a straight line. It seems to the authors that this test, like the rise-of-temperature test, determines the beginning of appreciable slip rather than the beginning of fatigue fracture. However, this test also seems to give reliable results for wrought ferrous metals.

For non-ferrous metals, for cast metals, and for metals with many minute flaws the reliability of the running-deflection test, and of the rise-of-temperature test has yet to be proven.

Short-Time, High-Stress Tests for Fatigue Strength.—Under the urge of commercial necessity the fatigue resisting qualities of metals have sometimes been judged from the results of high-stress tests, using the same stress for different metals, and using the "life" of specimens as an index of fatigue strength. Such tests have proven quite unreliable even as comparative indices of the ability of the metal to withstand millions of cycles of working stress. As an illustration may be mentioned the comparative results for ordinary cold-drawn steel and normalised high-carbon steel. Under cycles of high stress the cold-drawn steel gives longer life. Under long-time tests the normalised high-carbon steel gives the higher temperature limit. Under this head would be grouped various repeated impact tests which have been proposed. These tests may have value as acceptable tests for steel which has to withstand occasional abuse, but they certain-



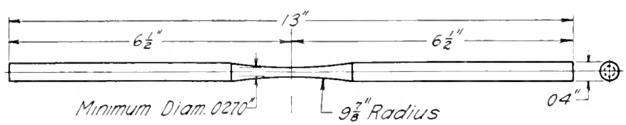


FIGURE 3 (*above*). FIGURE 4 (*below*).

ly do not give any index of the endurance limit of a metal.

The Charpy and the Izod notched bar tests for metal have come into rather wide use in recent years, and sometimes are said to give an index of the fatigue strength of metal. A comparison of test results of these tests with test results of long-time fatigue tests show that whatever qualities are indicated by notched bar tests fatigue resistance is not indicated.

Recent Investigations of Fatigue of Metals Using Long-time Tests.—The use of high speed machinery, and especially the development of the internal combustion engine and the steam turbine, greatly increased the length of service required of machine parts, and it gradually became evident that further data of long-time tests of metals under repeated stress (especially of modern steels and non-ferrous metals) were needed. In 1918 the Engineering Foundation (United States) decided to finance an extensive series of repeated stress tests, and in co-operation with the National Research Council and the Engineering Experiment Station of the University of Illinois, began the investigation of the Fatigue of Metals, with which the authors are connected, and which has been in active operation since 1919. The original problem decided on by the Advisory Committee for the investigation by the National Research Council was the obtaining and studying of test data of a series of tests of typical steels with typical heat-treatments, and several specimens of each heat treatment of each steel sandtested were to be run to at least one hundred million cycles of stress. This original problem has been carried out together with several other lines of investigation. During the progress of the investigation the following firms have co-operated in furnishing funds for the investigation:—General Electric Company, Western Electric Company, Copper and Brass Research Association, Allis Chalmers Manufacturing Company. To date the total amount contributed to this investigation is about $100,000.

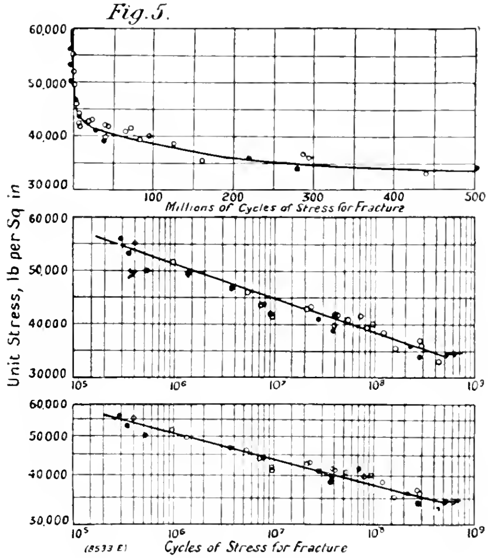
About the same time as the starting of this investigation of fatigue of metals there was started at the United States Naval Engineering experiment station an extensive series of long time tests of steel under the direction of Dr. D. J. McAdam, Jr.[4] In these tests also values of number of pepetitions as high as one hundred million were frequently used.

Still more recently the United States Air Service has carried out extensive long time tests of non ferrous metals, paying especial attention to aluminum and magnesium alloys. Three tests have been made at the laboratories of the Air Service at McCook Field, Dayton, Ohio, under the immediate direction of Mr. R. R. Moore[5].

In the laboratories of the investigation carried on at the University of Illinois, long-time tests on the copper, tin, zinc alloys are now in progress as well as tests on certain copper-nickel alloys.

It is not intended to give the impression that the three investigations named above are the only ones

Fig. 5.



being carried on in the United States. Certainly the work of Gillett at Cornell University in connection with the United States Bureau of Mines, and the work carried on at the United States Bureau of Standards should be mentioned. However, the three investigations named above have to offer as their special contribution a very considerable amount of data involving long time fatigue of metals—fundamental data which it is necessary to have before it can be reasonably certain that there is an endurance limit for a given metal.

A Brief Summary of Machines and Test Methods Used in the Investigations of the University of Illinois.—To a testing engineer desirous of performing a large number of long-time fatigue tests of metals, it is obvious that a battery of inexpensive machines simple to handle, and reasonably accurate, are necessary. Fig. 3 shows the diagram of the rotating-beam machine used for the basic tests of the investigation at Illinois[6]. Fifteen of these machines are in use. The specimen is shown in Fig. 4. The variation of extreme fibre stress over the middle 0.4 is only 1 percent. The beam is rotated at the rate of 1,500 r.p.m. Dead-weights are placed in a hanger suitably located and supported by a spring. These 15 machines have completed about 70 machine-years of work.

It has also become obvious that a correlation should be established between results obtained by the use of the above machines giving reversed bending stresses and results from other machines giving reversed bending shear, reversed direct stress, and cycles of stress repeated but not reversed.

The following additional types of machines are in use:—

(*a*) A rotating-spring machine giving cycles of bending stress not completely reversed.

(*b*) Two different types of direct-stress (tension compression) machines giving respectively completely reversed stress and stress not completely reversed.

(*c*) A reversed torsion machine giving torsional stress completely reversed.

d) An Olson-Foster torsion machine giving torsional stress completely or partially reversed.

A full description of these machines can be found in the bulletins on the fatigue of metals issued by this investigation[7].

In all the work performed by the investigation at Illinois the machines have performed a total of something over 100 machine years of work during the five years in which work has been going on. More than 100 specimens have been run to 100,000,000 cycles of stress or more.

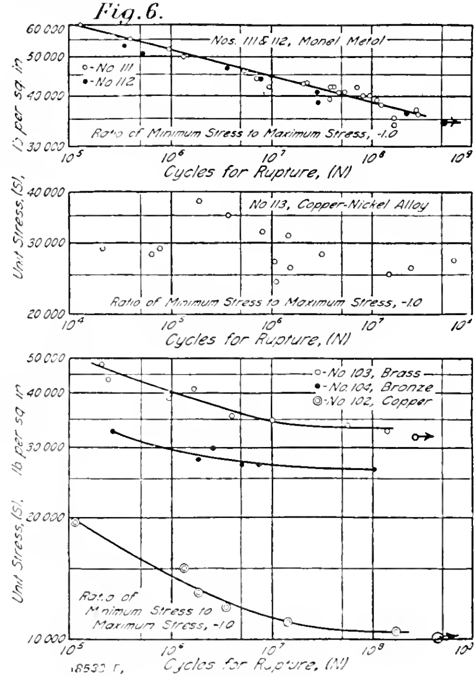
In addition to the fatigue tests there have been carried out the static and dynamic tests usually performed on metals—tension, torsion and compression tests together with hardness, impact-tension and impact-bending tests. In addition a number of micro-photoghaphic and magnetic tests have been performed for the purpose of studying the structure and the homogeneity of the materials used.

The Plotting of the Test Data.—In the investigations carried on in the United States it has been customary to plot the S-N diagrams either to logarithmic co-ordinates or to semi-logarithmic co-ordinates. The reason for this is two-fold: (1) a logarithmic cycle for the abcissas makes it possible to plot on the same diagram small values and large values of N with the same percentage degree of accuracy; and (2) in a Cartesian diagram there is some danger that the general tendency towards curvature of the diagram will lead the investigator to assume that an endurance limit has been reached at a comparatively small value of N when such is not the case. Fig. 5 which shows the data of tests on Monel metal plotted into Cartesian co-ordinates (upper), semi-logarithmic co-ordinates (middle), and logarithmic co-ordinates (lower), illustrates this point. The Cartesian diagram would lead the experimenter to report an endurance limit at about 32,000 lb. per square inch. The logarithmic diagram would indicate that the endurance limit had not yet been developed. It is felt that as long as any common system of plotting shows a straight line relation between S and N that an endurance limit should not be reported.

Endurance Limits of Wrought Ferrous Metals.—For wrought ferrous metals, the results of long-time investigations in the United States offer three items of evidence for the existence of an endurance limit.

(1) The S-N diagram, even when plotted to logarithmic co-ordinates, becomes horizontal, or as nearly so as can be determined by ordinary plotting.

Fig. 6.



Usually the horizontal part of the diagram is developed for values of N not greater than two million. For all wrought ferrous metals tested, the horizontal part of the diagram was developed for values of N less than ten million.

Moreover, at the junction of the horizontal part of the S-N diagram and the inclined part there is a fairly well-marked "knee" to the curve. This seems to indicate some change in the law governing the relation of S and N[5].

(Continued on Page 42)

Alfred Copeland Callen

L. R. Ludwig, ry.e.e., '25

Professor A. C. Callen, veteran mining head at the University of West Virginia, has returned to Illinois to take up the work of his chieftain of seven years ago. To the present group of undergraduates, the face of Professor Callen is a new one; but to the University he is an old friend, for he was from 1914 to 1917 an instructor and associate in mining engineering under the late Professor H. H. Stock.

A. C. Callen was born in Pen Argyl, Penn., on July 17, 1888. He received an elementary education in the public schools of his native state, graduating from the Reading high school in 1905. He then attended Lehigh university, and graduated four years, later, with honors. During summer vacations the student engineer was actively engaged in practical engineering work. His last two years in the university marked the beginning of his later successful career as a teacher, through his serving as student assistant in quantitative analysis. From 1907 to 1911 he served as an instructor, pursued his work in mining and geology, and obtained his M.S. degree in the latter year. For the ensuing three years, commercial work took Mr. Callen's attention. On April 9, 1912, the then twenty-five year old engineer took heed of the beckoning of matrimony, and was married to Miss Ida Saylor of Pottstown, Pa.

Professor A. C. Callen

It was in 1911 that Professor Stock selected Callen as a member of the staff of mining engineering at the University. His varied experience and special requirements were just those necessary for the subjects he was to teach. It was during those three years that Mr. Callen, through his eagerness and vivid personality, won marked success in the academic field.

In November, 1917, Professor Callen went to the University of West Virginia as professor of mining engineering and director of mining extension. The regular college work was not only strengthened under his guidance, but his extension classes and the short courses conducted at Morgantown have been eminently successful. Professor Callen remained at the University of West Virginia until his return to Illinois to take the place of Professor Stock as head of the mining department.

During his thirty-six years, Professor Callen's pen has been most active. He is the co-author of "Paint Ore Deposits of Eastern Pennsylvania" in the U. S. Geological Survey Bulletin 430, 1909. Circular 4 of the University of Illinois Experiment Station had Professor Callen as one of its co-authors. Many other bulletins and articles have been written by him alone, among which are those on "General Mining," "Coal Mine Gases" published by the Federal Board of Vocational Education, and "Explosives" issued by Coal Mine Management of which he is, by the way, the editor.

The American Institute of Mining Engineers, West Virginia Coal Mining Institute, and the Coal Mining Institute of America include the new departmental head among their membership.

The greatest of Mr. Callen's achievements however, are perhaps the possessing of the intimate friendship of hundreds of mining men, from the laborer to the highest official; and his three children, Katherine, Martha and a son A. C. Jr.

Tendencies in Woodworking Machinery

R. E. Peterson, m.e., '25

The days of the old hand turner are gone. The skilled artisan, pride of the woodworkers since the days of the old guild, has been replaced by an iron man who never tires. This soulless being is the product of industry and engineering science. The engineer has embodied his iron man with the skill of the old craftsman, but with an enormously greater capacity for work.

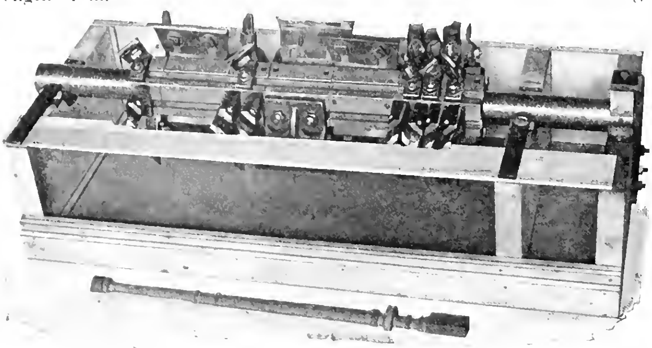


Figure 1: Setting Up Box

Progress demands that all industries keep abreast of each other in production. Economic conditions allow no laggards. Thus, engineering knowledge is drawn upon heavily by all branches of industry. The woodworking field, with its vivid history of centuries has not been so eager to keep pace with engineering progress. Conditions are rapidly changing, however, and recent years have seen remarkable developments in woodworking machinery.

Particularly in the method of turning is this progress noticeable. The popularity of period styles in furniture, such as Louis XVII, Queen Anne, Wililam and Mary, and Chippendale, have necessitated more adequate methods of production. The automatic turning machine and the copy lathe have been developed to meet this demand. The perfection of the cutter head as a method of cutting has made these machines possible.

The principle of the cutter head is precisely the same as that of the grinder in machine tool work. The work is rotated slowly and is finished by a cutter revolving at a very high rate of speed. The cutter head carries a series of knives ground to cut the shape desired. A setting up box (Fig. 1) is used in grinding and the knives must conform to a templet, shown in front of the knives, corresponding to the piece which is to be turned, shown in front of the box. The knives are made to cut obliquely with a shear, along and across the grain. This gives a smooth cut, as anyone knows who has handled a pocket knife. It will also be noticed in Figure 1 that the knife contact at any one time does not exceed three points. Consequently the cutting strain is not very great and pieces with the slenderness of a pencil may be turned. The completed cutter head is carefully balanced in order that the rotation should be uniform. The knives travel at 2,500 r.p.m. to produce the desired finish.

The automatic turning machine has many features of interest to both technical and non-technical men. The essential features may be grasped by use of Figures 2 and 3. The cutter head rotates in bearings on the rigid machine base. A carriage carries the work between head and tail stocks. On the older type of turning machine a sliding carriage was used. Due to friction and vibration, it has been superseded by the oscillating carriage shown.

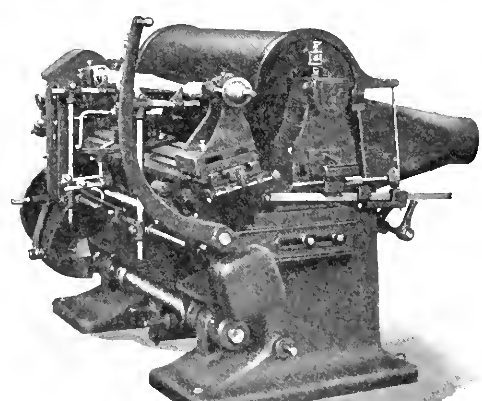


Figure 2: Automatic Turning Machine

For turning oval, square, hexagonal and octagonal work, a corresponding die, see Figure 3, is placed on the headstock. The die is kept in contact with a shoe on the base of the machine and thus the carriage moves in and out as the die rotates; consequently a cross section of the work will have the same form as the die. By adjusting the

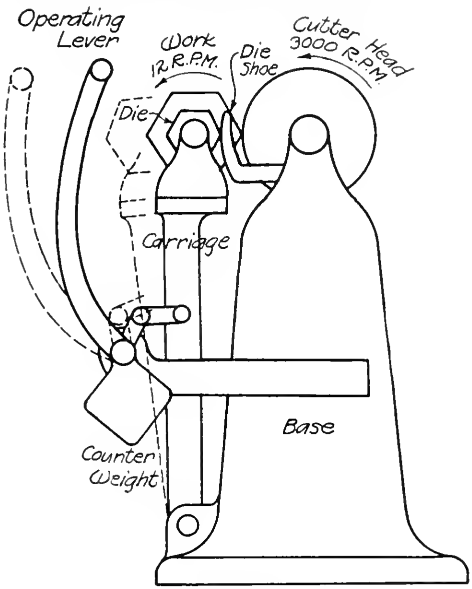


FIGURE 2.

shoe in or out, the size of the work may be decreased or increased, still using the same cutter head.

The carriage is moved in and out by a long hand lever which operates through toggle-links. A heavy counterweight, which aids in moving the carriage, is in a neutral position when the carriage is upright and the knives are cutting, thus giving a sensitive carriage control. This is apparent from Figures 2 and 3. When the carriage is thrown out for changing stock the headstock feed is automatically disengaged.

Enormous production may be obtained by using a continuous feed multiple spindle attachment, so that pieces may be fed into centers while others are being turned. Such a method is used in making pump handles for the Ford Motor company. Baseball bats, chairlegs, lawn mower rollers, bowling pins, Indian clubs, dumb bells, piano pillars, bed posts and countless other articles are produced by the automatic turning machine. Up to 1,000 pieces per day may be turned out at a cost of one tenth to one twentieth that of hand turning, and every piece is smooth and uniform. The automatic turning machine is a remarkable achievement.

The massiveness of portions of the turning machine is noticed by even the non-technical man. In the design of certain parts of wood working machinery, ordinary methods fail. Computations based on ultimate strengths with standard factors of safety give sections far too small. Design based on deflection is better, but in many cases proves inadequate. The loads are not generally static. Unusually large sections must be used to absorb vibration. The inertia of large masses increases stability. The completed work must not show chatter marks.

The turning machine is limited to work which symmetrical about its axis. Unsymmetrical pieces, such as propellors, Queen Anne chair legs, artificial limbs and gun stocks are produced on machines using the copy principle. This principle as applied to the copy lathes may be easily understood from Figure 4. A travelling carriage (A) supports two sets of centers. One set (B) carries the stock to be cut; the other set (C) supports a model of the desired shape to be cut. This model rides up against a shoe (D) which bears the same relation to the model as the cutter head bears to the stock being cut. As the carriage travels along past the cutter head the stock being cut and the model revolve in unison, and the action of the model riding against the shoe causes the carriage to move in and out according to the shape of the model. Since the revolving cutter head bears the same relation to the stock being cut as the shoe bears to the model, the shape of the model is exactly duplicated in the finished piece. By moving the die shoe (D) in or out, the turning can be made proportionally smaller or larger than the model. During the war, special machines embodying the copy principle were con-

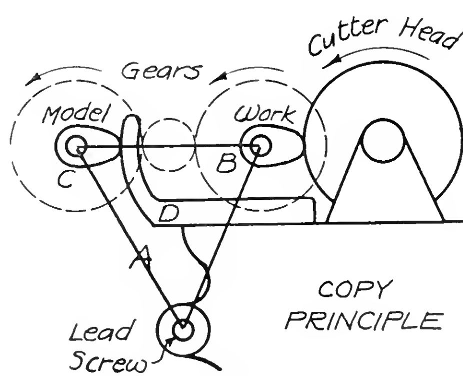


FIGURE 4.

structed for production of airplane parts. Figure 5 shows a propellor shaping machine. Others were made for struts and braces.

(Continued on Page 38)

Automotive Testing Laboratory

R. J. Solomon, e.e., '27

The diagnosis of automobile troubles has always been more or less a matter of guess work. The automobile mechanic has learned by experience to recognize certain sounds as indications of certain corresponding defects in the mechanism of the car. Unfortunately, however, all motor car ills do not manifest themselves in apparent disturbances and therein lies the difficulty. Similarly, a noise is not a very accurate indication of the exact degree of the trouble. Also, a sound may be conducted some distance, finally emanating from a place several feet away from the origin. A great deal of time must be consumed in this way before the trouble can be traced to the source. Time in the rapair shop is money, and inefficiency anywhere is not to be tolerated.

Looking at the matter of motor car diagnosis from another angle one can readily see how the owner is thrown upon the mercy of unscrupulous repair men. This danger is a very real one, and is probably the subject of greatest concern to the motorist. The average car owner knows little or nothing of the mechanics of his automobile and the repair man is able to extract large profits by pronouncing costly repairs necessary when only slight adjustments have to be made.

The development of the Wasson motor check, which has made possible the Automotive Testing Laboratory, has apparently provided a solution for all the aforementioned difficulties. In a few minutes the laboratory makes a complete and thorough investigation of the mechanical condition of a car, a list of necessary repairs is rendered, and provision is made for a rechecking after the work has been completed. In the case of a used car which is to be sold a "Tested and Approved" certificate (Fig. 1) is issued together with a data sheet and horse power curve (Fig. 2). This certfiicate is not issued until the recheck shows the car to be in perfect condition.

Approval No. 169

Automotive Testing Laboratories
Division
Chicago Automobile Trade Association
2838 South Michigan Avenue
Victory 0300

This Certificate

IS ISSUED TO Smith Sauer Motor Co.
and certifies that the motor vehicle described on the reverse side hereof has been tested and approved according to the standards of the Automotive Testing Laboratories, Division Chicago Automobile Trade Association on 5 31·24. An accurate record of the performance and mechanical condition of this vehicle is herewith recorded and made a part of this certificate

Engineer in Charge

Figure 1.

The equipment of the Automotive Testing Laboratory consists of a plant for the distillation and chemical testing of crank case oil, a standard Ambu Electrical Institute test board for the investigation of the electrical equipment, and the Wasson motor check for the mechanical tests. The laboratory is also provided with a garage for the storage of, and preliminary work on such cars as are to be tested.

The testing is done by a staff of trained men who are personally supervised by the chief engineer. The practice these men have had, together with the efficiency of the equipment, makes the testing an amazingly rapid and easy process. When a car comes into the garage it is placed in a stall and assigned a shop number which follows it throughout the entire test and finally appears on the data sheet. While still in the garage a record is made of the serial number, motor number, type of car, year, model, bore, stroke and displacement. This done, the water in the cooling system is changed to insure the absence of solutes that would lower the boiling point and a sample of the crank case oil is distilled to determine the amount of dilution. This distillation test is run largely to determine whether the lubrication is suffiicient to withstand the rigors of the Wasson test.

While the chemist is testing the oil the compression test is run. This is done by removing the spark plugs and inserting compressometers in their places. The compressometers are pressure gauges which operate on the same principle as that of the common type of tire gauge. The motor is turned over at the speed of the starter motor with the throttle wide open to insure a full and even charge of mixture in all cylinders. The compressometers then show the maximum pressure developed in each cylinder. Upon taking the readings of the compressometers the operator is able to ascertain two important facts:

1. The amount of explosive working charge of vaporized gasoline going into the cylinders.

2. The condition of the cylinder valves. Low readings of the compressometers are indicative of one, or both, of two things. Either there is a leakage of the working charge past the exhaust valves due

to their not seating properly, or there is slippage past the pistons due to excessive wearing of the piston rings or cylinder walls. Valve trouble will indicate carbon which necessitates a grinding job. Piston leakage requires a new piston seal. Further along in the process a more specific test will reveal which type of leakage is causing the trouble.

Now a thorough inspection is made of the running gear, wheels, king pins, steering gear, frame, springs, fenders, and shackles. The car is then ready to leave the garage and enter the laboratory proper.

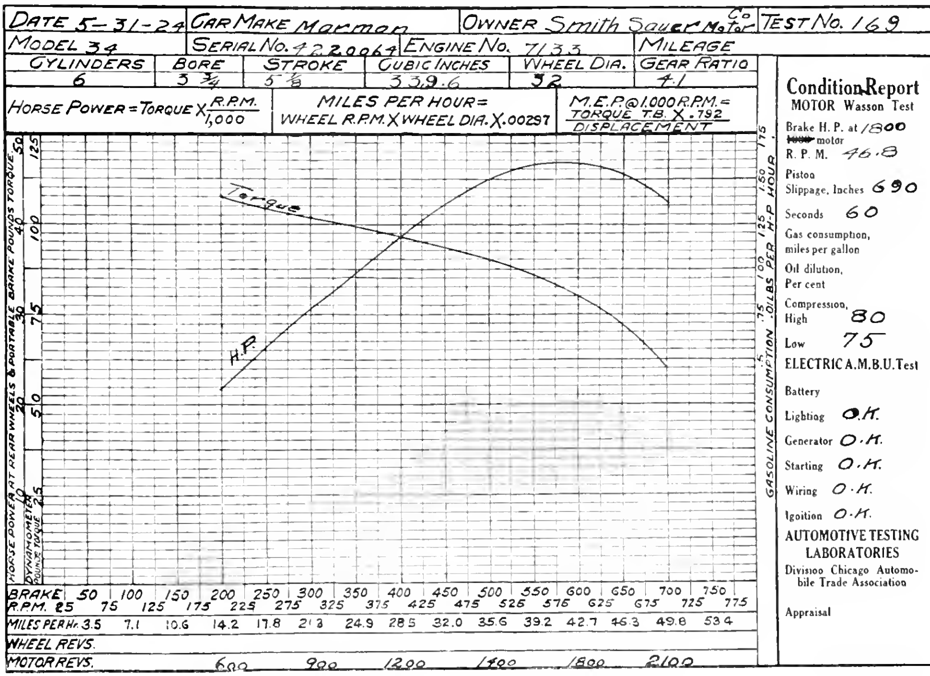


Figure 2: Data Sheet and Horsepower Curve

The first work done in the laboratory is that of the electrical tests. The battery is the first point to receive attention. The specific gravity of the electrolyte is taken with a hydrometer in the usual manner and the voltage of each cell is checked with a voltmeter. Then an ammeter is placed in the starter line and the circuit is closed through the starter switch. The current drawn by the starter motor is noted and compared with the general average for cars of that particular make. The starter circuit is restored to its normal condition and the motor is started and allowed to run at various speeds while the output of the generator is checked. The results of the generator output tests, together with the action of the regulator and charging cut out, are checked with standards that the laboratory has been able to prepare through its experience. Now, with the lights turned on, the balance of current is checked. The motor is then stopped and further light tests are made.

The ignition system is next given a very thorough and careful test. The spark plug gaps are measured micrometrically and the coil is tested to ascertain whether or not sufficient current is being developed to fire the mixture properly. Ground tests of all secondary wiring reveal any weak points in the high frequency insulation. The distributor head is then removed and an inspection is made of the breaker points to see if they are clean and meet squarely. The timing is checked and the lighting system is gone over again.

Three men perform the electrical tests but the entire process requires only fifteen minutes, and, at its conclusion, the engineer knows exactly what is the condition of the ignition system.

The next step is the testing of the power plant. This is accomplished by means of the Wasson motor check. In appearance the check resembles the greasing racks which may be seen at any gasoline

(Continued on Page 38)

Problems Met in Opening a Clay Pit

W. P. Whitney, cer.e., '25

When a clay products manufacturer has to locate new deposits he not infrequently meets with problems that involve every branch of the engineering profession. These problems, while not profound to the man trained particularly along that line, tend to give a variety of work that demands all of a man's resources and ingenuity. Briefly the situation as follows. An Illinois brick factory is faced with the problem of mining some new shale deposits that they already own. Their present shale pit is nearly worked out, only containing about a year's run. The new deposits lie a quarter of a mile from the present workings and consist of a shale bed, averaging 30 feet thick, with two feet of calico dirt, with a maximum of yellow surface clay overburden of 15 feet. The area to be worked comprises rough ground cut through by a small stream. The stream has such a small gradient that it is almost stagnant but it is subject to considerable seasonable rise and fall. The present workings are behind a levee since the water regularly rises until the bottoms are covered to the depth of two or more feet.

The types of work encountered in a brick yard, especially when additions are made or new pits opened up, are varied as may be judged from this article. Problems requiring the study of a trained mechanical, electrical, mining or railway engineer may come up and an immediate solution required. This might lead some to think that a complete staff of engineers would be carried but one must remember that the majority of brick yards are small affairs and cannot afford to carry such an organization. This means that all these problems are thrown on one or maybe two men and in the past when the technically trained man was not to be found and the rule of thumb prevailed it is small wonder that the term of existance of many yards was short.

The two main problems that present themselves in this job are, first, how to mine the clay most efficiently and economically, with the least possible interference from the water; and, second, how best to move the clay from the pit to the plant. A general discussion of these points follows.

Before the shale can be removed the fifteen feet of overburden must be cleared away. This operation is known as stripping and is customarily accomplished by one of five methods. The first system is by the use of the old stand by, the pick, shovel, and wheel barrow. This, however, is applicable to the case where only a slight overburden is encountered and the plant has a small output. Needless to say, with a 15 foot overburden and a plant calling for large production it is not to be considered, and some mechanical means will be used. Plow and scraper methods, another general scheme of operation on small jobs, come under the same head as being too slow and wasteful of man power. For level ground a machine known as a clay gatherer is sometimes used but the character of the land forbids its adoption here. One of the most adaptable striping outfits for ground of this character is a "mast drag line scraper" and because of its large capacity and general usefulness seems to be the solution of this problem. A hydraulic stripping outfit would be ideal for this work but the lack of drainage, water head, and an adequate water supply rule it out. Steam shovels may be used but general practice for stripping favors the drag line, with the shovels held in reserve for the cleaning up of the pit.

The actual digging of the shale now presents itself. For this we may go back to the methods of stripping. Pick and shovel and clay gathering machines are again ruled out and mechanical methods appear to be the most feasible. There are three machines on the market for this work that may be had in any size desired. They are the steam shovel, the drag line shovel, and the shale planer. Any of these may be used where the ground is level or only slightly rolling. The drag line works from the top of the bank and is by far the most efficient machine in general use as it also takes the place of any stripping equipment, but the steep slopes met with in this pit make its use impractical for actual mining. The shale planer is as yet little used but from all reports it is a machine that may soon expect general adoption. Its high initial cost and its lack of adaptability for rough country render its installation here difficult, to say the least. The highest efficiency in the use of this equipment is found where the working face is of an even height and large output is desired. A steam shovel, is the best for this work as it combines a relatively low operation cost with a high degree of adaptability and a general versatility of motion. From this it is apparent that the question of mining the clay simmers down to the fact that the ground is too rough for a drag line shovel, or a shale planer. A steam or electric shovel is the best solution of the mining problem.

Again looking at the map it can be seen from the high water line indicated that most of our work is going to be below water level for a considerable time each year. It is obvious that unless the pit is properly drained the mining operations will have to be suspended for a portion of the year and that time occuring when the brick yard needs clay for replenishing their stock of brick preparatory to the rush season. In excavating this deposit the pit floor will be about ten feet below water level and it will be necessary to work behind a levee of some kind. This can probably be best accomplished by digging straight into the hill from the stream, leaving a considerable wall of earth between it and the workings. At the point of entry, where the shovel crosses the stream, a levee will have to be thrown up and provisions made to pump all seepage water back into the stream. It is thought at present that the stream will drain off most of the rain water, but it may be necessary to deepen the stream to where it flows into a larger one about a quarter of a mile from this point. With these preliminary steps taken we are now ready to mine the clay on a commercial scale and transport it to the plant for manufacture into brick.

Transportation methods for clay haulage usually consists of either an aerial cable way or some form of industrial railway. The former is not suited for use at this plant because the haul will not be straight and the expense of installing a satisfactory overhead system to meet the conditions would be prohibitive. An industrial railway to haul the clay to the foot of the old incline would seem a logical conclusion. We can choose our motive power from three types of locomotives, gasoline, steam, or electric. There are three types of the latter in use in clay plants. First, the storage battery type, where the batteries are charged over night; second, the trolley system; and, third, the reel type. However, there is one objection to the use of an electric locomotive in this location and that is because of the dampness of the working conditions. The storage battery type would meet this requirement but it would require an expensive installation for charging apparatus since the power lines of this section are carrying only alternating current. Both gasoline and steam are practical, but steam has slight preference because of greater simplicity and slightly more rugged build. This latter is an important requirement from the viewpoint of repairs and general upkeep. Tracks can be laid so that the grade will not require a gear locomotive. The ordinary saddle back type can be depended upon in this project to meet the transportation requirements.

Our tracks and rolling stock are next to be considered. If we use a steam locomotive we must plan on at least forty pound rails. Also, our tracks will have to cross the bottoms and an embankment with several culverts under it seems to be the best system we can use for crossing these lands. The bridge over the stream is another consideration which must be dealth with but its design can be safely left with the firm providing the steel for its construction.

The present cable way, used to haul the cars of loaded shale from the old pit may be adapted, with only a few minor changes, to haul the cars from a delivery point at the front of the grade to the shale storage bins.

The rolling stock is next to be considered but as the company is already using a type of drop side car of their own design in the old pit it would be poor economy to specify a change. Especially if such a change would require new arrangements for handling and dumping cars. The aim in the opening of the new pit is to adapt as much of the old equipment as is possible, within reason.

Looking back over the points covered so far we find that we have reached, by a more or less circuitous route, the following general conclusions in the solution of the problems outlined at the beginning of the discussion. First, we will use a drag line scraper to dispose of our overburden; second, a steam shovel seems the logical tool for removing the shale; third, we will protect ourselves from the water by the use of a levee system and pumps; fourth, our choice of haulage is narrowed down to two types of locomotives, steam or electric; fifth, our tracks must be laid on an embankment to keep them dry during high water; and sixth, the present type of car will serve our purposes for hauling the shale fairly well.

Due to the fact that none of these plans have been put into actual operation as yet it has been difficult for the author to do more than roughly outline the general status of the conditions to be met and to describe the trend of the course to be followed. If the work was already under way it would be possible to give a detailed description of the equipment finally selected, however, this article may give some illustration of the kind of work a ceramic engineer on a brick yard may be faced with.

Bond Testing Trip of the University Test Car

CLIFFORD ANDERSON, ry.e.e., '25

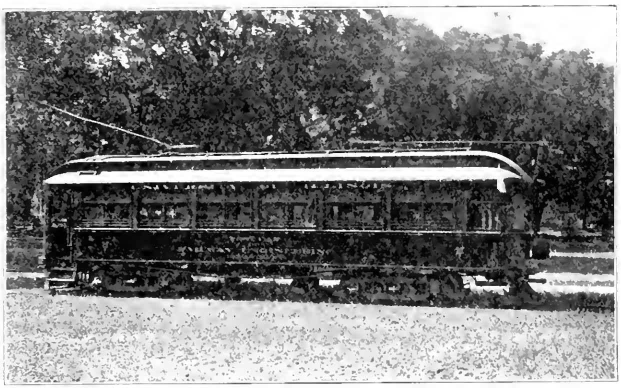
A bond testing trip was made this summer by the test car of the department of railway engineering over the lines of the Illinois Traction company. A similar test had been made over this road five years ago so this was the second trip for the same purpose. The trip was arranged by Professor E. C. Schmidt of the railway department with J. K. Tuthill in charge of the car. Besides the motorman and conductor furnished by the traction company a crew of three Illinois men, W. L. Brazee, '25, C. C. Anderson, '25, and Joe Lind, '24, were taken along to fill out the personnel necessary to conduct the tests.

Before attempting to narrate the happenings of the test it would be well to take a little of the mystery away from the terms "bond" and "bond testing." A rail bond is a copper or brass connection between adjoining rail ends, and provides a path for the current in the rail other than through the rail joint itself. The bonds we encountered were stranded copper cable or brass strips welded to the rail. Unfortunately, bonds will come loose due to vibration or weather conditions, and a large power loss results since the return circuit is imperfect. The electrical resistance of one rail joint which is not bonded will often be as high as that of one hundred or more feet of unbroken rail. The electrical resistance of a rail joint is the true indication of the condition of the bond.

The University test car has equipment which will test and record graphically each bond along a section of track, as the car runs over it at a speed of ten miles per hour or more. This is the quickest, cheapest, and most satisfactory method devised. There are several types of hand bond testers; but even a statistician would find it difficult to figure out at what probable age a man would stagger down the last section of a five hundred mile stretch of track on which he started in his youth to test bonds with hand testing equipment. The test car and crew did the same job in a few weeks. Each bond must be electrically tested by passing a current through it and measuring the potential drop across it. In hand testing equipment it is necessary to wait until a car is operating in the vicinity in order to utilize the current flowing through the rail in producing a voltage drop. The test car carries a motor-generator set and so is independent in this respect.

Reduced to the fewest technicalities, the operation of the test car equipment consists in sending a heavy current through each rail, measuring, and automatically recording the voltage drop across twelve feet of rail spanned by metallic brushes bearing on the rail. The front trucks of the car are insulated from the frame and the current from the generator passes first to the front truck and then through the track to the rear truck and then back to the generator. When a rail joint comes within the twelve foot span of the contact brushes it is momentarily up for inspection. If the bond is in good condition there will be no appreciable drop in potential and the recording millivoltmeter will cause no change in the line being drawn on the recording paper. However, if the bond is in poor shape the voltmeter will swing up on the scale and there will be a jog in the recording line for that rail. Telegraph poles are used as reference marks. Their position is recorded on the chart by pole marking pens operated electrically by an observer in the front cab of the car who presses a button as each pole is passed. As the poles are recorded they are automatically added up in groups of ten on the chart. The observer has telephonic communication with the man on duty at the recording instruments and whenever a station stop sign is reached, usually the sign is fastened to a telegraph pole, the observer gives the name to the recording man who writes it on the record in the proper place. The recording paper moves under the inking pens at the rate of one inch per one hundred feet of track. Thus, in locating a bad bond, the nearest station is observed on the chart, the number of poles between the bad bond and that station is determined, and then by means of a proper scale the number of feet from the bond to the nearest pole is read. Since the general direction of operation of the car is known, the proper instructions may be added to the data and the information necessary to find the bond is complete. A little should be said of the very clever method used in recording the millivoltmeter readings. A regular inking pen would prove to be too much of a drag on the instruments and would decrease their sensitivity too much; so the pointers are insulated from the meter and in place of the regular scale graduations there are small contacts placed. Each of these contacts is connected to a corresponding one directly over the recording paper, and by means of an auxiliary spark coil circuit, a stream of sparks are made to jump from the voltmeter needle to the contact which happens to be directly below it. The sparks appear again directly over the paper, jump through it to a brass plate under the paper and thus end their careers having produced a record of the position of the voltmeter needle. By painting the back of the record paper with ink, the spark trail shows a fine distinct line. This description of the operation of the equipment is of a very general nature but it is perhaps enough to give a practical idea of the subject.

Nearly a week was spent in getting the car ready for the expedition, part of this time being enforced on account of delay in the starting date. A trial trip was made over the street car system to the Illinois Central shops on the day before departing and everything was found to be in excellent operating condition. We pulled out of Champaign in June and started the recording instruments immediately south of town. The end of that first day found us in Clinton. There was not much time wasted in waiting for passing trains, at first, and so for the first few days we made 60 to 70 miles per day. We reached Bloomington and Peoria on the second day and Springfield on the third, but from there to St. Louis we were greatly delayed by the heavy traffic which is present on that division. Most of this section has block signal equipment and it was necessary to note their positions on the chart since the block signal sections are insulated from each other and whenever a block signal was encountered the effect on the recording instruments was the same as that of an open bond.



University Testing Car

We inspected many substations along the line, several of which were new and of the very latest type. There were no automatic substations. At Riverton we stopped to visit the new power plant owned by the Illinois Light and Power company, which furnishes some power to Champaign.

After finishing a day's run we would take out the roll of record paper, ink, and reroll it. There were no sleeping accommodations on the test car so our entire party had to stay at hotels; and in the evenings we took in whatever points of interest each city had to offer.

Upon reaching Granite City we stopped recording and started back north again at normal speed, stopping at Staunton to test the Hillsboro division. It was on this line that lightning ran in on the car and burned out the motor generator set, the air compressor cut-out, and caused several minor difficulties. It was necessary to lay over for a day to repair the damages and to send the motor generator armature back to Granite City for repairs.

When once again we reached Springfield, the recorders were started and we tested to Decatur and then returned to Champaign. The next day was spent over the Danville and Ridge Farm divisions. This ended the actual testing work and the folowing week was used in working up the data. Many hundreds of bad bonds were found and their position tabulated on special data sheets designed to enable the railroad bonding crew to locate easily the defective connections. It was found that 80 to 90 percent of the bad bonds occurred in city streets or country road crossings. This seems to bear out the theory that most bad bonds are caused by vibration because vibration is heaviest in cities or grade crossings.

Kansas Has Short Course for Public Utilities

Last spring the University of Kansas held its third annual three day course for public utilities men. It is given primarily for the benefit of city officials and particularly those interested in the problems of water supply and sewerage disposal. The attendance showed a considerable increase over that of previous years, indicating an increasing interest in the problems considered. The contact of the men engaged in similar work and the constructive thought stimulated by the program make the meeting worth while.

EDITORIAL

The Technograph

Thirty-nine years ago *The Technograph* was established. For thirty-nine years it has been the undergraduate publication of the College of Engineering, first as an annual and later as a quarterly in which form you now find it. When it was first organized and published it was one of two engineering school magazines, holding the field with the Michigan Technic. Now is is one of a large group of publications which form the Engineering College Magazines, Associated. In the course of its existence it has built up a reputation by which it is known throughout the field of undergraduate engineering publications. Particularly is it known for standing out on a definite policy which is not adhered to by any of its contemporaries.

The Technograph has faithfully followed out the practice of only publishing articles written by Illinois undergraduates, graduates, or members of the staff of the College of Engineering. The writings of the first group have always been given preference over those of the other two classes. This undoubtedly limits the field which we may cover, and we cannot expect to compete with the professional engineering publications. However, it makes *The Technograph* strictly an Illinois publication and to all practical purposes that of the students. It is the outlet for the work of the student engineers and as such fully justifies its existence. It offers and holds open a place for the future Illinois engineers to learn to write technical material for publication.

While the magazine is being discussed there is another point to be kept in mind. During the course of its career *The Technograph* has traveled the usual course of ups and downs of the campus publications. So far it has weathered all storms, but it is dependent on the engineers for support. When they get behind a thing and push big strides are made. When they fail to lend a hand the opposite result is obtained. It is not through lack of loyalty that the magazine has has a few close calls; but rather indifference and failure to take the responsibility. Whether *The Technograph* can count 1924-25 a banner year depends on those who are called engineers. All may not write, all may not work on the staff, but all can be boosters. If you want to see our magazine maintain its position among the engineering college magazines get behind and give a push. It is up to you of the "gang north of Green street."

The Schaefer Prize

For the fourth time Mr. John V. Schaefer, m.e., '89, is offering prizes for an engineering essay competition. This contest, known as the Schaefer Prize Competition, was instituted by Mr. Schaefer to promote effiiciency on the part of engineering students in accurate observation, logical thinking and the use of good English.

An engineering education is supposed to include these three points, and at Illinois is successful in giving a thorough training in the first two. As for the latter, it is generally admitted that we are devoting insufficient time to the study of the use of good English. At the present time this training officially ends with the course known as Rhetoric II. When the final examination papers are turned in at the end of the freshman year the popular habit seems to be to forget as much of this work as quickly as possible. The results of these tactics have been altogether too unsatisfactory.

The Schaefer prize should be an inducement to renew acquaintance with the accurate use of good English. So it has proved for a few in the past, but only for a few. The reward has often gone to any engineer willing to take the time to put his experience on paper. Once more oportunity is knocking!

Schaefer prize winners: 1922, Paul F. Witte, m.e., '23; 1923, C. E. Parmelee, cer.e., '25; 1924, H. E. Wessman, c.e., '24.

The Professional Touch

There has been a complaint among some of the engineers that the work, both in the classroom and the extra curriculum activities, lacks the professional touch. The tendency is to get away from the hard and cold methods of the business world and treat everything in the collegiate attitude. Maybe to many this statement means nothing but to the majority, those who have spent some time working during the summer or before coming to school, they will understand what is meant.

Everything in the commercial world, where nine tenths of us will land within the next few years, is based on the struggle for existence. Besides the typical engineering jobs we find titles of sales engineer, production engineer, etc. The world is on an engineering basis, the basis that calls for calculated, scientific, and on top of it all economical business methods. Hard and cold facts must be met with the same weapons.

How many of us practice these tactics in our laboratory work, our study systems, and in the methods of conducting the engineering societies! It is a lack of a realization of the proper preparation needed, probably more than anything else that has brought on this complaint. We can be collegiate in our amusements but in our work around the engineering college the professional touch should be cultivated.

Honorary Organiaztions

The engineering college is one of the most completely organized divisions of the University when it comes to honorary organizations. Distributed throughout the college and its various departments can be found thirteen professional and honorary fraternities, not to mention the eight departmental societies. In fact the point has been reached where the average upper classman engineer considers that his time here has been wasted and his course a failure unless he can show one, two and often three gold decorations for his watch chain.

It is not the idea of the magazine to adopt a policy of criticising such organizations but to express the prevalent feeling that these societies are missing a big field of activity. Practically without exception each one covers a separate field and probably is active to a certain extent although like most fraternal orders their work is not advertised for the knowledge of the general public. But their work can be expanded to cover a much greater field if they so wish.

We have the organizations: they have the field and the opportunity. What shall be the result of this year's work?

COLLEGE NOTES

Annual Senior Inspection Trip

Mining Engineers

One of the most interesting of the inspection trips was the seven day trip of the mining engineers to Upper Michigan which began Sunday evening, November 2. They first visited the hard and soft iron mines near Ishpeming and Neguanee, then went to Marquette where the large iron ore docks were inspected together with various glass furnaces and charcoal manufacturing plants in the vicinity. They next visited the copper mines and refineries in the "Copper Region" near Houghton; the Quincy mine, which is the deepest copper mine in the world (7,000 feet), being one of the points of interest.

Returning to South Chicago they visited various steel plants before going to LaSalle where they inspected the Long Wall Coal Mine and the Hegeler and Matthiessem Zinc Smelter, the latter being one of the largest zinc smelters in the world. Ten seniors in charge of Professor Drucker made the trip.

Ceramic Engineers

The seniors of the ceramics department, under the leadership of Professor Hursh, first journeyed to Streater where various brick, sewer pipe, and glass factories were visited, going Thursday to Ottawa and there inspecting fire brick and glass plants, and later in the day to Joliet to see other firebrick kilns. Friday and Saturday were spent in Chicago visiting terra cotta and metal enameling plants. Of special interest was the North Western Terra Cotta company at Chicago, which is one of the largest in the country and the first to try the car tunnel kiln for burning terra cotta.

Railway Engineers

Wednesday morning was spent at the Pullman Car Works at Pullman, the largest car works in the world; the afternoon being devoted to the inspection of the Illinois Steel company in South Chicago. Thursday and Friday the railway electricals spent with the electrical engineers in Milwaukee, the railway mechanical and civils remaining in Chicago and visiting various railway stations in addition to the Burnside shops, the Illinois Central improvement, and the Markham yards. Saturday morning the "railways" joined the "mechanicals" in an inspection of the new Crawford avenue station of the Commonwealth Edison company at Chicago.

Municipal and Sanitary Engineers

The Calumet Sewage Treatment Plant and Pumping Station at Chicago came first on the itinerary of the municipal and sanitary engineers, followed Wednesday afternoon by an inspection of the Chicago Garbage Reduction Plant and a visitation of the Chicago Sanitary District Offices. Thursday morning the Lake View Pumping Station, one of the five large pumping stations which supply Chicago with its water, was examined. The Evanston filtration plant and in the afternoon the Great Lakes Naval Training Station completed the program for the day. Friday was spent in Milwaukee, the group returning to Chicago for the inspection of the sewage treatment plant Saturday morning.

Electrical Engineers

Wednesday was spent in Chicago visiting the hydro-electric station of the Sanitary District, the new Crawford avenue station of the Commonwealth Edison company which had nearly reached completion, and the Western Electric company's works at Hawthorne. Thursday and Friday at Milwaukee the electricals visited the Allis-Chalmers Manufacturing company, the Lakeside power house and the high tension sub-station of the Milwaukee Light and Railway company, and the Falk company, manufacturers of fine gears. Friday at lunch they were the guests of the Allis-Chalmers Club. Returning to South Chicago they inspected the works of the Illinois Steel company Saturday morning.

Busses were used for all short distance transportation.

Mechanical Engineers

Wednesday morning the mechanical engineers, forty five strong, visited the Corwith works of the Crane company and in the afternoon the Illinois

Steel company in South Chicago. With the electrical and general engineers they embarked for Milwaukee by special train, there spending Thursday visiting the Allis-Chalmers plant in West Allis and the Falk Corporation, manufacturers of steel castings and cutters of fine gears. Friday morning the A. O. Smith company was inspected; here they saw side frames and structural steel for automobiles made automatically. In the afternoon, by special train, they returned to Chicago, stopping at Kenosha to visit the Nash automobile factory. Saturday morning they went through the new power station of the Commonwealth Edison company on Crawford avenue.

Architectural Engineers

The inspection of the Universal Portland Cement company at Buffington, Indiana, the Inland Steel company at Indiana Harbor, and the Sherwin Williams Paint and Varnish company made up the program of the architectural engineers for the first day. Thursday with the "Archs" they visited three Chicago theatres and the new Tribune Tower and printing plant. The steel work of the tower has been completed and the walls are now being put up; it is intended to be the most beautiful office building in the world. The Underwriters Laboratory, the principal testing station of building materials, and the new Palmer House were also visited. An inspection of the buildings under construction in the loop was made Friday morning, the afternoon being devoted to a trip through the Lassig plant of the American Bridge company and the North Western Terra Cotta company. Other buildings under construction in Chicago were visited Saturday morning.

Architects

The office of Perkins, Fellows, and Hamilton which the architects visited Wednesday morning gave them an idea of the layout and management of a large office. The afternoon was spent under the guidance of Mr. Benjamin Shapiro of Holabird and Roche in a survey of the office buildings of the loop showing the development in the design of office buildings. A trip through the Art Institute completed the day. Thursday morning the Chicago, Selwin-Harris, and Apollo theatres were visited, examples of modern theatre construction, each being of a different style of architecture. The Tribune Tower and printing plant, and Underwriters Laboratory were visited in the afternoon. As guests of Perkins, Fellows, and Hamilton they made a trip around Lake Forest Friday morning and inspected the Fourth Presbyterian Church and the North Western Terra Cotta company in the afternoon. The new $1,000,000 studio of B. H. Marshall at Wilmette which they visited Saturday morning completed their tour of inspection.

Civil Engineers

The South Works of the Illinois Steel company at Gary and The American Bridge company at Curtis were visited Wednesday. Thursday's inspection included the Lake View Pumping Station, Evanston Filtration Plant, and construction work on the north side. A special lecture was given on the design of the new Palmer House which was visited Friday morning. Other building construction in the loop, the Illinois Central improvements at Harvey and Riverdale, and the Markham yards concluded the day's inspection. Saturday morning was spent with the "M. and S.E.'s" visiting the sewage treatment plant.

General Engineers

The general engineers will not be with the "civils" to as great an extent as in previous years, being with them only Wednesday. The remaining three days will be spent with the "M.E.'s" in Milwaukee and Chicago.

Washington Award Goes to Talbot

During the past summer, Professor A. N. Talbot, C.E., D.Sc., D.Eng., professor of municipal and sanitary engineering in charge of the department of theoretical and applied mechanics, received word that he had been made the recipient of the Washington Award for the year 1924, by the Western Society of Engineers. This award is given annually to the engineer who "has done the most to promote the happiness and welfare of humanity." The five leading societies of the United States; the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers and the Western Society of Engineers, made the recommendation that lead to the award. In making the presentation, it was stated that without a doubt, "Talbot is the outstanding figure in engineering research in this country at the present time." The inscription on the tablet reads, "for his life work as student, teacher, investigator, and writer, and for his contributions to the science of engineering."

For twenty years, Professor Talbot's investigations and writings have been preminent in the fields of reinforced concrete, railroad track, and civil engineering research in general. Professor Talbot has written many papers and bulletins during his forty years service here at the University. These have dealt with the problems of every branch of the civil engineering field. The only other men who have received this award are Herbert Hoover and Robert W. Hunt.

Radio News

Station WRM, the radio broadcasting station of the University of Illinois, has arranged for the broadcasting of the football games played in the Stadium this year. A line has been run direct from the Stadium to the radio station on the second floor of the E. E. Laboratory so that a play-by-play report of the games may be broadcast. The Homecoming game on October 18 was broadcast through station WGN, the Tribune station at Chicago, by means of a leased Western Union wire direct from the press box in the west stands.

As to the programs that have been sent out twice weekly in the past, a definite decision as to their continuance has not been reached. In case they are discontinued the transmitter will be used in research work in transmission. This work was attempted last year but it was found that the two could not be carried on at the same time.

Physics Colloquium

The Physics Colloquium is an informal gathering, open to all interested, for the discussion of recent developments in physics and allied branches of science. Most of the contributions are the original research of members of the faculty and advanced students. It is well that there be such an agency for it is valuable not only as a means of disseminating new facts, fresh from the laboratories of the investigator, but also as a source of inspiration to those who are themselves engaged in such work. The Physics Colloquium meets Thursday evenings from seven until eight.

Some of the speakers and their topics of past and future colloquiums are:

October 9, Professor Jacob Kunz, "The Anomalous Zeeman Effect and the Magneton."

October 16, Professor Jacob Kunz, "The Anomalous Zeeman Effect and the Magneton," concluded.

October 23, Mr. W. M. Young, "The Mobility of Electrons in the Corona Discharge."

October 30, Professor J. T. Tykociner, "A Photo-Electric Valve."

November 6, Professor C. T. Knipp, "The X-Ray Investigation of Metal Fractures."

November 13, Professor F. R. Watson, "Reverberation in Buildings."

November 20, Mr. K. Hubbard, "The Measurement of Small Capacities."

December 4, Report of the Chicago Meeting of the American Physical Society.

December 11, Professor Jacob Kunz and Dr. V. E. Shelford, "The Use of the Photo-Electric Cell in Biology."

Book Reviews

Structural Engineer's Handbook, Third Edition

By M. S. Ketchum

Dean M. S. Ketchum of the College of Engineering has just completed the revision and enlargement of his "Structural Engineer's Handbook." The volume contains 1,080 pages of data, specifications, and details that are important for the structural engineer. Of these, 130 pages contain new material. The most important additions are a chapter on self supporting stacks, properties and details of constant dimension steel columns and steel column footings; revised specifications for steel mill buildings, steel office buildings, steel highway and railway bridges, and engineering materials.

The McGraw-Hill Book company are the publishers.

Resistance of Materials

By F. B. Seely

Classes in T. and A. M. 29 are now using a new book entitled "Resistance of Materials" by Fred B. Seely, M.S., of the theoretical and applied mechanics department of the University of Illinois. The volume contains 422 pages, which treat the subject matter in two parts. Part one is called Mechanics of Materials and deals with the principles of analytical mechanics and the experimental laws of structural materials.

A large number of practical problems are provided, with the answers given to about half of them. Professor Seely was assisted in his work by Professor H. G. Moore and Assistant Professors N. E. Ensign, H. M. Westergaard, and F. E. Richart. John Wiley and Sons are the publishers.

Ceramics in Ancient Egypt, Babylonia, and Assyria

By Rexford Newcomb

Rexford Newcomb, professor of the history of architecture, has just completed a thirty-two page monograph on "Ceramics in Ancient Egypt, Babylonia, and Assyria." The historical lineage and earliest uses of tiles in the oldest civilization are discussed, providing an oportunity for architects, artists, and designers to familiarize themselves with the ancient motifs, designs, and stylistic effects achieved with tiles.

The monograph is the second of a series of fourteen which Professor Newcomb will prepare for the Associated Tile Manufacturers, for whom he is architectural adviser.

(Continued on Page 50)

Contemporary Engineering News

Intelligence Tests Given at Princeton

The News-Letter of the Princeton Engineering Association tells of the progress made in the psychological tests at Princeton University. Tests were given the freshman class of '26 and again to the same class in the sophomore year, and others are to be given in the junior and senior years. The results are compared with the marks made by each man in the entrance examinations and also with the grades he has obtained in his work at the university. Similar comparisons have also been started for the class of '27.

Professor C. C. Brigham, who has sponsored the tests, states that hardly sufficient time has elapsed to draw any definite conclusions; but, nevertheless, he feels that indications show them to be distinctly advantageous as supplements to the entrance examinations, both to the faculty and to the individual. "Low scores," he points out, "do not necessarily indicate low mental ability, but high scores always denote exceptional ability, since under the conditions of the tests a bright person might fall down but a stupid person could never fall up. These examinations prove valuable in locating men of good intellectual ability who are neglecting their work, not realizing their maximum capacities. In many cases where this was pointed out to the student, he subsequently made a much better record."

The results of the tests are analysed for indications of aptitude in special lines, as linguistic, scientific, etc. So far the results have suggested that such aptitudes exist, and it is thought that they will prove useful in the guidance of men in the college—guidance in their choice of electives, in the amount of academic load they can carry, and the amount of time they can afford to devote to outside activities.

Penn Teaches Coal Mining

Because of the demand for special training in coal mine engineering by the young men from the coal fields of Pennsylvania, Penn State College has started this year, a new four year curricula which affords opportunity to specialize in the methods of the coal mining industry. Since the School of Mines was established twenty-eight years ago regular instruction has been given in that subject, but the great demand for coal mining engineers in Pennsylvania, which ranks first in the Union for coal production, has made it necessary to provide additional instruction. Dean E. A. Holbrook, who was once professor of mining at the University of Illinois, states that the requirements for admission will be the same as for the general mining and metallurgical courses.

A new four-year course in ceramics also starts this fall at Penn State.

Institution of Research Launched At Lehigh

Lehigh University is now to have an Institute of Research much in organization and purpose like our own Engineering Experiment Station. The board of directors is composed of thirteen of the university staff, each man being a recognized authority in his particular field.

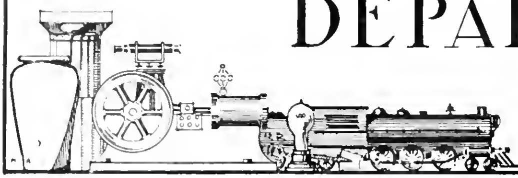
In announcing the purposes of the institute, the Lehigh board of trustees, of which E. G. Grace, president of the Bethlehem Steel Corporation, is president, stated that the object is "to encourage and promote scientific research and scholarly achievement in every direction of learning represented in the university, and in recognition of the need for further and more exact knowledge in science and in the application of science to the affairs of modern life. It is believed that the organization will be helpful in stimulating interest in liberal and professional education; and that it will prove to be of value to the professions and industries of the nation."

The results of the investigations will be published and distributed from time to time in bulletin form, thus preserving the records of the work and rendering them helpful to the various interests the institute was established to serve.

Book on Acoustics Praised

A recent issue of the California Engineer contained a review of the book, "The Acoustics of Buildings," written by F. R. Watson, professor of physics at the University of Illinois. The reviewer recommended the book as valuable to the architect, engineer and builder. To quote directly:

"The author in this book tells of his own original research without losing sight of the basic principles of acoustics and sound proofing. The work is a thoughtful and well considered study, filled with suggestions to the architect which are of practical value. The text is made more valuable by the inclusion of numerous illustrations, tables, and diagrams."



DEPARTMENTAL NOTES

Architectural News

Society Notes

The Architectural Society held its first meeting of the year October 8 in the Union building. All students of the architectural department, especially the freshmen, whether members of the society or not, had been invited; so there was a large turnout. John Gregg, '25, was unanimously elected vice president for the new year. Professors Provine, Dillenbach, Palmer, and Foster gave interesting talks upon the department, and welcomed the new freshmen, giving them a few helpful hints and words of advice at the same time. Johnny Senn and his nine piece orchestra enlivened the evening with some "hot" music. Eats for everyone at the close of the meeting sent everybody home happy.

Department Notes

There are four new members of the faculty in the architectural department this year. William A. Foster, assistant professor of rural architecture, is to instruct the students of the department in domestic architecture and farm building construction. He is the author of the well known book on rural architecture, "Farm Buildings." Prior to his coming here he was head of the engineering division at the state college of agriculture, at the University of Georgia. He has also taught the farm students at Iowa State College.

Newlin D. Morgan, the new associate professor of architectural engineering, is an engineer of note, having been associated with some of the largest construction companies in the country. He occupied responsible positions with the American Bridge company and the Chicago, Milwaukee and St. Paul railroad. He had been teaching civil engineering at the University of Colorado before coming to Illinois.

Alberta Rafll, who is to instruct the freshmen in design, graduated from the architectural department here in 1923 with the highest honors. She was the first woman student in the United States to be awarded the medal of the American Institute of Architects, which is given each year to the graduating senior having the highest scholastic standing for all four years. Since her graduation she has been employed as draftsman in the offices of Talmadge and Watson, prominent architects of Chicago.

James H. Chance will also instruct in architectural design. He graduated from Illinois in 1923, since which time he has worked for Stephens and Peterson of St. Louis, and in the office of James M. White, supervising architect of the University.

The Plym Scholarship for architectural engineers, which was held shortly before school let out in June, was won by G. C. Hewes, a.e., '23. The design part of the competition was the designing of a convention hall for a large city. The winner of the scholarship received seven hundred dollars to be used toward defraying of expenses of six month's study of architecture in Europe.

Scarab Competition

W. E. Armatrout, '25, O. Stephen, '25, and W. A. Rolleston, '25, are the three students of the architectural department who are entered in the national Scarab competition for the silver medal which is awarded annually to some member of the seven chapters of the Scarab Fraternity. The drawings must be completed by October 18 and the final judgment will take place here late in November, at the time of the national convention of the fraternity.

Beaux Arts

The various classes in the department are hard at work on their first Beaux Arts design problems of the year. The seniors have for their problem the design of a country club, while the juniors are working on a building for a state historical society. The sophomores, who are taking their first problem in the Beaux Arts, are designing a Guardian's Lodge for the entrance gates to a large public building.

Ceramic Notes

American Ceramic Society

The student branch of the American Ceramic Society started its activities for the coming year with a smoker at the Union building. Harold

Bopp, president of the society presided; David Innis, vice-president, and L. D. Fetterolf, secretary-treasurer, are the other officers for this semester.

Professor Parmelee addressed the society, welcoming the old and new students. He stated that the Illinois Gas Association plans to give furnace equipment costing approximately eight hundred dollars to the ceramic department.

All of the instructors were introduced and Professor Hursh in a short speech gave the new men some idea of the ceramic society.

A boxing match by Peacock and Brigham ended the program.

Milk and doughnuts were served at the mixer that followed the meeting.

Department Notes

The enrollment in the department this year shows a decided increase over last year.

Doctor Westman, a graduate of the University of Toronto, arrived October 6 to fill the position of research associate. He will take the place of Doctor Bunting who left last year.

Six public service companies in Illinois have combined to offer the sum of twelve thousand five hundred dollars to finance research work to be conducted by the department in electric porcelains and refractories.

Civil Engineering Notes

Department Notes

The old Horticultural building on the south campus has been remodeled and redecorated for use as a civil engineering surveying building. Owing to the crowding of space near Engineering hall, it has been necessary for students to go some distance for practice exercises in surveying. Going back and forth has seriously encroached on the working periods, and the use of this new building, which will be within a five minute walk of the surveying field, will make the instruction in surveying more effective. New steel lockers of the most improved design for the storage of surveying instruments have been installed.

Two recent publications of the Engineering Experiment Station have been well received by the technical press. Sixteen thousand reprints have been made of Circular No. 10, which deals with the grading of earth roads, originally published in the summer of 1923. It is being published in serial form in the Good Roads Magazine of Edmonton, Canada, and the Bureau of Public Roads at Washington has asked for permission to use parts of the content in a coming bulletin. Circular No. 11, dealing with the oiling of earth roads, has been liberally extracted in the Engineering News-Record, and in Municipal and County Engineering.

The University of Illinois is offering excellent opportunities in graduate study in civil engineering, particularly in the field of structural engineering. The courses offered cover the theory of continuous frame structures and arches, tall buildings, long span bridges, and indeterminate structures generally. Courses are also offered in foundations and valuations by the regular departmental faculty, and an advanced course in the design of industrial structures by Dean M. S. Ketchum. Most of the graduate students choose to elect mechanics as a minor, and take work in reinforced concrete under Professor A. N. Talbot, who has contributed so much to that subject. The new structural research laboratory offers exceptional opportunities for research in the behavior of structural elements. This work is under the professor of structural engineering who devotes all of his time to this work and and to graduate instruction. The number in graduate study has doubled each year for the past two years, indicating the recognition of the need of this advanced training for those who desire to become leaders in the profession. The presence of these graduate students at Illinois is a recognition of the facilities available at the University.

Professor W. M. Wilson is undertaking an extensive program of research in connection with reinforced concrete arches. His work for the past year has shown some interesting results in connection with the movements of arch abutments and piers, and the effect of temperature. The present program contemplates the making and testing of a considerable number of arches of large size, the direct object of the investigation being the determination of the effect of the slenderness ratio of an arch rib on the allowable unit stresses. This work will be done in the structural laboratory, and in conjunction with the research committee on concrete and reinforced concrete arches of the American Society of Civil Engineers.

E. E. Bauer, of the highway department, is making a series of tests of alumina cements. This class of cement is but little known in American concrete construction, although used to some extent in Europe, particularly where a high strength with a relatively short time of setting is desirable.

Dr. I. O. Baker, professor emeritus of civil engineering, sailed from Montreal for Europe the latter part of June. He spent the early portion of July in England and later visited France, Italy, Switzerland, and Germany. He will return to the University early in October and should bring us a fresh opinion concerning the Euporean situation.

K. L. Greeman, who assisted in the department of theoretical and applied mechanics last year, was killed in a crossing accident near Terra Haute on the twenty first of August. The death of Mr. Greeman is keenly felt by his friends at the university, for during the short time he was here, he came to be universally liked by both faculty and students, perhaps more so than any other man who has but lately come into the mechanics department.

Professor T. D. Mylrea has been licensed as a structural engineer by the Chicago board of examiners.

Electrical Engineering Notes

E. E. Society

The regular welcome to the freshmen and new students of the department was sponsored by the E. E. Society in a get together and feed on the first Friday after registration. There was a good turnout of loyal E. E. freshmen despite the fact that the Freshman Stag was held the same evening. L. A. Mollman, president of the society, opened the meeting with a short speech of welcome to the new men.

Dean M. S. Ketchum of the College of Engineering gave in interesting talk. He explained that the positions open to engineers today required them to be progressive men and active in societies. He urged all engineers to remain alert and abreast of the profession during their courses at the University and especially after graduation.

Professor E. B. Paine, head of the department of electrical engineering, was called upon and told how the men from this department were working themselves up to the positions left vacant by retiring electrical engineers all over the United States. Two instances were worthy of mention. A part of the work of the late consulting engineer for General Electric company, Mr. Steinmetz, is being taken over by Mr. Dougherty, a graduate of this department, and the late Mr. Laume of the Westinghouse Electric and Manufacturing company is said to have relied considerably on another graduate of the department with whom he had been working for some time.

Loud Speakers Used

The E. E. department was able to be of service to the entire university at the All-Illini Pow Wow at the Stadium on Wednesday, September 24. Two loud speakers and a three-stage power amplifier were installed at the Stadium through the efforts of H. A. Brown and C. A. Keener, of the department of electrical engineering, with the aid of W. V. Woodward and A. J. Sanial. This is the first time that an attempt has been made to carry the voices of speakers at university mass meetings to the large audiences by means of loud speakers and amplifiers.

Eta Kappa Nu Activities

Delegates from eighteen active and nine alumni chapters attended the annual national convention of Eta Kappa Nu held on October 24 and 25. This convention celebrated the twentieth anniversary of the founding of the local and first chapter of Eta Kappa Nu, the first chapter being founded here at the University of Illinois in 1904. Mr. G. P. Sawyer of Montclair, N. J., an alumnus of the University of Illinois and now the national president of the organization, presided. W. G. Kennedy, president of the local chapter, made the speech of welcome to the delegates. The annual banquet was held at the Inman hotel on the second evening of the convention.

Nine students of the department spent ten days, from August 25 to September 3, at Nela Park near Cleveland, Ohio, as the guests of the General Electric company at their National Lamp Works. These men were given a ten day course in illumination design and better lighting. The course consisted of lectures, inspection trips and entertainment for the men.

Students of the E. E. department enrolled in Company D, signal company of the R. O. T. C. at Camp Custer, Mich., this summer enjoyed an inspection trip to Detroit over the Fourth of July. They were shown through the Ford plant, the automatic telephone exchange at Detroit, radio station W.W.J, and the Conners' Creek plant of the Detroit Edison company. The Conner's Creek plant is one of the newer plants of the Detroit Edison company and consists of units with an aggregate turbine rating of 180,000 kilowatts.

Mechanical Engineering Notes

In the engineering college a department is judged not only by its teaching staff but by its equipment as well. During the past summer considerable new equipment has been added in the mechanical engineering laboratories and some of the old equipment has been repaired and improved. The power laboratory has received the most attention in this respect.

The largest piece of new equipment in the laboratory is a 100 K. W. Westinghouse direct current motor-generator unit turning out 250 volts at 400 amperes. The current generated will be used in the dynamometer test as well as for running other D. C. motors in the laboratory.

The generator of this unit is directly connected to a 150 h. p., 3 phase A. C. motor. The motor uses the power from the power house which is stepped down to 220 volts through suitable transformers.

Two new engines have been purchased for use

in the dynamometer test. One is a 6 cylinder Reo engine purchased from the Reo Motor Car company; the other is a Ford engine.

The dynamometer block is now in good condition and with these new engines some interesting tests will be performed. An innovation in this testing block makes it possible to change engines within an hour.

Another addition to the equipment is a new Worthingham $8\frac{1}{2}$ x 9 feathervalve air pump. It is to be used to furnish compressed air for starting the laboratory gas engines and for experimenting to determine the effect of throttling of the intake as well as the exhaust.

The Terry turbine has been torn down in order to fit pressure gages to most of the stages and to introduce thermocouples to some of the stages so that more accurate information as to the condition of the steam may be obtained.

An electric signal system is being installed by C. N. Arnold, of the department, which will permit better control of the time element in the test.

Some new equipment has been added in the shop laboratories, one of the larger pieces being a Jones and Lambert 6 tool flat turret lathe. It is an individual unit driven by a 5 h. p. motor.

Some of the smaller equipment includes a Black and Decker portable electric drill and a set of inverted counterbores. These latter are to be used on production work on the 2 cylinder gasoline engine manufactured by the department.

Under the direction of Mr. Irvine the heat treating equipment in the forge laboratory is being completely rearranged though as yet it is not in working order.

Three Simplex abrasive band grinders have been added to this department. With these grinders a practically flat surface can be ground on a test piece. The abrasives are graduated and after leaving the finer grinder the piece is taken to the polishers.

There are four of these single polishing units, all new. The spindles are driven through friction drive wheels which are connected to an electric motor.

A new Universal motor hand grinder and buffer is being used in the foundry shop to clean castings. It is much faster and more effective than the air chisel formerly used.

All of this equipment is not yet in use in the laboratories but should be before the end of the semester. It is hoped that the mechanical engineering department will be able to maintain the lead in modern and complete equipment which it has attained through these necessary additions.

Mining Notes

The newest member of the faculty of the mining department is I. M. Marshall, assistant professor of mining engineering. Professor Marshall is a graduate of Queens University, Canada. Before coming here to teach he was superintendent of the Yellow Pine Mining Co. of Nevada. He has been connected with mining work in practically every section of the United States, as well as Canada and Alaska.

Professor Marshall used his mining experience to good advantage in the war. He served with the Canadian Engineers doing tunneling work in France to undermine the German fortifications. Enlisting as a private, he soon worked his way to the top, and was discharged at the close of the war with a commission as a captain.

Thomas Frazer, min.e., '17, former assistant professor of mining research in our department, has joined the teaching staff of the mining department of the University of West Virginia with the title of assistant professor of mining engineering.

Railway Department Notes

David L. Fiske is the new research assistant in railway engineering to take the place left vacant by F. R. Mitchell. Mr. Fiske is a graduate of Massachusetts Institute of Technology in mechanical engineering. For the past two years he has done graduate work in the department of mechanical engineering under Professor Goodenough and received his master's degree last June. At present he is doing research in collaboration with Professor Snodgrass.

The department has purchased a new four-lever Saxby and Farmer interlocking machine from the General Railway Signal company. It will be used for instructional purposes in railway engineering courses. The machine is being set up on the first floor of the Transportation building.

Engine 131 in the railway testing plant was painted and put in good running condition during the summer.

C. C. Anderson, '25, and W. L. Brazee, '25, were assistants in the operation of the railway test car on the Illinois Traction System tracks this summer.

Professor Tuthill has just completed a series of drop tests on seam welded electric joints. Different combinations of joints with and without bolts were used in the tests to discover their resistance to impact, tensile strength, and elasticity. In brief it was found that the seam welded joints without bolts withstood a more severe test than those with bolts.

Tendencies in Woodworking Machinery

(Continued from Page 19)

Another tendency in wood working production is the increased use of the belt sanding. The simplest type of belt sander is shown in Figure 6. The belt is of ordinary sand paper, sometimes backed with cloth. The pressure is applied with a hand block. The machine is simple, inexpensive and saves considerable labor. From this type many developments have resulted. Among these is the stroke sander. This machine is used for automatically stroke sanding flat surfaces, such as table tops and doors. A sand belt travels about two pulleys as in its simpler progenitor, but the pressure is applied with a shoe which sweeps from one end of the table to the other. The kinematics of this machine are exceedingly interesting.

It is a general opinion among machine designers that wood machinery is invariably of cruder design than machine tools. Latest developments in moulders show that this is not necessarily the case. Moulders finish a board on all four sides in one passage through the machine by means of four cutter heads. Formerly the cutter heads were driven by belt and chains. The latest designs have individual motor drives for each head. Each cutter head spindle and its motor spindle are integral and run on ball bearings. The cutter heads ordinarily run at 3,000 r.p.m. but may be stepped up as high as 8,000 r.p.m. where quality work and capacity deem it advisable to do so. Vibration is due chiefly to minute unbalanced forces and couples. As these forces are proportional to the square of the r.p.m. it is apparent that all cutter head parts must be carefully balanced.

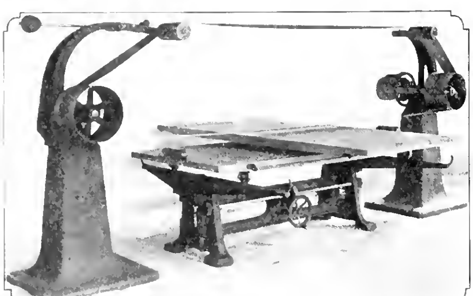


Figure 6: Belt Sander

Moulder bases are made unusually massive, similar to steam engine base construction. Channel ribs have proven successful in giving increased rigidity. The ball bearing, motor drive moulders probably present the very best which the wood-working field offers at present from an engineering design standpoint.

Design methods in general are slowly changing with the march of engineering progress. The old stand by, the babbit bearing, is being replaced by the ball bearing in critical places. Belt drives are giving way to direct motor drives. Precision of machine parts is becoming more necessary with high production and standards of interchangeability.

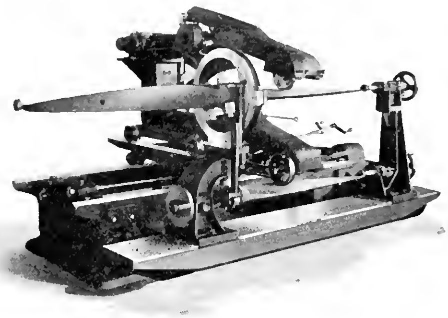


Figure 5: Propeller Shaping Machine

The wood working industry has found it necessary to abandon old time worn methods in order to produce profitably alongside of other industries. Although the engineer has solved many difficult problems for the wood worker, the field is enormous and much remains to be done. Research and engineering investigation will in the future find a fruitful field in wood working production.

Automotive Testing Laboratory

(Continued from Page 21)

station. The car is run up on the tracks and stopped in such a position that the rear wheels rest on a pair of wheels which have broad, smooth, steel circumferences which project a short distance above the track level. The car is locked in position by a rigid bar which is clamped to the front axle. The steel driven wheels are connected by a shaft to a water cooled pony brake drum. The load comes on with a weight balanced rope brake. One end of the rope is attached to a lever which is fitted with adjustable weights. The other end is made fast to a spring balance torque indicator. A tachometer carried on the brake shaft registers the revolutions per minute of the shaft. The horsepower delivered to the rear wheels is computed from readings taken from the torque scale and the tachometer.

The motor is started, a load is applied, and readings are taken at 200, 300, 400, 500, 600, and some-

times 700 r.p.m., corresponding to road speeds of 7, 14, 21, 28, 35 and 42 miles per hour. A typical data record of the brake test follows:

R. P. M.	Torque	H. P.
200	100	20
300	98	28.4
400	95	38
500	91	45.5
600	80	48
700	61	42.5

This motor peaked at 600 r.p.m. which means a flywheel speed of 2,010 r.p.m. Allowing for 20 percent transmission loss, it can easily be computed that the motor developed 57.6 h.p. during the test. The horsepower delivered to the driving wheels is computed by the formula:

$$\text{H. P.} = \text{torque} \times \text{r.p.m.} / 1{,}000$$

During the brake test the condition of the clutch shows up. If, when the load comes on, the clutch slips, a worn condition is indicated and will appear in the final report.

While the motor is running for the brake test a gasometer is connected to the crank case through the breather pipe. The gasometer scale is graduated in cubic inches and gives the leakage per minute of the working charge past the pistons. With cylinders and pistons in first class condition the leakage per minute should be approximately equal to the displacement of the motor. Double that leakage would not be serious but if the ratio rises to five or six times the displacement a new piston seal is recommended. By checking back with the compressometer results the engineer is able to find which cylinders are leaking.

Simultaneously with the brake and gasometer tests a gasoline consumption test is run. A flowmeter is placed in the feed line between the supply tank and the carburetor. The scale on the flowmeter shows the rate of fuel flow in gallons and pounds. The fuel consumption test is made with an average load and at about 25 miles per hour road speed. For example, if under the aforementioned conditions the flowmeter shows 12.8 pounds or 2 gallons consumed per hour a fuel mileage of 12.5 miles per gallon is indicated. This is considered a fair mileage for the average motor.

As soon as these tests are finished an operator goes under the car with an electric lamp and makes a thorough inspection. He feels all bearings from the transmission to the rear wheels to see if any run hot. If any unnecessary noise is noticed he listens with a stethoscope to determine the cause.

This concludes the test. The car is run off the rack and returned to the garage. It is delivered to its owner with a complete diagnosis of its mechanical condition which may be presented to the repair man to guide him in his work. After the repairs have been made the owner returns the car to the laboratory for a rechecking by which he assures himself that the repairs have been properly made. The original test, plus rechecking, is provided at a nominal figure and the owner has the satisfaction of actually knowing the condition of his car without having to take the word of the repair men.

Illinois Fraternity Architecture

(Continued from Page 6)

terior has been painted white. This practice has been taken up frequently of late by prominent country house architects in the east. A very imposing and inviting doorway of stone is the main decoration of the front of the house, and is excellently set off by the simplicity of the rest of the front.

The Chi Psi and the Alpha Chi Rho houses are French in character but have deviated enough from it to be suited to American environment. The ornateness of French detail has been omitted so that the houses would not seem incompatible with college requirements and spirit.

The only example of the Italian Renaissance style that can be found on the campus is the Kappa Sigma house.

There are various houses of the nondescript style which has grown up in this country, such as the Delta Tau Delta, Phi Gamma Delta, Phi Kappa Sigma and Sigma Alpha Epsilon houses. These houses fully meet the requirements of fraternity construction and accommodation; but, although they present a rather pleasing and different appearance, they are of a style of inferior quality and should not be encouraged if the Illinois campus is to maintain distinctiveness in architectural respects.

Fraternities are to be complimented upon the worthy contributions they have made to our campus architecture, and it is to be hoped that the organizations that are going to build in the future will follow the excellent example set by their predecessors. Any indulgence in wild or faddish styles which flare up every now and then should be deprecated, and the historical styles which have stood the test of centuries should continue to furnish the architectural inspiration for future building operations of this nature.

To read without reflecting is like eating without digesting.—*Charles Lamb.*

Fatigue Limit in Metals

(Continued from Page 16)

(2) Specimens of metal tested to one hundred million cycles of stress at or near the endurance limit when retested under cycles of higher stress have uniformly shown some gain in strength. The evidence is that below the endurance limit as determined from long time tests, repeated stress actually improves the metal rather than injures it.

(3) For wrought ferrous metals at stresses near the endurance limit there is noted a distinct rise of temperature. This, as has been previously pointed out, probably is not a direct indication of fatigue failure, but is an indication of slip, which usually precedes the formation of a fatigue crack. In a stress-temperature diagram near the endurance limit is a fairly well marked "knee." Below this knee the rise of temperature is very slight indeed. Since for wrought ferrous metals slip seems to precede fatigue fracture the absence of evidence of slip below the endurance limit as determined by test seems an indirect piece of evidence in favour of the existence of an endurance limit.

It cannot, of course, be dogmatically asserted that for any metal there has been determined a limiting stress below which it is certain that the metal can withstand an infinite number of cycles of stress, but it is felt that the data of long-time tests does show that for wrought ferrous metals the assumption of an endurance limit seems reasonably safe, and that such an endurance limit in all probability exists. The existence of an endurance limit for non-ferrous metals is discussed in the next succeeding paragraph.

6. *Endurance Limits of Non-Ferrous Metals.*—The data available on fatigue tests for non-ferrous metals are relatively few, when compared with those available for wrought ferrous metals. Mr. R. R. Moore has made one of the most extensive series of tests in the laboratories of the U. S. Air Service at McCook Field, Dayton, Ohio. The results of these tests indicate that the endurance limit for these non-ferrous metals is not so well defined as is the endurance limit for wrought ferrous metals, and that it is necessary for these metals to carry endurance tests much farther than for wrought ferrous metals.

In the work of the investigation at Illinois, Monel metal, brass, copper, bronze, and a copper-nickel alloy have been studied. Typical S-N diagrams are shown in Fig. 6. The authors of this paper give as a tentative conclusion that for annealed copper and annealed brass an endurance limit is indicated, but that it is not developed until tests have been run to at least one hundred million cycles. For annealed bronze and for Monel metal, no certain endurance limit has been developed, though for the latter tests have been run to about five hundred million cycles. For annealed copper and annealed brass the rise-of-temperature tests indicate endurance limits at about the same stress given by the S-N diagrams. For Monel metal the rise-of-temperature test does not indicate any endurance limit below 42,000 lb. per sq. in. which is evidently above any endurance limit which can be given its S-N diagram.

It should be noted that the S-N diagram for annealed bronze and for the copper-nickel alloy show considerable "scatter" of points. It seems possible that non-ferrous metals may fall into two divisions, one showing an endurance limit, and one not showing an endurance limit. For the second group it may be necessary to project the line of the logarithmic S-N diagram beyond the available test data and to estimate the unit stress corresponding to any desired life. In this connection it is interesting to note that based on the limited data then available for steel, Professor Basquin of Northwestern University proposed a similar method for ferrous metals in 1910.

In the non-ferrous metals tested, indications of an endurance limit are obtained for those which can be successfully cold-drawn. This is interesting, but it will be necessary to have many more tests before definite conclusions can be drawn.

[1] Memorandum of the Chief Engineer of the Manchester Steam Users' Association. 1913.

[2] Bulletin 124, University of Illinois, Engineering Experiment Station.

[3] Improved Methods of Fatigue Testing," *The Engineer*, August, 12, 1921.

[4] "Eudurance of Steel under Repeated Stress." Chem. and Met. Eng., December 14, 1921, "Endurance Properties of Steel." Proc. A. S. T. M., vol. xxiii, Part II, page 56 (1923).

[5] "Resistance to Magnanese Bronze, Duralumin and Electron Metal to Alternating Stress." Proc. A. T. S. M., vol. xxiii, Part II, page 106 (1923).

[6] This machine is of a type used by Wohler. The machine with two symmetrical loads and a uniform bending moment was used by Sondericker in 1892. This particular foim is closely modelled on a machine used by F. M. Farmer in 1918.

[7] Bulletins 124, 136 and 142 of the Engineering Experiment Station, University of Illinois.

[8] See Proceedings of A. T. S. M., vol xxii, Part II, page 293 (1922), discussion by L. B. Tuckerman, on the "discontinuity" of the S-N diagram.

Public Address System

A Western Electric public address system was used at the large Homecoming mass meeting. This system was mounted on an automobile truck and was used on this occasion because of the ease with which it could be moved about to suit the conditions under which it might have been necessary to operate.

Similar equipment was used extensively to broadcast the big political conventions this past summer so that the crowds, unable to gain admittance to the convention halls, could gather in parks and public places and follow the meetings.

CHUCKLES

First Lunch Hound: "Well, old strawberry, howsa boy? I just had a plate of oxtail soup and feel bully."

Second Counter Fiend: "Nothing to it, old watermelon. I just had a plate of hash and feel like everything."

HE MOVES

Mrs. Coogan: "An' isn't it scared ye are that he'll be loafin' on the job there so far away, just like he did in school?"

Mrs. Murphy. "Divvle a bit. Sure, he'll never loaf on the job he has. D'ye mind what it is? Patsy's the lad that lights the fuse that starts the blast."

Pessimist (looking at collegiate flivver): "How many will this car hold?"

Optimistic Salesman: "Three, but six can get in if they're well acquainted."

PUNCTURED BUT PROUD

"Here, waitress. This doughnut has a tack in it."

"Well, I declare! I'll bet the ambitious little thing thinks it is a flivver tire."

—*Youngstown Telegram.*

HE KNEW THE GIRL

A young man with a pretty but flirtatious fiancee wrote to a supposed rival: "I've been told that you have been kissing my girl. Come to my office at 11 o'clock Saturday. I want to have this matter out." The rival answered: "I've received a copy of your circular letter and will be present at the meeting."

Teacher: "What are the three important Greek orders?"

Small Boy: "Cups skuffey, roas big sanwitch, and peas cocoanut pie."—*Exchange.*

"But, Billy, if I married you with your income, you couldn't even dress me."

"Well, with a few lessons I could learn."

SOME ENGINEERS!

"What have you been doing all summer?"

"I had a position in my father's office. And you?"

"I wasn't working either."

Baggs: "I'm worried. My girl is running around with that new doctor in town."

Jaggs: "Feed her an apple a day."

First Souse: "Hic!!"

Second Ditto: "Hic!!"

First: "Don' talk back t' me!"

LUCKY GUY

Father (to young man at 3 a. m.): "What do you mean by bringing my daughter home at this hour?"

Young man: "Why, the taxi driver offered to match me whether I should pay him double or nothing for his services—"

Father: "Well?"

Young Man: "And I won."

TELL IT TO THE MARINES

The wife and daughter of Lieutenant Berry, of the Great Lakes naval training station, approaching a gate to the station were halted by a sentry on duty there who had orders to allow no one to enter that gate.

"Sorry, but you'll have to go around to the main gate."

"Oh, but we're the Berrys."

"Lady, I don't care if you're the cat's meow, you can't go through this gate."—*Chicago Tribune.*

Sign on truck farm near Traverse City, Mich.: "Truth crushed to earth will rise again, but vegetables will die. Be careful of Your Damn Feet."

Co-ed: "So Charlie is teaching you how to play baseball?"

Ditto: "Yes, and when I asked him what a squeeze play was I think he slipped one over on me."—*Judge.*

ALUMNI NOTES

Harry Clay Coffeen, '98, died suddenly Sunday, September 14, near Waverly Beach, Indiana. Coffeen was extremely active while in the University. He played football, was captain of the track team and president of his class; at the same time maintaing a Tau Beta Pi average. For the first year after his graduation he held a fellowship at the University. He then went to the University of Pennsylvania. After that be taught at Armour Institute of Technology for several years and was an instructor here in the department of general engineering drawing from 1900 to 1902.

Before his death Coffeen was president of the national association of agents of the Northwestern Mutual Life Insurance company. This last June he was selected as the president of the University Alumni Association.

F. S. Michael, cer.e., '24, *F. L. Molohan*, e.e., '24, *T. E. Ormiston*, e.e., '24, *C. T. Parker*, e.e., '24, *G. W. Robinson*, e.e., '24, and *J. W. McHugh*, cer. e., '24, are taking the students training course of the General Electric company at Schenectedy, New York.

Fifteen alumni of the College of Engineering are studying telephone and radio problems in the research laboratories of the Western Electric company in New York City. Investigations are being conducted on human speech and hearing, improved telephone and radio apparatus and the behavior of electrons.

Harland H. Edwards, '17, formerly city engineer of Danville, Illinois, had charge of the construction of a new $110,000 memorial bridge over the Vermillion river at Danville. Yeager and Sons, of Danville, were the contractors. *O. K. Yeager*, '11 is a member of the firm.

F. L. Thompson, c.e., '96, and *C. C. Westfall*, c.e., '07, handled the major part of the work of designing and constructing the new Illinois Central station in Champaign. The two men hold the positions of chief engineer and engineer of bridges, respectively.

C. H. Dodge, min.e., '24, holds a graduate research fellowship at the Carnegie Institute of Technology, Pittsburgh, Pa. He is now engaged in field work on the prevention of coal mine explosions by the use of shale dust. The investigations are being conducted in Illinois mines.

G. Buchanan, Jr., min.e., '22, is employed by the Old Ben Coal Corporation in its experimental coke plant at Waukegan, Illinois.

K. K. Bose, m.e., '14, was general manager of the 1923 Calcutta Exhibition held in Calcutta, India. Exhibits were brought from all parts of India and from among them were chosen the material for the Indian section of the British Empire exposition at Wembly Park, England, during the past summer. Bose's position was one of considerable dignity as well as great responsibility since it was an enormous task to organize the exhibits of a place such as India. The exhibition was a great success and went a long way to stimulate the trade and commerce of the state.

G. A. Smith, '24, is chief mining engineer of the Cia Carbonifera de Sabinas, S. A. Mexico. He has charge of the department of surveying and engineering, and of all new construction work for this 6,000 ton per day coal mine. A million dollar coking plant is now under construction among other surface projects for this newly developed mine. This is the most important position given to any of our graduates immediately after leaving college. Gilbert is anxious to hear from any of his old friends in the department.

H. E. Wessman, *H. E. Herting* and *G. V. Nelson*, civil engineering seniors of last year, are doing graduate work here this fall.

E. C. Hartman, c.e., '24, is employed with the Mississippi Bridge and Iron Works at Decatur, Illinois.

G. O. Bates, c.e., '24, is working as transitman for the Illinois Traction System.

J. R. Welsh, editor of the Technograph last year, is with the engineering staff supervising the construction of a large rock fill dam in Kentucky.

Earnest Martinson, c.e., '24, is in the Engineering Department of the city of Gary, Indiana.

Cheating the Mississippi

(Continued from Page 11)

depth across the bottom, usually from one to three feet. The ideal grade to be used with $1\frac{1}{2}$ to 1 slopes in the class of soil encountered in this lowland is 0.10 ft. per station, or 5.28 ft. per mile. This grade gives a flow which will just remove the natural erosion silt from the ditch slopes and still not wash the ditch to a lower grade. This grade cannot often be maintained, however, except in the design of relatively short laterals, *i. e.* up to two miles in length.

There are many special points not touched upon here for lack of space. Among them may be mentioned the retarding effect a flat slope has upon the velocity of flow in a channel, size of trees to be removed when cleaning out an old drain for an outlet, the effect of an unusual amount of vegetation and woody debris in this region upon the coefficient of roughness, and several others only to be learned by extensive experience. All of them cannot be covered in one short article, and even at that there still remain some which come up on every project which must be left to the good judgment of the engineer.

The creator of drainage design, as of any other engineer worthy of the name, must first of all be a keen observer; the keener the better. Secondly, he must have good judgment; the more astute the more satisfactory his work will be. Thirdly, he must be an executive; the more active the more will his works stand as monuments to earnest endeavor. First came the levee engineer to the delta; then came the drainage engineer; in the future the road engineer must lay the thoroughfares which lessen distances.

Today the levees hold back the Father of Waters in the great force of his spring rampage, the drainage channels are making possible great yields of cotton on the more perfectly cultivated land; and the great stretches of concrete highway of the future will serve a country teeming with vegetation grown on land reclaimed by cheating the Mississippi River.

[illegible]

A yard of silk, a yard of lace;
A wisp of tulle to give it grace;
A flower placed where flowers go;
The skirt knee-high, the back waist low;
One shoulder strap, no sign of sleeve,
If she should cough, good morning Eve.

—*Siren.*

The heigh of tolerance: a baseball game between the Ku Klux and the Knights of Columbus, with a negro umpire, and the proceeds of the game to go for the benefit of the Jewish Relief Fund!

Book Reviews

(Continued from Page 30)

Value of Public Utilities

By C. C. Williams

A 136 page mimeographed book on the "Valuation of Public Utilities" has been prepared by Professor C. C. Williams, head of the department of civil engineering. The volume is primarily designed to provide a text for Professor Williams' classes in public utility appraisal.

A brief discussion of accounting methods and corporation organization is introduced before the main subject is taken up. This is done in view of the lack of knowledge of these subjects among engineering students. Long judicial quotations have been avoided in order to provide opportunity for classroom discussion and the use of reference.

Professor Williams has also revised his "Design of Railroad Locations," published by John Wiley and Sons, New York. The entire subject matter was brought up to date and two new features were added. They are an analysis of the cost of transporting freight, and a discussion of the effect of electrification on the choice of grades and other location features.

Problems to Accompany Engineering Drawing

By Jordan and Hoelscher

H. H. Jordan, B.S., head of the department of general engineering drawing, and R. P. Hoelscher, B.S., assistant professor of general engineering drawing, have completed a new book, "Problems to accompany Engineering Drawing." It is designed to supplement the recent book, "Engineering Drawing," by the same authors.

The volume consists of fifty pages, and is paper bound. The subject matter is divided into ten sections which deal with the subjects of lettering, titles, use of instruments for geometrical construction, orthographic projection, fasteners, shop drawings, isometric projections, oblique projections, and perspective. The object of the work is to provide a large and varied assortment of practical problems to supplement the theory given in "Engineering Drawing." The problems are amply illustrated with typical examples accurately drawn and reproduced. John Wiley and Sons, of New York City, are the publishers.

P. F. Larson, cer., '24, is now working in the plant of the Midland Terra Cotta company, Chicago.

C. K. Mathews, assistant in the surveying department last year, is now connected with the firm of Burns and McDonnell, at their Kansas City office.

D. Kosrich, arch., '24, is taking gardnate work at the University and is employed by Royer, Daneley and Smith, architects in Urbana.

G. H. Bowen, m.e., '22, is employed at an experimental plant of the Linde Air Products company of Buffalo, New York.

W. B. Mathews, m.e., '22, is employed by the Standard Oil company at Whiting, Indiana, as a designer of oil refinery apparatus.

J. E. Weick, m.e., '22, is with the Yackey Aircraft company of Forest Park, Illinois. Previous to this position Weick did drafting and surveying for the United States Air Mail Service.

E. W. Smith, c.e., '23, is district sales manager of Certainteed Products Corporation of Minneapolis.

C. W. Wolf, ry.e.e., '21, is in general engineering work for the Chicago Rapid Transit company.

E. C. Johnson, min.e., '21, is taking graduate work in the Sheffield Scientific school of Yale University. The work leads to the degrees of mining engineer.

H. J. Burt, c.e., '96, has written an article on "The Growth of Steel Frame Buildings" which appeared in the fiftieth anniversay number of The Engineering News-Record. Burt has been a consulting engineer for Holabird and Roche, Chicago architects, for many years.

R. L. Jacobs, m.e., '24, was married some time in July, and as we understand, has joined the staff of the Nevada Consolidated Copper Co. in Nevada.

N. A. Tolch, min.e., '21, is now Metallurgist for the Moctezuma Gold Mining Co. of Colorado. He is working on the designs of a new mill to treat their silver-lead ores. Tolch will also have charge of the installation. Reports received on Tolch's work are very good.

L. I. Cotherne, min.e., '22, is assistant professor of mining engineering at the Penn. State school of mines.

Phillip Buckey, min.e., '21, is also an assistant professor of mining engineering at Penn. State.

J. H. Setinsky, '21, is surveying the roads and sewer lines around the new Grant Park Stadium in Chicago. He hopes to be connected with the mining industry in the near future.

INDUSTRIAL LIGHTING CODES.

In order to protect workers from accidents and eye sight damage, no less than five states, New York, New Jersey, Pennsylvania, Wisconsin and Oregon have now in force lighting codes for industrial establishments. Other states are now considering the adoption of an industrial lighting code, and it seems only a question of time when all the states will adopt such a code.

Proper lighting of work places is not only of great importance to the operators working therein, directly affecting their safety and eyesight, but it is a factor of equal importance to the employer, as quality and quantity of output are deciding factors of profit or loss in the operation of the plant.

The introduction to the Wisconsin code reads as follows: "Insufficient and improperly applied illumination is a prolific cause of industrial accidents. In the past few years numerous investigators, studying the cause of accidents, have found that the accident rate in plants with poor lighting is higher than similar plants which are well illuminated. Factories which have installed approved lighting have experienced reductions in their accidents which are very gratifying.

"Of even greater importance, poor lighting impairs vision. Because diminution of eyesight from this cause is gradual, it may take the individual years to become aware of it.

"This makes it all the more important to guard against the insidious effects of dim illumination, of glaring light sources shining in the eyes, of flickering light, of sharp shadows, of glare reflected from polished parts of work. To conserve the eyesight of the working class is a distinct economic gain to the state, but regardless of that, humanitarian considerations demand it.

"Finally, inadequate illumination decreases the production of the industries of the state, and to that extent, the wealth of its people. Factory managers who have installed improved illumination, are unanimous in the conviction that better lighting increases production and decreases spoilage."

The Wisconsin Commission has adopted a rule to the effect that, "diffusive or refractive window glass shall be used for the purpose of improving day light conditions or for the avoidance of eye strain, wherever the location of the work is such that the worker must face large window areas, through which excessively bright light may at times enter the building."

A glass is now available which meets the above requirements. It properly diffuses the light and prevents sun glare passing into the building and is known as Factrolite.

Engineers of to-day are making a thorough study of illumination, so that they may be able to plan and lay out industrial plants, to scientifically increase their efficiency to as near the maximum as possible. This accomplished the engineer is not only doing something worth while for his employer, but is doing quite as much for himself by coming into prominence with modern ideas.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

220 Fifth Avenue,

St. Louis. New York. Chicago.

Pioneer Automobile

The first "horseless carriage," as automobiles were called in days before the invention of the term we now designate them by, in the Middle West was purchased by Hieronymus Mueller, founder of the Mueller Manufacturing company of Decatur. It was made by the Benz and Company of Mannheim, Germany, and reached Decatur April 25, 1895. A Decatur paper in speaking of it at that time said it was a "peculiar looking machine and attracted a great deal of attention as it was being towed from freight house to a carriage shop by an express wagon." The paper further stated that the machine "used kerosene and would run 100 miles without refilling the tank: the average speed over an ordinary road being 12 to 15 miles an hour."

The machine weighed about 1,500 pounds. It was given a thorough overhauling after its arrival and a few days later people in Decatur were astonished when it appeared on the street occupied by Mr. Mueller and his family. Horses tried to climb telephone posts, small boys and bicyclists chased it in crowds and it was generally regarded as an eighth wonder of the world.

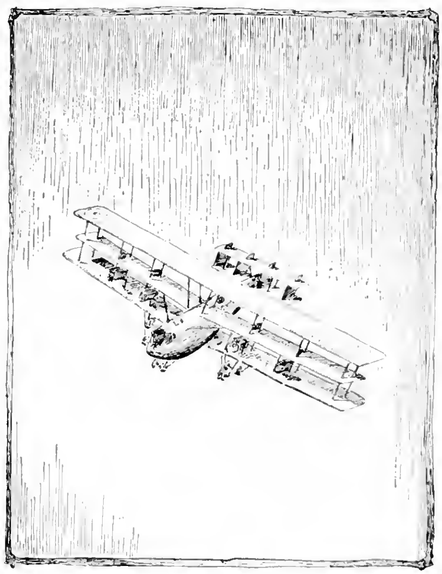
Mr. Mueller was confident from the day he received the machine that the automobile was to be the future mode of transportation, and within a few years he had improved the machine by inventions of his own. He built a number of automobiles and had he lived, the chances are that he would have become an automobile manufacturer. The Mueller "horseless carriage" won the first auto race in the country. After many postponements it was finally agreed that a special race be held Friday afternoon, November 1st, from Halsted and Fifty-fifth streets, Chicago, to Waukegan, Illinois, and back for a special prize of $500. Mr. Mueller won the race, returning at 6:43 in the evening to an awaiting crowd of 150,000 men, women, and children. The number of miles actually run was 92.

Another race was arranged for Thanksgiving day, since the first had caused so much interest. In this race the Mueller wagon failed to place first but did place second, taking a $1,500 prize. It is very interesting for us to go over the papers and magazines of the past and note the early means and new phases of transportation. Think how the "horseless carriage" has changed in a few years and how common a thing it is today. However, were this former Mueller wagon to appear on the streets today it would create as much interest as it did 29 years ago. Today if this wagon were to race it would be sure to get the booby prize; yet the tortoise sometimes wins the race.

Index to Advertisers

THE TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS



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1925

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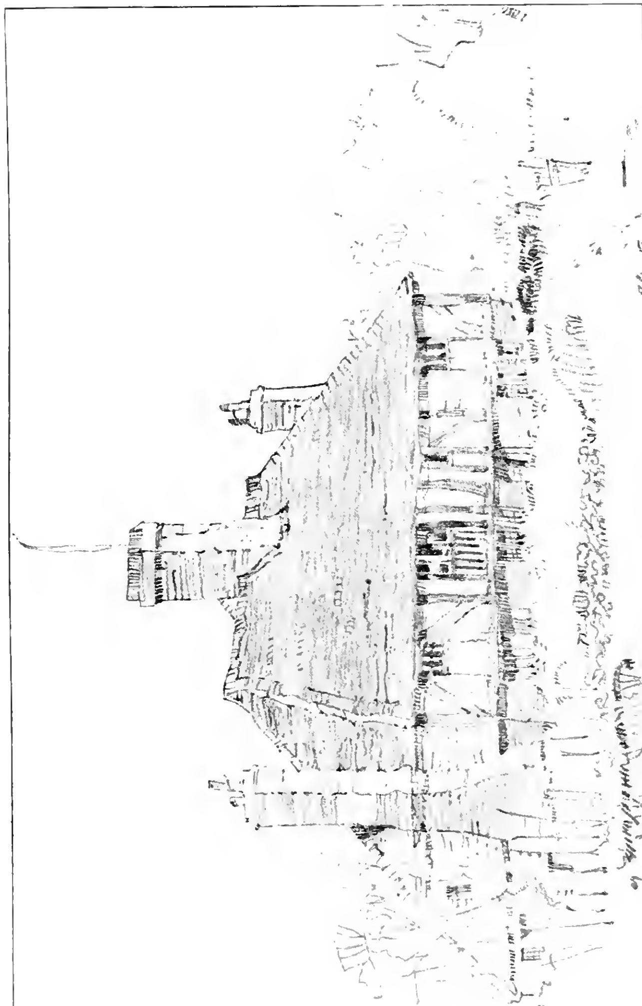


A Cottage at Rolvenden Lane, Kent

THE TECHNOGRAPH

Published Quarterly by the Students of the College of Engineering—University of Illinois

VOL. XXXVII JANUARY, 1925 NUMBER II

Origin and Growth of the English Cottage

C. T. PAUL, arch., '25

Abstract of First Prize Paper in Ricker Prize Competition, 1923-24

"Houses," wrote Bacon in his essay "Of Building," "are built to live in." Thus, tersely, he summed up for all time the mission of domestic architecture—houses, large and small, are built to live in. The basis of the whole history of house building, considered in its broadest and most catholic aspect, has been governed by this truism. Throughout the ages, order has developed out of chaos. It has represented man's tentative efforts to express in material form his conception of a habitation and a home.

No type of a building is capable of bearing a more presonal stamp than the cottage. It has an intimate appeal, for its very size brings about a close association between the dwelling and those who live in it. Therefore, in considering the English cottage, we can only see it in true perspective by tracing the development of man's dwelling from a very early period. We will skip that period in which primitive man made his home in caves and in the tree-tops, and examine first, his earliest dwelling on terra-firma.

The first dwellings on solid earth were very primitive. They were round, made by erecting two basket-like cylinders, one within the other, and separated by an annular space of about a foot, by inserting upright posts in the ground and interweaving hazel wattles between. The annular space was filled with reeds or straw. These early Irish houses had no chimney. The fire was made in the center of the house and the smoke made its exit through the door or through a hole in the roof.

Many of the early round huts were sunk below the ground. Pit dwellings, as they have been called, have been found at Fisherton, near Salisbury, and elsewhere. The pits were carried down through the chalk to a depth of from seven to ten feet and the roofs were made of interlaced boughs coated with clay. They were entered by tunnels excavated through the chalk, sloping downwards to the floor. The depth to which such buildings were sunk grows less as we approach historical times.

The rectangular house was evolved from the temporary booth or tent built by the shepherds for their summer residences in the mountains or summer pastures. These buildings were erected in bays, the house of one bay being the simplest form. The principle of the construction of the house of one bay was simple. Two pairs of bent trees, in form resembling the lancet-shaped arches of a Gothic church, were set upon the ground and united at their apexes by a ridge-tree. The framework, so set up, was strengthened by two tie beams and four wind-braces and was fastened together by wooden pegs. The bent trees, or arches, were placed at a distance of about sixteen feet apart and the space included between them was known as the bay. Thus the bay formed a sort of architectural unit, for the building of one bay might be increased indefinitely in length by adding other bays.

These couples, or pairs, of bent trees were anciently known as "forks" or, in Latin, "furcae." They are now popularly called "croks," "crucks," and "crutches" and a building erected in this manner is said to be built on "crucks."

The oldest of these buildings had no upper story and the walls were made of wattle-work plastered over with clay or mud. Sometimes they were covered with planking resting on the "crucks" and laid parallel to the ridge. The door of these buildings was in one of the gable ends.

A house at Scrivelsby, near Horncastle, popularly known as "Teapot Hall," is an excellent example of this kind. (Fig. 1 and 2.) It is built of two pairs of straight crucks which extend from the four corners of the house to the ridge-tree and which support the ridge-tree. The framework is further strengthened by the addition of wind-braces. The length, breadth, and height of the building are each nineteen feet. The doorway in the south gable end and a small "outshot" building, whose roof is considerably below that of the main building, projects from the opposite gable end. This "outshot," built of wood, and coeval with the house, contains the

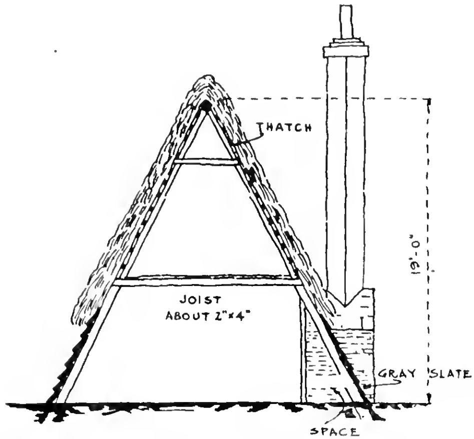


FIG. 1. SECTION THROUGH HOUSE AT SCRIVELSBY

pantry and scullery, the pantry being, as is usually the case, in the northwest. From the floor of the "outshot" a ladder goes up to the bedroom above.

The walls, which are about six inches thick, are composed of wooden studs, with twigs or branches of trees interwoven, the whole being overlaid with plaster. The sides are thatched with straw down to a point a little below the bedroom floor. From this point, gray slate extends to the ground. The roof of the "outshot" is rounded and is thatched with straw. The fireplace, which may be in its original position is of brick, and it, as well as the chimney, is of more recent date than the rest of the house.

The next evolutionary step was to make the walls of these buildings straight, while still retaining the original construction. For, obviously, when the walls were straight there was more space in the house and it became a more convenient place in which to live. The change was accomplished in the following manner. The ends of the tie-beams which braced the "crucks" together, were lengthened outwardly, so that the tie-beam became equal in length to the base of the arch formed by the "crucks." Upon the tops or at the ends of these extending tie-beams, long beams known as "pans" or "pons" were laid and then the rafters were laid between the pans and the ridge-tree. Finally, a side wall was built from the ground as far upwards as the pan so that the pan rested on the top of this wall.

The walls were built in after the wooden framework had been set up. It is obvious that this must have been so when they were composed of upright posts and interlacing twigs. But we should hardly expect to find that such was the case when the walls were of stone. Numerous extant examples, however, prove that it was so and the section of a barn at Treeton, near Sheffield, (Fig. 3) will show one way in which stone walls were added to a building of this kind.

The change from the ancient method of supporting the roof by pairs of arches springing from the ground, to the modern way of supporting it by pairs of principals was made very slowly. To us, in these days, the modern roof resting in upright walls of stone or brick seems too plain and simple a thing to be regarded as a triumph of human skill. And yet it is of comparatively recent date in the English popular art of building. Nowhere is the spirit of conservatism more conspicuous than in architecture. As the Romans usually framed their roofs with the tie-beam and king-post, it is strange that the English people should have been so long in adopting this method of construction.

It is obvious that a house consisting of one bay would provide poor living quarters for a family. It could, however, be increased in size by adding other bays to the ends or by building additional

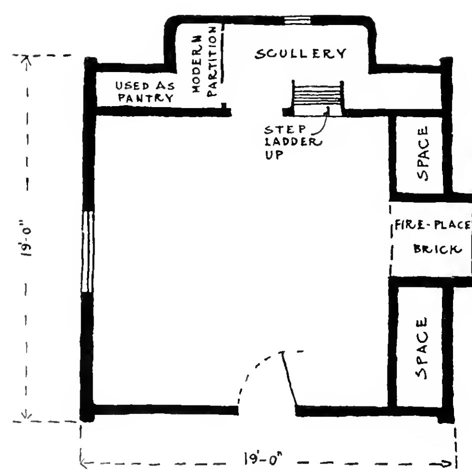
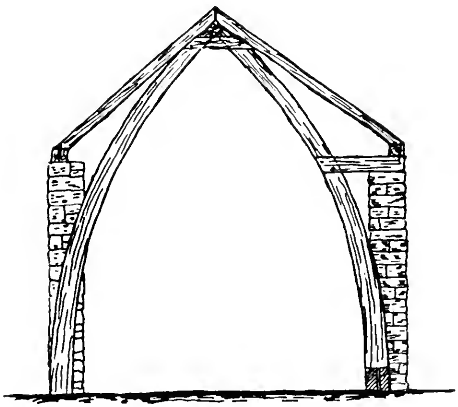


FIG. 2. HOUSE AT SCRIVELSBY

rooms at the ends or sides. When the latter course was adopted, the additional rooms were known as "outshots" or "outshuts," the name still being preserved in the "outshot" kitchens often built at the rear of workmen's dwelling-houses. Though outshots adjointed, and formed part of the house itself, they were not "built on crucks," and could not strictly be described as "bays." They were outside



"CRUCKS" IN BARN AT JACKSON'S FARM AT TREETON
MR. T. WINDER
FIG. 3

the "bays" or nave, as we may call the central part of the building.

In the larger buildings, the "aisles" at the sides usually extended along the whole length of the structure like the aisles of a church. We shall deal with these larger buildings later and shall now examine the cottage of one bay only, with upright walls and with additions at the ends as well as at the sides, in the nature of "outshots."

A cottage at Westward, near North Meols is an interesting example. (Fig. 1.) The cottage is plain, square, and whitewashed, with eaves 5 feet 8 inches from the ground. There are no upper rooms and there is no ceiling beneath the roof. In other words, it is "underdrawn." The room in which the family live is known as the "house-part."

The house-part contains the only fireplace and consists of a single bay sixteen feet long and about thirteen feet broad, the crucks being in the usual positions. In the plan in Fig. 4, the bases of the crucks are shown by the letter "C." Within the doorway is a covered inner porch, with a screen which keeps the wind out and protects the house-part from the gaze of the stranger and from the wind when the outer door is opened. This screen is known as the "speer." A wooden bench is fixed against the inner side of the speer, so as to form a seat. The top of the speer forms a large shelf for holding dishes, pots, and other things. The mantel-piece, known in the West Riding of Yorkshire as the "aitch," extends across the whole width of the room. Upon it are displayed the pair of potdogs so common in houses of this kind, as well as a number of small earthenware figures and statues. The chimney in such houses is rarely straight; it usually leans considerably to one side. This is often the case when the chimney stack is outside the wall.

From the house-part a door opens into a small out-shot room known as the "buttery" where food and pots are kept, this room having originally had no windows. Another door opens into two small bedrooms on the first floor known as "chambers." The inner chamber is divided from the outer "chamber by a wooden screen, anciently known as a parclose, which extends about halfway up to the roof and is not unlike the partition which divides cowstalls from each other. Opposite the speer is another small chamber.

The floor of these chambers is made of clay, as was that of the house-part originally. The whole cottage was originally built "clam staff and daub," there being no stone in the neighborhood. Brick has, however, been inserted in place of the woodword and clay so that only a part of the original outer walls can now be seen. The cottage is white-washed within as well as without and is exquisitely neat and clean.

In historic times the houses of the English peasantry were built mostly of wood, stone being used only where wood could not be obtained. This kind of buiding continued to the close of the sixteenth century. The old English word for build was "timbran," to timber, and the man who built the house was called the "treowwyrtha" or carpenter. The setting of the timber framework of a house

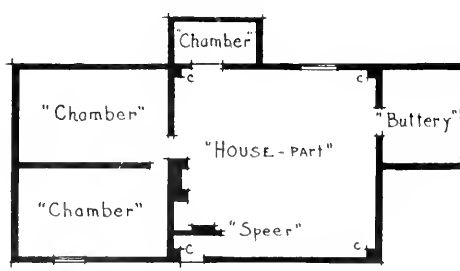


FIG. 4. PLAN OF HOUSE AT WESTWARD, NORTH MEOLS

was called the "rearing" of the house. A wooden house, or one built of wood and plaster is still known in Yorkshore as a "reared" house, to distinguish it from a stone house.

In the houses of the wealthy, stone was used at an early period, how early we do not know. In such houses it may have been used continuously since the Roman occupation. Where wooden framework is filled in by stone or bricks, the construction is known as "half timber" work. Such are essentially wooden houses, built of wood from the foundation, the interstitial spaces having been filled in by the material nearest at hand, whether that material were clay, mud, stone, or brick. The oldest way was to weave twigs or brushwood in and out of the posts. After that came laths, which were filled into "slots" in the posts by a process known as "shooting."

In a house at Warrington, wattle and daub, and stone and brick are used in different parts. Here hearth stood in the middle of the floor and in a German house it stood several feet from the nearest wall. It is undoubtedly for that reason that the fireplace of the Middle Ages did not adjoin an outer wall, as is the custom at present, but stood at some distance from the outer wall.

Only the hovels of the poorest inhabitants were without a funnel of some kind to convey the smoke. It is true that stone or brick flues which formed tubes "in the sides of the walls" were to be found only in castles or large buildings but wood-and-plaster canopies or "covers" to convey smoke were commonly used from a very early period. The summits of the oldest chimneys resemble louvres and the smoke did not escape from the top, but from one

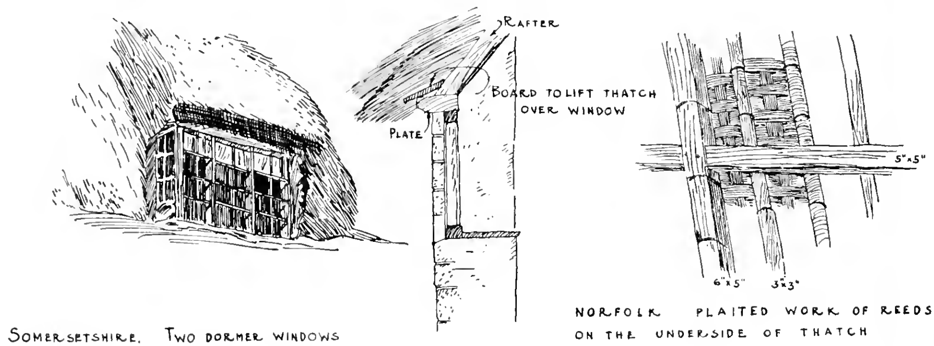


Fig. 5 Details of Roof and Thatching

the wattles are rods of hazel, with the bark on, laid close together in an oblique direction and covered by a thick coat of clay. The act of throwing this material on is still known in South Yorkshire as "parging" and in Derbyshire as "sparging."

The word, "brick," does not occur in English literature before the middle of the fifteenth century and perhaps the earliest true brick building is that of Little Wenham Hall, believed to date from the end of the thirteenth century. But we are not to suppose that the art of brick-making, so commonly used by the Romans, was ever lost in England. Such a loss would have been exceedingly improbable. The old name for a brick was "tigel," or tile, and the tiler was the brickmaker. Formerly bricks were much thinner than they are at present and there was little to distinguish them from tiles. It is a curious fact that the walls known in Yorkshire as "parpoint" walls, consisting of thin rather than small stones, resemble walls faced with Roman bricks.

The evolution of the chimney is one of the most interesting questions which concern domestic architecture. In the English pre-historic hut, the open or more holes in the sides.

The windows in ancient English dwellings were very small. This may be inferred, not only from the extant examples, but also from the costliness of glass. Another proof is to be found in the fact that the word, window, means "wind-eye" or "wind-hole," as though its main use was to admit air rather than light. What the oldest forms of English mural windows were like may still be seen in the various loop-holes or apertures found in the walls of old barns. Here we have narrow, vertical slits, triangular, and sometimes, round holes.

It is probable that the original loop-hole was an aperture through which light or air could enter, or through which smoke could escape. Glass windows, except in churches and gentlemen's houses, were rare before the time of Henry VIII. A substitute was used in the form of framed blinds of cloth, or canvas; called "fenestralls." In the time of Henry VIII, they used linen dipped in oil, as well as glass.

English houses were plastered and white-washed

(Continued on Page 100)

Lifting Illinois Out of the Mud

FRANK T. SHEETS, C.E., '11
Chief Highway Engineer

The year 1924 has marked a climax in the history of Illinois road building. During the year, 1205 miles of durable hard-surfaced pavements were completed—a world's record. Of this mileage, 1,023 mlies were located on the State bond issue system and built directly by the State, while 182 miles were State aid or 15d roads financed by the counties and built under State supervision. This year's record on the part of the State was marked also by individual records of accomplishments being established by many of the contractors engaged in Illinois road work.

This remarkable performance exceeding last year's world's record, and getting practically double the mileage built by any other State in the Union was made possible through the co-operative and coordinated efforts of all agencies engaged in the highway industry. The contractors, material producers, and the State's forces have functioned with such efficiency that this record has seemed comparatively easy of accomplishment. It is safe to predict that these same agencies can build a much larger mileage of paved roads during the years to come than has been completed this year.

Illinois enters the year 1925 with less than 20 miles of last year's contracts held over unfinished. This represents practically 100 percent completion of all 1924 contracts.

During the latter part of 1924 bids were received on some 600 miles of State roads, the acceptance of these bids being condditional upon the passage of the $100,000,000 State road bond issue. Awards on these bids are now pending.

The State offered for sale on December 30 the first block of the $100,000,000 bonds, the amount of th eoffering being $4,000,000. These bonds having sold satisfactorily, the State is proceeding with the purchase of all materials required, awarding the contracts, and within a few days contractors can begin to lay their plans for 1925 construction. It is planned to advertise additional mileage and award contracts, provided satisfactory prices are obtained, with the ultimate goal of completing at least 1,200 miles of State bond issue roads and perhaps 300 miles of State aid or 15d roads during the coming year of 1925. Referring to the map, the solid lines show all the roads to be built from the $60,000,000 bond issue, and the dotted lines give the location of the roads to be built from the $100,000,000 bond issue passed last November.

The record breaking performance of Illinois during the years 1921, 1922, 1923, and 1924 has been in accordance with the policy of rushing to completion as rapidly as possible the State highway system. Fair and equitable prices have been demanded, a dollar's worth of value for every dollar expended has been the slogan, and roads of unsurpassed quality, workmanship, and finish have been provided for our citizens. Illinois has literally been lifted out of the mud.

PROPOSED ILLINOIS HIGHWAY SYSTEM

Flying Model Airplanes

Bertram Pond, m.e., '25

Model airplanes had been built many years before the Wrights' first man carrying airplane. Many of the first were built by Samuel P. Langley in his experiments while connected with the Smithsonian Institute. Some of Langley's best steam driven models flew extremely well. One writer states that a circuitous flight, measuring probably one mile, was made. Langley followed his successful model experiments with a full sized airplane but in an attempt to launch this promising plane from the top of a houseboat on the Potomac river, a wire caught and collapsed the wings causing the plane to dive into the river. It then remained for the Wright brothers, through their work with gliders, to operate the first successful airplane.

Then came the trying years of aviation, a fluttering newcomer of science. Enthusiasts banded together and formed aero clubs. The game was fascinating and the result we all know—"aviation is here to stay." Aero science clubs and research cliques formed here and there over the country. The Illinois Model Aero Club of Chicago was one of the oldest and foremost organizations interested in the research of aerodynamics through model airplanes and gliders.

In 1917 the members of this club, in the annual competition, won their third leg and permanent ownership of the silver, Henry Villard trophy cup for model airplanes, along with a considerable amount in cash prizes for the individual members. The second international air race at St. Louis last year contained an event known as the Mulvihill Model Trophy contest. An interesting trophy with small plaques and cash totaling three hundred dollars were all won in a positive fashion by the members of the Illinois club. Edward Lange won first place with a flight of 257 seconds. Robert Jaros, ex'27, and Pond were second and third respectively. The St. Louis meet was such a success that the contest committees of the National Aeronautical association raised the prize money for the 1924 contest to five hundred dollars and the newspapers and magazines featured the Mulvihill Trophy event of the Dayton races.

The Mulvihill Trophy, a beautiful bronze statue (Fig. 1) goes annually to the organization taking first place. The prize itself portrays several symbolic features. The base, an upturned head of the God of the Winds, is surrounded by a border of stars, clouds and waves. Above a well modelled figure of an athletic youth shown tying wings to his arms.

The competition for this award was held in connection with the big aviation meet at Wright Field, Dayton, Ohio, on October fourth. Among the thirty-five contestants lined up by Major Schroeder at the timers stand were college graduates, air pilots, and mechanics of years gone by, students from the universities of Michigan, Chicago, Illinois, and Armour Tech, high school lads and small boys.

To many the frail and plain looking models seemed but toys to be flown a few hundred feet and the luckiest fliers given the prizes. The aerobatics, the racing airplanes, parachute jumps, smoke screens, and other events that are a part of an air carnival were matter of fact performances which people enjoyed and "ahed" at in a semibored attitude. Real astonishment and intense interest and curiosity, however, were shown by thousands of spectators as the first model flew away and landed out of sight of the grand stands. Orville Wright commented in his usual practical manner that this model flight was much longer than the early flights of his first plane.

In the competitions the contestants are required to strictly follow the flying procedure as outlined in the rules of the contest committee. Each flier is notified, shortly before his turn, to prepare his model for flight. Minor adjustments are made quickly and the motors prepared for winding at this time. When the preceeding contestant's model has landed, the course is clear and the judges call for the next man. He then winds up his model. The rubbers are stretched out to give as many winds as possible. This is done by having a helper hold the model by the propellers while several thousand energizing turns are cranked into the four to six strands of 1/32 by 1/8 inch rubber with a gear winder. This winder is an abbreviated eggbeater supplied with hooks to fasten to the strands of rubber. When fully wound up a last look is taken at the adjustments of the planes and the flier calls "time." The model is then launched nose into the wind for one of its three official flights. Some sailed high and some low, others sailed far and some crashed at the feet of their pilot. There is really much excitement among the spectators as well as at the timers stand, together with a lot of confusion typical of a championship meet.

Each flier is allowed three starts, the best one being counted. One after the other, models are timed in their flights. For this work there are numerous judges with split second watches, and an advance guard of assistant judges on motorcycles bearing large red flags who follow the models and signal their landing. In this way it is easy to follow the flights and accurately signal to the timers the instant of landing.

When the smoke had cleared and the spectators were calling for more, young Robert Jaros, former Illini, had broken all existing world records for distance and duration and had returned the coveted trophy to the shelves of the Illinois Model Aero Club. His model (Fig. 3) had been lost from sight by the most advanced judge at the end of ten minutes and fourteen seconds. This was considered a very good performance, but not out of reason for the scientific design and selection of material exercised by Jaros.

The lightest wood known, balsa wood, was used for the true pitch motor base, wing beams, and ribs. Music wire, a very strong steel wire, was used for wing clips, loops, hooks and shafts. The wings and elevator were covered with Japanese silk tissue, an extremely light and tough paper. The motive power was provided by the use of the purest para rubber strands obtainable. The result was a model with the extreme light weight of one and a half ounces.

Familiarity with the handling of small tools is soon acquired in model work. Workmanship is an important factor in a model. The use of more than common arithmetic is required in calculating the beam stresses and the performance characteristics of the model. Some of these characteristics are taken from books, but others are deduced from comparing the tabulated results of many actual flights by similar types of machines. Models fly at low speeds and with light loadings which make the direct application of wing section data subject to a considerable correction. For this much of the data used in the making of the large airplanes is not applicable to model work unless correction factors are determined.

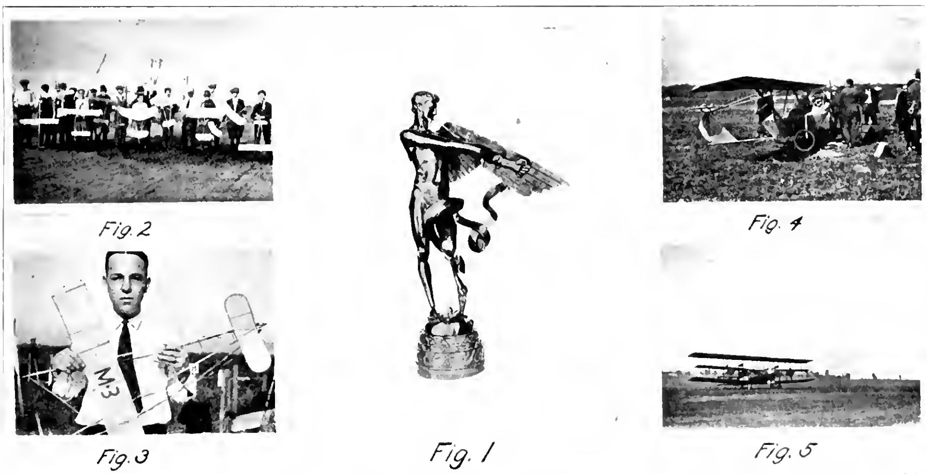


FIG. 1, THE MULVIHILL TROPHY; FIG. 2, A GROUP OF MODEL AIRPLANES; FIG. 3, A WINNING MODEL; FIG. 4, A "DORA MAY"; FIG. 5, THE BARLING BOMBER

However, it is but a short step from model work to the making of a small airplane like the 250 pound Dora May, or flying bathtub, with a Henderson motorcycle engine (Fig. 4). Another step beyond this and really not far removed from the model is the large plane of the type of the Heath Favorite and many others of the commercial types. The principles of the Barling Bomber (Fig. 5) also are the same as those in the smallest model airplane. There are a number of principles upon which size has no effect. The model fliers know these many principles well, and are potential designers of larger aircraft.

When Gar Wood, the speed boat designer and pilot, expressed the wish to the boys that he were free to join them in their sport he, no doubt spoke the thoughts of many others present.

Research Results in Heating and Ventilation

A. C. Willard

Professor of Heating and Ventilation and Head of Department of Mechanical Engineering

Editor's Note: *Professor Willard is consultant on ventilation for the Tunnel Commission of New York and New Jersey. The other members of the Engineering Experiment Station who have been actively engaged on both of the investigations discussed herein are A. P. Kratz, research professor in mechanical engineering, and V. S. Day, special research assistant professor in mechanical engineering*

The editor of The Technograph has suggested that a brief discussion of some of the results of the research work in heating and ventilation, as conducted by the Engineering Experiment Station, might be of interest to Technograph readers. Of the investigations in this field, there are two of a co-operative nature which have proceeded to a point where some of the experimental results may be of interest to engineers in general. These investigations are: (1) the study of the factors affecting the performance and operation of warm-air furnaces and heating systems, and (2) the study of the power problems involved in the ventilation of the new vehicular tunnel under the Hudson River between New York and Jersey City.

The Warm-Air Furnace Investigation

The former investigation began in October, 1918, and is still in active progress. Four Engineering Experiment Station Bulletins' Nos. 112, 117, 120 and 141 have already been issued, and the scope of the work which is being carried on in the Mechanical Engineering Laboratory (Fig. 1) has just been materially extended by the completion and equipment of a residence (Fig. 2) at 1108 West Stoughton street, Urbana, to be used solely for research work in warm-air heating. This investigation of warm-air furnaces and heating systems is conducted under a co-operative agreement between the National Warm Air Heating and Ventilating Association and the University of Illinois. The results of the work have not only established the performance characteristics; that is, the relation between efficiency, heating capacity, and air temperature at registers for widely different types of furnaces, but methods of improving the efficiency and capacity of furnaces and heating systems for a given amount of fuel burned, have been developed.

The factors affecting the performance of a warm-air furnace as it is installed in this country today can be grouped under seven general heads, as follows:

(1) Fuel, which may be solid, liquid, or gas.

(2) Chimney and smoke connection, which determine draft available.

(3) Cold air duct, which may have single or multiple connectons, and supply either inside or outside air.

(4) Casing, which may be large or small in diameter, lined or unlined, and with a variey of bonnets.

(5) Leaders, stacks and registers, which may comprise a long or short system, running to first, second and third floor, or to only one floor.

(6) Temperature of the air entering cold air face and leaving warm air registers. This item also controls the rate at which fuel must be burned, and hence the draft required of the chimney.

(7) Insulation or lack of it below furnace, on furnace front, furnace casing, leaders and stacks. A large amount of data have been secured under each of the seven general heads and are presented in the bulletins already mentioned.

Of the many factors affecting furnace performance, it will be possible to refer to only one or two in this discussion, and such phases of the investigation have been selected as will probably have the most general interest.

Fig. 2. Research Residence

Effect of Inner Casings and Radiation Shields on Furnace Performance

The performance of a furnace as affected by the use of practical linings of different types and by radiation shields has been investigated and the results secured are most illuminating as to one important source of heat loss in these systems. This loss is occasioned by the radiation of heat from the casing of the furnace. Both manufacturer and furnace owner can profit by a study of the results obtained in this one simple phase of the investigation. The following is abstracted from Bulletin No. 141 of the Engineering Experiment Station.

FIG. 1. THE MAIN PLANT, FRONT VIEW

The functions of all such linings is to increase the heating capacity of the furnace by decreasing the loss of heat from the casing and by increasing the temperature of the air in the system. Increases in the temperature of the air are reflected in increased velocities of air flow and hence in heating capacity.

No lining.—In connection with the study of casing size, discussed elsewhere, tests of four diameters of unlined casings were made. In these tests a single thickness of galvanized iron separated the moving air stream from the exterior atmosphere. This series of tests has been used as a basis of comparison for the lined casing tests. The furnace used was of the cast-iron circular-radiator type. The connections (Fig. 1) to the furnace were identical in all four cases, 801 sq. in. of recirculating duct area and 808 sq. in. of leader pipe area being provided. In Fig. 3 the dotted lines represent the performance of the four sizes of unlined casings.

Black-Iron Lining.—Three of the four casings were tested with black iron sheet linings spaced one inch from the casings and extending from the top casing ring to the grate level as shown in Fig. 4. The performance with the three different casing sizes may be observed in Fig. 3 in the full lines. It is evident that the lined casings gave decidedly higher efficiencies, capacities, and register air temperatures than the unlined casings. It should be noted that the linings were not as effective in increasing the capacity when the casing was of small diameter as when the casing was of large diameter. The following table illustrates this point with data taken from the curves of Fig. 3.

TABLE I.
EFFECT OF LININGS ON CAPACITIES OF FURNACES

Casing Diameter in.	Casing Free Area sq. in.	Capacity at Bonnet for 7 lb. Combustion Rate, B.t.u. per hr.		Pct. Gain Lined over Unl'd Cas'gs
		Lined	Unlined	
50	716	147,000	137,000	7.3
52	860	135,000	123,500	9.3
56	1155	142,500	130,000	9.6

The effect of increasing the distance between the casing and the black iron lining from 1 inch to 2 inches indicates some advantages in favor of the wider air space. An average gain of 2 percent in capacity was obtained by this increase, the gain being greatest at low combustion rates.

The heat loss calculations based on observed casing surface temperatures showed that the heat losses from the furnace with a 2 inch air space between casing and lining were less than for the same furnace with a 1 inch air space. The lower tempera-

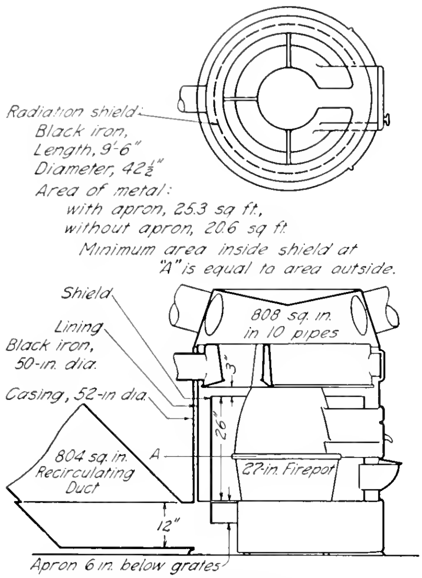


Fig. 4. Section of Furnace Showing Lining and Radiation Shield

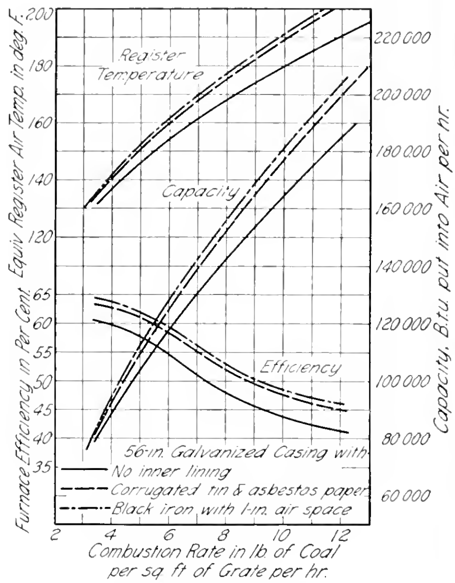


Fig. 5. Performance for Tests of Corrugated-Tin and Black Sheet-Iron Linings

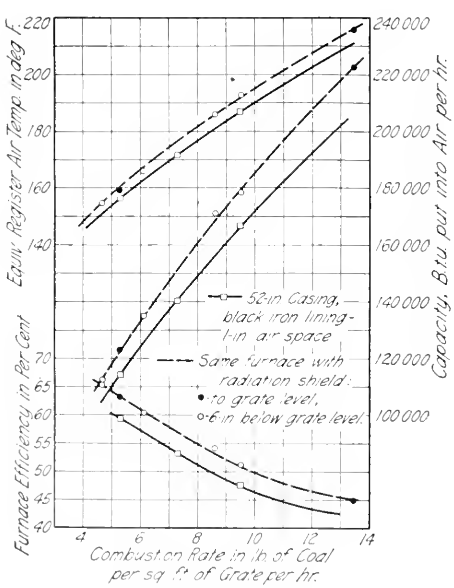


Fig. 6. Performance of Furnace with Radiation Shield

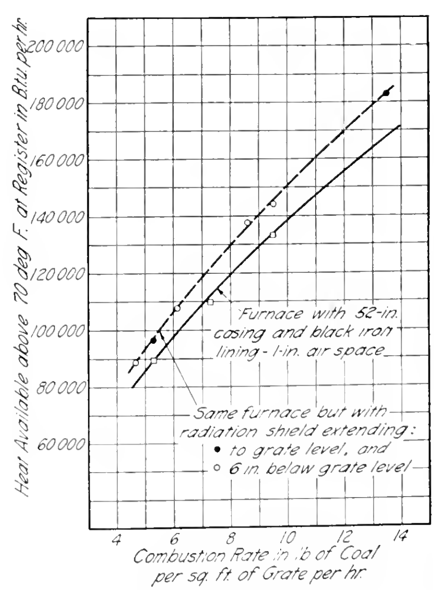


Fig. 7. Heat Available at the Registers with Radiation Shield

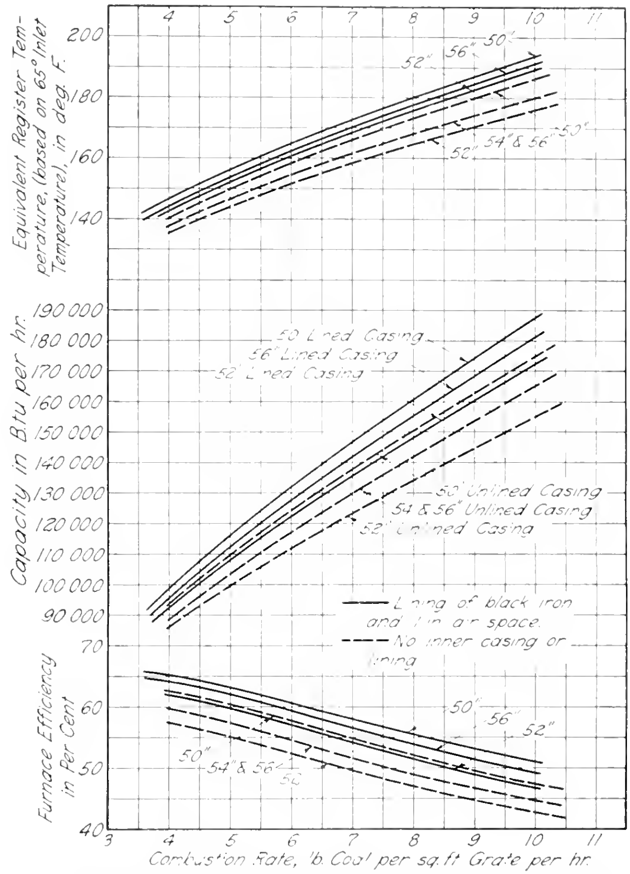


Fig. 3. Performance Curves for Four Sizes of Casings on a Cast-Iron Circular-Radiator Furnace

tures of the casing surface when the 2-inch air space was used indicated that a greater proportion of the air passed between the casing and lining.

Bright Tin and Asbestos Paper Lining.—A second comparison was made to show the relative value of (a) the 1-inch air space with black-iron lining and (b) a corrugated bright-tin lining backed with asbestos paper, pasted to the casing. In Fig. 5 the performance curves for furnaces having the two types of lining are shown. As may be observed from Fig. 5 the air-space lining proved the more efficient, the capacity averaging about 2 percent higher than for the asbestos paper and tin lining.

Radiation Shield.—A third test made with a cylindrical shield of black iron, located as shown in Fig. 4, showed that such shields placed adjacent to the hottest surfaces, so as to intercept a large part of the radiant heat, improved furnace performance. This is true when the increased heating effect and the increased motive head due to the flow of air of higher temperature are not offset by the resistance of the shield to the flow.

In the tests, the shield of black sheet iron was so located as to divide equally the area of the air stream at the elevation of the top of the firepot. As shown in Fig. 4 the shield carried a detachable apron which extended 6 inches below the level of the grates. The results of the tests on this equipment are embodied in the curves of Figs. 6 and 7. From these curves the following conclusions may be drawn:

(a) Marked increases in furnace efficiency, capacity and register air temperature resulted from the use of the radiation shield, the increase in capacity amounting to 7.5 percent at an average rate of combustion.

(b) No difference could be detected between the performances with the short and the long shields. This fact may be observed in Figs. 6 and 7 in which points representing tests with both types of shields lie on a common curve.

(c) The actual heat available at the registers of the plant, Fig. 7, for any assumed rate of combustion was increased approximately 8.5 percent by the use of the shield. This increase was the combined effect of higher air temperatures at the registers and a greater weight of air flowing.

(d) Intercepting the radiant heat from the hot castings reduced the casing temperatures from 150 to 105 deg. F. at low rates of combustion and much more at high rates, and reduced the heat losses about one-fourth, or 3 percent of the heat of the fuel.

(e) The temperature of the shield ranged from 310 to 510 deg. F. approximately the same as the temperature of the ashpit.

Recirculating Ducts of Two Types

Reference has been made to the seven factors affecting the performance of a warm-air furnace and heating system, and under item (3) the cold air duct supplying air to the furnace was mentioned. It will be evident to anyone with the simplest knowledge of the laws of air flow that when operating under gravity head the air in this duct must not be heated *on its way down*, and that there should be as little friction in the duct and *at the elbows* as possible. Nearly every furnace heating system violates these two conditions; many do so flagrantly, and the operation suffers accordingly. Keeping the duct away from the hot casing of the furnace, and eliminating the sharp 90 deg. elbows will increase the furnace capacity materially. This duct should connect into a wide low shoe, the top of which is not above the level of the grate in the furnace, as such a shoe will greatly assist in avoiding preheating of the down-coming air. The results of tests on two types of recirculating ducts are abstracted from Bulletin 141 and are typical of the data presented in the bulletins on warm-air furnaces and heating systems.

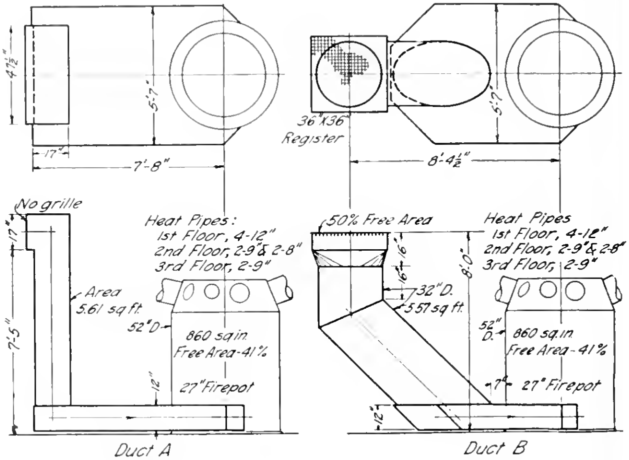


Fig. 8. Two Types of Recirculating Duct Tested

Description of Plant and Tests.—These tests were run to determine the effect of recirculating duct design on the performance of the furnace operating under conditions of gravity circulation. The comparison has been made on the basis of heat available at the registers for each type of duct. This basis shows the over-all effect of such ducts on the actual heating of a house. The furnace plant (Fig. 1) used in the tests was identical for both cases except for the changes necessary (Fig. 8) in the recirculating duct. The tests were made as follows:

(a) A series of four tests was selected from previous work, for comparison. These tests were run on the plant as described under the "Main Plant" in Bulletin 112 of the Engineering Experiment Station.* The essential features of the duct are shown as Duct A, Fig. 8.

(b) A series of tests was run on the furnace with the improved recirculating duct shown as Duct B, Fig. 8.

Results of Tests.—The results of the tests are shown in the curves of Fig. 9, in which the heat available at the registers above 70 deg. F. is plotted against register air temperatures.

Discussion of Results and Conclusions.—The round duct with 45-deg. elbows and without unsatisfactory right-angles bends of the rectangular duct handled a much greater quantity of air and developed a greater heat available at the

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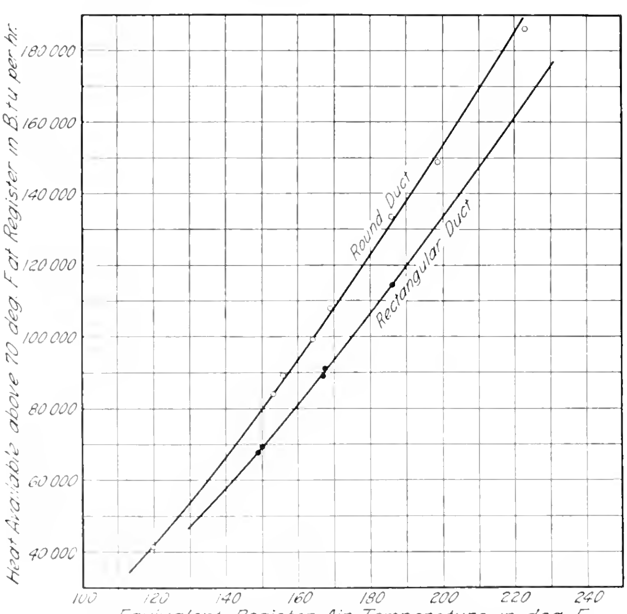
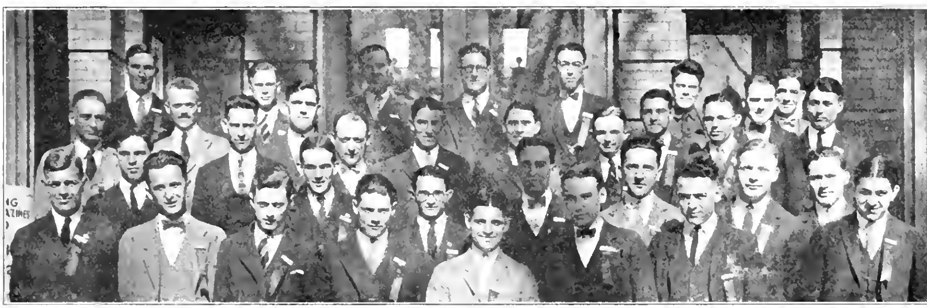


Fig. 9 Register Air Temperature—Heat Available Relation for Tests of Two Types of Recirculating Ducts

Convening With E. C. M. A.

L. R. Ludwig, ry.e.e., '25
Technograph Representative

The Engineering College Magazines Associated celebrated its fifth reunion on October 25 and 26, 1924. The ceremony was the annual convention held at Madison, Wisconsin. The candles burned brightly, for E. C. M. A. is becoming a square shouldered young giant who will surprise the world some day by exerting a powerful influence on the American engineering press. The University of Wisconsin was an excellent host. All the luxuries which make the life of the delegate worth living were present, and there were excellent facilities for the accomplishment of definite results at the convention.



Engineering College Magazines, as the official name of the organization goes, was formed to secure standardization of the undergraduate engineering publications; to combine in the securing of national advertising; and to stimulate improvement in editorial policy and make-up. The association has served its purpose well, in fact so well that the sacrities made by loyal member publications to bring it into the world have been repaid. One cannot help but be pleased with the noticeable improvement which has been made in many of the publications, particularly within the past year. The business staffs are certainly aware of a profitable calm in the previously stormy sea of national advertising. There has undoubtedly been a great saving of time to advertisers.

The inspiration of a convention is often its greatest achivement. The recent meeting has indeed instilled into the delegates the desire and determination to make their publications a keener reflection of student engineering life, and true representatives organs of the engineering schools of the American universities. The clear insight into the problems confronting the college editor and business manager has been brought about by such speakers as Prof. J. M. Hyde of the school of journalism at the University of Wisconsin, and Prof. Gardner of the school of commerce at the same institution. Prof. Hyde handled the subject of "The Physical Makeup of a Magazine" most capably, illustrating his opinions by pointing out the strong and weak points of the various publications. Hyde was once managing editor of "Popular Science Monthly" and is thoroughly versed in the subject. The gist of his talk was a plea to make the college periodical less of a monthly text and more of a reflection of the lighter moments in the life of the young engineer. Prof. Gardner treated the business problems of the publications in much the same way, urging the sale of advertising on a merit basis alone. He introduced to the convention the principles upon which advertising should be handled by the entire group of publications. The round table discussions which were unfortunately limited did much merited work in the same direction.

The convention has more definite results to offer than inspiration, however. A national advertising rate card for the group of members has been published. It is available to prospective advertisers with full information as to the circulation and nature of each publication. A very complete style book, a long needed luxury, has been afforded by the convention. The officers elected for the ensuing year are: chairman, L. F. Van Hagan, of Wiscon-

(Continued on Page 104)

Champaign-Urbana Water Supply Treatment

Harold Alfred Vagtborg, m. and s.e., '26

If one should look into the history of Champaign-Urbana, one would find that perhaps the most interesting development is that of the water supply. Years ago when the sole source of supply was the well in the yard and the cistern under the house, a coal company, which had a mine shaft adjacent to the Big Four tracks in Urbana was fighting to stop the water which seemed to flow through the walls of the shaft at a depth of about seventy-five feet. The timbers and braces finally gave way and the mine was abandoned. The company then used the mine shaft as a well and installed a small pumping system to supply neighboring buildings with water. The water proved to be good and the system gave such satisfactory results that more wells were drilled and the distribution was expanded. After eight wells had been drilled to depths of 60-90 feet underground, it was decided to drill future wells deeper. In digging new wells, a finely grained white sand bed 20 feet deep was found at depths varying from 160 to 200 feet, depending upon the location of the well. From this sand bed a seemingly inexhaustible supply of water was obtained. At first it was believed that an underground river had been found but more recent investigations seems to indicate that the bed is a glacial sand pocket. Advantage was taken of the sand pocket for in 1913 the company had nineteen wells in operation, while at the present time there are thirty-seven.

Underground waters, as a rule, contain minerals. This particular water as it leaves the well contains iron of a soluble ferrous form in a proportion of two parts of iron to one million parts of water, by weight. As soon as the water becomes exposed to the air, the ferrous iron is oxidized to an insoluble ferric iron which is easily detected as small, brown, and flaky particles floating in the water. The iron existing by itself in the water is not particularly harmful to the operation of a water supply system, but due to the presence of a microscopical organism, the crenothrix, the iron particles are enmeshed in the jelatinous substance of the feelers which the crenothrix shoots out. It does not take long until thick mats form on all the surfaces over which the water flows. In the case of pipes, this growth will go on until the pipe becomes clogged and the flow of water stops. In 1913 just before water treatment was introduced, it was necessary to employ four or five men the year around to clean out clogged pipes. Most towns would have accepted the iron particles in the water and the system which required a crew of men to clean out pipes. In Urbana, however, much interest was shown by various departments in the University, and many tests were made to determine what could be done to eliminate these undesirable factors. Under the direction of Prof. A. N. Talbot of the College of Engineering, much experimental work was done and finally in 1913 the first iron removal plant in the country was constructed. Practically all of the iron was removed by a method of filtration through a sand and gravel bed which is similar to the method now used, and which will be explained later. This process eliminated the crenothrix-iron action in the system from the point of filtration on, but a layer of the brownish mass still existed on the sand and walls of the filter, the layer greatly obstructing the passage of the water through the sand.

In 1918 chlorine was added to the water before filtration in a proportion of one-half part of chlorine to one million parts of water by weight. The chlorine was added as a sterilizing agent which effectually ridded the water of any disease producing organisms that might have been present. It also stunted the growth of the crenothrix organisms to such an extent that the plant was entirely relieved from the action of this undesirable factor. Chlorination has proven so successful that it is

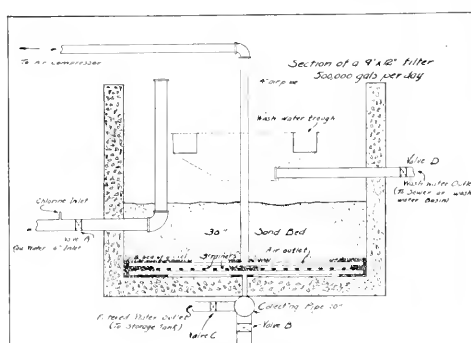


Fig 2

Rapid Sand Filter

now almost universally used in water treatment.

Filters are for the purpose of removing suspended matter as well as bacteria and other micro-organisms. There are two general types of filters that are now extensively used; namely, the slow sand filter and the rapid sand filter. The former can take care of from 2,000,000 to 7,000,000 gallons per acre per day whereas the latter has a capacity sand to be much higher than in the case of the slow sand filter. Rapid sand filters are much more efficient if a coagulating agent is introduced to coagulate the suspended matter in the water before filtration.

At first it was believed that rapid sand filters did not remove the matter as efficiently as the slow sand filters did, but tests have shown that with

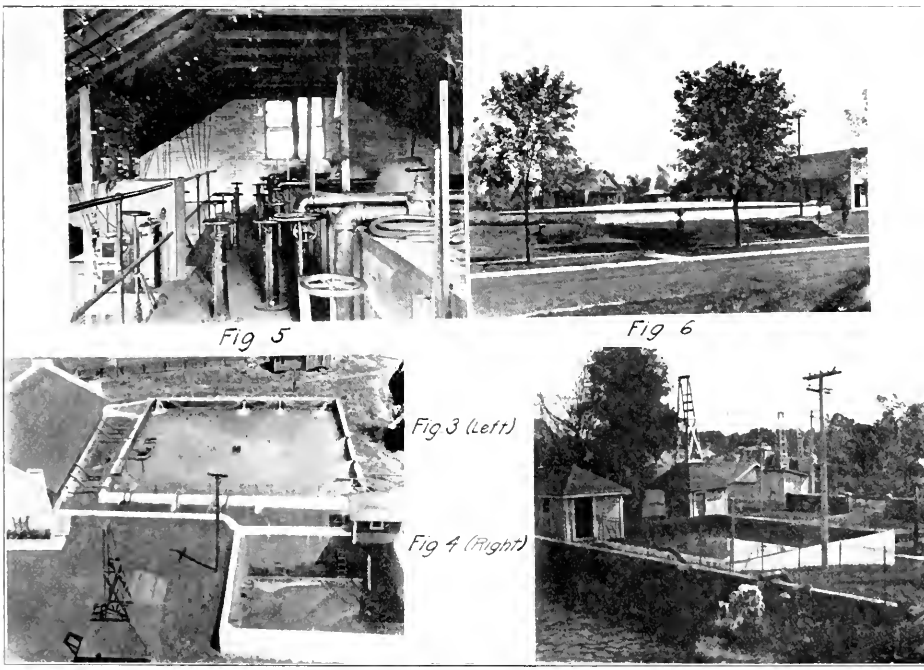


Fig. 3, Receiving Tank; Fig. 4, Spray Board; Fig. 5, Operating Platform; Fig. 6, Concrete Storage Tanks

of 100,000,000 to 150,000,000 gallons per acre per day. The marked differences of capacities necessitates important differences in construction and operation. The slow sand filter may be described as a large water tight reservoir having an area of from one-half to three acres. On the bottom of the reservoir is laid a system of drains. Over these are placed successive layers of gravel of decreasing depth. The water flows up and passes through the sand and gravel and is conveyed by the drains to a collecting tank. A rapid sand filter may be described as a tank having an area of 150 to 200 sq. ft. and with the bottom being built up of layers of gravel and sand with a system of drains underneath. (Fig. 2). The weight of a depth of water over the sand causes the rate of flow through the proper care the one is as good as the other. At the present time the rapid sand filter is used much more than the other, due probably to the economy of space.

As rapid sand filters are the most economically adapted for the removal of iron, the Champaign-Urbana water is rapid filtered. Fig. 2 represents a cross section of one of a battery of five rapid sand filters used by the Champaign-Urbana Water Company. The raw water enters the filter from the orifice of the raw water inlet, valve A being open, and as it falls through the air, oxidation of the soluble ferrous iron takes place, forming the brown insoluble particles. The water filters through a sand bed 30 inches in depth, which removes the iron particles and micro-organisms, and then flows

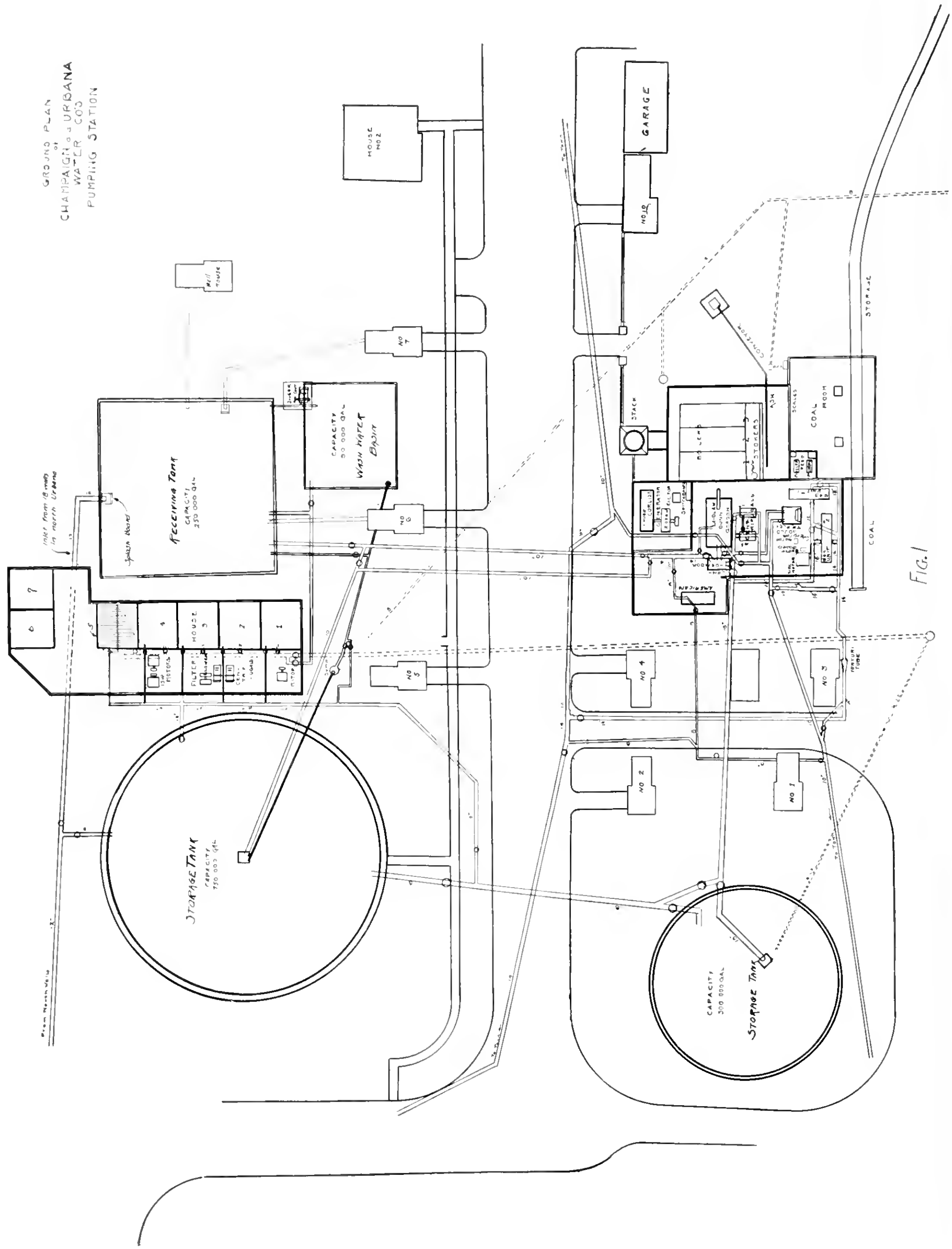

GROUND PLAN OF CHAMPAIGN and URBANA WATER CO'S PUMPING STATION
GARAGE
RECEIVING TANK CAPACITY 250 000 GAL
CAPACITY 50 000 GAL WASH WATER BASIN
FILTER HOUSE
STORAGE TANK CAPACITY 750 000 GAL
CAPACITY 300 000 GAL STORAGE TANK
STACK
BOILERS
STOKERS
COAL ROOM
SCALES
ASH
COAL
STORAGE

FIG. 1

through strainers into receiving pipes which are buried in a bed of gravel eight inches in depth. This gravel prevents the strainers from being stopped up by the sand. These receiving pipes are parallel to each other and six inches apart. The pipes are represented by the solid lines in filter No. 5 of filterhouse as shown in Fig. 1. The water then empties into a ten-inch collecting pipe and thence into a tank through valve C, valve B being closed.

As filtration goes on the bed becomes overloaded with residue and it is necessary to wash the filter. In the Champaign-Urbana plant this is done every twenty-four hours as follows. Valves A and C. are closed. Valve B is opened and the raw water which had been flowing through valve A is forced through B. The flow through the strainers is reversed and the water is forced upward through the sand bed. With the aid of compressed air, which is forced through openings in pipes which lie between the receiving pipes as shown by the dotted lines in filter No. 5 of Fig. 1, the sand bed is thoroughly broken up by the resulting bubbling action. The water rises in the filter, carrying with it the waste in suspension, and then flows over into two water troughs extending the full length of the filter. The wash water flows to one end of the trough, empties into a catch pan, and then flows into a sewer or a wash-water basin. This process goes on until the water in the filter begins to clear up. Valves B and D are closed, the compressed air turned off, valves A and C opened, and filtration is resumed.

Each of the thirty-seven wells has an electrically driven pump which lifts the water from the well and forces it into an underground pipe which terminates at the 250,000 gallon receiving tank shown in Fig. 1. Fig. 3 shows clearly how these pipes project over the edge of this tank. A spray board, Fig. 4, attached to the end of each of these pipes causes the water to splash in such a way that it comes into contact with much air, thereby oxidizing the ferrous iron to the ferric iron. The brown particles of the latter give the water in the tank a muddy appearance.

Centrifgal pumps take the water from the receiving tank and distribute it to the raw water inlet pipes of the five filters. Fig. 5 gives a view of the operating platform at one end of the filter house. The water can be seen, rising and falling from the orifices of the inlets of three of the filters. The pipes coming over the edge of the concrete wall to the right of the view, are the compressed air pipes, which lead into the sand beds as shown in Fig 2. All the valves of the filters are so fixed that they can be worked from the operating platform (Fig. 5).

Just before the water enters the filters it is treated with 15 pounds of chlorine per day, which is about 15 pounds per 3,000,000 gallons. This chlorine inlet is shown in Fig. 2. The water flows through the filters, passes through the strainers, then into the collecting pipe, and thence into the filtered water outlet. The outlet of the five filters discharges into a large main which carries the water from the filter house to the storage tank. As the water leaves the filter house, it is again treated with chlorine. This time with 5 pounds per day. This is done to insure chlorination.

When the filters are being washed, as has been explained, the wash water flows to the 90,000 gallon wash water basin, which is shown in Fig. 1 and in the center of Fig. 4. After the five filters have been washed, the tank is about filled to capacity. A pailful of alum dissolved in water is then added to the tank to coagulate the suspended matter, which gradually settles to the bottom. The water in the wash water basin is next pumped over into the 250,000 gallon tank and refiltered. The sediment is pushed into a sewer in one corner of the basin. During the washing no water flows into the storage tanks, but before these are emptied, filtration has been resumed.

Fig. 6 shows one of the 750,000 gallon, concrete storage tanks with the filter house to its right. As the figure shows, most of the tank is underground and the top is covered. This almost airtight roof acts as an insulator from heat, also protecting the water from rain, dust, and insects. Being underground, the tank tends to keep the water cool and fresh.

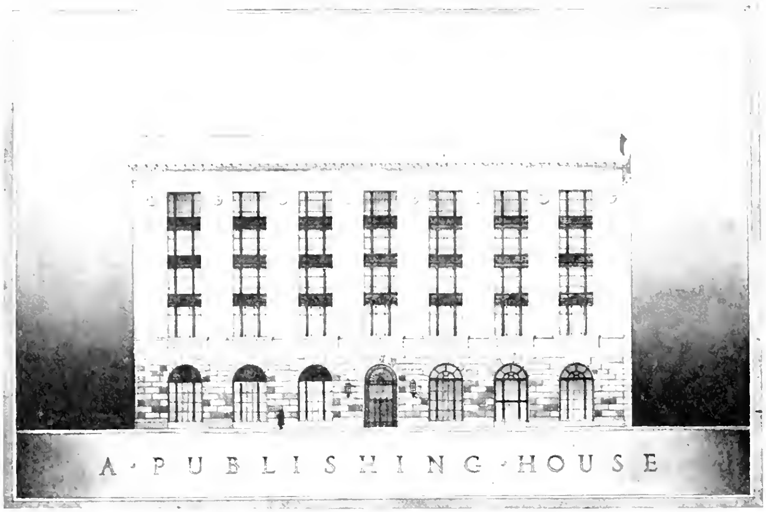
Centrifugal pumps in the power house draw the water from these tanks and force it into three mains which in turn distribute the water over the two towns. A few years ago the company produced its own power for the entire plant. At the present time, however, several electrically driven centrifugal pumps have taken the place of much complicated machinery. The Illinois Power and Light Corporation has contracted to furnish the power for the entire plant. In case of an emergency the water company has several large gasoline units available. Normally one centrifugal pump takes care of the 3,000,000 gallons per day required by Champaign-Urbana, but in case of a fire, the alarm is given at the power house and a second pump is put in operation, increasing the capacity to 5,000,000 gallons per day.

At the present time two new filters are under construction, indicated as Nos. 6 and 7 in the filter house of Fig. 1. In the new filters compressed air will not be used to aid in the washing and in

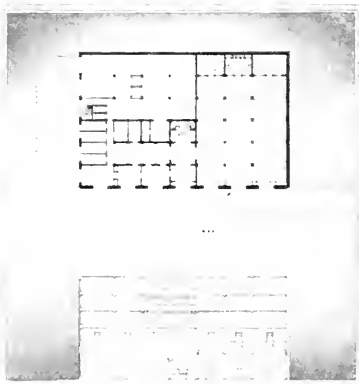
(Continued on Page 100)

Beaux Art Institute of Design

The ultimate destination of most of the work of the students in architecture is the Beaux Arts Institute of Design, or as it properly could be called and probably more clearly understood, the institute of intercollegiate competition. This latter term is truly descriptive of the nature of the Beaux Arts Institute.



C. T. Pau — First Mention



The idea and plan of this work was derived from the system of the same name in France. As carried out in this country the various architectural schools have formed a competitive union through which all work is gathered together and judged on a collegiate basis. A definite problem is assigned for certain classes and in every school groups are working on the same design. When finished these are sent to New York for judgment. The returns on every problem range from 50 to 100 drawings and are given their comparative ratings by a board of New York architects. New York has been used as the logical center for this work because of the number of prominent architects available in that city to form the judging boards. Various ratings are assigned to the work but there is no definite scale of grade. From five to ten percent of the drawings, however, are usually classed as premiated drawings, some award or standing being given to them.

The standing of the Illinois architects is very high and the accompanying illustrations, showing one of the problems assigned, is typical of the class of work turned out here for these competitions. Many novel and interesting treatments of the work assigned usually result and an effort will be made to show some of the best of these in this magazine.

The work of the institute is shown in the monthly bulletin. A number of the better drawings submitted in the competitions are given and it is considered an honor to have one reserved for this bulletin. Several pieces of Illinois work are to be shown in it this year. K. G. Reeves', '25, "Country Club" drawing will be the first.

Building the Joliet-Calumet Transmission Line

H. E. WEAVER, e.e., '25

The Public Service Company of Northern Illinois has started the development of super power lines which will eventually encircle Chicago. These lines are operated at 132,000 volts. The line in present use runs from the new generating station at Waukegan to Evanston. A fifty-two mile line running from the new steam station at Joliet to the Indiana state line near Lansing, Illinois, and tying in with the Calumet station of the Commonwealth Edison Company has been built during 1924. This is the line which crosses the Illinois Central railroad at Richton, a little south of Chicago.

Before actual construction could begin, a certain amount of preliminary work had to be done. In the first place the voltage at which the line was to operate and its course through the country had to be decided upon. Following this it was necessary to obtain a profile map of the route to be used in locating towers. In this case the profile was run by a local surveyer. This is usually advantageous as a local man will be more familiar with the country, the bench marks, and the government markers. At the same time the profile was determined the right of way, 150 feet wide, was staked out.

Immediately upon determination of the course, steps were taken to procure the land. This work was started a long time in advance of the actual construction because of the difficulties which occur in obtaining possession of the real estate. Whenever possible a representative of the company obtained an option of the parcel in question. When it was impossible to obtain the land by option the company had to resort to condemnation. The Public Service Company of Northern Illinois did not condemn land unless it was absolutely necessary, in order to avoid the slow court proceedings which would have resulted. Legal difficulties arose from irregular titles or from undivided estates. However, in many cases these difficulties were settled by friendly condemnation.

The engineers of the company decided upon five types of towers to be used. All the types approved were made of galvanized open hearth steel put together by bolts. The steel had been dipped, after being punched, and the bolts were sherardized. Bolts were used so that the towers could be assembled in the field; and their use meant the minimum injury to the protective coat on the steel. All nuts were secured by lock washers. The middle cross arm was longer than either the top or bottom cross arm, this length being 28 feet. All towers were to withstand a wind pressure of 15 pounds per square inch, the weight of the wires, and the additional weight of one and one-half inches of ice on the conductors.

The first of the five types was the suspension tower, designed to support the weight of the conductors and to withstand the unequalized stress produced by having any three wires broken. These towers were not designed to stand lateral or bending stress, and could not be used for changes in the line greater than one or two degrees. These towers were 92 ft. 6 in. high and weighed about four and a half tons. They were held together by five-eighth inch bolts and were 20 ft. between legs at the bottom. Semi-strain towers were designed to withstand line stresses plus the bending stress of a change in the line of 60 degrees. In actual use, however, they were not subjected to changes greater than about 20 degrees. Every ninth tower was a semi-strain type so that in case of extreme conditions most of the line strain would fall upon these heavier towers. Semi-strain towers weighed between six and seven tons and were 96 ft. 6 in. in height. The legs were made up of 6 x 6 x 3-8 in. angles and were secured by three-quarter inch bolts.

Dead-end or strain towers, much like semi-strain towers, were used where the lines were dead-ended. A line is dead-ended when the end is pulled up and anchored fast to a strain insulator at a tower. The transposition towers were just like the semi-strain towers up to a certain height. On top there was a different cross arm arrangement so that line transposition could be made. On these towers the middle cross arm was quite short and the top and bottom cross arms long. Ninety degree corner towers were used when the line turned as much as 60 degrees. These towers were 96 ft. 6 in. high and weighed between nine and ten tons. The bottom sections of the legs were 8 x 5 x 5-8 in. angles, held to the foundation stubs by twenty-two 3-4 in. bolts per leg.

After the types of towers had been chosen, it was necessary to find how many were needed and where they were to be placed. A flexible cable supported only at the ends hangs in a curve called a catenary. A flat catenary approaches a parabola, and parabolic formulae are much simplier, so in calculations parabolic formulae were used. A template of celluloid was constructed to the same scale as that used on the profile map. On the template were three curves. The top curve represented the position of the cable and was constructed upon the basis of the average or normal span under maximum load. The middle curve was similar to the first and was under it a distance equal to the minimum allowable clearance of the ground. The third or bottom curve was below that representing the cable by a distance equal to the height of the cable above ground supports. In this case the normal span was 880 ft. or one-sixth of a mile and the minimum ground clearance was 26 ft. The position of the first tower was placed on the map arbitrarily. The lower curve was placed on that point and the template shifted until the axis was vertical and the middle curve tangent to the ground line. Where the bottom curve again crossed the ground line the next tower could be placed. Of course, in some instances that point might fall in a swamp or creek or on a road and the actual span might have to be changed to satisfy local conditions. The distance up to the top curve indicated the necessary height of the tower. To locate the other towers the template was moved along and the process repeated. All towers were of the same height normally. If the height of the tower was not sufficient, an extension was bolted on at the bottom. On this line 5, 10, and 20 ft. extensions were used. Ground clearance could also be increased by placing the towers closer together. Soil tests were made at the tower sites to determine the type of anchors necessary. If the soil was firm, Malone anchors could be used; but if the soil had a tendency to cave into an open hole, earth anchors had to be used.

Jeffrey DeWitt insulators were used on the towers. These were of three types; namely, suspension, semi strain, and dead end. The suspension insulators were made up of a single string of units. Semi-strain insulators consisted of a double string of suspension units. Dead end insulators were heavier and stronger than either of the others. All were made up of eight units ten inches in diameter, each unit having three petticoats. These units were light blue in color. It would be easier to detect cracks in dark insulators but light blue insulators were used because they were not quite so conspicuous and, consequently, not so subject to wanton destruction.

With the completion of this preliminary work the company was ready to award contracts. In taking bids very complete and accurate information was given in regard to the entire line, and specification made a part of the contract. For instance, the contractor had to stencil all steel and provide erection blue prints with the numbers shown on the prints. The contractor had to replace all shortages and replace any pieces rejected by the company. Steel was to be shipped at the command of the company. In order to be certain of the quality of material the engineers of the company required the steel manufacturers to pay for two towers for test purposes. These towers were tested by the Robert B. Hunt Company. The contractor was to permit Public Service engineers in the plant at all times to inspect manufacturing methods. Since there was a vast amount of material to be handled, the company acquired steel yards in all the villages near the line, and handled its own material with the use of two and a half and five ton trucks, tractors, and trailers.

The right of way was then cleared in order that the tower footings or anchors could be set. For all towers, except suspension types, concrete footings were used. All suspension tower foundations were Malone footings or earth footings. For each concrete footing a hole eight feet square and nine feet deep was dug. In this a concrete form was constructed so that the finished footing was a frustrum of a rectangular pyramid with a short column on top. Into these forms foundation stubs, to which the tower was later bolted, were placed. These stubs were made up of heavy angle irons with short angles bolted across them. The tops were held in the proper position by the heavy steel templates and leveled so that the tower would stand true. The forms were poured full of concrete from portable concrete mixers. Malone footing steel consisted of crimped angle irons. A hole 18 in. in diameter was bored into the ground to the depth of 18 in., then a smaller hole was bored to a depth of about five or six feet, and into this was placed and detonated a charge of six sticks of dynamite. If the hole blown was not at least 40 in. in diameter another charge was put in. The footing steel was set and leveled and the holes poured full of concrete. In setting earth anchors a hole six ft. long, 4 ft. wide, and about 8 or 9 ft. deep was dug, grillages of steel angles being placed at the bottom. The tops of the footing stubs were held by templates which were removed when the footings were leveled and the holes back-filled. The Malone anchors were set more rapidly and cheaper than the earth-anchors.

The next operation was assembling the tower steel. The assembly gangs consisted of from nine to thirteen men and a foreman. Each crew had a box of equipment consisting of a gin pole, rope, blocks, jack, structural worker's wrenches, boots, a spade, a sledge, and a drift pin. The bottom legs of the tower were laid on the ground with ends against the foundation stubs and were then bolted together. After the bottom side had been laid out and bound together, the top sides of the section were laced together with the top end of the legs on the partially assembled tower, and the bottom portion on the ground. The section was raised with the gin pole and the side lacings fastened. The same process was repeated for the next section. Then the ladder bolts were put on, insulators hung, cross spiders put in place, and the tower was completed on the ground, ready to be upended later.

Under good conditions a tower could be assembled on the ground in from six to fifteen hours, depending upon the type. It required 18 to 25 hours to built a tower in the air, and it was more dangerous, more difficult, and the fabrication not so good. A tower could be upended in fifteen minutes, but the time required to bolt the tower to the footings and to move to the next tower brought the total time up to two hours. It was, therefore, cheaper to build the tower on the ground and raise it than to assemble one in the air.

It was necessary, though, to assemble a few towers in the air. In doing this one side of a section was bolted together on the ground, raised into position, and bolted to the footing studs. The other side was put up and the two laced together. Then a gin pole was hoisted and lashed to the top of one of the legs of the completed section. One side of the next section was assembled on the ground, hoisted to the required height, and held in position by hand lines while it was bolted fast. The other side with lacings attached was bolted into place and the two fastened together. This procedure was repeated until the tower was finished.

The tower which was assembled on the ground was upended by means of a 27 ton Northwest crane. The crane, which was equipped with an internal combustion engine and a caterpillar tread, could move under its own power, and had a fifty foot boom and a fifty foot stiff leg. At the top of the boom was a sheave through which a cable ran to a sling under the tower. The towers were upended by winding in the cable. With the crane properly set there seemed to be no tendency for sidewise motion; the tower always came up in position. In order that the tower might not be pulled over it was anchored to a never creep anchor by a large guy rope. These ropes were held by a small set of blocks which could be let out as the tower was raised. With this system about five towers could be raised in a day. While the towers were still on the ground and also after they were raised they were subjected to rigid inspections. Each was carefully inspected for missing pieces, every joint was examined and every bolt tapped to be sure that it was right.

After most of the towers were up the work of stringing the wire started. The conductor was a nineteen strand copper cable of 300,000 circular mils area. The cable was six-tenths of an inch in diameter and weighed 0.817 pounds per foot. It came in reels weighing from four to four and a half tons each. The reels were hauled into the field by a tractor and a highway trailer, spotted at about the place they were needed, and raised by reel jacks put under a bar extending through the reel. Cable slings were put over the cross arm at a point where it was easy to pull up the bottom end of the insulator so that it could be fastened to the lower end of the wire. In the sling was hooked a number eight snatch block. A long manila rope was pulled through the snatch block by a tractor and the rope then threaded through the next snatch block. This operation was continued until the wire was drawn out, or until it had reached a place where it could be dead-ended. Here it was anchored and pulled from the other end. The wire was pulled to tension by a tractor pulling a rope from a pair of one-inch blocks. The fixed end of the blocks was fastened to a Never Creep anchor. In this case the wire was held by a "cum along" and was pulled to a tension of 2930 pounds, as measured by a dynameter between the "cum along" and the blocks. The tension varied considerably with the temperature. Best results were obtained when the wire was pulled at every four or six tower spans. It could be pulled every ten or twelve spans but the stress did not equalize. To equalize the stress a snatch block and hand line were put on the cable and run down to the center of the span. This line was pulled and released several times in succession. This caused motion of the wire through the sheaves and the stress equalized.

The loose end of the wire was dead-ended and then the bottom ends of the insulators along the line were drawn up and clamped to the wire. Just before the line was dead-ended, however, the stress in the wire was checked by measuring the sag, which in a normal span was 28 feet. At the same time the ground clearance was checked. No ground wire was used on the line. When it was necessary to splice a wire, a copper sheath was placed over the ends of the wire, on each end was attached a splicing clamp and the wire and the sheath twisted so that there were four complete turns. Once every three miles the lines were transposed. That is, the wires were spiraled or the order was reversed. The top wire was changed to the bottom, the middle wire to the top, and the bottom wire to the middle. This was done to decrease the mutual inductance between the power line and the neighboring power or telephone lines.

When the wire had been strung all towers except those having earth anchors were grounded. A rivet was placed in a ten-foot piece of one-inch gas pipe. The pipe was driven into the ground, the rivet

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EDITORIAL

Culture vs. the Engineer

The title of this article is misleading in that it implies the existence of a chasm between the cultural aspects of life and the engineer which does not exist. I wish to propound this question, "What is Culture?" If I remember rightly it was Matthew Arnold who said, "Culture is the study of Perfection." How then, does this agree with the modern, popular conception of the meaning of the word "Culture"? It may be said that a certain man is cultured. Perhaps because of some single fineness of taste that he is able to indulge due to great wealth, or its equivalent, leisure time. Or perhaps in some of his tastes he is eccentric and so gains among some the name of being a "man of culture". I question his culture, or rather I question the popular conception which ascribes culture to such an individual. For my standard, I choose the definition of culture left the world by Matthew Arnold, which is one of the best of the many definitions that have survived the trying tests of time and the ever-changing stream of Man's thought.

Culture then, for my purpose, is but the "Study of Perfection." I may study where I please, be it in books, or among my fellow men, only it must be Perfection in the broadest sense of the word. Why limit the field of culture to books and art alone? Literature, like all forms of art, is but the record of the lives and thoughts of men and can be but second-hand information at the best, perhaps clarified by this writer's vision, perhaps distorted by another's. I say that though one read ever so long and deeply, if one read only, then he would never become cultured in the true sense of the word. Contact with one's fellow-man in the trying situations that arise in one's lifetime is absolutely essential to the development of true culture.

This then, is the object of this writing, not to "prove" that supposedly cultural studies alone will refine the metal that goes into the making of an engineer, but to show in its proper light the true meaning of the word "Culture", and then the relation of the engineer to true culture becomes plainly manifest.

As an engineer, an individual must display a wide, intelligent curiosity toward civilization in all of its phases. A pertinent curiosity, if you please. I do not have to give formal proof of this statement, for its truth is evident after some thought and reflection on the progress of civilization. This wide interest will seek out the best in literature, in music, in all of the fine arts. This type of interest alone

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Clippings from the Editor's Desk

After due consideration of vague rumors floating into the office to the effect that on one ever reads the editorials the editor decided to practically abolish the traditional form of the page and see if the readers could be persuaded to read his writings if they were dressed up in another form. If you approve of this change, say so, if you don't say so, but if you especially like to see a page of this sort write some snappy comments on your own about what is going on in the engineering college and turn them in at 213 Engineering Hall. From now on it is an open forum.

But don't follow the usual practice and pass by the page opposite this. "Culture versus The Engineer," as expressed by T. W. Oliver, '25, is well worth your consideration.

Several other articles in this issue deserve special mention. "Origin and Growth of the English Cottage" by C. T. Paul, '25, traces the evolution of the English cottage through several centuries of development. The original paper was much longer and more extensive but had to be cut down for publication purposes.

If you have not as yet looked over the research residence of the Warm Air Heating and Ventilating Association over on Stoughton street drop by some Sunday afternoon. The official dedication last month officially opened it and some more interesting experimental results should soon develop.

Now that the University of Pittsburgh has lead the way it probably will not be long before the expression going "out to the Armory" will be changed to "up to the Armory." We only hope the elevators never fail to work when someone is trying to make an eight o'clock on the fortieth floor—or above.

Did you know that The Technograph has an international circulation? Among others on the list is the Patent Office Library in London. Even if a large number of the Illinois engineers fail to consider it worth their time reading here, there is some consolation for the staff when they realize that it is appreciated in other countries. We try not to make the jokes all English and endeavor to keep them on the plane of the average student's comprehension.

A suggestion was advanced in the last issue that the honorary societies make their influence felt. A majority of them have not as yet made much of a stir. Still too busy ordering new keys?

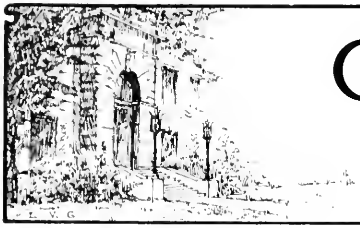
A page in this issue has been devoted to engineers prominent in the campus activities. We feel that these men should be known to the rest of the engineers and their work appreciated. They are the biggest boosters for the College of Engineering on the campus and deserve a lot of credit. In many cases they have given up their chances of a Tau Bete key to help campus activities. We are not going to argue the relative merits of such a case but we will guarantee that if they had it to do over again they would follow the same course.

The Technograph is discussing the possibilities of changing the magazine from a quarterly to a monthly, as is the case in a majority of the engineering schools. Do you want to see the magazine in a monthly form next year?

Before getting out the hammer too heavily on the honorary societies, Chi Epsilon deserves special mention. One of the requirements exacted of their pledges this fall was that they solicit memberships in the A. S. C. E. The result of the campaign was fifty memberships and now the civil engineers boast a membership of thirty three percent in their society. How about the rest of the departments?

When you finish looking through the magazine for the first time go back and read Professor Willard's article on the results of heating and ventilating work carried on by the department of mechanical engineering. Don't let a few curves bluff you out of reading it. Next issue will contain the second part, covering the ventilation problem of the Hudson River Vehicular Tunnel.

Now that the seniors have had their inspection trip we wonder just what they all think of it. To some it was disappointing. In most cases an attempt was made, to see too much in a short space of time. We are glad that there is only one such trip a year.



COLLEGE NOTES

Research Residence Dedicated

The University of Illinois was host to more than three hundred heating and ventilating engineers, executives, manufacturers, and installers of warm-air heaters from all over the country, who were in attendance at the mid-year meeting of the National Warm-Air Heating and Ventilating Association held here December 1, 2, and 3. The gathering of men interested in this work was the largest that had ever come together in any meeting of the association; there being representatives from Canada, Texas, California, New York, and practically every state in the Union. The Research Residence, of which so much has been said and printed was dedicated at that time, and it was principally because of the interest in it that the number in attendance so greatly exceeded that of other meetings.

Considerable work had been already been done in the mechanical engineering laboratory on warm-air heating and ventilating, and at the meeting of the association last December 4 the results were considered to be of such value and further investigation of such promise, that the plan of the Research Residence was conceived, a laboratory in which the conditions would be exactly typical of those met in actual residence heating. Arrangements were then made for the construction of the project which with the lot and furnishings cost $24,000 and plans made for a program of research to cost approximately $8,000 a year.

The dedication ceremonies were held at 10:30 Tuesday morning, December 2, at the residence which is located at 1108 West Stoughton, Urbana, and though quite simple were highly impressive. After the invocation by Rev. E. D. Johnson, Prof J. M. White, supervising architect of the University, on behalf of President Kinley delivered the address of welcome. He stated that it was a matter of great pride to the University of Illinois that the association "should have selected this university as the one best qualified through its facilities, method of organization, and its staff, to render the kind of services which you are seeking." "We know we are better able to serve you than any other agency and we are greatly pleased that you came to the same conclusion."

W. C. Markle, president of the National Association of Sheet Metal Contractors, presented, on behalf of his organization a handsome bronze tablet which appears to the right of the entrance and which expresses the appreciation of the installers of the work being done by the manufacturers of furnaces. Perry C. Houghton, secretary of the American Society of Heating and Ventilating Engineers, presented a handsome visitors register in which the first names entered were those of the officers of the National Warm-Air Heating and Ventilating Association and members in attendance. The residence was then opened for the inspection of those assembled.

The few things still remaining to be done such as the installation of instruments, etc., have been completed and by the first of the year a three-months' program of heating investigation had been started by Professors Willard, Kratz, and Day. The research will be a continuation of that already done in the mechanical engineering laboratory.

The residence is open to the public and every one is invited to inspect it. Though no regular visiting hours have been established one is practically assured admission between 3 and 5 in the afternoon. Many residents of the Twin Cities and others from out of town have already visited it. Some of the home economics classes have inspected it, taking notes on the planning, heating, and ventilating of a home. Professor Willard explained to them the principles and superiority of warm-air heating.

Preliminary Honors

Corliss Dean Anderson, g.e.
Guy Banister, m.e.
Smith Cullen Bean, c.e.
Earle Ellsworth Blount, min.
John Nowry Demmler, m.e.
Ralph Loring Dugger, e.e.
Oscar Charles Levy, e.e.
John George Lynch, g.e.
Wayne Edwin Lynch, e.e.
Bradford H. Quackenbush, c.e.
Erich Max Sobota, e.e.
Phillip Ervin Soneson, a.e.
Erwin Frederick Stahl, g.e.
Arthur Charles Tostetti, c.e.
Joseph John Weiler, a.e.

Preliminary honors are awarded at the end of the sophomore year to students who have shown outstanding scholastic ability. The requirements for candidacy for preliminary honors are fifty percent of A, and not more more than fifteen percent of C or below. As in the past years the electricla engineers lead the list with the largest representation.

Engineering Council

Through co-operation with the faculty committee on activities of the undergraduates in the College of Engineering the Engineering Council has been able to make some plans for the annual spring celebration. An effort has been made to draw up a program that will be carried on in future years. Especial attention has been directed to avoiding conflicting events within the college. In this line it is planned to have the Electrical Show and the Engineering Open House on alternate years instead of the same year as in the past. This will avoid any duplication of exhibits as previously has been the case with the department of electrical engineering. The convocation and engineers' dance are scheduled to appear every year under the new plan, as in the past. The question of the parade, as held last year, has been given a good deal of thought and in all probability will not be repeated this year.

The members of the council feel that with a program of this nature it will be possible to develop an engineers' spring celebration that will have some definite feature every year, and in no year will there be conflicting events. Due to the heavy schedule of work that is carried by most of the engineers and especially by those upon whom the work of the events would come it has been necessary to plan programs that will require a minimum of extra effort on the part of the committees.

The council is also making the recommendation to the various departmental societies that the members of the council hereafter be selected for a term of office of one year. In the past a majority of members have been withdrawn at the end of the first semester when several of the societies re-elect presidents. This has resiously broken up the work of the council since the first semester is devoted to planning the spring activities and when the new council is formed much of this work is lost.

The members of the Engineering Council this year are W. A. Rolleston, '25, president of the Architectural Society; Harold Bopp, '25, president of the student branch of the American Ceramic Society; M. N. Quade, '25, president of the student branch of the American Society of Civil Engineers; L. A. Mollman, '25, president of the Electrical Engineering Society; B. G. Rich, '25, president of the Mechanical Engineering Society; M. A. Rowley, president of the General Engineers Society; A. E. Murton, '25, president of the Mining Society; C. C. Anderson, '25, president of the Railway Club; and C. E. Parmelee, '25, editor of The Technograph. The officers of the council are, president, M. N. Quade; secretary, C. C. Anderson; and treasurer, A. E. Murton.

A. I. E. E.

At the joint meeting of the American Institute of Electrical Engineers and the Electrical Engineering Society, December 17, Prof. C. T. Knipp repeated his experimental lecture on "The Vacuum as an Aid to Research" which he gave before the Physics and Chemistry sections at the state teachers convention. A series of twelve interesting and, in many cases, very beautiful experiments were performed, consisting of methods of obtaining a high vacuum and the conduction of electricity through rarified gasses. Practically all the apparatus used was designed and constructed by Professor Knipp.

Among the experiments was one with a large X-ray apparatus and another illustrating the use of the photoelectric cell to detect and measure light radiations. The most striking experiments were those with the kathode rays which Dr. Knipp was literally able to tie up in knots by means of a powerful electro-magnet.

A small reproduction of the aurora borealis was obtained by means of Villard's apparatus. Professor Knipp explained that the phenomena of the northern lights was due to streams of enormously fast electrons, similar to the kathode rays produced in the laboratory, ejected from the sun, and which are collected and guided by the magnetic lines of force to the earth's polar regions. They there ionize and cause luminosity in the lightly attenuated regions of the earth's atmosphere, just as they do in a vacuum tube.

Experiment Station

Bulletin No. 143: Tests on the Hydraulics and Pneumatics of House Plumbing, by Harold E. Babbitt.—This bulletin is a very complete treatise on the subjects indicated in the title. To quote the first paragraph of the book, the purpose of the tests undertaken was to "obtain definite information concerning the positive and negative pressures found in soil-stacks, waste pipes, traps, and vent pipes, and also concerning the limitations of rates of discharge and the capacities of waste pipes and soil stacks." Adequate information concerning these matters has been secured and this information is thoroughly and well presented in this bulletin. Numerous diagrams, graphs and charts, make the bulletin interesting and easy to absorb. Anyone interested in this subject will find the reading of this bulletin well worth their while.

Bulletin No. 142: An Investigation of the Fatigue of Metals, by H. F. Moore and T. M. Jasper. This bulletin is a continuation of two other bulletins (Nos. 124 and 136). This bulletin deals at some length on the Theory of the Fatigue of Metals and its application. Three or four pages deal with the "Evidence of the Existence of an Endurance Limit for Wrought Ferrous Metals and of the Improvement in Strength of Such Metals by Cycles of Reversed Stress at or Below that Limit." Quite a few pages are devoted to "Resistance to Reversed Axial Stress and Other Repeated Stresses." Various other miscellaneous tests are also recorded. The bulletin is full of tables, charts, graphs, and figures of all sorts, and has a few photographs. It will prove of interest to anyone caring to read and study it.

American Physical Society

The new physics laboratory of the University of Michigan was the scene of the annual Thanksgiving meeting of the American Physical Society; and, because of its unique design, embodying conveniences and equipment such as would be desirable in advanced work and research, attracted considerable attention. Prof. F. R. Watson presented a paper on "Accoustical Double Resonator" and Prof. C. T. Knipp exhibited his alpha ray track apparatus which recently has been attracting no little interest. Other representatives of the University of Illinois were Professors A. P. Carman, R. H. Baker, Jacob Kunz, E. H. Williams, and Dr. R. F. Paton.

Professor Knipp also exhibited his apparatus at Indiana University and at the Christmas meeting of the American Physical Society at Washington, D. C., which he and Professor Baker, of the astronomy department, attended.

Pictures of Grand Canyon Shown

Col. C. H. Birdseye, chief of the topographical division of the United States Geological Survey, on December 3, under the auspices of the College of Engineering and the State Geological Survey, told of the surveying trip of 450 miles down the Colorado river through the Grand Canyon of Arizona. His lecture was illustrated with moving pictures which followed the party down the river through 250 miles of rapids and dangerous waters which had only once been explored, and that by the Powell expedition in 1870.

The freshman engineering lecture was dismissed that the students might attend the lecture that night, and so many availed themselves of the opportunity that an audience resulted far greater than the capacity of Morrow Hall. In order that all who de-

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ILLINI ENGINEERS

WALLACE WESLEY McILWAIN, m.e., '25

Taking the country as a whole, perhaps our best known senior this year, is "Wally" McIlwain. "Wally" has been one of our outstanding stars on the football team for three seasons. Playing at half, "Wally" has plowed through the line and provided interference for his teammates, the like of which is seldom seen. Due to an injury, he was unable to play full time and his absence from any game was keenly felt. He was selected by Walter Camp as one of the backs to receive honorable mention on his All-American team.

"Wally" has also taken an interest in R. O. T. C. work, being a senior in the advance course this year.

He is a member of Theta Tau, Tribe of Illini, Ma-Wan-Da, and Scabbard and Blade.

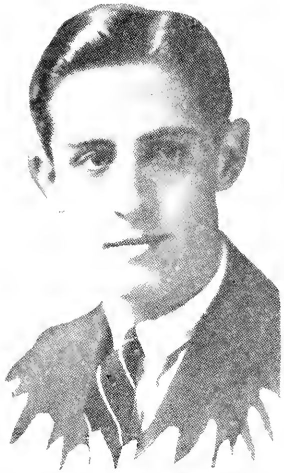
JOHN MEREDITH TRISSAL, ry.e.e., '25

"Jack" Trissal is perhaps more responsible for the athletic activities of more of the student body than any other student in his capacity as Intra-Mural Athletic Manager. He has charge of everything that pertains to the intra-mural side of men's athletics. This is a tough job, but he is handling it very well. He is also on the Athletic Board of Control and was on the Stadium Clean-up Committee.

He has found time to take an active interest in the Y. M. C. A. being in the cabinet last year and a member of the building committee both last year and this year.

He is a member of Ma-Wan-Da, Theta Tau, Sigma Epsilon and the Railway Club.

ILLINI ENGINEERS



WILLIAM KENYON PIERCE, c.e., '25

One of the most outstanding men of this year's senior class, is "Bill" Pierce. Taking an active interest in various extra-curriculum activities, "Bill" has given much of his time and energy to his work. Perhaps his chief contribution to the University as a whole, has been his work in Illinois Union. He has been a member of several Union committees at various times and this year is successfully holding down the busy job of social director of Illinois Union. He has also served on several class committees, among them, the Sophomore Informal Committee.

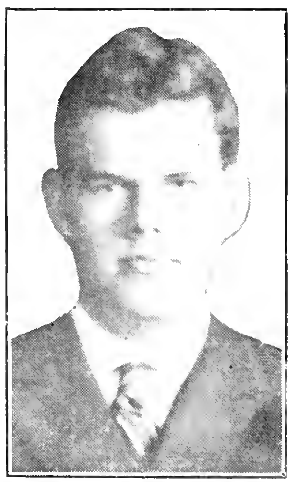
For the past two years he has been a member of the Illini Board of Control and in this capacity has aided in the selection of those who guide the destinies of the various campus publications during the year.

PAUL RUTLEDGE WILSON, m.e., '25

One of the most versatile of those who are spending their last undergraduate years here, is Paul Wilson. One of his chief activities has been in the line of dramatics. Here he has taken an important role, being in several plays and holding membership in both Mask and Bauble, and Pierrots.

He has also spent considerable time with the Y. M. C. A., attaining the office of vice-president of that organization this year. He has risen steadily in the R. O. T. C. until at the present time he holds the rank of Lieutenant-Colonel of Field Artillery. His activities commenced with his freshman year, he being chairman of the Frosh Stage Committee at that time. In between times he plays the chimes.

He is a member of Ma-Wan-Da, Scabbard and Blade, and A. S. M. E.



Fraternity Activities

Tau Beta Pi

Six senior honorary engineers were taken into active membership in Tau Beta Pi on December 3 at the formal initiation held at Philomathean Hall. The six men initiated were: R. E. Campbell, e.e.; R. C. Erickson, e.e.; H. H. Hilderbrand, e.e.; R. R. Levy, e.e.; S. H. Reid, c.e.; W. G. Roesch, m.e. After the formal initiation a banquet was held at the Urbana-Lincoln Hotel. Prof. H. F. Moore, of the department of theoretical and applied mechanics acted as toastmaster. L. A. Mollman, '25, president of the chapter, welcomed the new men. S. H. Reid responded. Prof. G. A. Goodenough spoke on the topic, "Science vs. Salesmanship" and Dean M. S. Ketchum upon "Science in Engineering". S B. Hunt, '25, had as his topic, "The Scout's Opinion of the new men."

Gargoyle

The officers for this semester are as follows: E. G. Spencer, president, J. A Boyd, vice president, W. E. Fraser, treasurer, H. W. Holmes, secretary. The pledges are: J. L. Berner, W. L. Edholm, J. W. Gregg, W. P. Kramer, J. D. Pronty, P. E. Soneson. An initiation and banquet was held at the Urbana Lincoln Hotel, December 17; the program was as follows: "Welcome to Initiates," by Prof. Rexford Newcomb; "Response," by J. L. Berner; "Points of Interest in Design," by L. C. Dillenbach; "The Architect as a Professional Man," by Dean M. S. Ketchum; "Sand," by Prof. L. H. Provine.

Sigma Tau

Sigma Tau initiated the following men November 12: H. P. Arkema, gen. e., '26, E. E. Blount, min., '26, J. N. Demmler, m.e., '26, L. D. Fetterolf, cer.e., '26, J. W. Greene, e e., '26, J. R. Grout, cer.e., '25, H. N. Hayward, e.e., '25, E. M. Sobota, m.e., '26, Erwin Stahl, gen.e., '26, E. G. Spencer, arch., '25, J A. Tomasek, c.e., '26, A. C. Tosetti, c.e., '26, and K. A. Werden, e.e., '26. Professors Rexford Newcomb, of the department of architecture, and A E. Drucker, of the department of mining engineering, were made honorary members of the fraternity. The formal initiation banquet was held at the Inman Hotel, November 12. An informal initiation was held the night before at Mercer's cabin on the Sangamon.

Sigma Tau will award a medal to the sophomore who had the highest standing for his freshman year. In case of two or more having the same average their practicability as an engineer will be considered.

The officers for the year are: president, R. G. Johnson, a.e., '25, vice president, E. R. Troche, m.e., '25, recording secretary, J. E. Inman, e.e., '25, corresponding secretary, C. V. Erickson, e.e., '25, historian, L. A. Mollman, e.e., '25, treasurer, W. A. Rolleston, arch., '25.

Scarab

The activities of Scarab this year have been confined chiefly to preparation for the national convention which was held November 28 and 29 at the University of Illinois, the home of Karnak Temple, the mother organization of Scarab.

The convention assembled for its business sessions at the Wesley Foundation. A tour of inspection of the campus and university district was conducted by Professor White, supervising architect, to acquaint the visitors with Illinois. The visitors, many of whom represented the large eastern schools, were greatly impressed with the size and scope of the University and especially with the magnitude of the College of Engineering. The department of architecture and Ricker Library of architecture was unanimously conceded as far superior to any of the other schools of architecture of the country. A smoker and stunt show provided entertainment one evening. The convention was brought to a close at the Urbana-Lincoln Hotel with a banquet truly architectural in all its features.

The work of the convention has given an impetus to co-operative effort among the members of Karnak Temple. A successful year is anticipated.

Delta Mu Epsilon

The officers for this semester in Delta Mu Epsilon are as follows: Edwin Bremer, president; Albert Koenen, vice president; J. W. Schaefer, treasurer; J A. Blair, secretary. The recent pledges are: G. E. Morris, '25, A. G. Cadaval, '25, Don Coulter, '25, C. E. Stephens, '26. Informal initiation was held December 7 in a mine near Danville, followed by formal initiation and banquet December 14.

Chi Epsilon

December 4, Chi Epsilon, honorary civil engineering fraternity, at a formal initiation banquet held in the Southern Tea Room, took into membership, eight undergraduates. Of these men, B. J. Fry, P. W. Joy, and F. A. Stronce are from the class of 1925, while S. C. Bean, E. C. Bray, A. C. Tossetti, J. C. Voorhees and J. D. Vorhees, are from the junior class. Professor W. G. Raynor, remembered by all C. E.'s for his work on the "Theory of Errors in Surveying," and Mr. G. W. Pickles, professor of drainage engineering, were initiated as honorary members. M. N. Quade, '25, acted as toastmester. C. V. Erickson, '25, gave the address of welcome and E. C. Bray, '26, responded in behalf of the initiates. Toasts were given by Prof. C. C. Williams, Prof. Hardy Cross, G. W. Pickels, W. H. Rayner, T. D. Mylrea, C. C. Wiley, and H. E. Wessman, '24.

Eta Kappa Nu

Initiation ceremonies of Eta Kappa Nu, the honorary electrical engineering fraternity, were held at the E. E. Laboratory on the evening of November 25 preceeding an initiation banquet in honor of the new members at the Urbana Lincoln Hotel. Prof. A. R. Knight, newly elected national president of the fraternity, acted as toastmaster for the evening. A welcome was extended to the new members by W. G. Kennedy, '25, president of the local chapter, to which J. W. Greene, '26, responded. Prof. E. B. Paine, head of the department of electrical engineering gave the address of the evening on "The Beginning of Eta Kappa Nu". An "Uncle Ab" story by H. A. Brown, of the department, concluded the program. The new members were R. E. Campbell, '25, F. E. Roberts, '25, C. G. Elder, '25, J. W. Greene, '26, R. L. Dugger, '26, E. M. Sobota, '26, F. P. Morf, '26, W. S. Duncan, '26, W. E. Lynch, '26, and F. B. Powers, '26.

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Contemporary Engineering News

University of Pittsburgh Skyscraper. Have you ever heard a person say, "I'll have to go now. Have a class on the fourtieth floor," or have you ever thought of taking an elevator to your eight o'clock on the twenty-second floor? High buildings may become as common as low ones, and the students at the University of Pittsburgh may begin using just such expressions, if the plans for the new 52-story building there are approved. The proposal of this radical change in college building practice has stirred up much discussion among educators and people in iPttsburgh, and, indeed, all over the country. A person upon hearing of the proposal immediately has reactionary ideas; the folly of getting away from custom, the impracticability of the plan, the difficulties and expense involved, are all cited. However, some of the foremost educators in the country have become converted to active support of the scheme.

Dr. John G. Bowman, chancellor of the university, was the originator of the idea. He has won the backing of his trustees in the effort to build the structure, and expects to break ground next May. Among the many advantages that Dr. Bowman claims for his plan is unity. He believes that by getting all of the departments and colleges of a university under one roof, that a unity of purpose, a bond of thought and ideals, will be established far greater and more binding than is possible with the spread out arrangement of the present college. In short, college spirit would increase, and the moral effect of the unification would be to give the students a broader outlook on their university training, to make them realize that their education is to be regarded as a whole, rather than as a collection of small chunks, picked up one at a time in different buildings, with little or no relation to each other.

Such an immense building, standing in the center of the fourteen acre quadrangle provided for it in the city of Pittsburgh, would be more than an ordinary college building. It would be a monument to learning.

Testing the ZR-1. Massachusetts Institute of Technology has been carrying on a series of tests with a celluloid model of the airship ZR-1 during the past ten months. By loading the various members and photographing them, it is possible to tell just how the airship itself will act under various conditions. Polarized light is used, which when passed through the celluloid of the model under different loading conditions shows the stresses in rainbow colors. Since celluloid acts structurally the same as do the metals used in construction, it may be used to settle troublesome problems of design, many of which cannot be solved mathematically. The phenomena of photo-elasticity have only recently been used for this purpose, although they have been known for some time.

—Tech. Eng. News, Nov. 1924.

Steinmetz Memorial Scholarships. Union College now has four scholarships as a memorial to Dr. Charles P. Steinmetz. A fund of $25,000 has been appropriated by the General Electric Company, where Steinmetz was chief consulting engineer, and the income from this fund will go to the scholarships. Steinmetz was a professor at Union College for many years, and it is felt that these scholarships will be a fitting memorial to one who had an intense interest in boys of small resources who were trying to get an education.

Engineers' Co-op at Minnesota. The University of Minnesota has an Engineer's Bookstore similiar to the Engineer's Co-op at the University of Illinois. It has been in operation for four years, and is starting out on the fifth as a firmly established and profitable enterprise. The management and direction of the store is under a student board with faculty supervision, which is responsible for the sound policy which has made the store a success.

Kansas has Broadcasting Station. Many colleges and universities are installing radio broadcasting equipment at the present time. The University of Kansas will have one of the most up-to-date and powerful of these stations when its new Western Electric 500-watt equipment is installed. A complete studio for the artists is being provided, and steel towers are being erected for the antenna. Not all colleges care to go to this much trouble and expense, of course, but almost all have some equipment for the use of students who wish to learn the new art of broadcasting.

Pennsylvania's Booster Society. The Kite and Key Society has just been formed at the University of Pennsylvania. Its object is primarily to give prestige to the University, to advertise it to prospective students, and to extend hospitality to representatives of other institutions which visit Pennsylvania. The society accomplishes these objects by committees which take care of the housing of visitors and which supply newspapers with information about the school and student body. On May 2 a conference was held with similiar societies from other eastern colleges for the purpose of co-ordinating the work with that of these societies.

Perfect Discharge Integrator. The Cornell Civil Engineer has printed an article about work being done by the U. S. Geological Survey on Survey on methods of computation of river discharge. The old methods are inaccurate and unsatisfactory, their application difficult, and the results sometimes uncertain. To meet the deficiency, engineers of the Geological Survey have perfected the Discharge Integrator, which makes a continuous application of the rating curve of a station to gage height graph throughout the period to be measured. The instrument is similiar to an ordinary planimeter. Six of them have been built and are in district offices in various parts of the United States and one in Hawaii so that they are available for use as needed.

New Stadium at Purdue. Purdue has fallen into line with the rest of the middle western universities and now has a stadium. The land for the Ross-Ade Bowl was donated by the two men whose name it bears. The bowl, as finished in November, 1924, has 13,100 seats, and the ultimate capacity is 23,200.

Smoke Nuisance Research. Carnegie Institute of Technology is conducting a series of research experiments on the elimination of the smoke nuisance in cities such as Pittsburgh, Salt Lake City, and Ogden, Utah. The object of the experiments is to develop a smokeless fuel by low temperature carbonization. The results will be applied to the investigation of the cost of building and operating a plant

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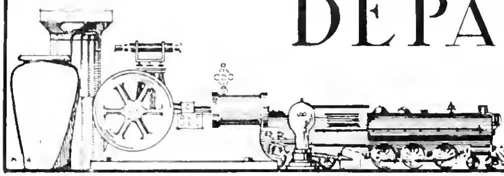


DEPARTMENTAL NOTES

Architecture

The Architectural Society held its second meeting of the year December 2 in the Union building. J. C. Llewellyn, '77, a prominent school architect of Chicago, was the speaker of the evening, giving a talk on his experiences in the profession, and of the many problems confronted in designing educational buildings. Plenty of free smokes and Illini sundaes were served to all who attended.

A telegram was received by the department from the Beaux Arts Society of Architects, New York, congratulating the seniors upon their success of their last problem in the Beaux Arts competition, "A Country Club." Out of nine problems submitted b ythe seniors, eight were awarded first mention, which is an excellent showing. 'Cupie" Reeve's design will be published in the magazine of the society.

The sophomores, on their problem, "A Guardian's Lodge," made a good showing, considering the fact that it was their first Beaux Arts competition. All but three were awarded second mention. They are now at work on a three-week problem, "A Post Office Portico."

The juniors finished an interesting problem, "A Wrought Iron-workers' Establishment" just before the Christmas holidays.

Ceramics

American Ceramics Society

The student branch of the American Ceramic Society has been very active this semester. The society was fortunate in being able to secure two good films which were shown at the meetings.

On December 1 a very interesting film on the process of making Portland cement was shown. Both the wet and dry methods were given.

At the meeting of the society on October 30 several short talks were given by students. John Baer, '26, gave an interesting talk on sewer tile and the problems which arise in its manufacture. C. E. Parmelee, '25, gave a talk on electric porcelains. Parmelee was connected with the Western Electric company during the past summer. He stressed the accuracy required in making the electric porcelains. The pieces used in telephone switchboards must be made to vary not more than nine-thousands of an inch. W. D. Kimmel, '26, who worked for the Crown Pottery in Evansville, Indiana, during the summer, gave the society some idea of the methods used by that company in the manufacture of dishes and table ware.

A committee, of which W. P. Whitney, '25, was made chairman, was appointed by President Bopp to make arrangements for a Pig Roast to be held in the kiln house.

The final arrangements for the Pig Roast were made and the committee reported at the meeting of December 4 that the Roast would be held on December 13 at five-thirty. About seventy-five ceramists attended the second annual Pig Roast of the society on that date and stuffed themselves on roast pig, potatoes, apple sauce, pumpkin pie, rolls and coffee.

Department Notes

Harold Bopp, '25, has made up several ash trays that are to be given to the paid-up members of the American Ceramics Society. The ash trays have the initials of the society on them and make very good souvenirs.

Several of the students have been working on Christmas pottery. C. G. Fels, '25, and C. E. Griggsby, '25 have both made up some good pieces.

The department has recently installed a new glass case in the main hall on the second floor containing some interesting pottery and glassware.

Civil

An investigation of the relation between rain-fall and run-off in Champaign county, Illinois, has been progressing for some time. A number of rain-fall gages have been placed in the county, and measurements are being made of the flow of several streams. The results, covering the observation of several years, will probably appear this coming summer in a bulletin of the Engineering Experiment Station. The work is under the direction of G. W. Pickels, assistant professor of drainage engineering.

F. C. Wight, editor of the Engineering News-Record, recently addressed the civil engineering students of the University in an open meeting of the student chapter of the American Society of Civil Engineers. Mr. Wight briefly outlined the gist of the common criticisms of engineering education, and touched on the three prevalent false conceptions of the status of the engineer. He mentioned the popular heroic conception held by the general public; the mechanistic view held by a few influential people, of the engineer as a man useful only for the solution of problems involving the technical details of his profession; and the idea held by most students of the engineer as a worshipper of pure truth or fact. Mr. Wight then urged the students as engineers to adopt a broad, catholic attitude of life in their tri-fold relations between men who finance, men who build, and men who use the creations of the engineer.

Under the direction of Prof. C. C. Williams, an investigation is being conducted with a view to determining the relation, if indeed any exists, between the settlement of foundations, and the vibrations set up by heavy street and railway traffic. Instruments for measuring these vibrations and their effects have been devised and some interesting results are expected.

Electrical

E. E. Society

The E. E. Society, co-operating with the Urbana section of the American Institute of Electrical Engineers, was quite fortunate in securing several good speakers to address the joint meetings of the two societies. Mr. Hall, representing the General Electric Company branch at Fort Wayne, Indiana, gave a talk in which he explained and demonstrated a set of quite delicate instruments, recently perfected, by which the tremors of a human hand could be recorded. The set involved a system of mirrors and the principle was somewhat similar to that used in the oscillograph. The instrument is used in the study and diagnosis of nervous diseases. The second lecture was by R. E. Doherty, '09, head consulting engineer of the General Electric Company at Schenectady, New York. Mr. Doherty presented the new problems which are confronting engineers in the field of long distance, high voltage transmission systems and outlined the general method for attacking these problems. Mr. Doherty was for many years an assistant to the late Dr. Steinmetz and has delivered lectures here on several previous occasions. Following Mr. Doherty's lecture Eta Kappa Nu gave an informal luncheon in his honor at the Green Tea Pot.

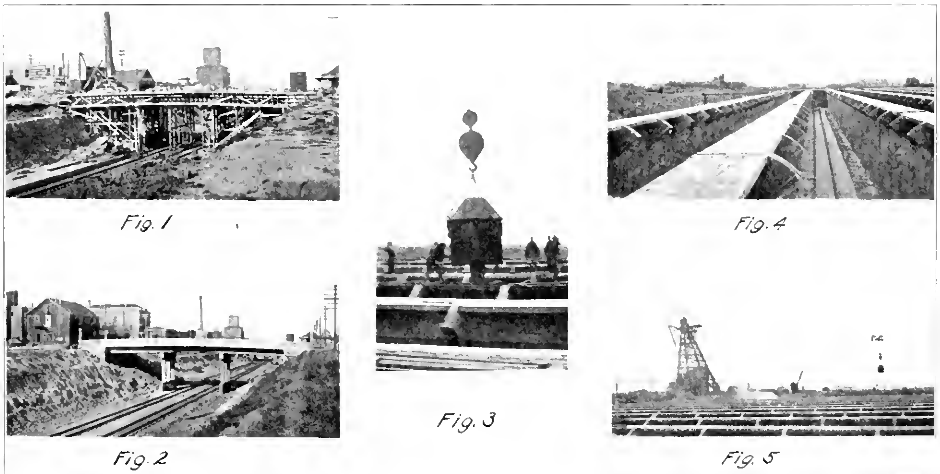
New Equipment

A new 100 kilowatt motor generator set has ben received and installed at the Electrical Engineering laboratory. The set is a Westinghouse unit and consists of a 2,300-volt, three-phase synchronous motor and a 220-110-volt, three-wire, direct current generator. This machine will be used to supply the direct current for the laboratory and will replace the old 85-kilowatt set which was of insufficient capacity for the present needs. The old set will be retained as an auxilliary and emergency unit. The synchronous motor on the new set is self-starting and will start as an induction motor on 2,300 volts. This machine is one of the few 2,300-volt motors on the campus. New equipment has also been added in the radio laboratory. A 200-volt storage battery has been installed for laboratory work and for power amplification in the broadcasting set. A new supply of precision radio frequency meters, standard precision variable condensers and a new set of power tubes for laboratory and investigation work have also been received.

Research work along various lines is being conducted by eight faculty members of the department of electrical engineering. Prof. J. T. Tykociner is devoting his entire time to extensive research work on short radio waves and model antenna systems. L. P. Garner, a graduate student, is assisting Professor Tykociner in the work which is being carried on in the recently erected portable sheds near the Stadium. Radio transmission systems are being investigated by C. A. Keener and H. A. Brown. Prof. A. R. Knight and M. A. Faucett are studying the effect of temperature on the polyphase watthour meter after having recently completed tests on the single phase watthour meter. The effect of power factor variation on the above mentioned polyphase watthour meter is being investigated by Prof. E. A. Reid. J. O. Kraehenbuehl is devoting his time to the study of harmonics in a transformer.

Dr. E. J. Berg, of the General Electric Company, gave a series of lectures on the Heavisides operations at the Electrical Laboratory on December 8, 9, and 10. The lectures were attended by the seniors and juniors of the department of electrical engineering and interested members of the mathematics, physics and other departments. Dr. Berg has been a consulting engineer for General Electric Company for

(Continued from Page 95)



Pictures from Senior Civil Inspection Trip. Fig. 1-2, Reinforced Concrete Street Crossing and Form-work for the Same over the Illinois Central Railroad at Paxton, Illinois; Figs. 3, 4, and 5, North Side Sewage Treatment Plant, Chicago, Illinois; Fig. 3, Depositing Concrete; Fig. 4, Cableway for Concreting; Fig. 5, Longitudinal View of Completed Aerating Basin

Do You Know These?

The young instructor: "Now Gentlemen!"

The old instructor: "Well, men!"

The associate professor: "In fact, fellows!"

The oldest prof.: "You boys, please!"

—The Technique.

For the Yell Contest

E to the x, dx, dx,
Sin x, tan x,
Duplex, Cot x
Wow!

He: "Dearest, will you marry me?"

She: "John, I can't marry you, but I shall always respect your good taste."

"He says he thinks I'm the cutest girl he ever saw. It makes him happy even to think of me. Shall I give him a date?"

"Naw, let him be happy."

This Sounds Like a Dirty Crack

Two juvenile inhabitants of Brickdust Row, where tempers are higher than social standing, were having an altercation.

"Yah!" taunted one. "Yer mother takes in washin'!"

"Wot if she does?" countered the other. "Yer didn't suppose she'd leave it hangin' out over night unless yer father was in prison, did yer?"

"How did you puncture that tire?"

"Ran over a milk bottle."

"Couldn't you see it?"

"Naw, the little runt had it under his coat."

Radio Note!

The university station in the basement of Engineering Hall has developed a very accurate tuning radio outfit. Rumor has it that is so selective that a quartet may be tuned in so delicately that all the voices except the tenor can be cut out resulting in some wonderful tenor solos.

Irate Wife (discovering scofflaw husband on front steps fiddling with door knob): "What are you doing there, Webster?"

Husband (continuing to turn knob): "—Pssh! I'm trying to get Pittsburgh."

Note for Webster

Definition of a male quartet: Three engineers and a chemist.

She. "Oh, how my knee itches."

He: "Shall we dance?"

Mining Department Joke

—Censored.

Echos of Inspection Trip

Chub Rich (observing head lettuce salad with thousand island dressing): "Waiter, do I eat this or have I already."

Inquisitive visitor (visiting the Keokuk dam): "And did they put that dam to the bottom of the river?"

Altruistic engineer: "No, madam; they left two inches so that the fish could swim through."

"Stop, I never heard such profanity since the day I was born."

Blondy Wessman: "What were you, a twin or a triplet?"

At the Funeral

Cousin Hiram: "Is that a new hall clock over there?"

Wife of deceased: "Sh-h-h. That's poor old John. I knew the room would be crowded, so I stood the coffin on end."

We heard recently of a poet who wrote about the "window in his soul," and wondered if he was any relation to the guy who had a pane in his stomach.

—Flamingo.

Reformer: "My dear fellow, are you troubled with evil thoughts."

Hard-boiled: "Naw, I ain't troubled with 'em, I like 'em."

—Purple Cow.

Foaming Youth

"But you said I could kiss you!"

"Kiss, yes; but who said anything about a massage?"

—Chapparal.

"Save the surface and you save all!"

The co-eds should live to a ripe old age at the present rate.

Electrically Speaking

Judge: "What's your name, occupation, and what's the charge?"

Prisoner: "My name is Sparks, I am an electrician, and I'm charged with battery."

Judge: "Put this guy in a dry cell."

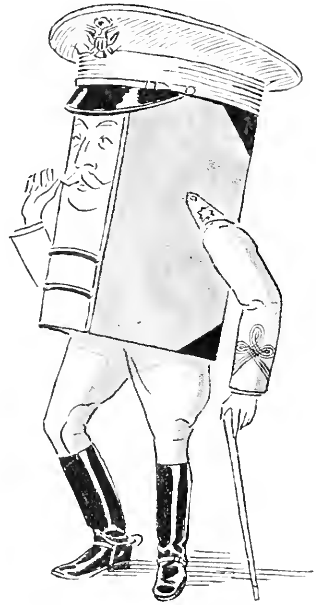
—Exchange.

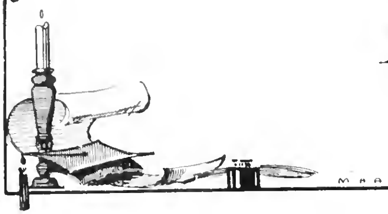
Generosity

Hostess: "Won't you have some more pudding, Mr. Brown?"

Mr. Brown: "Oh, just a mouthful."

Hostess: "Nellie, fill up Mr. Brown's plate."





ALUMNI NOTES

Stadium Executive Committee

Of the eleven members of the Stadium Executive Committee three are prominent alumni of the College of Engineering. Much of the success of the stadium work is due to the work of this committee and the engineers have played their part.

W. L. Abbott

The oldest of the three is William L. Abbot, m.e., '84, who is chief operating engineer of the Commonwealth-Edison Company, of Chicago. He has always been an active alumnus of the University and for eighteen years served on the board of trustees, all except five of which he was president.

E. E. Barrett

The second member, E. E. Barrett, c.e., '93, is president of the Roberts and Schaefer Company of Chicago, manufacturers of coal mining machinery. He has also been actively connected with the University having served as president of the alumni association.

M. J. Trees

The third engineer on the committee is Merle J. Trees, c.e., '07. Most of his time is taken with the job of vice president and general manager of the Chicago Bridge and Iron Works. He was formerly president of the alumni association and at present is serving as a member of the board of trustees.

C. W. Cross, a.e., '92, died recently in St. Louis. He was chief engineer and plant superintendent of the Christopher and Simpson plant of the Mississippi Valley Structural Steel Company.

He was an engineer of considerable note and leaves as monuments behind him such buildings as the Whitehall building in New York, the Maison Blanche building in New Orleans, the City Bank and Trust building in Mobile, Alabama, the St. Frances De Sales Church, the Time building, the National Bank of Commerce, Missouri Athletic Association building, Public Library and the City Hospital of St. Louis.

He was born in Kewanee, and attended the public schools there. While in the University he was catcher and captain of the baseball team as well as a member of the glee club.

His first two years after graduation were spent with Holabird and Roche, Chicago architects, after which he entered the employ of the Brown Ketchum Iron Works of Indianapolis. He remained in this position for eighteen years prior to his location with the Mississippi Valley concern.

E. J. Raich, c.e., '22, is working as an assistant highway engineer. His present address is 414 1-2 E. Washington Street, Springfield, Illinois.

G. Bentley Brown, m.e., '22, is located in Topeka, Kansas, with the Atchison, Topeka, and Sante Fe railway. He is a test department assistant and is engaged in testing locomotives by means of the dynamometer car.

R. E. Welton, e.e., '23, has taken a position in the industrial control engineering department of the General Electric Company at Schenectady, N. Y. He was previously employed in the testing department of the same company.

Stadium Building Committee

The committee in charge of the stadium building consisted of E. L. Scheidenhelm, c.e., '92, and F. L. Thompson, c.e., '96, with George Huff and Robert Zuppke as ex-officio members. Largely due to their valuable assistance the big structure was ready for the official opening this fall. Both men have had a great deal of experience in construction work and were able to give good advice. Since 1908 Scheidenhelm has been operating as the Edward L. Scheidenhelm Company, building contractors. He has to his credit the building of the stands of Stagg Field of the University of Chicago, the sheds of the Municipal Pier, the Chicago assembly plant of the Ford Motor Company and the Warehouse of the Reid-Murdock Company.

E. L. Scheidenhelm

F. L. Thompson

Thompson is chief engineer of the Illinois Central railroad. His interests centered chiefly in planning the improvements of the railroad so that they would be ready for the opening game. At present he is busy with the plans for the electrification of the railroad in the Chicago district. He played baseball while in the University and was awarded an "I" as an old-time athlete at the time the stadium was inaugurated.

J. W. McDonald, c.e., '22, is in construction work with headquarters in Chicago. His work takes him to all parts of the country.

Departmental Notes

(Continued from Page 91)

a number of years, is professor of electrical engineering at Union College, Schenectady, New York, and was formerly head of the electrical engineering department here. Dr. Berg gave a number of lectures on Heavisides operations here last year.

Mechanical

The student branch of the American Society of Mechanical Engineers held its third meeting of the year on Wednesday, November the nineteenth. G. S. Mican, '25, gave an interesting talk, illustrated with slides, on the steel industry. He used as an example the South Works of the Illinois Steel Company at South Chicago.

Starting with the ore and raw materials, he traced the course of the product through the blast furnace, Bessemer converters, open hearth to the ingots, then through the rail mill and out as a finished rail. All the processes and machinery were described in the order in which they were used.

A number of the senior mechanical engineers were in attendance with note books. The steel mills will probably be a popular subject for the inspection trip reports.

Department Notes

J. H. Macintire, associate professor of refrigeration, attended the twentieth annual meeting of the American Society of Refrigeration Engineers in session in New York City, December 1, 2, and 3. On Monday evening he delivered a report before this body on, "Tests on a Rotary Ammonia Compressor".

J. L.Whitten, a new instructor in machine design, is proving to be very capable and popular with the students. He received his B. S. and M. E. degrees from Purdue University, from which institution he graduated in 1922.

The Westinghouse unit, which was described in a previous issue of The Technograph, has now been installed. It is used to furnish power for the regularly for testing automobile motors.

Railway

Partly as a result of experiments carried on at the Engineering Experiment station under Prof. J. M. Snodgrass, a book entitled, "The Chilled Iron Car Wheel" has been published by George W. Lyndon and F. Falk of the association of manufacturers of chilled iron car wheels. The book contains much of the material published in three of the bulletins put out by the engineering experiment station and some of it comes from a bulletin published by Prof. E. C. Schmidt, of the department of railway engineering.

Prof. E. C. Schmidt of the department of railway engineering has been made a member of the executive committee of the fuels division of the American Society of Mechanical Engineers.

Railway Club

Among the recent speakers at Railway Club meetings was E. G. Young, an Illini graduate of the class of 1913, and who also received a master's degree here in 1916. Since leaving school he has been actively engaged in railway work in this country and in recent years, in China. He is now a member of the Board of Standardization of Chinese Railways and his duties brought him back to this country where he took the opportunity to meet old friends at Illinois. Mr. Young was one of the founders of the Railway Club and his talk brought back many reminiscences of early doings of the club. Present labor conditions and opportunities for railway work in China were the main points of his talk. He brought with him an abundance of views of railway nature which clearly illustrated instances in his talk. An article by Mr. Young will appear in a later issue concerning railway work in China.

On October 30 H. N. Parkinson, of the railway department, talked before the meeting on "Modern Locomotive Design". He emphasized the point that modern locomotive equipment still had many undesirable features which research was trying to correct. At the previous meeting Prof. J. K. Tuthill talked on the "Virginian Electric Locomotives". John R. Trissal, '25, was elected vice president of the club to fill the vacancy left by R. S. Watts.

College Notes

(Continued from Page 85)

sired might see the picture it was shown a second time.

The expedition was made by the geological survey of the United States Department of Interior and had for its purpose an accurate survey of the river with possible locations for dams and for power and irrigation in mind, many very favorable sites being found.

Pi Tau Sigma

Pi Tau Sigma, honorary mechanical engineering fraternity, recently took into membership three senior and five junior mechanical engineers. The initiaton banquet was held at the Inman Hotel, Monday evening, December the first. It was well attended by faculty members.

R. B. Hall, '25, acted as toastmester. The address of welcome was delivered by E. V. Johnson, '25, and was responded to, in behalf of the initiates, by J. Muller, '25. Prof. A. C. Willard spoke on "Traditions". He told of the difficulties encountered by S. W. Robinson in starting the mechanical engineering school at Illinois. B. G. Rich, '25, spoke of the annual convention at Minneapolis to which he and E. V. Johnson, '25, were delegates.

A very interesting sketch of the biography of J. A. Bashear, a pioneer in the optical field and prominent in all branches of engineering, was given by Prof. G. A. Goodenough. The program was brought to a close by the entire party singing, "The Rambling Wreck," an old mechanical engineering song.

The initiates were: J. Muller, '25; R. F. Wikoff, '26; P. R. Boyce, '25; J. N. Demmler, '26; J. T. Tomasek, '26; A. H. Heinman, '26; A. J. Stejskal, '25; and N. J. Alleman, '26.

Contemporary Engineering News

(Continued from Page 89)

in the vicinity of these cities, with reference to the profit to be derived from the distillation by-products. Work is also being done on the subject of coal dust explosions and the prevention of them by the rock dust spraying method.

Classes for Sheet Metal Workers. Apprentices in the sheet metal workers' union at Pittsburgh will now be obliged to attend classes one day a week at the Carnegie Institute of Technology, according to an agreement between the workers and the employers of that city. The apprentice is allowed his regular day's pay while attending school, but must pay his own fees. Subjects related to sheet metal working are taught. This is one of the first attempts to be made by organized labor toward a definite training of apprentices.

Louis Rosenstein, e.e., '24, is employed by the Illinois Fixture and Electric Supply Company at Chicago.

Culture Versus the Engineer

(Continued from Page 82)

can lead him to the highest in science, in his profession, and to the highest in his function as a tool in the hands of civilization. This is also evident when one considers the many and powerful influences which come to bear upon the engineer during his long and varied apprenticeship in school and in life. Our discussion then, has narrowed down to the consideration of an attitude, or perhaps a quality of mind. How is this quality of mind obtained?

I believe that as an engineer, a man has an exceptional opportunity to become acquainted with his fellow-man. Furthermore, the character of the engineer's profession requires him to adopt relations of the highest moral quality with his fellows. His profession brings him into contact with men from all walks of life, each with their own peculiar griefs, interests, and ambitions. The wide knowledge of natural philosophy or physical laws required in the training of an engineer, together with the hard knocks given him by experience as he forges upward in his profession, these two things taken together I say, give him a calm, sympathetic, and philosophic attitude of mind most favorable for the development of culture which is the "Study of Perfection".—T. W. Oliver, '25.

Joliet-Calumet Transmission Line

(Continued from Page 81)

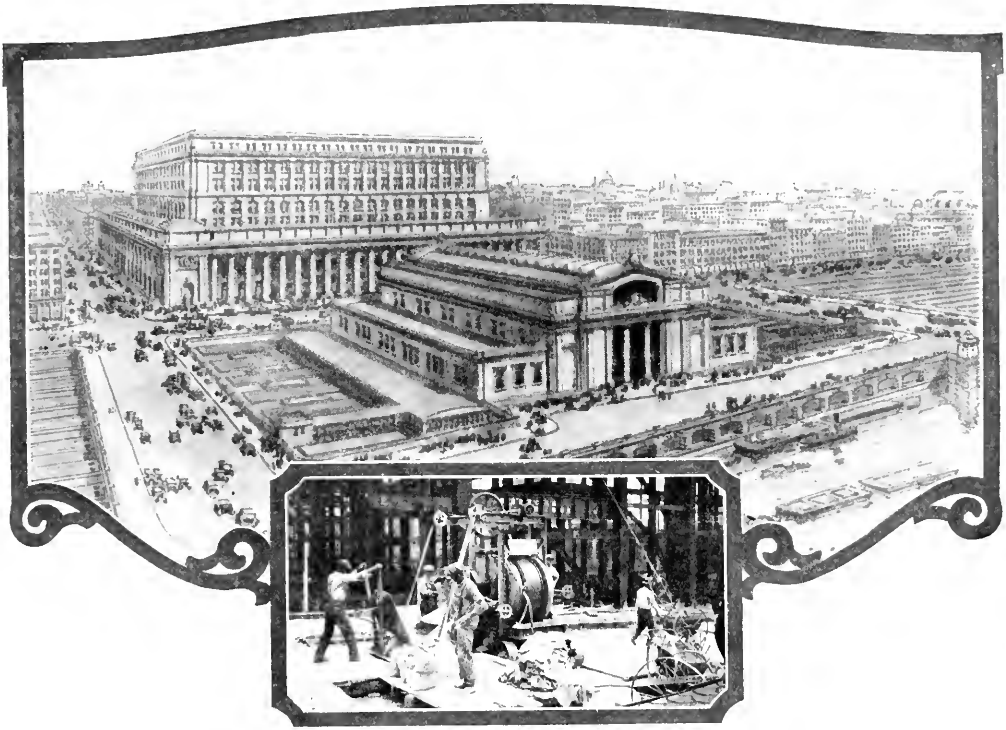
punched out, and the pipe filled with ordinary salt. A piece of No. 2 copper wire was forced down into the pipe and babbit poured around the wire. The wire was securely fastened to the tower by coiling it around the bolts and screwing the nut down tightly. After all operations on the tower were completed, anti-climbing devices were put in place. These consisted of numerous closely spaced barbed wire strands held out at right angles to the tower. They were placed at a height of eight feet.

Work on the line was started during the early part of the year 1924 and it continued throughout the year. After the completion of the sub-station and conections the second part of the super-power line, which will eventually encircle Chicago, will be ready for operation. This will be sometime during the early part of the present year.

Commerce: "Think of those Spaniards going 3,000 miles on a galleon."

Engineer: "Aw, forget it. You can't believe everything you hear about those foreign cars."

—*Kansas Engineer.*



New Union Station, Chicago, and Koehring

THE new terminal of the Chicago, Milwaukee and St. Paul, Chicago, Burlington and Quincy, Chicago and Alton and Pennsylvania railroads now being completed, will be the finest railway station in the world. Covering two entire blocks, the value of the buildings alone is $15,000,000.

Caisson work, retaining walls, substructures; concrete arches, superstructure—the concrete work throughout on this Union Station is another product of Koehring Concrete Mixers.

Over 22,000 cubic yards of concrete were used in the 163 caissons, retaining walls and substructures; and approximately 25,000 cubic yards additional were required for the arches and superstructural work.

Koehring Mixers and Pavers are identified with the noteworthy building and road construction projects in all parts of the country.

"Concrete—Its Manufacture and Use", now in its fourth edition, is a 207 page treatise on the uses of concrete, including 26 pages of tables of quantities of materials required in concrete paving work. To engineering students, faculty members and others interested we shall gladly send a copy on request.

KOEHRING COMPANY
MILWAUKEE WISCONSIN

Manufacturers of Pavers, Mixers—Gasoline Cranes, Draglines, Shovels

Origin and Growth of the English Cottage

(Continued from Page 64)

from the earliest times of which we have any record. Often a color wash was applied to the exterior. When the roof of a whitewashed house was covered, as it often was, with green moss or turf, its appearance must have been very striking. Although stone, slates, straw, reeds, rushes, and other materials used for roofing, moos or turf, on account of its cheapness, was often used for farm buildings and the cheaper kinds of houses. The most picturesque mode of roofing is the thatch. Its glories and beauties have often been sung by poets and depicted by artists. (Fig. 5.)

Probably the most interesting type of domestic architecture in England is found throughout the Cotswold Hills. All the buildings are of the local limestone; which was practically the only material available. Construction of the simplest forms were practiced, based on traditions, handed down through generation after generation, gradually evolving into a distinct type or style. There were, apparently, no fixed rules as to composition, the windows and doors being placed where best suited to the interior arrangement. Roofs of simple construction were used. There is a great variety of designs shown in the smaller details, such as doorways, window mouldings, finials, chimney tops, and wrought iron work. The so-called Cotswold type, dates from 1570 to 1700. Another very interesting section, rich in examples of smaller domestic architecture, is found throughout Surrey, Sussex, and Kent.

Few people realize that the first houses built in America by the colonists were not log cabins but the English type of half-timbered cottages. The art of building this type of structure was apparently forgotten, and was totally obscured by the Colonial style. However, there is genuineness about this English work that is often lacking in our Colonial architecture.

In considering the small houses of today, it must, therefore, be remembered that it is not so far back to the time when they were being built upon principles that were good; principles which had stood the test of centuries and produced admirable results. And, as architecture is of necessity an art of tradition, accompanied by a perpetual striving to improve knowledge by experiment, it is natural to look to those periods when it flourished best, for that which shall help most to meet the needs of our own time.

It is not here suggested that any art is a matter of copying, for none can live by such means. It is mere hypocrisy and affectation to reproduce forms of a bygone age, simply because they are old, for such forms had definite uses and were brought into being to meet certain needs of other days. But when old work demonstrates artistic, constructional or sentimental principles that cannot be bettered, and furnishes the best methods for solving present problems, it is of great practical use and full of suggestive, as opposed to reproductive, value. The practice of building is advanced by past experience as are all other branches of human effort.

Champaign-Urbana Water Supply Treatment

(Continued from Page 77)

stead of the strainers there will be holes pointing downward in the receiving pipes, through which the water will flow. There are varied opinions as to the results of these changes, but as other towns have found them to be satisfactory it is hoped that the result will be the same here. Little can be said, however, until the new filters are put into actual operation next spring.

(The writer wishes to acknowledge his indebtedness to Mr. W. Ainsworth, plant manager, for the photographs of the plant.)

Results in Heating and Ventilation

(Continued from Page 72)

registers (Fig. 9) than the rectangular duct. Table II contains a comparison of the performance of

TABLE II.
HEAT AVAILABLE AT REGISTERS FOR TWO TYPES OF RECIRCULATING DUCTS

Register Air Temperature deg. F.	Heat available at Registers above 70 deg. F. B.t.u. per hr.		Pct. Increase for Round Duct
	Rect. Duct	Round Duct	
130 (Low)	47 000	54 000	15.0
160 (Moderate)	81 000	94 000	16.0
190 (High)	120 000	138 000	15.0

the plant with the two types of duct on a percentage basis for three register air temperatures. The round duct had a center line length of 11 ft. as against 14 ft. for the rectangular duct. On the other hand, the round duct was equipped with a register grille, whereas the rectangular duct had none. The grille resistance amounts to 1 percent of the furnace capacity at moderate temperatures. The failure of the rectangular duct to handle the same quantity of air as the round duct may be ascribed to sharp right-angle turns, greater length, and greater frictional surface for the same cross-sectional area.

The values in Table II were selected from the curves of Fig. 9.

Warm-Air Heating Research Residence

The new residence (Fig. 2) will make it possible to compare and correlate the results of tests of furnaces which are now being made in the laboratory with the results obtained on the same furnaces under actual house conditions. In addition to this, there are many factors affecting the performance of a furnace heating system which cannot be adequately investigated in the laboratory. Such factors are:

(1) The effect of wind,

(2) the relative value of inside and outside air supply,

(3) the significance and proper percentage relative humidity in the house,

(4) the variation of air temperature from floor to ceiling in actual rooms with different air temperatures at the registers,

(5) the proper location of furnace with respect to center of basement,

(6) the relative value of return air ducts above basement floor compared with ducts placed below basement floor,

(7) the proper location and number of recirculating registers,

(8) the proper location of warm-air inlet registers,

(9) the effect of various installation details on operation of wall stacks to upper floors,

(10) the effect of various installation details on operation of basement pipes,

(11) the relative value of inside as compared with outside chimneys,

(12) the importance of constant temperature both day and night,

(13) the problem of the remote roof with three sides exposed, and

(14) the proper installation for a sun porch.

The house will afford a most unusual opportunity to check up many of the requirements of the new Furnace Installation Code.

* "Report of Progress in Warm-Air Furnace Research," Uni. of Ill., Eng. Exp. Sta., Bul. 112, 1919.

EDITOR'S NOTE: *The second part of this article, dealing with the study of the power problems involved in the ventilation of the new vehicular tunnel under the Hudson River between New York an Jersey City, will be published in the next issue of the magazine.*

H. W. Dietert, m.e., '22, visited the campus recently on his way to the meeting of the American Foundrymen's Association at Cleveland, where he presented a paper on the testing of molding sand. Harry is with the United States Radiator Corporation at Detroit.

Convening with E. C. M. A.

(Continued from Page 73)

sin; eastern vice-chairman, W. V. Merrihue, of the "Pennsylvania Triangle"; and western vice-chairman, W. O. Birk, of the University of Colorado.

Aside from the strict business, there was the usual polite convention photograph, and an unusual banquet. The place cards were linotype slugs bearing the delegate's names. Everyone joined in the toasts. Saturday brought the motor tour to points of interest, the beautiful scenes an lakes about Madison, with explanations of the wonderful summer and winter sports enjoyed there. The country home of Robert LaFollete was included as one of the principle points of interest.

The next convention of E. C. M. A. will be held at Ithica, New York. Between now and that time it is well to realize that the growing child will be a man some day, and must have new garments in the form of greater power, a broader field, and liberal, conservative management. Then the association will take its place as an influence on the young business managers and editors, many of whom will later publish the cream of the American engineering periodicals.

Mooney: "Hello, is this the working girls' home?"

Lady: "Yes."

Mooney: "And do you try to save bad girls?"

Lady: "Yes?"

Mooney: "Well, do your darndest to save me a couple for tomorrow night."

Co-ed (alighting from car, powdering nose and making other adjustments): "Well, I certainly enjoyed the ride."

Ed (politely): "Oh, the pleasure was all mine."

Co-ed: "Don't kid yourself, I'm not that accommodating."

GOOD IDEA

"This is my car," shouted the irate motorist to the garage man, "and what I say about it goes—see?"

Just then a mechanic crawled from under the car and pleadingly said, "Say 'engine', mister."

DAYLIGHT ILLUMINATION.

The angle of refraction being equal to the angle of incident, it is a simple matter to determine the correct angles to use in manufacturing glass which will give good illumination. But for proper industrial plant illumination, there is more to be considered than mere deflection of light. The direct beam of light must be eliminated in order to prevent sun glare, which is objectionable on account of its causing heavy shadows and strong contrasts which decrease the efficiency of employees and necessitate the use of shades which in turn reduce the light to such an extent that daylight illumination any distance from the light source is not sufficient. Therefore, in order to produce a glass which when used in the windows of industrial plants will produce as near to ideal illumination as possible, we must first eliminate the direct rays of the sun by deflecting the light to the ceiling and side walls which re-deflect it back to a distance 25 to 50 feet from the window throughout the entire working area. To accomplish this we have scientifically designed a type of glass which is named "Factrolite."

Factrolite consists of 30 ribs to the inch, running at right angles, forming 900 pyramidical prisms or 3,600 light deflecting surfaces which completely disintegrate the direct beam of light from the sun. Furthermore, the depressions in the surface of Factrolite are so slight that the accumulation of dirt and dust is minimized and can be perfectly cleaned with an ordinary dry scrubbing brush. Incidentally, the cleaning of windows is most important for keeping up production and increasing the efficiency of any industrial plant and should be given more consideration in plant management.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

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THE TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS

March

1925

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The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

Member of the Engineering College Magazines Associated

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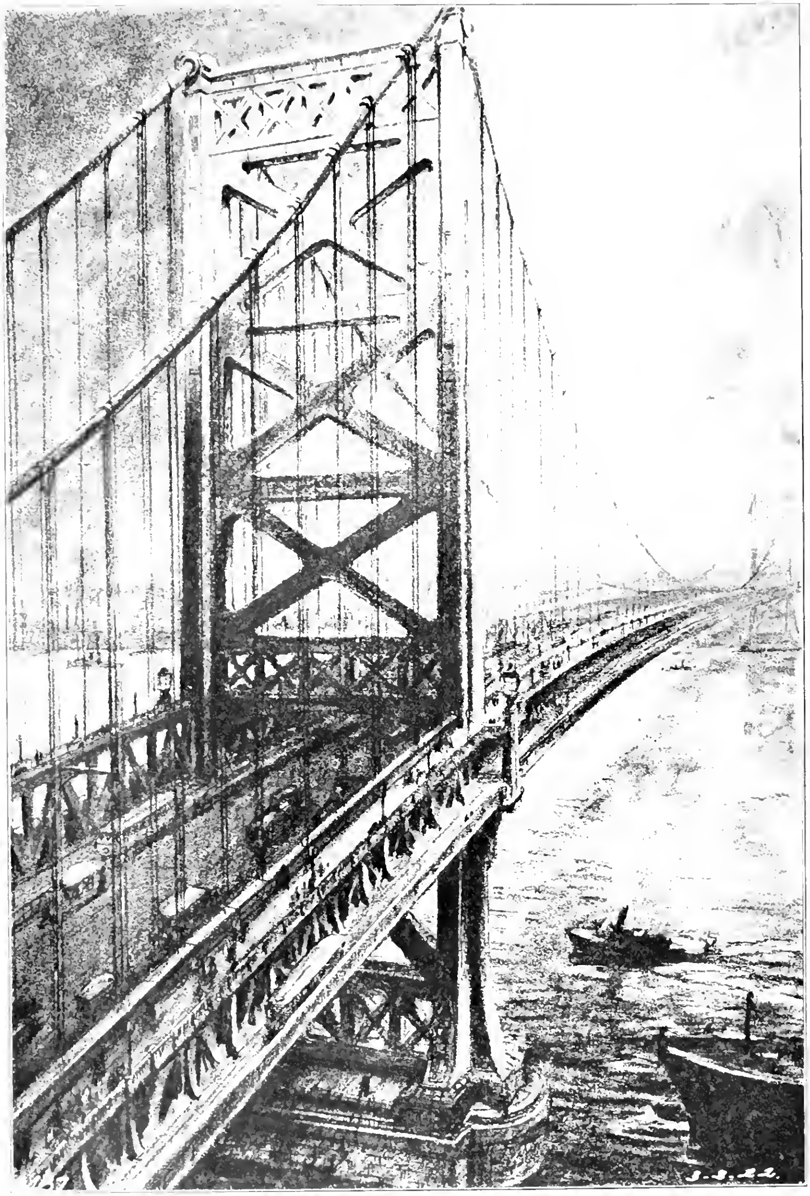


The Delaware River Bridge

THE TECHNOGRAPH

Published Quarterly by the Students of the College of Engineering—University of Illinois

VOL. XXXVII | MARCH, 1925 | NUMBER III

The Delaware River Bridge and Its Builder

P. J. HOWARD, c.e., '25

Montgomery B. Case, '06, sends us data concerning the construction of the Delaware River Bridge, of which he is the senior resident engineer. This, the world's longest bridge of the suspension type, will be completed by July 1, 1926, spanning the Delaware river between Philadelphia and Camden, New Jersey. This huge structure was made necessary by the heavy vehicular traffic, amounting to some 5,000,000 vehicles yearly, or a maximum of about 24,000 daily, which traffic has rendered inadequate the present system of ferries. The great expenditure which is involved in the construction of this bridge is further justified by the fact that hundreds of thousands of dollars will be saved in a commercial way, as Philadelphia and Camden are interdependent manufacturing centers. A third reason which influenced the states of Pennsylvania and New Jersey to undertake this project, is that the bridge when completed will form a strategic link in our national system of hard roads.

The main span of the bridge is 1,750 feet, while the approach spans are 720 feet in length. These three main spans together with the smaller approach spans, amount to an overall length of bridge of 1.81 miles. The bridge itself is suspended from two 30-inch cables which pass over steel saddles on the supporting towers 385 feet above mean high water, and which are anchored to huge girders imbeded in the end suports for the 720-foot spans. Greater rigidity than that usually secured in suspension bridges is obtained by relatively heavy stiffening trusses upon which the actual floor system rests. Ample room for the large amount of traffic to be accommodated has been attained in the design by providing space for four trolley lines, two local and two high speed, six lines of vehicular traffic and two ten-foot walks for pedestrians, making the total overall width of bridge about 125 feet.

A volume of 320,000 cubic yards of masonry comprises the piers which support the spans. These piers are of concrete faced with Georgia granite down to the water line, and were sunk by the pneumatic caisson process to bed rock at depths of 65 and 84 feet on the Philadelphia and Camden sides respectively. An idea of the immensity and stability of these piers is gained when it is known that they are equivalent to a solid mass of concrete, one-fourth of a city block wide, one half of a block long, and three-fourths of a block high. Tonnage of steel including cables, stiffners, and suspenders totals 50,000 tons.

The construction and spinning of the huge cables presented problems which were the most difficult as well as the most interesting part of the whole work. Each of the two 30-inch suspension cables is composed of 18,666 wires 0.195 inch in diameter. The making of this wire was done under the strictest supervision as the safety of the bridge and its human load depends upon them. Acid open hearth steel containing not more than 0.85 per cent carbon, and not more than 0.04 per cent sulphur or phosphorus was used. The steel billets were carefully heated to a predetermined temperature before being rolled into three-eights inch rods. Wire was made from these three-eights inch rods by running them through five separate dies, the temperature of the rods and their speed through the dies being carefully regulated throughout the entire operation, since the final tensile strength of the wires depend almost wholly upon the care with which the heat treatment and cold working in the dies is done. By making one test for each 3,000 feet of wire manufactured, a high degree of uniformity and strict adherence to the specifications was obtained. To indicate the quality of wire secured one has only to note that the average tensile strength is 223,000 pounds per square inch, the yield point 144, 000 pounds per square inch, that the maximum variation in diameter was but 0.003 inch, and that the wire, despite its hardness, could be bent around a rod one and one-half times its own diameter without fracture. As to the amount of wire, if all lengths were placed end to end, it would more than reach around the world.

The spinning of the cables was accomplished by the ordinary methods, but this project has been noted for the rate at which the work has progressed. A temporary walk ten feet wide, having the same curve as was desired in the main cable, was erected just under the final position of the main cables, to facilitate the handling of the 61 small strands which were to constitute the main cable. These small strands were then spun by securing one end of the wire, after passing it around a sheave, and allowing the reel upon which the wire was wound, to let the wire out at twice the speed with which the sheave was pulled across the river, thereby hanging two wires at once. Work was under way for twelve hours per day, and the record for stringing wire was 578 in one day. Each cable when finished will have been formed by 61 smaller strands each of which will contain some 306 wires. These strands will form a regular hexagon when first hung, but by means of a hydraulic press cable of exerting a pressure of 6,000 pounds per square inch, they will be compressed into a circular form. Special tests on a typical section showed that a total pressure of 30 tons was necessary to compact a hexagonal section of extreme diameter of thirty-five and one-half inches to a circular section of twenty-nine and fifteen-sixteenths inches diameter. Transverse wires will be wrapped around this circular section, and castings for the suspender ropes will be bolted to the completed cables. Splices in the wires are accomplishd by means of sleeves threaded right and left hand, and mitered to prevent the wire from turning out. Tests of these splices show an efficiency of 98 per cent of the strength of the wire.

Foundations for the towers consist of eight cylindrical piers down to bed rock, two under each pier. The piers are sunk as reinforced concrete, open-dredged caissons, the walls being four feet thick allowing for an eight foot dredging well. The cutting edges are of steel, and the caissons are pumped out as sinking goes on, the space in the center of each caisson to be filled later by depositing concrete, in the dry.

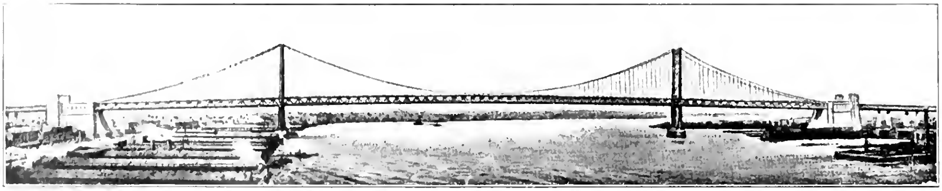
The stiffening trusses, which assist in making

MONTGOMERY CASE '06

this structure noteworthy, are of the Warren type, and are 28 feet deep, center to center of chords. The steel used is a very high quality nickel steel with an ultimate strength of 90,000 pounds per square inch, and a yield point of 55,000 pounds per square inch. Web members and main members of the floor system are a silicon steel of good quality though not as good as that used in the main trusses.

As is usual in projects of this kind, the actual

(Continued on Page 160)



ELEVATION OF THE DELAWARE RIVER BRIDGE

Design in Power Plant Lighting

Erving J. Ulrich, ry.e.e., '28

If, on your next visit to a large power plant, you will examine the lighting installations, you will find that power plant design is indeed a difficult problem. Due to varying conditions almost every room in the structure requires a different type of installation. It is the task of the illuminating engineer to consider these conditions and provide correct lighting for each part of the plant.

"Poor illumination may be either insufficient lighting or excessive glare. The golden mean between these two extremes of lighting is considered correct lighting, that which gives men and equipment a fair chance to work. Incorrect lighting is responsible for many accidents as has been proved by carefully kept records covering an entire year; the curve plotted in Fig. 1 shows that the greatest number of accidents happened during the dark months. A number of states have realized the importance of correct industrial illumination and have passed laws specifying the minimum degree of light required for various kinds of shops and yards.

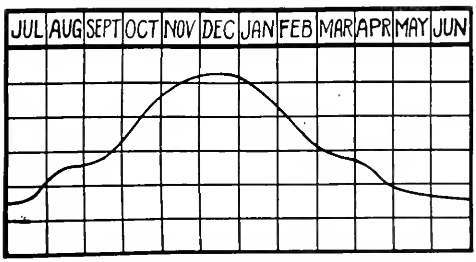


Fig. 1. Curve of Relative Power Plant Accidents

The units of measurement used in illumination design are the lumen and the foot candle. The lumen is the quantity of light produced by a standard candle. Electric lamps are rated in lumens and in watts; a 100 watt lamp produces 1,260 lumens, and a 200 watt lamp produces 3,100 lumens. The degree to which a surface is illuminated is measured in foot-candles. One foot candle is the intensity to which a surface of one square foot is lighted by one lumen. Two other important terms are co-efficient of utilization and depreciation factor; the first being the percentage of lumens effective, and the second representing a safety factor which takes care of loss of light from the ageing of the lamps and the decrease of the reflecting efficiency of the reflectors, walls, and ceilings.

There are four main steps in the calculation of the illumination for a room. First, decide upon the foot-candles, or intensity, required. Second, select the lighting unit to be used. Third, determine the mounting height and the number of lighting units. Fourth, ascertain the size of lamp which will give the desired number of foot-candles. In complying with the first requirement, the designer consults tables, compiled by illumination experts, giving the recommended foot-candle illumination for a certain type of room. The conditions of the cases covered in the tables are seldom similar to those in question; and here is where the illumination engineer's experience and knowledge of power plant construction counts most. In selecting the lighting unit, the designer is governed by the type of equipment in the room, the construction of the room, and the color of the walls and ceilings. The mounting height of the units is dependent upon the height of ceiling and the physical layout of the room. The size of the room, position of beams and columns, and the arrangement of the equipment determine the number and location of the lighting units. The fourth and last step, the calculation of the lamp size, is a summary of the three previous steps and is accomplished by the use of the formula: $L = (A \times I \times D) \div (E \times N)$. L is lumens required per outlet, A the total floor area in square feet, I the intensity in foot candles, D the depreciation factor, E the coefficient of utilization, and N the number of lighting outlets in the room. For example let us take a room of 3,600 square feet, to be lighted to an intensity of 5.5 foot candles. The depreciation factor for power station lighting is usually chosen as 1.5. And let us say the efficiency coefficient is found to be 0.50, and the number of outlets is 18. Our formula then becomes:

$$L = (3{,}600 \times 5.5 \times 1.5) \div (0.5 \times 18).$$

The lumen output of a 200 watt lamp, being 3,100, is the nearest to this figure; therefore, a 200 watt lamp would be used. A large Boston engineering firm keeps a record of the illumination design for each room, and when the plant is in operation, the calculations are checked by means of the foot candle meter. In addition to the above steps there is the usual routine work accompanying each design; that of dividing the lights up into circuits;

dividing the lighting circuits into switching circuits; determining the size of the conduit and the size of wire; locating the plug receptacles and switches in the most accessible positions; and making a bill of material for the room.

The Weymouth power plant, located fifteen miles south of Boston, and built for the Edison Electric Illuminating Company of Boston, is an excellent example of a well lighted station. Stone and Webster of Boston were the engineers and contractors of this large steam generating station, which furnishes power for greater Boston. The ultimate capacity of this station is 400,000 horsepower, which will place it next in size to the Crawford avenue station of Chicago. In the Weymouth plant were incorporated many new features, involving numerous unique problems in illumination design.

The conduit installation in the Weymouth plant consists almost entirely of the concealed type. This means that all lighting drawings, as well as power and control conduit layouts, had to be in the field at the same time the building plans were there, because the walls and floors could not be built before all the information concerning the number and size of the conduits was in the hands of the construction superintendent. In Fig. 2 conduits and lighting cabinets are shown ready for the construction of the columns between the turbine room and auxiliary bay. Concealed conduit installation in the power station is an expensive construction, but the excellent appearance and neatness obtained is well worth the additional cost.

The turbine room is the show room of the entire station; therefore a high degree of illumination must be provided to make the enamelled brick walls and tile floor appear to best advantage. The chief difficulty encountered in the lighting of the turbine room was the huge 110 ton movable crane, which necessitated locating the lighting units about forty feet above the floor. Sixteen 1,000 watt special Holophane units were mounted below the framing of the skylight. These lights were remotely controlled by means of a push button station located above the turbine room floor. In addition to these ceiling lights, large ornamental 500 watt wall lights were placed on each column. To add to the decorative effect of the wall fixtures, a large illuminated Edison light symbol was placed in the window facing the ocean.

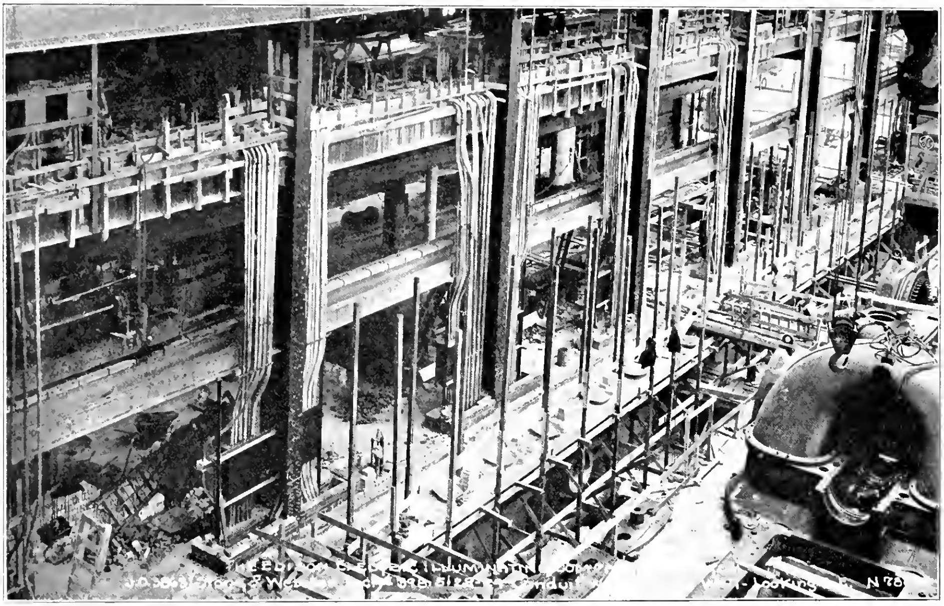
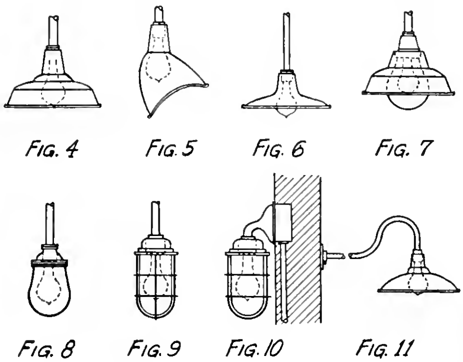


Fig. 2. Conduit Work Between Turbine Room and Bay, Weymouth Power Plant

The boiler room, being the hardest part of the station to keep clean, did not require such careful attention to artistic effect as the turbine room, and part of the conduit installation is exposed, that is, run on the outside of walls. The many stairways, walkways, platforms, and the different floor levels made the boiler house the most diffiicult for lighting design. The economizer floor was above the boilers, and the columns and beams were so placed that the lighting outlets could not be placed proper-



TYPICAL LIGHTING FIXTURES

ly. In order to insure sufficient light at the economizers, various definite points were chosen and the combined foot-candle illumination of these spots was calculated by means of the distribution curve of the fixture used. Dust-proof guarded fixtures were used in the ash handling room. At the automatic stokers and the water columns on the boilers special fixtures were used.

The switch house and control bay maye up a building separate from the main group, which consist of the office bay, turbine room, auxiliary bay, and boiler house. The control of practically all motors, fans, and large valves is accomplished in the switch house. This building is the center of an intricate nervous system consisting of an enormous number of power, control, signal, and lighting conduits. The conduits become so numerous at places that floors 18 inches thick had to be constructed to contain them all. In Fig. 3 a portion of the floor and wall of the control bay is shown before the pouring of the concrete. The long pull box shown in the center of the picture is used to facilitate the pulling of the cables through the long iron conduits. To the left of the pull box are two lighting cabinets, and on the column at the right a switch outlet box can be seen. The lighting design for the main operating room in the control presented a very difficult problem and many preliminary designs were made before the requirements were fulfilled. In order to obtain uniform illumination over the circular shaped switchboard and instrument racks, a glass ceiling was constructed and powerful units were placed above ,affording an even distribution of light and eliminating all glare.

The lighting of the extensive system of coal handing equipment required a great amount of the designer's time. In the breaker house and in the transfer house special dust proof fixtures were used to prevent coal dust explosions. The inclined coal conveyor, being a rather unsightly structure, was dimly lighted to make it less conspicous. Where the inclined conveyor was attached to the boiler room, provision was made for vibration and expansion. Since iron conduit could not be used across the gap, a flexible connection was made by means of some armored cable. The long conveyors over the coal bunkers were lighted by units placed in the roof slab. In order that a man may enter the conveyor at one end and leave by the other without continuously pressing three-way switches, a push button station located at each end of the

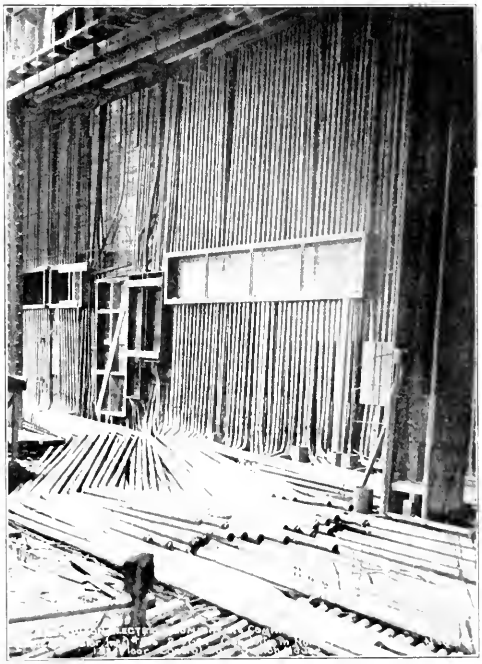


FIG. 3. CONDUITS IN FLOOR AND WALL OF CONTROL BAY

conveyor controls a solenoid in the lighting cabinet which switches on or off all the circuits of lights over the walkways.

Practically every kind of fixture and switch in the catalogs was used in the lighting of the Weymouth plant. The most typical are shown in Figs.

(Continued on Page 164)

Electrification of Illinois Central Terminal

J. S. Thorpe
Distribution Engineer

Part I: Power Supply System

The Illinois Central Railroad Company has long considered the rearrangement and enlargement of its Chicago Terminal facilities, and in connection therewith, the electrification of its train service in the Terminal. By agreement with the city of Chicago, embodied in an ordinance, the railroad company is to complete the electrification of its entire suburban service in 1927, the electrification of freight service north of Roosevelt Road in 1930, including a freight yard at South Water street, which will eliminate practically all steam engine service immediately adjacent to the Loop District; followed by the electrification of all major freight operation within the city limits by 1935; finally the conditional electrification of all through passenger service within the city limits by 1940.

This article was obtained for The Technograph by F. L. Thompson, c.e., '96, formerly chief engineer of the Illinois Central Railroad Company and recently chosen as vice president of the company, in charge of the Chicago Terminal development. The power supply and distribution system to be used for this development are completely described, the former being discussed in this issue and the latter in the second part of the article which is to appear in the May issue of the magazine.

Preliminary to installing structures and wiring for the initial stage of electrification, it has been necessary to rearrange tracks and other facilities to a maximum degree of permanence. This has involved anticipating future traffic needs as far as possible, and the planning of all facilities so as to develop the available right of way for greatest possible utility. In carrying out such development, the railroad company has adopted a policy of eliminating grade crossings whether railway, highway, or pedestrian, along its main line. New overhead and underground crossings have required considerable track elevation and depression and attendant cutting and filling of the right of way. This work of rearranging present facilities and constructing new and additional facilities has been in progress since some time in 1922.

A contract has been consumated with the Commonwealth Edison Company whereby that company will supply direct current at 1,500 volts to the railroad company's traction system, and alternating current of suitable characteristics to its distributing lines for signal, light, and power loads. In negotiating the contract with the Edison Company, thorough consideration was given alternative arrangements for furnishing power as follows:

(1) Purchase by the Railroad Company of suitable high voltage alternating current, to be delivered to sub-stations owned and operated by the Railroad Company.

(2) Purchase by the Railroad Company of both direct and alternating current of voltage and frequency characteristics desired on the Railroad Company's distribution lines, sub-stations to be owned and operated by the Power Company. Taking into consideration the costs of operating a sub-station system, the second alternative was considered to be the more economical arrangement for the Railroad Company, and it is on this basis that agreement has been reached.

The suburban electrification comprises a large proportion of the load. At the present time some 400 suburban trains are operated per day and a large growth of traffic is anticipated after electrification. Four tracks will be used exclusively for this service from Randolph Street south to 18th Street, a distance of approximattely two miles; six tracks south to 53rd Street, a distance of approximately four miles; four tracks to Kensington (115th Street), an additional eight miles, and then two tracks to the end of the suburban zone at Matteson, approximately twenty-eight miles from the Randolph Street terminal. In addition, there is a double track branch of four and one half miles to South Chicago serving a thickly settled residential district and providing frequent service; and a single track branch of four and one half miles to Blue Island, Illinois, southwest of the city limits. This track scheme, as shown by Fig. 1, comprises a total track mileage of approximately 110 miles along some thirty-eight miles of route, exclusive of yard and shop facilities. The initial electrification of suburban service will be followed by the electrification of freight and through passenger service within the city limits, as shown schematically by Fig. 2. Present plans must, therefore, anticipate as many as fifteen main line tracks in parallel in some sections, and an ultimate of 115 miles of electrified track, including yards and sidings. It is planned to make the change over from electric to steam for both of these services in the vicinity of Harvey about twenty miles from the center of Chicago. This point is near the north end of Markham Yard, the new freight classification yard now being constructed by the Railroad Company.

Catenary System for Main Line Tracks

The catenary system over each track will in itself provide the required current capacity without any

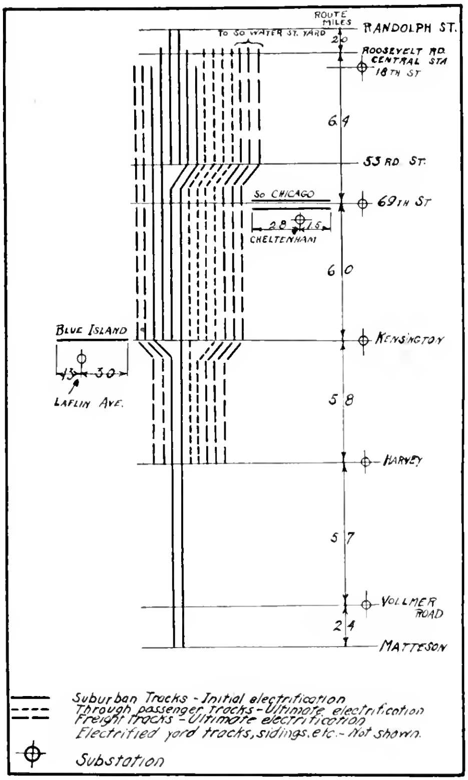


Fig. 2. Track Layout of I. C. Chicago Terminal Electrification

additional feeders. The distribution system will provide for an average voltage drop in normal rush hour service of appromixately twelve per cent, with an all day average drop estimated at three per cent. The average conductivity over each track, thoroughout the life of the contact wire, will be approximately 790,000 circular mils copper equivalent. The system over each main track will comprise a composite main messenger of high tensile strength, two bronze or copper grooved contact wires, and a hard-drawn copper lacing cable, or auxilliary messenger. In the heavy traffic section north of 67th Street, 3/0 bronze contact wires will be used in order to obtain the best wearing qualities. On the rest of the main line and on the South Chicago and Blue Island Branches, 4/0 copper contact wires will be used. The make-up of the catenary systems will vary somewhat in other respects, as tabulated.

	67th Street, North	67th Street, South
Contact wires	2 3/0 Bronze	2 4/0 Copper
Conductivity of contact	80 pct. cu. equiv.	
Composite main messenger	.81" dia.; 19 strands	.81" dia.; 19 strands
H. D. copper auxiliary messenger	200,000 c.m	No. 1/0 A. W. G.
Hanger spacing	20 ft	15-ft.
Ultimate strength of main messenger	31,500 lb.	31,500 lb.
Copper equivalent of system, new	838,900 c.m.	898,700 c.m.

The normal height of contact wire will be twenty two feet above top of rail at structures, with a "hog" of three inches to insure against excessive sag under heavy current densities and high temperatures. This height will be maintained south of 43rd Street, excepting at a few points where passing under overline structures. On account of the frequent present and proposed bridges over the railroad providing for access to Grant Park and the new Lake Front Park, the contact wire north of 43rd Street will have a normal height of eighteen feet six inches. The minimum height of contact wire will be sixteen feet six inches, and a gradient of one per cent or less with respect to track will be used where the height varies.

The auxilliary messenger will be highly flexible, nineteen strands in each case, to assure a contact line free from hard spots. It will be hung from the main messenger by hangers spaced at twenty and fifteen foot intervals, for the respective catenary systems. Clips for the contact wires will be spaced at half this interval and each contact wire supported from alternate clips. The bronze contact will thus be suported at twenty foot intervals and the copper contact at intervals of fifteen feet. The two contact wires of a system will hang side by side, with points of support staggered, but with no appreciable sag.

The resulting contact system differs from any other so far used by electric railroads in actual operation. The double-contact wire arrangement has been used previously, but suspended directly from the main messenger. The insertion of the stranded auxilliary messenger increases the flexibility of the system and, it is believed, will practically eliminate "hardness" of contact. At the same time it provides positive connection between messenger and contact and eliminates wearing due to moving parts, as compared with the various forms of "lift

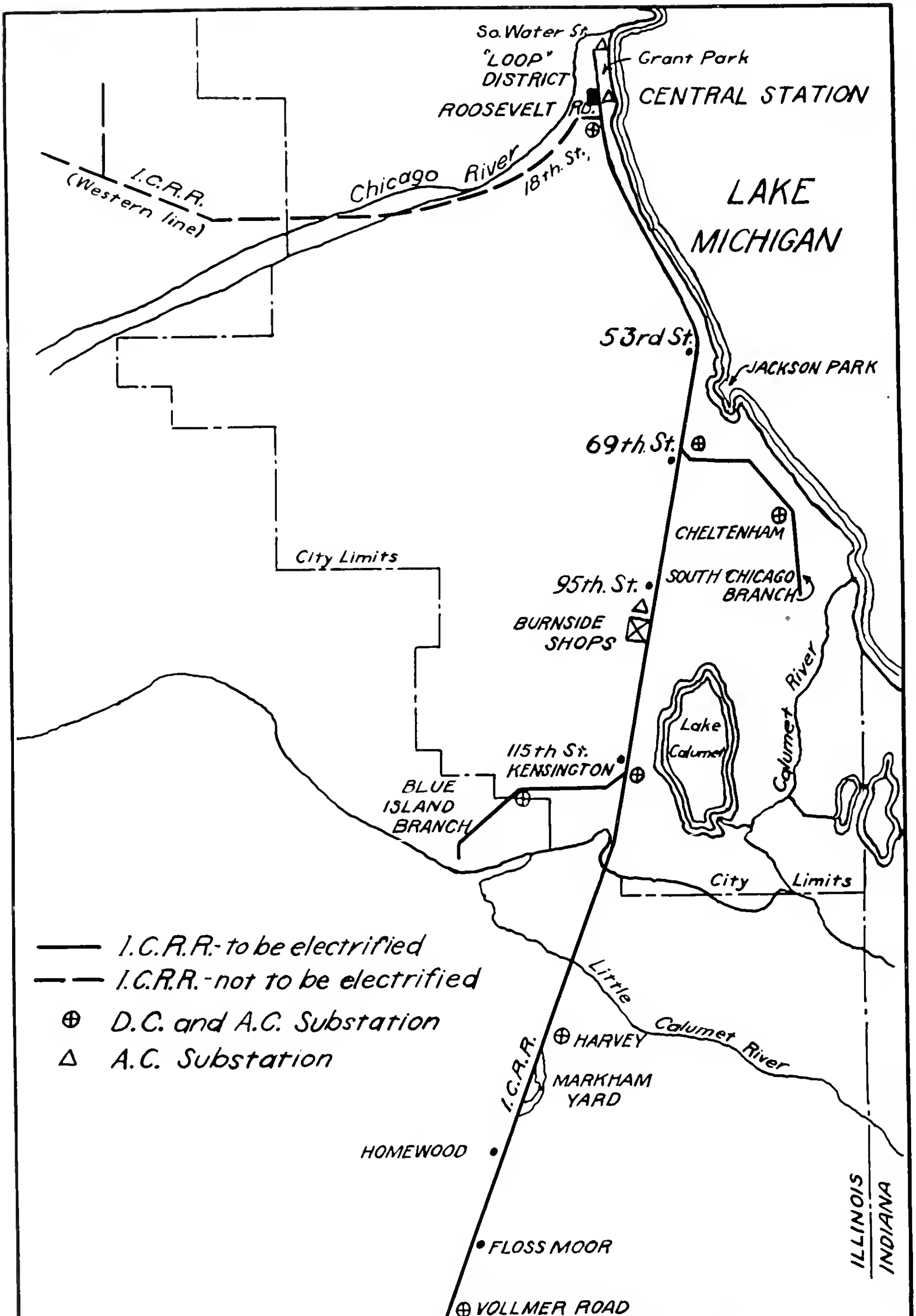


Fig. 1. Map of I. C. Chicago Terminal Electrification

ing" hangers. The double contact wire will insure good contact with pantograph at all times, and thus prevent the burning and pitting of the wire that generally results from minute though invisible arcing, when a current-collecting device is used on a single wire.

The use of the relatively elaborate system comprised of four wires might be prohibitive for some installations, but in the case of the Illinois Central electrification the total copper would be required in any event for feeder capacity. It thus becomes advantageous to provide the electrical conductivity in such a way as to give a mechanical arrangement of great advantage.

The main messenger will have a sag of four feet nine inches under normal conditions for the stanard span of 300 hundred feet. The resulting tension in the messenger will be 7,700 pounds for normal loading in still air at 60 degrees F., and under conditions of maximum loading (0 degrees F., with ice and wind) the tension will be 12,300 pounds. Sags will of course vary with the span lengths in such a way as to maintain the same tension throughout a messenger. Chord construction will be used for curves, of which there are relatively few.

The messenger will be supported from the catenary structures by suspension insulators, double insulation being used throughout. The entire catenary system will thus be below the supporting structure. This allows the use of suspension insulators rather than pin insulators for the heavy catenary system. Further, men may work on structures without danger of contact with live wires, this feature being of added importance in view of the use of catenary structures for signals.

Non-ferrous hangers and fittings will be used exclusively, and all connections between the parts of the catenary system will be fixed. For electrical purposes, the component parts are thus so thoroughly cross-connected that they are in effect a single conductor. The minimizing of corrosion of fittings will insure good electrical connections, as well as facilitate maintenance work, indefinitely.

Catenary System for Yard Tracks

The catenary construction over crossovers, sidings, and yard tracks will be of simpler and less expensive construction than for main tracks. A single contact wire will be used, suspended directly from the main messenger, which will be of smaller section than for main line tracks. Such messengers will be mechanically independent of the main line messengers, but contact wires will merge into main line contact wiring so as to avoid any crossing of contact wires and still use the advantageous method of wiring in each case. Crossover wiring will be connected electrically to the adjacent main line tracks, but sectionalized so as not to interfere with the complete sectionalization of the main tracks.

Sectionalization

At important interlocking points, sub-stations and tie-stations have been located so as to come within the interlocking limits. Catenary systems will be sectionalized at these points, and tied together through sub-station or tie busses. The double-contact wire lends itself to the air-gap sectionalization very advantageously. At the desired point, the contact wires will be alternately raised high enough to insert a strain insulator in each without danger of such insulators fouling a pantograph. The contact wires will thus be continuous, and there need be no additional dead ends. As a part of the insulation, the contact wires must be held apart by suitable spreaders at such points. Single contact wires will be used over crossovers and sidings. On account of the fewer pantograph passes and lower speed of operation, these will be insulated with air-gap or wood section insulators cut directly into the contact line.

Tie Stations

Although the catenary system over each track will be independent electrically, the several parallel systems will be tied together through circuit breakers and automatic or remote-controlled equipment at ends of stub feed and at certain points between sub-stations, so as to give each track benefit of the conductivity installed over other tracks. The tie-stations will be owned by the Railroad Company, whereas the seven sub-stations for conversion to 1,500 volts D. C. will be owned and operated by the Commonwealth Edison Company, from whom power will be purchased. Operation of tie-station circuit-breakers, in so far as such operation will not be automatic, may be by supervisory control from the railroad load dispatching office or by Edison Company sub-station operators through orders of the Railroad Company, at the option of the Railroad Company.

Bonding of Tracks

All track is of 90-lb. ARAA-A rail. The same size of bond will be used throughout. A single 4-0 bond will be used on each joint. Additional return circuit conductivity will be obtained in the heavy traffic section of the line between 16th Street and 69th Street by bonding initially some of the tracks not electrified in the initial stage.

Impedance bonds will be installed at the ends of every signal circuit. Tracks will be cross bonded at alternate impedance bonds, resulting in a spacing of 5,000 to 8,000 feet for the several classes of

(Continued on Page 160)

Research Results in Heating and Ventilation

A. C. Willard
Professor of Heating and Ventilation and Head of Department of Mechanical Engineering

Editor's Note: *The first part of this article dealing with (1) the study of the factors affecting the performance and operation of warm-air furnaces and heating systems, appeared in the Technograph for January, 1925.*

II.
The Hudson River Vehicular Tunnel Investigation

The latter investigation is practically completed and final reports have been made to the Chief Engineer* of the Bridge and Tunnel Commissions of New and New Jersey. This investigation began in January, 1921, and the last experimental work was finished during the past summer.

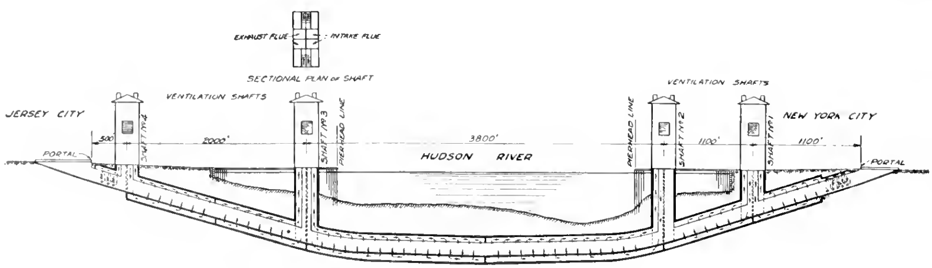
The ventilation of the new "Holland" Hudson River Vehicular tunnel will require the installation of eighty four fans and motors in four ventilation towers (Figs. 10-12) capable of supplying and exhausting 3,600,000 cu. ft. of air per minute, when the tunnel is operated at its maximum capacity of 1,000 automobiles per hour. In many parts of the ventilating system, the air must be handled at high velocities, which range from 1,000 to a maximum of nearly 6,000 feet per minute. The sizes of the fans and motors depended out only on the air quantity but also on the pressures (Fig. 12) against which the fans must be operated either when blowing into the tunnel supply ducts or exhausting from the tunnel exhaust ducts. The actual work of driving the tubes under the river is now completed. These tubes are 29 feet 6 inches in diameter and run parallel to each other, about 60 feet apart on center lines. From portal to portal the tunnel is 8,500 feet in length. A brief description of the system adopted for ventilating the tunnel will be found in the October, 1921, number of the Technograph.

The experimental work at the University of Illinois involved the determination of the pressures to be maintained throughout the tunnel system. It will be evident that these pressures were, in general, exactly balanced by the friction losses: (1) in straight ducts, (2) in simple and compound elbows, (3) in changes in section, (4) at inlet and outlet ports to and from the tunnel roadway, and (5) by the turbulence created by many jets of air entering the exhaust duct through the tunnel ceiling. Finally, in the case of the exhaust fans, there was a further pressure loss (6) resulting from the pressure equivalent of the velocity head necessary to get the 3,600,000 cu. ft. of air per minute out of the exhaust stacks.

Tests for Friction Losses in the Small Scale Models

General Statement. A reference to Fig. 12 will show that in addition to the friction pressure losses in the vertical ducts (risers), the horizontal ducts (drifts), and the air distributing tunnel ducts, there are losses in the elbows (Fig. 12—Elbows C, E and G) which must be used wherever a change in the direction of air flow is made. More or less information is available on air flow through ordinary right angled elbows (Fig. 14) of varying curvatures at heel and throat at low velocities. No information is available on the compound elbows (Fig. 15), which must be used to make the transition from the vertical shaft to the lower tunnel duct. Moreover, little is known as to the effect of using a venturi departure tube (Fig. 14, Elbow No. 4) in an elbow that would otherwise have a very

*Mr. Clifford M. Holland was Chief Engineer of this project from the time of its inception until his death on October 27, 1924, just a few days before the tunnel headings met in the bed of the Hudson River. The project is now known as the "Holland Tunnel". He has been succeeded by Mr. Milton H. Freeman, formerly Engineer of Construction.



PROFILE
Fig. 10

short radius throat as shown in Fig. 11, Elbow No. 1.

It was therefore, decided to investigate a limited series of small model elbows, similar in proportions to those which might be used in the tunnel, and to determine the friction pressure losses in such elbows at the air velocities which will occur in the tunnel ducts.

A brief discussion of the experimental studies of the performance of simple and compound elbows, in which small and large scale models were used, has been taken from the final report. By using models dimensionally similar (Figs. 15 and 17) but of two sizes, as in the case of the compound elbows, it was possible to extend the experimental results to the full size tunnel elbows. The scale ratios are given in Table 1.

TABLE 1

	Linear Ratio	Area Ratio	Hydraulic Mean Radius
Small model	1 : 10	1 : 100	0.1798
Large model	1 : 2	1 : 4	0.899
Full size tunnel	1 : 1	1 : 1	1.798*

*(area) (perimeter) = (71.31 sq. ft.) (39.66 ft.) = 1.798.

Theory Underlying the Relation between Performance of Models and Full Size Unit

In making comparisons as to the performance (Figs. 18 and 19) of the various elbows, select any desired velocity of air flow at entrance to elbow and read friction pressure loss on the ordinate at its intersection with the various elbow curves. In accordance with the laws of dimensional similitude, the elbow loss at the same air velocity in both small and large models decreases with increase in size, or more specifically with increase in hydraulic mean radius.

The mathematical relation between the elbow losses in small and large models may be expressed, therefore, in terms of the hydraulic mean radius. The procedure follows:

Experiment has shown that the loss of head in any elbow may be expressed as a function of the mean velocity head of the air as it enters the elbow. Hence, the head (h') lost in the elbow friction is equal to some constant (c) multiplied by the velocity head ($w^2/2g$), or

$$h' = c \times w^2/2g.$$

The experimental work on the tunnel ducts has shown that the most acceptable form of expression for the coefficient (c) is

$$c = a + b\,(wm)^2$$

where (a) and (b) are constants, (w) is the mean velocity of the air as it enters the elbow, and (m) is the hydraulic mean radius. Then, for the small model (galvanized iron) elbows,

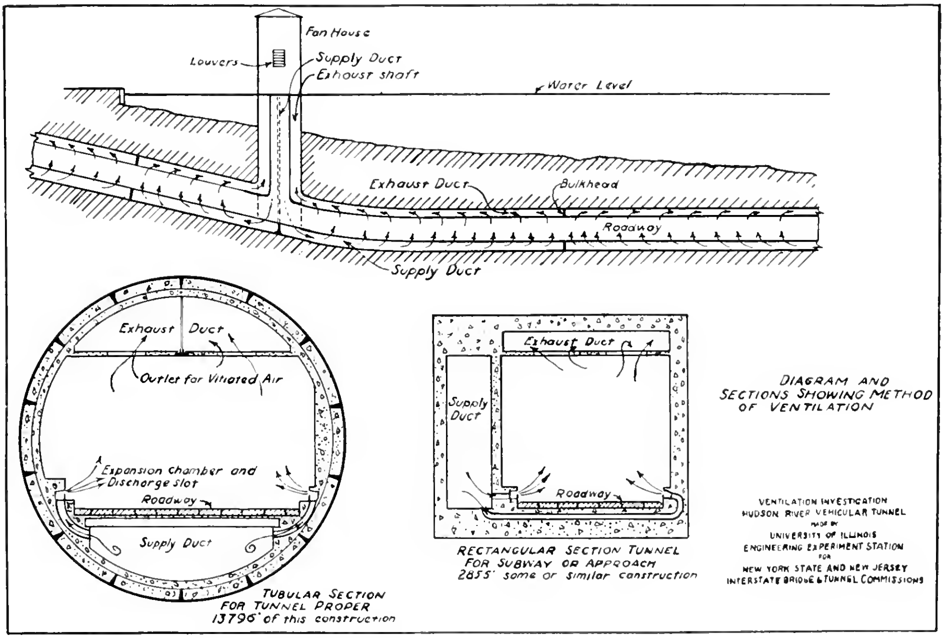
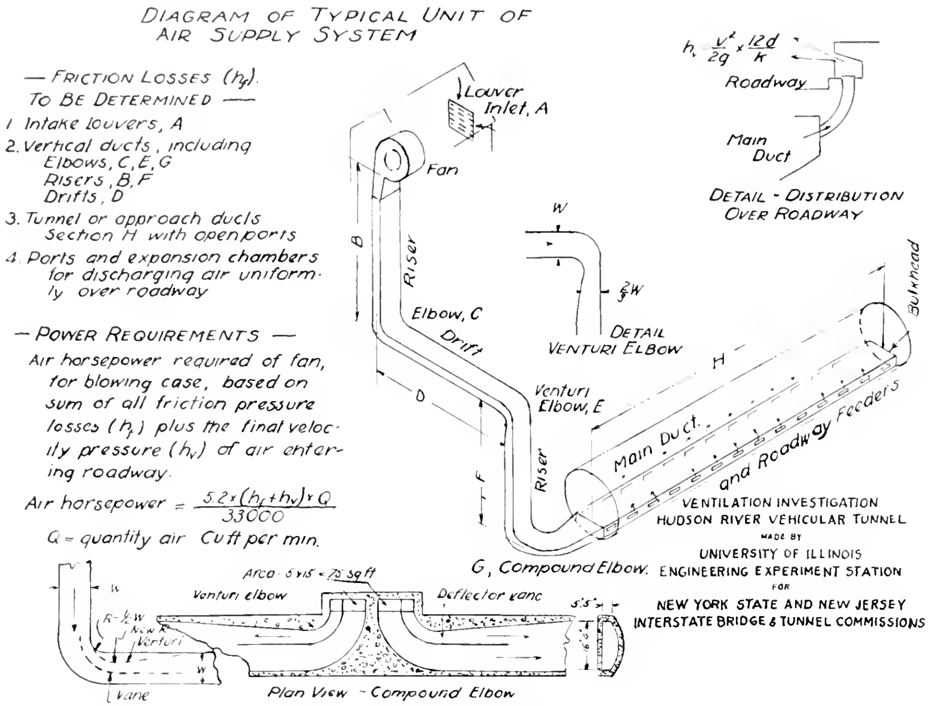
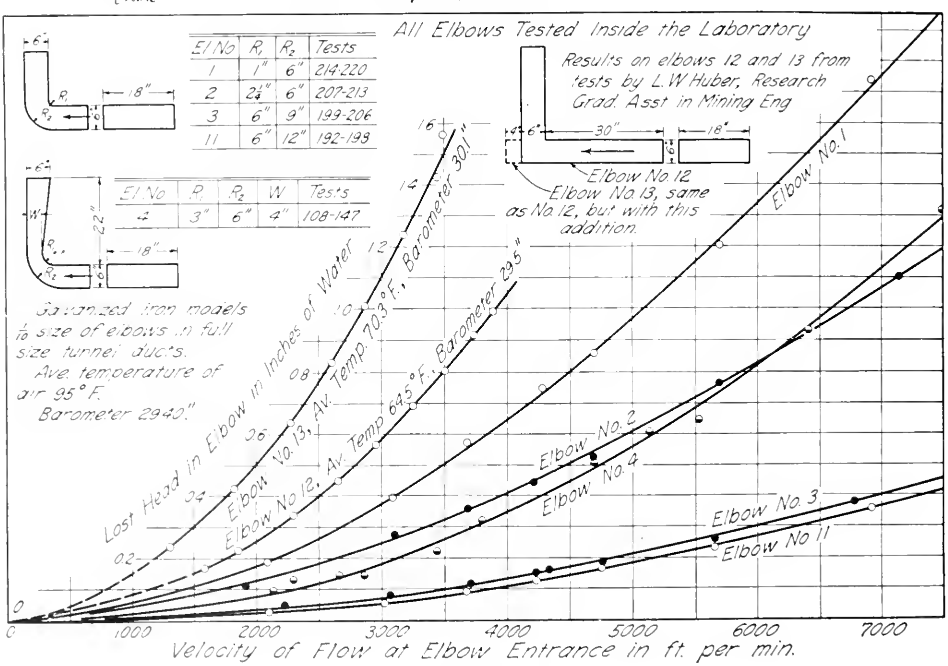


FIG. 11. DETAILS OF VENTILATING SYSTEM, HUDSON RIVER VEHICULAR TUNNEL





FIGURES 12 AND 13

$$c_1 = a + b\ (wm_1)^2$$

and for the large model (concrete) elbows,

$$c_2 = a + b\ (wm_2)^2$$

Also, since $m_2 = 5\ m_1$, $c_2 = a + b\ 25\ (wm_1)^2$. For the actual tunnel elbows, $c_3 = a + b\ (wm_3)^2$, and since $m_3 = 10\ m_1$, $c_3 = a + b\ 100\ (wm_1)^2$. Therefore,

$(c_1 - c_3)/c_1 = (c_1 - c_2)/c_1 \times (99/100)/(24/25) = 99/96 \times (c_1 - c_2)/c_1$.

But $(c_1 - c_2)/c_1 = c_1/c_1 - c_2/c_1 = 1 - c_2/c_1$, and since experiments on the small model (galvanized iron) elbow and the large model concrete elbow show the ratio

$c_2/c_1 = 0.78$, we have $1 - c_2/c_1 = 0.22$.

Therefore,

$99/96 \times (c_1 - c_2)/c_1 = 99/96 \times 0.220 = 0.227$, so that

$(c_1 - c_3)/c_1 = 0.227$ and $c_3/c_1 = 0.773$.

It should be noted that the decrease in loss of head is considerable (0.45″ − 0.35″ = 0.10″ water gage) in changing from a small compound elbow No. 6 (Fig. 18) to a large compound elbow with vane (Fig. 19) at a given air velocity of 1,000 ft. per min. There will be, however, very little decrease in the elbow loss in changing from the large compound concrete model to the actual compound concrete tunnel elbows, at this same air velocity, as a simple computation will show. It has just been shown that, $c_3/c_1 = 0.773$, which is the ratio of the head lost in a full size elbow to head lost in a 1/10 scale model, at 1,000 ft. per min., and 0.773 × 0.45″ = 0.348″ water. The losses in the three elbows, at a velocity of 1,000 ft. per min., are:

Small 1/10 scale = 0.450″ water gage.
Large 1/2 scale = 0.350″ water gage.
Full size = 0.348″ water gage.

See Table I for elbow characteristics.

Testing Equipment. The small scale elbows were tested at the end of a straight run of 6″ x 18″ G. I. duct of the same cross section 6″ x 18″ as the cross section of the elbow. This duct had a straight run of over 25 ft., and the static pressure reading in the duct was taken at a piezometer ring approximately 2′ 8″ ahead of the elbow. For low velocities of flow a Wahlen Gage was used, but for the higher velocities, where the static pressures exceeded 0.5″ water head, differential Ellison Gages were used. The air velocities were computed from velocity head readings taken in a round duct 21″ in diameter. The air velocities ranged from about 2,000 to 7,500 ft. per minute for the right angled elbows, and from about 2,500 to 7,000 ft. per minute for the compound elbows. In the straight duct tests, two piezometers were used placed 15.9 ft. apart and the velocity range was about the same as for the elbow tests.

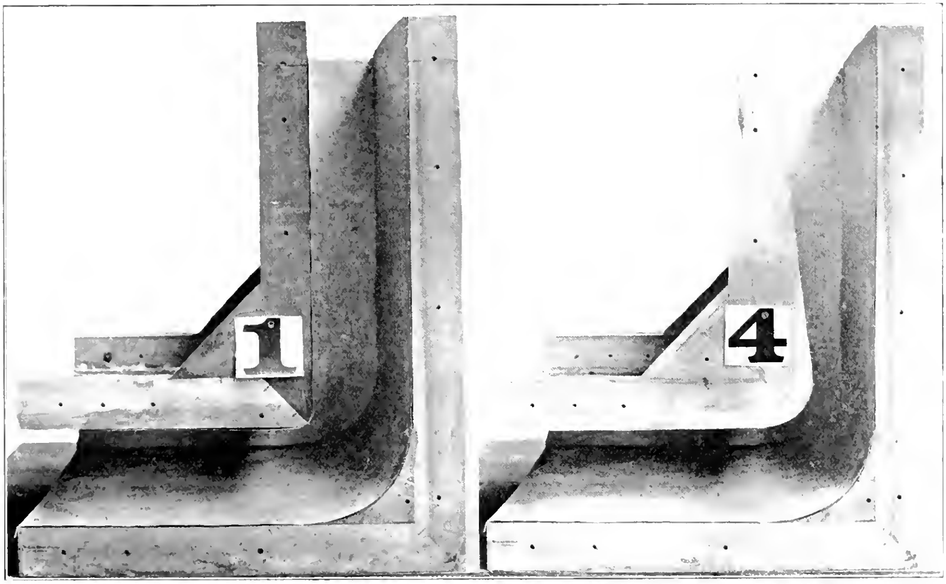
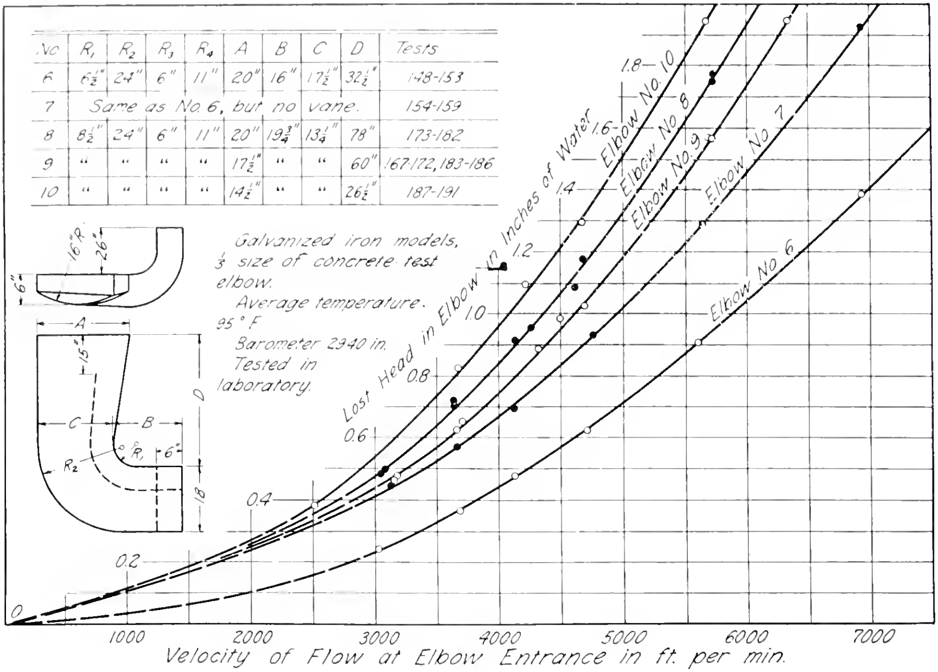
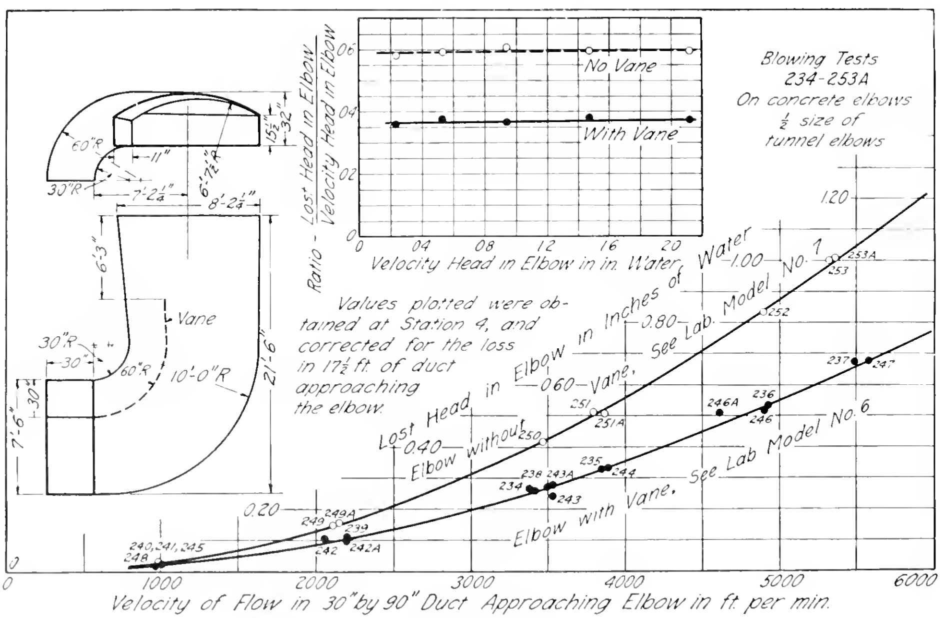


FIG. 14. TYPES OF RIGHT ANGLE ELBOWS HAVING STRAIGHT AND VENTURI DEPARTURE TUBES





FIGURES 18 AND 19

Results of Tests—Small Right Angled Elbows. The friction pressure losses in the elbows marked 1, 2, 3, 4 and 11 as shown in Fig. 14 are given by the curves in Fig. 13. These losses are expressed (Fig. 13) in heads measured in inches of water at average air and water temperatures of 95° F. and a barometric pressure of 29.40 inches of mercury. The heads as plotted represent the static pressure at the piezometer ring, which was about 30 inches ahead of the elbow, corrected for the friction head in the straight 6″ x 18″ pipe entering and leaving the elbow.

In the case of the venturi elbows, the departure tube leaving the elbow was 22 inches long and its friction loss is included in the elbow friction. The double venturi elbow having a venturi approach tube also, was found to be much worse than the single venturi elbow (4) (Fig. 14) and was abandoned after the first series of tests.

The two right-angled elbows Nos. 12 and 13 shown in section in Fig. 13 have been included in the discussion of small elbows as extreme cases. Their performance curves (Fig. 13) show excessive turbulence as reflected in the rapidly increasing loss of head which takes place as the air velocity through the elbow is increased. Such elbows actually exist at the base of many mine shafts, creating a most uneconomical operating condition which is especially severe at high velocities. These two elbows were investigated by Mr. L. W. Huber, Research Graduate Assistant in Mining Engineering at the University of Illinois, using exactly the same testing equipment as was used in testing the other elbows shown in Fig. 13.

Example Showing Application of Test Data on Small Elbows to Practice. A comparison of the operating costs resulting from the use of different elbows at the base of the down-cast shaft in the ventilating system of a mine or tunnel is most

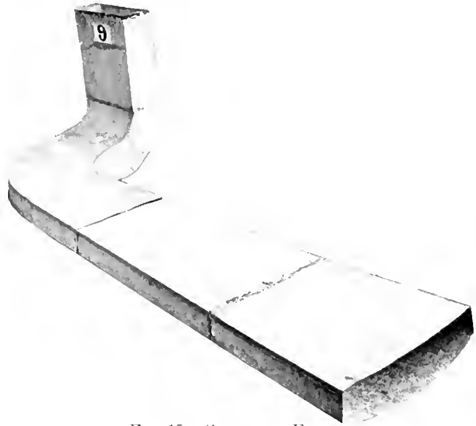


Fig. 15. Compound Elbow

illuminating. For the purpose of securing some definite figures we will assume that our ventilation problem involves 187,500 cu. ft. of air per min., with a velocity in the down-cast shaft of 2,500 ft. per min. Elbows Nos. 2 and 13 (Fig. 13) are under consideration, the latter, of course, being somewhat

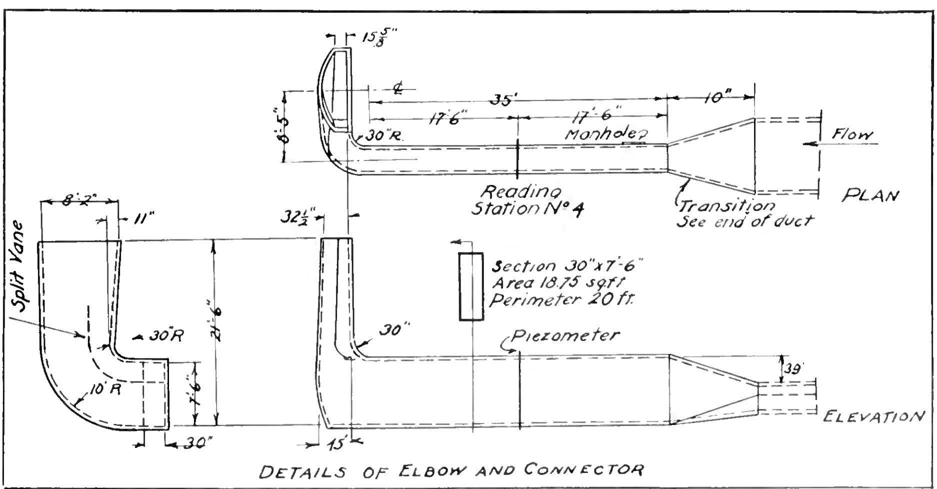


Fig. 16

easier to construct. We will also assume our fans are motor driven with an overall efficiency of 50% from switchboard to air delivered by fan, and that electrical energy costs 5c per kw. hr.

With elbow No. 13, the actual friction loss in the elbow at 2,500 ft. per min., is 0.77″ water as shown by tests on the model of 1/10 scale dimensions. The full size elbow would be 5′ x 15′ = 75 sq. ft. in area, and at a velocity of 2,500 ft. per min. would handle 187,500 cu. ft. per min. The loss in the large elbow would be less, at the same air velocity, than the loss in the small model. According to the data presented on dimensional similarity, the ratio c_2/c_1 = 0.773 for the proportions under discussion, and hence the actual friction loss in the large elbow would be 0.77 × 0.773 = 0.595″ water. The air horsepower required is found as follows:

Air hp. = 5.2 × [(C. F. M. × F. P. L.) / (33,000)]
= 5.2 × (187,500 × 0.595) / (33,000)
= 17.6

C. F. M. = 187,500 (assumed at 70° F.)
F. P. L. = 0.595″ water.

The Electrical input is:

(17.6 × 0.746) / (0.50) = 26.3 kw. per hr.

and the oest per month (24 hrs. per day) is:

26.3 × 30 × 24 × 0.05 = $947.00.

With the elbow No. 2, the actual friction loss in the elbow at 2,500 ft. per min., is 0.18″ water as shown by tests on the model of 1/10 dimensions. The full size model would be of the same general dimensions and capacity as full size elbow No. 13, and the actual loss would be 0.18 × 0.773 = 0.14″, where c_2/c_1 = 0.773. The air horsepower required is:
Air hp. = 5.2 × (187,500 × 0.14) / (33,000) = 4.14.
The electrical input is (4.14 × 0.746) / (0.50) = 6.18 kw. per hr. and the cost per month (24 hrs. per day) is:

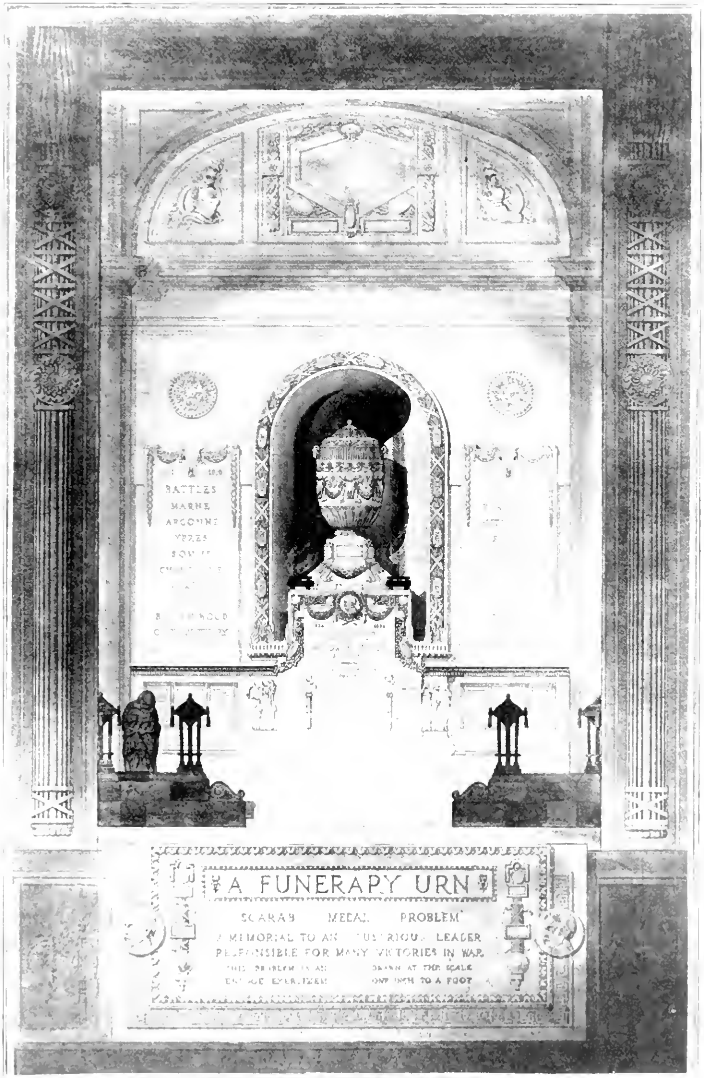
6.18 × 30 × 24 × 0.05 = $223.00.

The saving per month, using elbow No. 2 instead of No. 13, is 947 − 223 = $724, or $8,690 per year. Assuming that only half of this saving could be realized in practice, due to factors beyond the control of the designer which would interfere with the successful operation of the better elbow, it would pay to spend, with money at 6%, (8,690) / (2 × 0.06) = $72,400 for the better elbow. Even though electrical energy costs only 2½c per kw. hr., it would still pay to spend $36,200 more for elbow No. 2 than for elbow No. 13.

Fig. 17. Large Size Compound Elbow Made of Concrete

Results of Tests—Small Compound Elbows. The friction pressure losses for the compound elbows marked 6, 7, 8, 9 and 10 as shown in general features by Fig. 15 are given by the curves in Fig. 18. The details of the elbows, which were small scale models of the proposed down-cast elbows at the base of the tunnel air supply shafts are shown in Fig. 18. Only one elbow, No. 6, carried a deflecting vane. Except for the vane, elbows 6 and 7

(Continued on Page 154)



1924 Scarab Medal

W. A. Rolleston, '25

Development of the Gothic Vault in France and England

E. G. Spencer, a.e., '25

An Abstract of the Second Prize Ricker Paper 1924

The vault played a great part—perhaps the greatest—in the development of Gothic architecture. While the problems of scientific vaulting had presented themselves before and had been partially solved by the Romans and the Romanesque builders, in the hands of their Gothic successors, vaulting was improved and developed into a new art.

In Rome the dome and the tunnel vault were the common roofing motifs, but both had defects

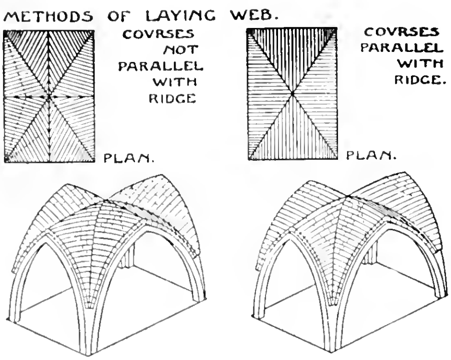


Fig. 1

which the perfectly groined vault overcame. A dome requires continuous support around its base, and the tunnel vault, though requiring no support at the ends, must have it the full length of the sides. On the other hand a groined vault, see Fig. 1, requires support at only the four corners. In the second place, windows may be inserted in any or all of the four arched areas of the sides. A window correspondingly high in a dome or tunnel vault would have to pass through the thick masonry of the tunnel or dome. The groined vault[1] was very skillfully used in the Basilica of Maxentius in the Roman Forum. The innovation was never followed to any extent in Roman work, but we find it meeting with great favor in the Romanesque work following.

The science of vaulting was retarded for a long time by the problem of vaulting the bays of both the nave and aisles of a church, for a groined vault could only be thrown over a square bay by the builders of that time and since the width of the nave and aisles was necessarily not the same, the bays of one or the other apparently had to be of oblong plan. This problem, however, was solved at S. Ambrogio, Milan, by the simple expedient of making the aisle half the width of the nave and making two small vaulting bays in the aisle to one in the nave. This was called the "alternate" system of construction.

Another step was taken at S. Etienne, or the Abbey of Men, at Caen, France in 1135. Here the architect desired to show some relationship between the two aisle vaults and the large nave vault and to derive this effect he bisected the nave bay with a transverse rib meeting the crown at the

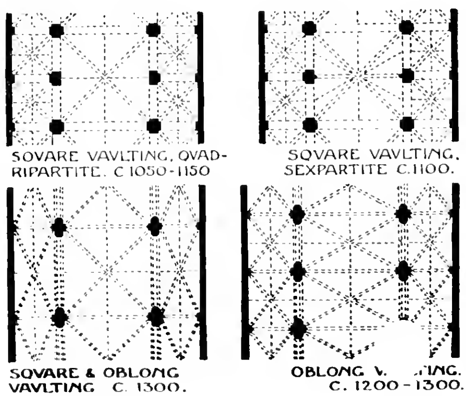


Fig. 2

intersection of the diagonals. On the back of this he raised a thin wall for some height and then spread it out with vaulting surfaces right and left to meet those of the main vaults. This was the first "sexpartite" vault.

The plain groined or quadripartite and sexpartite vaults, see Fig. 2, are the two things, then, which the Romanesque builders bequeathed to the architects of the new Gothic style. The Abbey Church of Morienval was one of the first Gothic

[1] Formed by the intersection of two semicircular tunnel vaults of equal radii.

examples in France. Here we have illustrated the first step in the final transformation of the Romanesque into Gothic for the builders were *forced* to make use of the *pointed* arch in order to counteract the inequality of arch heights in the apsidal aisle, Fig. 10. St. Leu d' Esserent, a neighboring church, carries the pointed idea forward. Here the transverse ribs are loaded to raise the surface of the vault and give it a more acutely pointed form, while genuine "flying buttresses" are used to abut the thrust.

Fig. 3. Interior of Cathedral at Rouen

Fig. 4. Exterior of Cathedral at Rouen

Fig. 5. Interior of Cathedral of Notre Dame, Paris

St. Denis near Paris offers an almost complete solution for the apsidal vaulting problem. It is so well understood and the work so intelligently planned, that it is obviously the outgrowth of continued experiment and the culmination of less perfect predecessors. Here we have established the distinctly Gothic arrangement of diagonal ribs in apsidal aisle vaulting. It was not a far cry from St. Denis to the great monument of Notre Dame in Paris, begun by Bishop Maurice de Sully in 1163. It is one of the four great French Cathedrals and the one in which the Gothic principles were first distinctly and systematically carried out. Notre Dame, Fig. 1, has its vast nave crowned with sexpartite vaults of an early type which have lasted intact for seven hundred years and are still in excellent condition despite the many restorations, so called. The vaults have a distinctly domical appearance due to the fact that the main transverse ribs are a little lower than those of the diagonals. The shells consist of successive courses of masonry which are slightly arched from rib to rib over each triangular cell.

Following Notre Dame came Chartres, Rheims and Amiens the greatest of French cathedrals. These examples were all roofed with simple quadripartite vaults, differing but little from those developed at St. Denis over a century prior to their time, except that the arrangement of the construction was masterly without the tentative efforts of the earlier example.

Thus we begin to sense the whole spirit of French vaulting. In the four cathedrals which marked the epitome of all that is fine in French Gothic, though the builders decorated the facades with splendid decoration and the best figure sculpture of the continent, they strove only for simplicity and perfection of workmanship in their vaulting. Later in such flamboyant examples as Rouen Cathedral, Figs. 3 and 4, and S. Ouen, Rouen, where we find such overdecorated and decadent facades, the builders had still maintained their ideal of simplicity on the interior. It is not until we verge the Renaissance style that any semblance of the English decorated vault makes its way into France and then it is found only in relatively unimportant examples. After the refined and simple vaults of the French it is doubly interesting to watch the trend of events transpiring just across the channel and to follow the work of contemporary builders in England.

Much the same development as we have just discussed also took place in England, Fig. 9. The groined vault of round arched character was quite prevalent in Romanesque times, used in the alternate manner. Later in attempting to vault irregular or oblong bays the English builders came to the expedient of using the pointed arch as a generating motif. Thus we find at Durham Cathedral the first use of the pointed vault in England, and as some writers say, in the world. Certainly a great deal has been written in asserting the claims of various countries to the priority of their invention of the pointed vault and much documentary evidence can be had for the claims of each country, but we shall not attempt to settle it here. At any rate, we find the French and English architects travelling parallel routes. The Durham vaults were quite like those of St. Denis except for one particular: the former had level ridges while the latter were domical, as we have mentioned, and, with few exceptions, these ideals were always followed in their respective countries. Both types have ad-

small. the size of the boss was increased until at Winchester, we find them weighing as much as two tons. Rapidly gaining favor as a motif, the boss was used with greater and greater frequency. In fact, at Exeter Cathedral, Figs. 6 and 8, no less than 573 bosses are to be found. The bosses were of a simple design when first introduced, but in the later work, they were carved elaborately with foliage, coats of arms, grotesques, and other forms. Generally a hole was pierced through the center of the boss through which a chain was passed holding from its lower extremity a lamp or censer name, was called a "boss." While at first quite

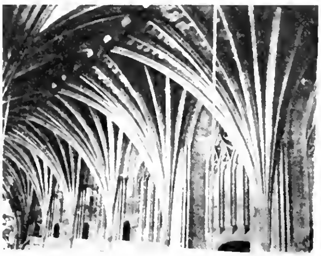


FIG. 6. VAULTING OF NAVE SHOWING BOSSES, INTERIOR OF THE CATHEDRAL AT EXTER, ENGLAND

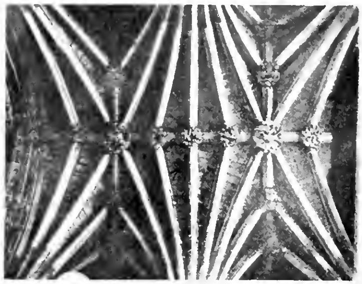


FIG. 7. VAULTING OF ST. JOHN CHAPEL, INTERIOR OF CATHEDRAL OF EXTER, ENGLAND

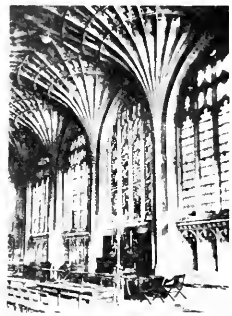


FIG. 8. PETERBOROUGH CATHEDRAL, ENGLAND

vantages; in the former, construction was tremendously simplified as the centering could be moved along from bay to bay while it must needs be taken down in the latter case. On the other hand, the French vault was more stable and the thrusts were brought down more nearly vertically, requiring less abutment. It is at this point in the history of the vault that the two schools of France and England diverge, due, no doubt, to the difference in masonscraft of the two countries.

The English masons used centering for only the heavy masonry diagonal ribs, cross ribs, and wall ribs. With these ribs to transfer the thrusts, the vaulting web could be filled in one section at a time. In this way the the web could be of lighter construction—some of the webs so constructed being no more than four or five inches thick. This led to lighter piers so supporting elements, giving, ultimately, more life and dynamic quality to the vaulting.

At their point of intersection, the diagonal ribs often abutted awkwardly and obliquely against each other. To remove this unsightly effect, a new member was inserted at the point of intersection. This member, a sort of keystone, for want of a better

which, on certain days, was swung back and forth throwing off a cloud of incense.

In laying in the web, the English did not shape the severies or infilling, or vary their sizes, so that on the completion of the vault the severies met on an angle to each other. When two half cells of a cross-ribbed vault were filled in this fashion, there was bound to be a ragged joint and to improve this joint and to hide it from view ,a new rib—the ridge rib—was devised. At first, only a longitudinal ridge rib was employed, but presently two ridge ribs—one longitudinal and one transverse —were introduced.

Soon the "tierceron," an additional rib thrown in between the ridge rib and the diagonals, was introduced. The palm of priority of this invention rests with the architect who designed the Lincoln Choir. This example is usually regarded as an architectural freak, while it really is an ingenious attempt to provide additional permanent centering to make the web construction easier. In this case the ridge-rib was divided into three equal parts and these points connected with the piers by tiercerons. It can readily be seen that this solution was an imperfect one as it still left two of the cells broad; and it was probably for this reason that the curious vault was never imitated. But with this as an inspiration, the correct solution was soon reached in the south transept of Litchfield by dividing both ridge ribs into four equal parts, thus allowing the sue of the diagonal ribs. The introduction of a single pair of tiercerons in each major panel was soon followed by two and even three pairs as at Hereford and Exeter. The latter may well be said that the decorative effect produced

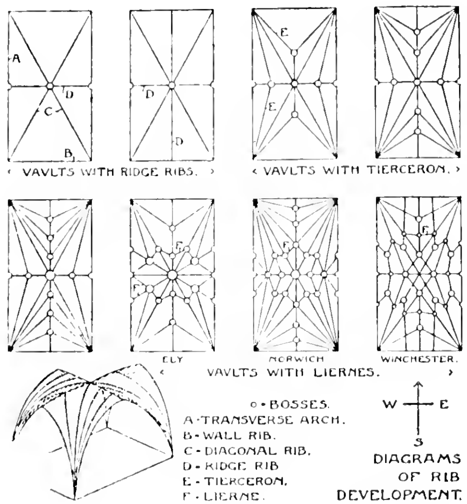


Fig. 9

is most pleasing. Of course, tiercerons were not essential members of the vaulting system, and perhaps they were better omitted entirely, but that their usage can be vindicated from an aesthetic standpoint is proved by such vaults as those at Exeter.

This practice seems to have had a singular facination for the English builder and his predilection for such ribs gathered strength as the native taste asserted itself. At Exeter the builders might well have stopped, but, in the logic of the vaulting thus far developed, it will be noticed that the tierceron is abutted only obliquely by its complimentary members; it seems to call for abutment in the same plane, so a little strut was inserted which provided the abutment needed. This tie rib did not rise to the central boss, nor did it rise from the capital of the pier shaft :it passed from any point on one rib to any point on an adjoining rib. Such a member was called a "lierne." The merits of Lierne design vary greatly. In its simpler form it is often very objectionable; it compares unfavorable with such a vault as that at Exeter, where every curve of vault seems to flow upward and bear up the ridge of the vault. However, in its more complex patterns, it tends to make a glorious crown for the church below.

As the addition of the ribs became greater, the space between the ribs above the pier for some distance was so slight that it was unnecessary to make the web separate from the ribs. In such cases the body of the pier was carried on up to about half the height of the vault and built in the true form of the arch. Upon this the ribs and the web were carved as so much decoration and did not function structurally in the vault. This marks a point of definite decline in the vaulting! Structional necessity is being used as a sham for that which has been so beautifully done.

This addition of multiple ribs played a distinct part in the creation of a distinctly novel construction known as "fan vaulting." The space between the ribs was a cross between a half or hollow sided

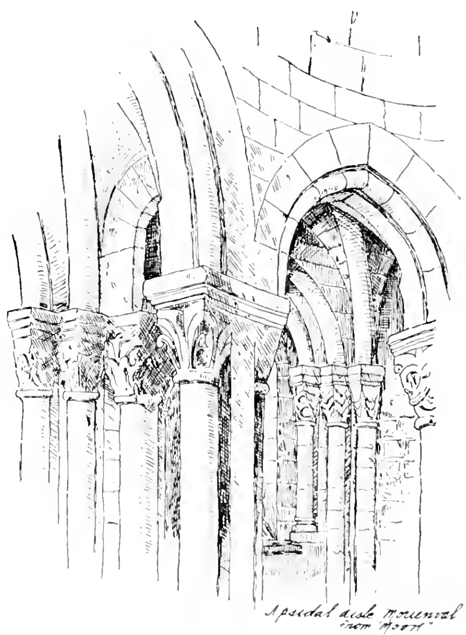


Fig. 10

pyramid and a cone, and it was natural, therefore, that the English builders should conceive of the idea of making all the ribs of the same curvature but of different lengths according to their several positions. Again it was quite logical to use the shortest ribs as a radius and connect all of the

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EDITORIAL

Use of the Engineering Intelligence Tests

DEAN H. H. JORDAN

The College of Engineering has been giving one or another of the so-called intelligence tests to its entering classes for the last five years. On three occasions it has used the type of test called an aptitude test in addition to the intelligence test. In the case of one class, instructor's ratings have been secured at the end of each semester upon those characteristics of the student which are supposed to have a direct bearing upon his fitness for and probabilities of success in engineering work. When this class graduates there will be on file in the college office at least sixteen independent instructor's ratings for each student in the class. The instructor's ratings are made on such personal qualities as accuracy, judgment, imagination, et cetera.

For the purpose of comparison, these various marks and ratings, including, of course, the scholastic averages, have been correlated one with another. All these records of a single individual taken together form sort of a cross-section view of his capabilities. They could easily render him a valuable service in connection with the self analysis he must invariably make in selecting the position at which he is to play in the great game of life.

It is a known fact that men who do well in college work do well also in the business of living after they leave college. A few do not. It is also true that some who earn low marks in college are successful in their life work. Grades are very good foundations upon which to base a judgment as to a man's chances of making good after leaving college. Nevertheless, grades alone are not to be trusted implicitly in judging men. Too many factors of a disturbing character may enter into the scholastic achievement of a particular individual to permit of reliable forecasts being made on his basis alone. Other tests, judgments, and ratings are helpful in discovering the real worth of the individual. The College of Engineering is constantly seeking to find and to improve these other methods of measuring abilities and aptitudes in order that it may help its graduates help themselves to the best opportunities life holds out to them.

The so-called intelligence test is used early in the freshman year as a means of holding a short and effective conversation with each student in respect to the thinking equipment which he brought to college and the method of using it. The mere conduct of the test teaches the student how to concentrate and how to achieve at a rate quite surprising to himself and quite beyond any rate he

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Clippings from the Editor's Desk

Now that the engineering seniors have had their annual splash in the political pool they should be able to go on to a successful finish of the process of graduation. This plunge appears to be as contagious as spring fever and equally unavoidable. It is a hard thing to explain. It seems that three and a half years of grinding away in the laboratories and drafting room, with little time for general campus activity, seems to breed a desire to make one grand finish to the college course and, since politics is the sole remaining outlet, the effect is as noted.

Did you know that The Technograph is one of the few campus magazines that is making both ends meet, financially speaking? But just on that account don't think your continued support is not needed. Although your money is important we want you, and while you are climbing on the wagon bring along some delinquent friends. We want the magazine read by the entire engineering school.

The second of the articles on Heating and Ventilation appears in this issue. Although the experimental work on the ventilation of the Hudson River Vehicular Tunnel was carried out over three years ago much of the material in the article has never been published before this. It is considered of sufficient value to the technical world so that plans have been made by the department of mechanical engineering to reprint it for distribution to those interested.

With the current discussion of the ten best books being carried on by The Daily Illini it should be interesting to learn of the reading list prepared for the library of the College of Engineering. It is described more in detail in the College Notes section of this issue. This brings to mind the selection of books made by Charles P. Steinmetz, the electrical wizard, when asked what ten books he would choose if he were to be left on a desert island. The ten he selected were: Homer's "Odyssey"; "Odes of Horace"; Goethe's "Faust"; Mommsen's "History of Rome"; Kipling's "Jungle Book"; Stevenson's "Treasure Island"; Stanley's "In Darkest Africa"; Sienkiewicz's "The Deluge"; and Mark Twain's "Tom Sawyer" and Huckelberry Finn." He considered the latter two as belonging to the same book; one was not complete without the other.

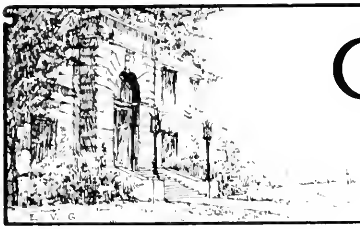
The time has come for the seniors to start out on a search for jobs. In fact the best are rapidly being filled. For the benefit of those who have one or more years before leaving school it might be well to mention the statement recently made in this connection. Grades made for the sake of the grade only are of no value unless something has really been carried from the course. But the grades form a record and the men with the best record are the ones to whom preference is shown by those offering jobs. Often the men with the best records will have several opportunities for jobs while those at the other end of the list must take what is offered.

While we are on the subject of work we might as well finish it up. It has been found that ninety per cent of the engineering students work during the summer. Sixty per cent are doing some kind of engineering work. To help this group find places the College of Engineering has a committee on summer employment, composed of representatives of every department. Those interested in finding such work for the coming summer would do well to get in touch with this committee in the near future, the nearer the better.

By the time this comes off the press the Engineers Dance will be upon us or just recently part of history. We know that the committee has worked hard and the credit for the party goes to them. The dance may have been a new venture for a few but we will guarantee that enough experienced artists of the waxed floor were on hand to "do their stuff."

After seven tries we finally made an average approaching the maximum and now have a great deal more respect for those who have been able to maintain such a standing over the whole seven semesters. The men wearing the Tau Beta Pi key deserve a lot of credit and are to be congratulated. They have at least done one thing well instead of dabbling around with several and only achieving mediocre success in all.

F. L. Thompson, '96, has always been a good friend of the College of Engineering and his response to a request for an article on the electrification of the Illinois Central Railroad was immediate. It was so long that we found it necessary to divide it into two sections.



COLLEGE NOTES

Engineer's Assembly

As a continuation of the custom of several years standing, the engineers will hold their annual Engineer's Day March 27. The program consists of the assembly in the afternoon at three o'clock with a parade to the Auditorium, and the Engineers' Dance in the evening at the Gymn Annex. The assembly this year will be of considerable interest not only because of the speaker, but also because at that time the portrait of Prof. Arthur N. Talbot will be presented to the University by William L. Abbott, '84, chairman of the portrait committee. The gift will be accepted by President Kinley in behalf of the University.

The engineers will assemble and march to the Auditorium in company with the faculty, where there they will be one great body of the whole engineering college—comrades in chosen profession. The purpose of the Engineer's Day is to promote the spirit of fellowship among the students and faculty members of all the various departments. The addresses at the convocation will acquaint the young engineers with advances in their profession and should be a source of inspiration. The Engineer's Day has become a time honored and necessary University custom that has grown in the past few years to considerable proportions. It is now something to be looked forward to and remembered; it is distinctly a day of the engineers. The parade, asssembly, and dance of last year was probably the most successful of all past attempts. An engineer's band, followed by a military escort of regular army officers led the parade of students and faculty who marched behind the floats of their departments. Prof. Ira O. Baker was the principal speaker.

In 1923 the all-engineering convocation consisted of the induction of Dean Ketchum who spoke on "Engineering Education and Research." The principal speaker was E. J. Mehren who will speak again this year. His address was "The Importance of Research to the Progress of Industry." In 1922 the assembly was called the Ricker Convocation and Professor Ricker made the address of the day.

E. J. Mehrens, '06

Edward J. Mehren, e.e., '06, who will speak this year, is now vice-president of the McGraw-Hill Co. Mr. Mehren graduated from St. Ignatius College, Chicago, in 1899 and in 1906 received the Bachelor of Science degree in civil engineering at the University of Illinois. After his graduation he was with an engineering party locating the Milwaukee and Puget Sound Railway. From 1907 to 1911 he was associate editor of the Engineering Record, after which he became the secretary and manager of The Emerson Co., efficiency engineers. From 1912 to 1917 he was editor of the Engineering Record and 1918 to 1923 editor of the Engineering News-Record. He is a member of the A. S. C. E., Tau Beta Pi, Sigma Xi, Delta Sigma Rho, and Triangle. He served on many engineering committees and was an organizer of the Highway Industry Association. In 1921 he was chairman of the New York Conference of Business Paper Editors.

Dean Milo S. Ketchum will preside at the convocation.

The Engineer's Dance

The Engineer's Dance in the evening will bring the day to a close. The decorations are to be made by a Danville firm and will be somewhat semi-oriental in nature, consisting of columns around the side and large hanging lamps. The booths will be decorated representing the various departments, as civil engineering, electrical engineering, and the others. The music will be by the Illini Rhythm Kings. A cup has been offered for the best poster advertising the dance. Those already received display marked ability and originality. Three hundred tickets will be sold and to engineers only, seniors having the preference.

The committee in charge of the dance is composed of the following: W. P. Whitney, cer., chairman, C. V. Erickson, e.e., W. G. Kennedy, e.e., Joe Green, e.e., Bob Hall, m.e., Dick Seepe, m.e., Ed Bremer, min., L. R. Ludwig, ry.e.e. E. B. Brady, gen., J. W. Ganschinietz, arch., and W. A. Rolleston, arch.

Talbot Portrait Fund

The contributions to the progress of Engineering that have been made by Prof. Arthur N. Talbot have been recognized at different times in various ways. He has received honorary degrees, and awards, and has been honored with the presidency of great engineering societies. The latest recognition of the work of Professor Talbot is of an entirely different sort from these others.

It has been proposed that a portrait of Professor Talbot be painted and presented to the University. The presenters will include alumni and any others who admire him and his work or who may have come under his influence. The eminent portrait painter, Ralph Clarkson, has been secured to do the work. Contributions should be sent to Prof. M. L. Enger at the University, who is treasurer of the committee in charge. Other members of the committee are: W. L. Abbot, '84, chairman, J. N. Chester, '91, L. H. Provine, '03, E. J. Mehren, '06, and O. C. F. Randolph, '13.

The Engineer's Five-Foot Shelf of Books

"Engineers, in common with other busy people, find it sometimes impossible to choose intelligently the few books they have time to read. The College of Engineering has prepared two short but comprehensive lists of books which it recommends to its students for their guidance in making the most of their reading hours while in college and afterwards." The foregoing is a quotation from the introduction of the small booklet containing the two lists of recommended readings which comprises in all 159 books.

The first list of books is selected from the "permanent" body of literature with which the engineer must be familiar to hold his place among his professional associates or lay claim to the title of a cultured man. The second list contains books of a more modern and more popular nature, produced out of the experience and ideals of our present civilization. The little booklet containing the lists has been distributed to the freshman engineers at Engineering Lecture and can be obtained at the Dean's office or at the Engineering Library. It is the plan of the Engineering Library to keep all the listed books on the reserve shelf for use during the leisure hours of the day. Other copies can be found at the main library.

The books were selected by a faculty committee composed of Professors H. H. Jordan, C. C. Williams, and E. C. Schmidt, assisted by Miss Anne M. Boyd of the Library School. The committee expressed the wish that the students read a goodly number of the books before their graduation, and also suggests that one might well make the lists a basis for the choice of his personal library.

Fete Chairman

E. G. Spencer, '25

Highway Short Course

The twelfth annual Short Course in Highway Engineering held at the University February 16-20 was preeminantly a success. The Highway Short Course was started in 1913 by Prof. Ira O. Baker and since has been held every year, continually broadening its program and extending its service. The Highway Short Course, like the Metermans' Short Course, and the Ceramics Short Course, extends the service of the University throughout the state and has for its object the bringing together of engineers, contractors and officials connected with highway construction and improvement for the purpose of studying, discussing and formulating a solution of the problems that arise in the work; to promote better co-operation, co-ordination and mutual understanding throughout the state; and to distribute the best information attainable on the subject of highway improvement.

One of the outstanding points in the program was the address the first afternoon by Gov. Len Small. This meeting was held in the Auditorium and was started with an organ prelude played by H. F. Clemmer, engineer of materials, Illinois Division of Highways, and was followed by an address by President Kinley. A feature of the morning meeting was a discussion by E. W. James, of the United States Bureau of Public Roads, Washington, D. C., on "the National Highway Program."

The first day was devoted to group meetings in which bridges, road design, maintainence, materials, and administration were discussed. Wednesday, contractors day, was held in joint session with the Illinois Municipal and Highway Contractors Association which was holding its annual convention in Urbana at the time. H. F. Clemmer described the profilometer and its use, at the conclusion of the afternoon session a practical demonstration of the profilometer was made. Thursday Prof. A. N. Talbot spoke on "Recent Advances in Concrete," and a demonstration was made in the structural laboratory on quick setting cement, consistency of concrete, and the bulking of concrete materials. The advantage of luminite cement over Portland cement in its quick setting was shown when specimens of each were broken after forty-eight hours, the luminite showing seven or eight times the strength of the other

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The Arch Fete

The freshmen have their Frolic and the seniors their Ball, but college wouldn't be college to the Arch's if there wasn't an Arch Fete. The Fete this year was held in the Ricker Library, as has always been the custom, Friday night, March 20. The decorations, very extravagant, were Persian of the Saracenic period. Bright colors, colored lights, crayola decorations, and Oriental rugs all contributed to the Oriental atmosphere. A small shrine was situated at one end of the room.

The feature of the evening was a form of pageant which typified the Persian New Year celebration which in Persia comes in the spring. It corresponds very much to our annual spring celebration here on the campus. It is the time when King and common people mix, a time of festival and celebration in which every one of all classes takes part.

The Arch Fete was inaugurated in 1917 and has been repeated every year since with the single exception of the year 1919 after the war. The Fete has always had particular atmosphere representative of some period or country, those held in the past were: 1917, Venitian; 1918, Pompeian; 1920, Egyptian; 1921, Futurist; 1922, Greek; 1923, Spanish; 1924, Chinese.

The committee in charge of the Fete consisted of: E. G. Spencer, chairman, W. E. Frazier, Harold Nagele, C. T. Paul, J. A. Boyd, R. F. Smith, A. W. Wenthe, J. C. Arntzen, W. P. Kramer, and K. Jacobson. The music was by the Illini Rythm Kings.

On the following night the Honorary Engineering Fraternities held their dance in the Ricker Library as has been the custom.

ILLINI ENGINEERS

MAURICE NORTHROP QUADE
c.e., '25

JOHN CHARLES KOONZ
ry.e., '25

One of the things of which Illinois has boasted for a number of years, is the championship track team which Coach Gill turns out rather regularly. "Johnny" Koonz, is one of those who have made the championships possible. This is Johnny's third year as a varsity track man. Last year he was one of the members of the team which journeyed to California and did his bit to subdue the "Golden Bears." His specialty has been the quarter mile.

He is a member of the Tribe of Illini, Sigma Tau, and Eta Kappa Nu.

A few men are gifted with the ability not only of maintaining their scholastic work at a high level but also of participating in other fields of endeavor. One of these is "Maury" Quade. Not content with attaining the scholastic top of the Civil Engineering department, he has also taken part in numerous activities. During his sophomore year in the University, he was president of his class. He has taken an active part in the affairs of Illinois Union, being chairman this year of the membership committee. He is also chairman of the Engineering Council.

He is a member of Theta Tau, Chi Epsilon, Tau Beta Pi, and the student branch of the A. S. C. E.

ARTHUR CHARLES REHM
g.e., '25

"One of the best of one of the best," is the slogan that might be applied to Art Rehm. Illinois has always been noted for her track team, and Art is one of those who have kept the fame of our team pronounced. He has been a member of the team since his sophomore year. During his first and second years here, he was a member of the class soccer team. He has also taken an active interest in the R. O. T. C., being a senior in the advanced course this year in the Field Artillery Brigade.

He is a member of Tribe of Illini, Scabbard and Blade, and Theta Tau.

Contemporary Engineering News

New Courses at Carnegie Tech.

Carnegie Institute of Technology has established two additional courses in iron and steel making for the benefit of men working in the steel plants. The courses are given one night a week for twenty-six weeks, and consist mainly of lectures and informal discussions on the physics and chemistry of steel making. Another course recently begun is a short meter course for employees of electric meter plants. A series of lectures and exhibits form the course of study; no fees are charged to any of the students.

The Institute reports show that there has been a marked increase in the number of students taking night school courses in the building and machinery trades compared with the group that are studying "white collar job" subjects. Most of those taking the trade courses, the report points out, are men who do office work as draftsmen, clerks, or timekeepers in the daytime, and are studying the technical subjects either with the object of changing over to work as tradesmen or to familiarize themselves with the mechanical part of their own work in order to gain greater efficiency in that line.

Mercury Boilers.

Mercury is finding a new use as a heat transfer agent. There has been some talk of using it in the boilers of power plants instead of water, but the cost of installation of a system of this kind is so great as to forbid its adoption. A more important use is that of heating vessels for chemical operations. After the first difficulties due to boiler design and transfer of the vapors have been overcome, the plan is a very satisfactory one, for it enables much higher temperatures with lower pressures to be used, and gives a more constant and more easily controlled temperature than is obtained by the use of water or oil

Leather Research at Cincinnati.

The University of Cincinnati now has a laboratory for research in leather, which was presented by the Tanner's Union of America, as a recognition of the work done by Dr. G D. McLaughlin and his associates in the chemistry of tanning. The work of the laboratory will be solving the problems of the tanning industry, and the equipment consists of all up-to-date chemical and analytical apparatus necessary for this work. There are also student laboratories for those taking courses in leather preservation.

Photoelasticity to Study Stresses.

The phenomena of photoelasticity, which have been used in the past at Massachusetts Institute of Technology for the determination of stresses in aircraft members, have now been applied to other fields of study, such as determining the causes of failure of railway motor pinions. The experiment is made with a celluloid model, which is stressed the same as the metal object. These deformations show as colored lines under polarized light, and can be photographed and studied very readily.

Rubber Blocks for Paving.

Blocks of rubber are the latest thing in paving material. Freedom from vibration and noise, and few replacements due to long life are some of the qualities claimed for the new paving. Several test sections have been laid in various parts of the United States and England, and the results so far have been very encouraging. The material has not, however, been in use for a long enough time to really test it thoroughly. It may be interesting to know that the Michigan Boulevard bridge in Chicago is paved with rubber blocks. The paving is especially adapted to bridges, as it eliminates the troublesome traffic vibration.

Paris Institute of Optics.

The University of Paris has founded an institute of optics, for the training of optical workmen and engineers, and for theoretical and experimental work required by both the science and the industry of optics. The science of optics, both mathematically and technically, is a very precise and exacting one, and trained engineers and skilled workmen are needed to do the work of making instruments. The school is divided into three parts: one for the optical engineer, one for the practical workman, and one for research and experimentation.

The University of Cambridge, England, has had such a course for some time, and gives degrees in "Optical Engineering."

Westinghouse Lectures and Pictures.

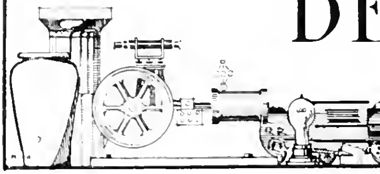
Westinghouse Electric and Manufacturing Co. has prepared a series of lectures and moving pictures on subjects relating to the electrical industry. They are of two types,—technical and semi-technical. The first group is for students and graduates of technical schools and practical engineers, the second for the entertainment of public school or general audiences. The lectures and films are loaned free of charge to anyone interested.

New Automobile Finish.

The new pyroxlyn finishes are coming into great favor with automobile manufacturers. They are easy to apply, being simply sprayed on, and as the solvent evaporates very quickly, it is possible to work around and around the job and apply one coat right over the other. This eliminates the enormous spaces formerly used to store cars while the oil or varnish finish was drying. One manufacturer lists eighty different colors and shades in this new material.

Crankcase Cleaning Device.

Another one of this year's contributions to the automotive field is that of a crankcase oil cleaning device, developed by one of the manufacturers. Oil from the cylinders, which is diluted with gasoline, is taken into a special chamber where the lighter liquids are distilled off by heat from the exhaust, and then burned; the oil returns to the crankcase. This is one of the methods which are being developed with the object of keeping the oil clean, matter which is becoming increasingly important in these days of high speed engines. Another is a centrifugal cleaner for the intake air, to prevent dust from entering the cylinders and getting into the oil from there. A water filter air cleaner is in use on some tractors, but the device is too bulky for autos



DEPARTMENTAL NOTES

Architecture

The department of architecture again made an excellent showing in the Beaux Arts Institute of Design competition which was judged February 16. Of the six seniors who submitted designs, H. F. Pfieffer was awarded second medal, while K. G. Reeve, C. T. Miers, and F. H. Naefle were awarded first mentions. Considerable distinction comes to Pfieffer through winning second medal, since there are very few awarded. The problem, which was of six weeks duration, was the design of an office building with a private bank, to be located in the heart of the financial and business district of a large American city. The plot is a corner lot, 80 by 150 feet, and the two inside lines of the property are bordered by large commercial buildings. The main entrance to the banking quarters shall be on the narrow side, which fronts the most important street. Pfeiffer's design was a very successful solution of the practical and artistic phases of the problem. It will be published in the February issue of The Beaux Arts Institute of Design Bulletin

On drawings submitted on a nine hour exercise for the design of "A Boat House Pavilion," K. G. Reeve and H. F. Pfeiffer were given second mentions. These awards are considered unusually good, owing to the very high standard demanded by the New York jury on this particular type of problem.

Alberta Raffl, W. L. Thomas, and W. I. Hamby were awarded second mentions in the archeology competition, which was the design of a French-Gothic Cloister. These problems were very artistically presented in a variety of mediums, which included colored pencil, lithographic, and color wash renderings.

The week-end of February 21 was one of the busiest seen this year among the sophomores and juniors, both classes working feverishly to get their problems in on time. The juniors had to design an interior of a bank, with a lobby and banking room. The designs were all exceedingly well worked out, and are considered on the whole as being one of the best sets of problems turned in this year. The sophomores worked out an interior bay of an important church, to be built in a wealthy community. Since the problem called for a careful study of stone joints, most of the designs were in the Romanesque and early Gothic styles.

The annual Scarab National Sketch exhibition was shown on the fourth floor of Engineering Hall the last week in February. The exhibit consisted of a collection of water color, pencil, and pen and ink sketches made by architectural students chiefly during the summer months. Students of Penn State, Kansas University, Carnegie Tech, and the University of Illinois were represented in the exhibit. An award is given for the best set of sketches. All those who saw the exhibit were impressed by the high grade of work done by the students of Illinois.

Announcement is made of the recent election of Professor Rexford Newcomb to the presidency of the Central Illinios chapter of the American Institute of Architects. This organization will hold a convention sometime during April, in New York City. Both Professor Newcomb and Professor Provine, head of the department, expect to attend this convention and Prof. L. C. Dillenback may also attend. The latter will attend the Beaux Arts judgments in New York City a few weeks before the convention. This is the first time that Illinois has had an official representative at the Beaux Arts judgments.

A new branch of the department has been established with Prof. W. A. Foster in charge. It is known as Rural Architecture.

Professor O'Donnell is preparing material for the publication of a series of articles in the *Architectural Forum*. The title will be, "The Influence of the Greek Revival in the Western Reserve."

Earnest Pickering is publishing in the "Architect" a series of measured drawings on architectural monuments made while studying abroad as Plym fellow.

Ceramics

Departmental Notes

The three new furnaces, which were given to the department by the Illinois Gas Association, have been installed in the Kiln Laboratory. The total cost of the furnaces is about $1150.

The smallest of the furnaces is a single-burner, circular pot furnace. One of the two larger is a square double-burner furnace. The other furnace is a load furnace for the purpose of testing fire brick. All of these furnaces are made by the Surface Combustion Company.

A. C. S. Convention

The convention of the American Ceramics Society was held at Ohio State University from February 16 to February 21. This convention celebrated the Thirtieth Anniversary of the founding of Ceramic Education.

The first Ceramic school in the United States was founded in 1895 at Ohio State University by Dr. Edward Orton Jr.

All of the heads of the Ceramics schools in the country were present. The faculty members from Illinois who attended were: Prof. W. A. Noyes, head of the department of chemistry; Prof. C. W. Parmelee, Prof. R. K. Hursh, Dr. A. E. R. Westman, R. T. Watkins, all of the department of ceramics; W. H. Vaughn, graduate; C. E. Parmelee, '25; W. P. Whitney, '25; C. G. Fels, '25; J. R. Grout, '25, also attended.

Each school presented an exhibit of Ceramic products. The Illinois exhibit was among the best shown. It included pottery, plaster molds, refractories, chemical, pyrometric, and general laboratory porcelain equipment; also samples of heavier products. Most of the exhibit was ware made by students as part of the regular required laboratory work.

The next convention of the Americon Ceramics Society is to be held in February, 1926, at Atlanta, Georgia. The Chamber of Commerce of Atlanta has promised plenty of entertainment.

Electrical

E. E. Society

The E. E. Society held the last meeting of the semester on January 23. The most important business taken up at this meeting was the election of officers for the second semester. The officers eleted were: President, R. D. Cox, '25; Vice-president, W. T. King, '26; Seretary, W. S. Duncan, '26; Treasurer, R. G. Hotchkiss, '25; Librarian, O. C. Levy, 26. The new officers took the oath of office and the retiring officers were given a vote of thanks for their faithful service during the semester.

An E. E. feed and get together was sponsored by the E. E. society at the E. E. laboratory on February 13. The meeting was opened by R. D. Cox, '25, the newly elected president. After a short address of welcome to the new students present the president introduced Professor E. B. Paine, head of the department of electrical engineering. Professor Paine spoke upon the growth and development of the electrical engineering department. He explained that the electrical engineering department was now the largest department in the College of Engineering and that it had more students in 1924 and 1925 than any other two departments in the engineering college. He went on to explain how this growth meant an increase in the stock of equipment, laboratory room and class rooms with a consequent spreading out of the department. He told how the department had always been a unit and of the excellent co-operation and feeling of good fellowship which had existed among the students and faculty of the department and asked that the society do all in its power to continue this spirit of unity and spread it among the new students and underclassmen. Professor A. R. Knight speaking upon the same subject suggested among other things that the student district of the twin cities be divided into sections and that the upperclassmen of the department in these districts be appointed to see that the underclassmen were kept in touch with the activities of the department. Professor E. H. Waldo, spoke about a few of the developments being carried on by the General Electric Company at Schenectady, New York. A number of interesting points were brought out and his talk gave an idea of the progress being made by the large concerns in the development of electrical machinery and equipment. The meeting ended in the feed and general get together of the department.

Several meetings of the E. E. Society were held in conjunction with the Urbana branch of the American Institute of Electrical Engineers. One of these meetings was addressed by Dr. C. T. Knipp of the physics department on the subject of "Vacuum." Dr. Knipp performed about twelve experiments on vacuum including demonstrations of X-rays, effects of pressure on the electrical discharge in a tube and the effects of magnetic fields on cathode rays. Another of these joint meetings was held on the afternoon of February 27 at which time Mr. R. F. Schuchardt, an electrical engineer for the Commonwealth Edison Company of Chicago and a man who has been in close contact with the electrial supply industry for a number of years gave an illustrated lecture on The Electricity Supply Industry and the Engineer.

New Equipment

The growth of the electrical engineering department has recently required much new equipment. Among the department's latest acquirements is a new storage battery of 160 ampere hour capacity and a voltage of 124 volts. The 62 cells required for this battery will be similar to the cells in use on the present battery and will be used with the present battery to give a source of 240 volt supply for various tests which it is desired to run at this voltage.

A new Reliance, variable speed, direct current motor, has also been received. A most unusual feature in this machine is the method of speed control. The speed which may be varied from 200 to 1,600 revolutions per minute is varied by sliding the rotor along its axis of rotation either into or out of the magnetic field set up by the field windings. This gives a speed ratio of (8) to (1). Most motors are limited to a ratio of (3) to (1). The new arrangement also makes it possible to develop the full rated (5) horsepower at all speeds between the two extreme limits.

The new 100-kilowatt unit which was being installed in the electrical engineering laboratory has been tested and is ready for operation.

A new calibration research laboratory has been set up in room 305 of the E. E. laboratory. Watthour meters are being calibrated at the present time. Later in the semester some new equipment given to the department by the American Telephone and Telegraph Company will be installed and used for experiments on long distance telephone transmission. The watthour meter tests are being made by H. L. Hildenbrand, '25, J. C. Leach, '25, J. P. Wallace, '25, and M. S. Luthringer, '25. The long distance telephone transmission tests will be in charge of R. D. Levy, '25, and R. B. Taylor, '25.

Professor Morgan Brooks of the department of electrical engineering who spent several days in New York C ty attending the mid-winter convention of the American Institute of Electrical Engineers was fortunate enough to secure ticket number one and was among a group of some twenty delegates from the convention who were taken on an inspection trip of the new vehicular tunnel under construction under the Hudson river from New York to New Jersey. Professor Brooks was perhaps the most interested man of the group which took this inspection trip due to the fact that the power required to ventilate the tunnel was calculated by Professor A. C. Willard of the department of mechanical engineering after a series of experiments on a miniature tunnel here at the University.

H. E. Brown, associate in electrical engineering, will give a lecture at Iowa State College at Ames, Iowa, sometime during April. He will speak on the "Development of Radio" with particular reference to the new noncarrier system developed here at the University. He and C. A. Keener we e responsible for the development of this system. A bulletin on the matter has been issued by the Experiment Station.

Research work is being carried on at the present time on short wave radio transmission by Professor J. T Tykociner, research assistant.

Considerable new equipment has been received by the department. This has necessitated an expansion of the laboratory and some of the classrooms have been taken over for this purpose. A gift of equipment was made to the department by the Bell System It is of a very desirable type

Included, is an oscillator, with a range of 100 to 50,000 cycles. Also 200 miles of line have been added.

Mechanical

DEPARTMENTAL NOTES

At a recent meeting of the Student branch of the American Society of Mechanical Engineers, N. J. Alleman, '26, gave an interesting talk on "Progress in Carburetors." He explained, by sketches the progress made in carburetor design and the operation of some of the more recent models. Curves showing the relation of the air to gasoline ratio and the resultant variations in economy and power, were also presented.

B. G. Rich, '25, president of the student branch of the society is conducting a drive for larger attendance at the meetings and while the attendance has been improving, it is by no means satisfactory. It is the duty of every mechanical engineer to attend these meetings.

Plans have been made for a meeting during Vocational Week and a very good program of speakers has been arranged for. Arrangements have also been made to participate in Oil and Gas Power Week, April 20-25., 1925, which is being conducted under the auspices of the leading technical societies interested in gas ond oil power.

E. J. Crane, associate in machine design, has resigned to accept a position as design checker with the Western Electric Company. The good wishes of the department follow him. The vacancy has not as yet, been filled.

Prof. V. S. Day, special research assistant, will leave shortly for Toledo where he will deliver a talk on "Warm Air Research" before the Daugherty Co.

An investigation of the various characteristics of ammonia is about to be undertaken with Prof. H. J. MacIntire, associate professor of refrigeration, in charge.

The committee on the economics of railway location(known as Committee XVI) will hold a meeting shortly. Prof. E. E. King, of railway civil engineering, is chairman of the committee and Prof. E. C. Schmidt, head of the department, is a member of the committee.

Considerable new signal equipment has been secured by the department. A locomotive feedwater heater, donated by the Superheater Co., also has been added to the equipment. The installation of air-brake equipment has been completed. Research work is being carried on concerning draft devices. There has been much controversy on this point and it is hoped to settle the matters definitely.

Mr. R. A. Hall, associate in drawing, has recently secured his Masters degree.

Mining

Leslie Moses recently was married at Johannesburg, South Africa. He is connected with the government coal mines as mining engineer. He received his master's degree here last year, and expects to prepare himself for teaching at the University of Transvaal.

Gilbert L. Smith, '24, has sent maps and blueprints to our department showing complete underground workings and developments of the mine he is working in, in Mexico. The capacity of this coal mine has now reached 1,200 tons per day, and it was Gilbert's particular problem to lay out the mine in such a way as to make this possible.

The new coal washery is now running and is up to date in all respects.

Smith now has eighteen men on his staff, distributed between surveying, helpers, and draughtsmen. He thinks there is a good opportunity for young graduates down there, especially chemical, mining, and metallurgical engineers. He reports that his work is very interesting and that he likes it better every day. Gilbert is certainly making good.

T. Banno, who finished his work for the degree of master of science in mining engineering in February, is working for the Inland Colleries Co., Indianola, Pa. He expects to return to Japan after receiving his degree in June.

Prof. A. C. Callen attended the meeting of the Illinois Mine Safety Conference which was held at Springfield in January. He addressed the conference on "Maintaining Interest in Safety." His paper was published in the Explosives Engineer for February. A photograph of the students and faculty of the mining department was used as an illustration with the caption, "here safety is not taught as a separate course—it is made a part of every subject."

Four rock drills have been added to the equipment in the mining laboratory. Two of these were presented to the department by Mr. L. A. Busby, president of the Iron Mountain Co., through the efforts of Prof. I. M. Marshall. They are D x 61 Sullivans. A model 37 Turbro Waughammer and a Leyner-Ingersoll Drifter, model R72 were purchased from the manufacturers.

Prof. Drucker is hoping to secure a Marcy rod mill and an Oliver filter for use in the ore-dressing laboratory. This equipment, together with two small Wilfley tables for small-scale tests, will permit fine grinding experiments to be made under the conditions of actual practice.

Railway

The department of railway engineering has received a new locomotive feed water heater as a gift from the Superheater company of New York and Chicago. This gift valued at about $1,000, came through R. M. Osterman, vice-president of the firm. The heater is on exhibition in the railway engineering laboratory.

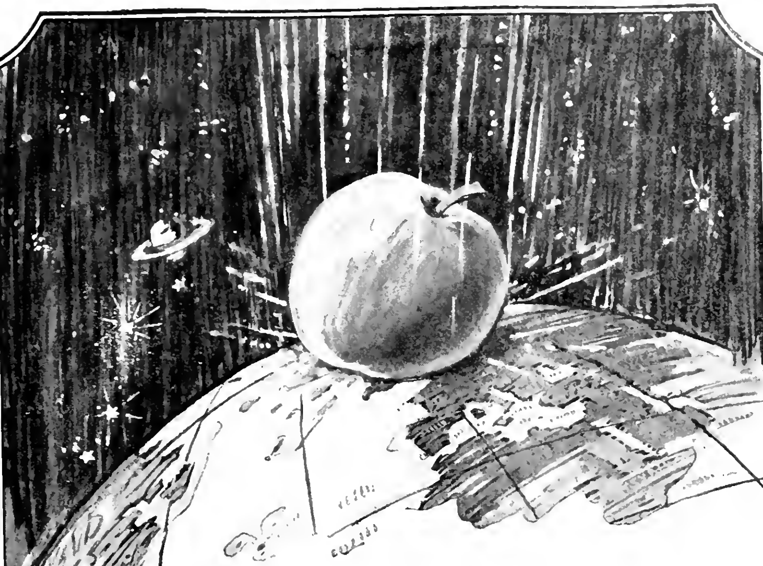
H. N. Parkinson, instructor in railway mechanical engineering was in Chicago the lâtter part of February in conference with representatives of the Westinghouse Air Brake company. Mr. Parkinson has been doing research in air-brake equipment during the last few months.

Offiicers of the Railway club for the second semester are: President, J. H. Smith, '26; Vice-president, W. L. Hunt, '26; Secretary-treasurer, H. G. Mason, '26. C. C. Anderson was retained as representative to the Engineering Council.

The Illinois Central Railroad has sent six signal relays to this department for test. Two of the relays were built by the General Railway Signal company, two by the Union Switch and Signal company, and two by the Hall Signal company. The relays will be battery connected and put to a long time test, probably two years, to determine resistance, wear, and other factors in connection with the contact points and other parts of the relays. The results will be a guiding factor in the future purchase of signal relays by that railroad.

The new equipment of the railway department includes a 500-watt turbo-generator locomotive head light purchased from the Pyle National Head Light company. New signal equipment includes a top-post automatic signal system built by the General Railway Signal company, an alternating current current relay for track circuits built by the Union Switch and Signal company, an alternating

(Continued on Page 152)



Fraternity Activities

Gargoyle

At a recent meeting of the Gargoyle Society the following officers were elected: W. E. Fraser, president; J. Arntzen, vice-president; P. Sonesome, secretary; and W. P. Kramer, treasurer.

A series of papers are being presented by members of the society before the society this year. The first meeting was featured by talks by Professors Palmer and Newcomb. The annual open meeting for freshmen was held on March 5, at the Zeta Psi house. Talks were given by Professor Newcomb of the architectural department and by Professor Watson of the physics department.

Sigma Tau

During the first week of March the following juniors were pledged to Sigma Tau, honorary engineering fraternity: R. D. Wilson, a.e., P. E. Soneson, a.e., J. L. Berner, arch., F. B. Powers, e.e., W. T. King, e.e., P. S. Emley e.e., R. G. Hageman, m.e., J. F. Lubrs, m.e., G. B. Banister m..e., S. I. Rottmayer, m.e., D. R. Conner, c.e., F. A. Dollinger, c.e., R. J. Crossett, m.e., H. K. Pritchard, e.e., H. G. Mason, ry., W. L. Hunt, r.e., R. W. Morgan cer., W. E. Schroeder, m.e., J. G. Lynch, gen., H. C. Stearns Jr., gen., Prof. F. B. Seeley, and Prof. H E. Babbitt.

On Friday evening, March 6, the active members of the chapter sponsored the Sigma Tau Mardi Gras, a costume dance, in honor of the new pledges. The dance was held at the Alpha Chi Rho House. Chaperons from each department were present as well as the presidents of various honorary and professional engineering fraternities who had been extended an invitation.

The Sigma Tau medal which was awarded at the last freshman engineering lecture of last semester went to G. H. Zenner, '27. Dean Jordan presented the medal for the chapter. He asked the new students to keep ever in mind the various honors to be had in the Engineering College, and urged them to compete for them whenever possible.

Keramos

At the time of the meeting of the American Ceramic Society in Columbus, Ohio, plans were made with students in ceramic engineering at Ohio State University to establish a chapter of Keramos at that institution. The chapter was installed early in March. The fraternity was first organized at Illinois in 1915 but up until now has had only the one chapter. With the establishment of the chapter at Ohio the organization is assured of being the only one in the ceramic field since the two schools have the largest and most important departments of ceramics and are the leaders of the work in the country.

The officers of the local chapter this year are: C. E. Parmelee, president; D. H. Innes, vice-president. W. P. Whitney, secretary-treasurer.

Eta Kappa Nu

Eta Kappa Nu, the honorary electrical engineering fraternity elected officers for the second semester at the regular meeting on January 22. The new officers elected were: President, M. S. Luthringer, '25; Vice-president, A. L. Dugger, '26. Secretary, H. E. Weaver, '25; Treasurer, W. E. Lynch, '26; Sergeant-at-arms, F. P. Morf, '26.

Seven juniors were pledged to Eta Kappa Nu on February 25. They are W. L. Branch, '26, P. S. Emely, '26, E. F. Hettel, '26, W. Hickman, '26, W. C. Webb, '26, and F. E. Leib, '26.

Sigma Epsilon

Sigma Epsilon, professional railway engineering fraternity, held its formal initiation and banquet at the Southern Tea Room on March 1. The following men were taken in at that time: J. H. Smith, '26, J. M. Trissal, '25, W. L. Hunt, '26 T. C. Stresse, '26, W. G. Mason, '26, D. L. Fiske, research assistant, and H. N. Parkinson, instructor of railway mechanical engineering.

Chi Epsilon

At the regular meeting held January 20 the following officers were elected to serve for the second semester of this year: president, S. H. Reid; vice-president, W. S. Clayton; secretary-treasurer, E. C. Bray; corresponding secretary, J. D. Voorhees.

During the past school year two additional chapters have been installed at the engineering schools of Cornell and Wisconsin. This makes a total of six chapters in the national organization at the present time. These chapters are all located in the larger universities of the country.

Mu San

Mu San, the professional municipal and sanitary engineering fraternity, held its semi-annual banquet on the evening of February 22 at the Urbana-Lincoln Hotel in honor of its new members, C. V. Erickson, '25, H. B. Norain, '25, F. C. Roe, '25, and E. F. Schad, '26. J. C. Saeger, '26, acted as chairman.

Prof. A. N. Talbot gave an interesting account of the achievements of some of the alumni of the municipal and sanitary engineering department. Prof. H. E. Babbit, Prof. M. L. Enger and Dr. P. E. Greenfield related some of their experiences. The other members present were C. T. Wright, '26, E. E. Lamp, '26, H. A. Vagtborg, '26, and H. E. Schlenz, '27.

Delta Mu Epsilon

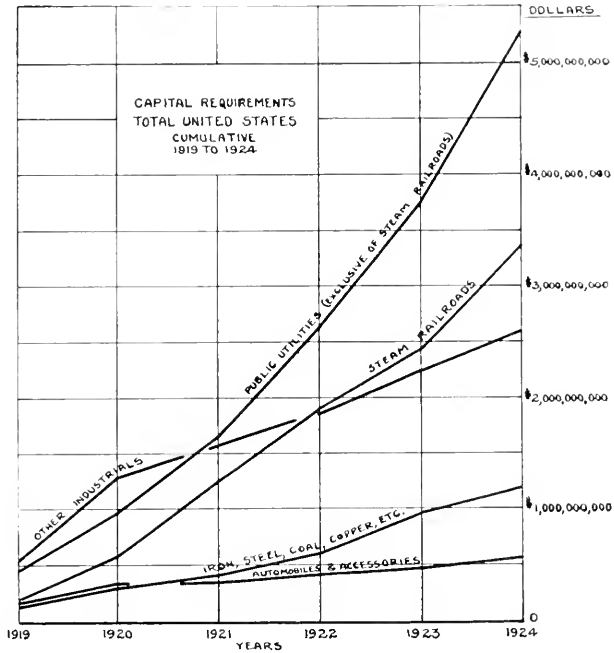
Delta Mu Epsilon, honorary mining engineering fraternity, enjoyed an evening spent with Prof. Hoskins and his family at their home. Several subjects of interest were discussed, and then the members were entertained while refreshments and smokes were served. An informal gathering of this sort certainly helps to further the interest in our departmental fraternity.

Harold Dean, e.e., '09, is superintendent of the New York and Queens Electric Light and Power Co. He lives at present at 25th and State Streets, Flushing, New York. Mr Dean recently visited Chicago to attend the meeting of the A. I. E. E.

A. B. Campbell, e.e., '09, is with the National Electric Light Association in New York.

G. C. Fanrote, arch. '15, is an engineer for the Detroit Steel Products Co., Detroit.

C. F. Geiger, cer., '15, is a refractories engineer with the Carborundum Co., Perth Amboy, N. J.



The Public Utility Business

as a Field for the College Man

THE above curves clearly set forth the present day magnitude of the Public Utility Business compared with other industries. The Public Utilities during the past six years, have issued new securities totaling more than $5,278,000,000, a much larger total than that of any other class of business. Part of this large amount of money, about $1,185,000,000 was used in refunding maturing securities, and the balance, or about $4,093,000,000 was spent for permanent additions to plant and equipment.

As a result of this tremendous development the utility business is calling the trained College Man in increasing numbers, to solve its problems of engineering, designing, construction, economics and finance.

In the rapidly increasing Public Utility field the Commonwealth Edison Company of Chicago has maintained its place as the largest distributor of electricity produced by steam. This growth has resulted in an expenditure during the past three years for new plant and equipment of over $63,000,000, a sum equal to the total amount of money spent for the same purpose in the first twenty-eight years of the Company's history.

Truly this presents a field worthy of the endeavor of any ambitious man.

COMMONWEALTH EDISON COMPANY

EDISON BUILDING, 72 WEST ADAMS STREET CHICAGO, ILLINOIS

"He's one of the most altruistic men I know."

"What's he been doing now?"

"He spent all the afternoon telling hair raising stories to a couple of bald-headed men."

From a Freshman Rhet theme on Newton:

"Sir Isaac was sitting one day under an apple tree at Appomattax composing "Paradise Lost" when an apple fell from the tree and hit him on the head. He jumped up, cried "Eureka" and immediately invented the steam engine."

Citizen: "Your honor, I'm too sick for jury duty. I've got a bad case of the itch."

Judge (to clerk): "Scratch this man out."

With rolled hose it isn't the original cost, it's the upkeep.

She: "Is my face dirty or is it my imagination?"

He: "Well, I don't know about your imagination, but your face isn't."

"Oh, Semmy! Semmy! Such extravagance. At four o'clock in the afternoon you buy an all-day sucker."

They were seated on a little rustic bench. The moon shown through the trees. All at once the girl timidly said, "Jack, dear, I can't understand why you lavish all your affections on me above all other girls in the world. Why is it?"

"Hanged if I know," he replied, "and all the other fellows down at the house say they can't make it out either."

GIVE HIM GAS

Dentist: "So you have broken off a tooth, have you?"

Patient (tough youngster): "Yes sir."

Dentist: "How did you do it?"

Youngster: "Oh, shifting gears on a lollypop."

Friend: "What courses is your daughter taking at college?"

Dad: "Cigarette inhalation, highball construction, genteel snubbing, and general cosmetics."

Kind Old Gentleman: "Did 'ums break 'um 'ittle dolly?"

Sweet Child: "Yea. Why the hell do they make the damn things so fragile, anyway?"

Mr.: Aren't you ready to go yet?"

Mrs.: "Tell me. Does my gown look as though it were slipping off my shoulders?"

Mr.: "No, let's go."

Mrs.: "Well, you'll have to wait a minute. It's supposed to look that way."

He (over telephone): "What time are you expecting me?"

She (icily): "I'm not expecting you."

He: "Then I'll surprise you."

"Papa, what do you call a man who runs an auto?"

"Well, that depends upon how close he comes to hitting me."

Paul Dingledy wants to know if the Technograph was justified in refusing all corset advertising.

Query for Ceramists: "Where is Pittsburgh Glass made?"

Bellhop(after guest had run for ten minutes): "Did you ring, sir?"

Guest: "No, I was just tolling. I thought you were dead."

Stranger: "Please, sir, can you direct me to the library?"

Stude: "Sure. See that girl ahead of you all dressed up and no books under her arm? Well, just follow her."

And then they call the library at Kansas University "Spooner Hall."

Al: "Dearest, can you accept a pet monkey?"

Allie: "Oh Al, this is so sudden. You'll have to ask father."

Ed: "What' da' ya doing tonight?"

Coed: "Studying."

Ed: "I'm not doing anything either. Let's go to a show?"

Prof. Goodenough in M. E. 15: "Now let's all sit down and see where we stand."

Marriage is a great institution.

So is the penitentiary.

A very self-satisfied man arrived at the gates of Heaven and asked for admittance.

"Where are you from?" asked St. Peter.

"Hahvard."

"Well, you can come in, but you won't like it."

Mother: "Connie, I do wish you wouldn't wear that one-piece bathing suit."

Connie: "But mother, one must wear something."

ALUMNI NOTES

Honens Busy with Civic And Engineering Work

Fred W. Honens, c.e., '96, stands out as a colossal success in life. At the time that he entered the University the government started work on the Illinois and Mississippi canal which ran through his home town of Milan. This gave him an opportunity for practical work with the surveyors on that job during h's summer vacations. His last summers, however, were spent in Sterling where the canal feeder taps Rock River.

After graduation, Honens spent a few months in engineering work on the Chicago River, and then returned to Sterling to assist the engineer in charge of the feeder. While on this job he helped in the designing of the big government dam between Sterling and Rock Falls which impounds Sinisippi Lake, the largest body of water in Illinois. At this time he also wrote articles about the canal which appeared in the "Engineering News" and the "Engineering Record."

The canal was finished in 1909, and Honens was transferred to Kansas City where his job was to look after the 2,000 miles of Missouri River between that city and Fort Benton, Montana, and to watch operations in the Osage River.

In 1914, Honens, now a family man, returned to Sterling and went into the foundry business. Almost as soon as he returned he was made president of the city high school board and a member of the library board, as well as director of the Y. M. C. A. and a trustee of the Presbyterian church. In 1923, he was elected mayor of Sterling by an overwhelming majority. Since his return to Sterling the high school has added a $75,000 addition, the Presbyterians have built a new $150,000 church, and the city has built a $200,000 concrete bridge across Rock River.

Honens is a Mason, a member of the Elks, the association of commerce, the Rotary Club, the Sterling Club, and the Hamilton Club of Chicago. Besides all these things, he is superintendent of the Presbyterian Sunday school, president of the local Illini club, and a member of the A. S. C. E.

LINCOLN BUSH, '88

Ceramic Grads Meet

Since the department of ceramic engineering was established in 1901 about one hundred have graduated from it. Of this number twenty-three attended the annual convention of the American Ceramic Society held last month in Columbus, Ohio. Those present were: H. R. Straight, '07, R. K. Hursh, '08, B. S. Radcliffe, '10, Paul Teetor, '11, Robert Back, '13, R. R. Danielson, '14, R. A. Horning '14, F. S. Hunt, '16, C. C. Treischel, '16, G. E. Sladek, '17, F. L. Steinhoff, '17, J. L. Crawford, '17, B. F. Carter, '18, Robert Twells, '20, J. R.: Green, '22, R. A. Galbraith, '23, H. G. Wolfram, '23, Dr. Louis Navias, '23, V. W. Boeker, '24, J. W. Hall, '24, R. E. Reif, '24, R. H. Weston, '24, and Dr. G. E. Shelton, '22.

The work of the convention was divided between the seven divisions of the ceramic work. R. R. Danielson was head of the enamels division with H. G. Wolfram as secretary of the same group. The former was also elected to fill the position of a trustee of the society. B. S. Radcliffe was the head of the terra cotta division. Papers were given by H. R. Straight, J. R. Green, H. G. Wolfram, Dr. Navias, and V. W. Boeker.

Lincoln Bush Noted for Ingenious Work

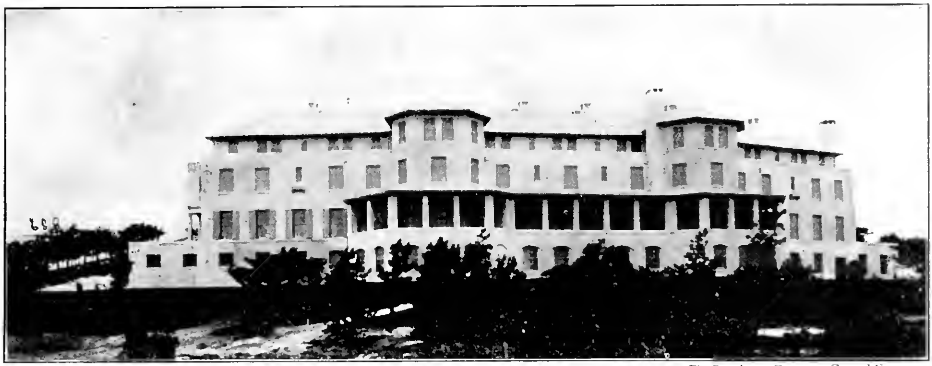
The College of Engineering may well be proud of Lincoln Bush, c.e., '88, who has distinguished himself by his remarkable ingenuity. Three great accomplishments stand out above his many important and remarkable feats. The first of them is the moving of the Lackawana Railroad Bridge over the Passiac River twenty-five meet upstream, to new abutments ten and one-half lower than the old ones, in twenty minutes time between trains. The trick was done by placing barges under the trusses of the 221-foot double-deck bridge which rose with the tide lifting the structure free of its bearings. The trusses were supported by large boxes filled with dry sand which was allowed to run out when the bridge was in its new position allowing it to settle perfectly on its new bearings.

Another thing that Mr. Bush did was to remake the Lackawana Railroad so that it could adequately take care of its business. To do this, many lines were relocated and new buildings and bridges were erected, all under his supervision as chief engineer.

Following this work he invented the Bush train shed which is now used almost exclusively by every line in the country. He then left the railroad and formed the firm of Bush and Roberts which built the Tunkhannock Viaduct, the largest re-inforced concrete bridge in the world.

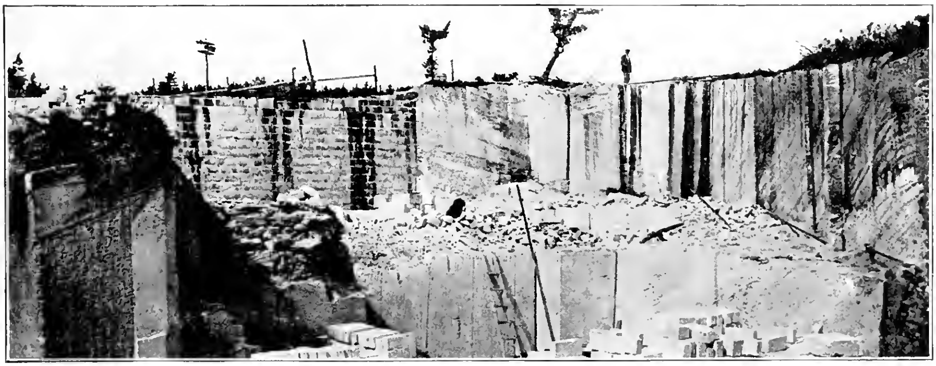
He was commissioned lieutenant-colonel in the construction of the army during the war and was awarded the honorary degree of doctor of engineering by the University of Illinois.

Philip Donohoe, c.e., '21, has announced his engagement to Mandaline Powell of Chicago. Donohoe, is in Davenport, Ia., with the General Electric Co. While in school he was captain of the track team and ran on several of the championship one-mile relay teams.



Warren and Wetmore, Architects. — The Foundation Company, General Contractor

Bermuda Golf Club House, Tuckerstown, Bermuda



Quarry of native stone, used for foundations and walls.

ECONOMY, IN CONJUNCTION WITH GOOD CONSTRUCTION, IS AN IMPORTANT FACTOR IN ALL WORK UNDERTAKEN BY THE FOUNDATION COMPANY. TO FURTHER THE ECONOMICAL CONSTUCTION OF THE CLUB HOUSE AT TUCKERSTOWN, BERMUDA, NATIVE LABOR WAS EMPLOYED, AND A QUARRY, AT THE SITE, WAS OPERATED TO OBTAIN THE CORAL ROCK USED IN BUILDING.

ON LAND OR WATER, AT HOME OR ABROAD

THE FOUNDATION COMPANY, AN ORGANIZATION OF DESIGNING AND CONSTRUCTING ENGINEERS, SPECIALIZES IN THE BUILDING OF DIFFICULT STRUCTURES. THE WORK OF THE FOUNDATION COMPANY, THROUGHOUT THE WORLD, INCLUDES ALL PHASES OF PRIVATE OR PUBLIC UNDERTAKINGS IN THE CONSTRUCTION FIELD.

THE FOUNDATION COMPANY

CITY OF NEW YORK

Office Buildings - Industrial Plants - Warehouses - Railroads and Terminals - Foundations Underpinning - Filtration and Sewage Plants - Hydro-Electric Developments - Power Houses Highways - River and Harbor Developments - Bridges and Bridge Piers - Mine Shafts and Tunnels

CHICAGO	SAN FRANCISCO	LIMA, PERU	LONDON, ENGLAND
PITTSBURGH	LOS ANGELES	CARTAGENA, COLOMBIA	PARIS, FRANCE
ATLANTA	MONTREAL	MEXICO CITY	LOUVAIN, BELGIUM

BUILDERS OF SUPERSTRUCTURES AS WELL AS SUBSTRUCTURES

College Notes

(Continued from Page 137)

At the final meeting Friday Prof. Ira O. Baker spoke on the "Elements Necessary for Success," and Frank T. Sheets, c.e., '11, closed the meeting by outlining a policy of highway construction for the future. The 1925 Highway Short Course was attended by over 300.

Prof. C. C. Williams in speaking of the benefits of the Short Course stated:

"The Highway Short Course at the University has been one of the most valuable agencies in carrying out the program of improved highways in the state of Illinois. Here state engineers, county superintendents of highways, and highway contractors have met on neutral ground; free from the strain of construction and in the scientific atmosphere of the University, they discuss their probelems and receive instruction and inspiration from the more formal papers and lectures of the course. As one of their number remarked, the vision of the county superintendents has been broadened from the local county affairs to a comprehension of the great state system by this means. Certain it is that the highway short course has been the most potent co-ordinating influence in enabling all concerned to work together effectively."

Inter-College Debating

Something new on this campus was inaugurated last year, when a debating team from this college met a similar team from the College of Commerce in an intra-college debate. This year the work started is being continued and on a larger scale. An inter-college league has been formed for the purpose of stimulating intra-mural debating on the campus. Teams representing the colleges of Engineering, Commerce, Law, Education, Agriculture, and Liberal Arts, will compete for a trophy which will be awarded the winning team for one year. Some colleges will have two teams entered, very likely, but how many, is not known yet. Some try-outs have been held and the members of some of the teams have already been picked The remainder will be selected in the near future. Both the preliminaries and the finals will be held sometime during the month of March. The members of the team representing our college who have been selected to date are: S. S. Ball, c.e., '25, L. R. Ludwig, ry.e.e., '25, J. Muller, m.e., '25, B. G. Rich, m.e., '25, I. D. Sklovsky, m.e., '25, S. I. Rottmayer, m.e., '26, and C. E. Eichorn, e.e., '27. It is expected that this will be an annual affair from now on, the debates probably coming, however, during the first semester hereafter. It is hoped to introduce intra-college oratorical and extemporaneous contests next year if not this semester.

Experiment Station

Circular No. 12. "The Analysis of Fuel Gas" by Prof. S. W. Parr and Mr. F. E. Vandaveer. This circular, a pamphlet of forty-one pages containing two figures and seven tables, is a comprehensive review of the different methods of gas analysis, describing also investigational work as to the efficiency of the various methods. The Illinois apparatus which is a modification of the enlarged Orsat outfit is described, together with a discussion of the preparation of the reagents and the manipulation of the apparatus. There is an appendix, "Methods of Fuel Gas Analysis," in which the different processes of Fractionation at Low Temperature, Optical Methods, Absorption Methods, and Combustion Methods are discussed, all the processes for the determination of the different gases being summarized in a table.

Bulletin No. 144. "Power Studies In Illinois Coal Mining" by Professors Arthur J. Hoskin and Thomas Fraser. The report contained in this bulletin was prepared under a co-operative agreement between the Engineering Experiment Station, the State Geological Survey and the United States Bureau of Mines. It consists of eighty-two pages besides thirteen tables and numerous illustrations and graphs. It is "written in response," as the introduction states, "to requests received from numerous Illinois coal operators for dependable information concerning the various phases of their general power problem." The investigation was started in the spring of 1922 and the data used was obtained from fifty representative Illinois mines. There is a quite comprehensive discussion of the various mechanical labor saving devices, and a great deal of space is devoted to the electrification of the mines. The power is classified according to its use, as for ventilation, hoisting, loading, hauling, etc., and the various characteristics and costs of each considered in detail. The value of the bulletin has been demonstrated by its wide demand.

Physics Colloquium

A partial program of the Physics Colloquium for the second semester has been announced. At the first meeting, February 19, Prof. Jacob Kunz spoke on the observations he and Professor Stebbins, of the University of Wisconsin, formerly head of the astronomy department at the University of Illinois, made during the recent solar eclipse. The data obtained furnished valuable new in-

(Continued on Page 152)

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Departmental Notes

(Continued from Page 142)

current relay for electric-pneumatic interlocking machines built by the United States Signal company, and a model of a 2-lever electric interlocker from the General Railway Signal company. This costly equipment of the latest types together with previous additions affords opportunity for those who study railway signaling to receive practical information.

The research work now being done under the immediate supervision of the Department of Railway Engineering is of some general interest. This work is concerned with the design of certain features of the railway locomotive and is being done on a quarter size model of a modern freight locomotive. This model is now set up in the locomotive laboratory. It is as much a small edition of an actual engine to the car as to the eye, for with steam puffing up its small stack it sounds like the real thing.

This is not a co-operative investigation, no railroad being directly concerned with the work. It was started by the station due to a wide interest among railway men in the improvement of the locomotive "front end" or the equipment for maintaining the draft,—front of the boiler and stack. Without a forced draft a locomotive would hardly be able to do more than move itself. The heavy drafts used in practice in the engine fire box result from the "puffs." The system is most effective and simple, but decidedly expensive, and it may even happen that it takes as much energy to keep up the draft as it does to pull the train.

The inefficiency of the draft apparatus is perhaps the greatest weakness of the modern locomotive. It is natural then, that railway officials and engineers are interested. A locomotive is a rather bulky and expensive thing to experiment upon, consequently the model has been built. This will enable the investigator to vary the design in various ways, attach his instruments, and get the whole problem in the confines of the laboratory. With the results it should be possible to make improvements upon locomotives and test them on the road.

Professor Edward C. Schmidt, head of the Railway Engineering Department, is in charge of the work, which occupies the time of Mr. D. L. Fiske, Research Assistant with the co-operation of Mr. H. N. Parkinson, Instructor in Railway Mechanical Engineering.

College Notes

(Continued from Page 150)

formation as to the exact nature of the sun's corona.

Prof. Chas. T. Knipp, at the second meeting, February 26, continued the discussion of the solar eclipse observations, with a report of the magnetic observations made here at Urbana during the eclipse. Magnetic observations furnish considerable information as to the nature of the earth's magnetism. Such observations have also been made here during previous eclipses.

Other colloquium subjects were:

March 12. Dr. C. C. Wylie: "Solar Eclipse Observations."

March 19. Mr. V. A. Albers: "Valve Action of Light."

March 26. Professor Goodenough: "Problems in the Flow of Steam through Turbines."

April 2. Professor Kunz: "High Temperatures in Physics and Astronomy."

L. W. Huber, min.e., '21, teaches metallurgical and mining engineering at Carnegie Tech, Pittsburgh.

C. C. Lundeen, arch., '23, has been superintending the construction of a school building in Morris, Illinois.

Heating and Ventilating Research

(Continued from Page 128)

were alike. Elbows 8, 9 and 10 (Fig. 18) had a larger throat radius (R_1) and a narrower throat (C) than elbows 6 and 7, and contained no vane. The departure tubes were of different lengths, otherwise these three elbows were all alike. The curves in Fig. 15 represent the loss in head as measured in inches of water at 95° F. and a barometric pressure of 29.40 inches mercury. The heads as plotted represent the static pressure at the piezometer ring, which was about 36 inches ahead of the elbow, corrected for the friction head in the straight 6″ x 18″ pipe entering the elbow. In all cases, the loss in the departure tube leaving the elbow is included in the elbow friction. See column (D) Fig. 15.

Conclusions. It is, of course, quite apparent, that of the right angled elbows tested (Fig. 13) only those with radii equal to or larger than Nos. 3 and 11 should be used. If space conditions render such large radius bends impracticable, then a venturi departure tube should be used as in No. 4. Proportions for such a venturi elbow may be taken as shown in Figs. 13 and 18.

In the case of the compound elbows tested, No. 6 with deflecting vane was far superior to all other designs. It should be noted that elbow No. 10 showed a greater friction loss than elbows No. 8 or No. 9. This results from the fact that in reducing the length of the departure tube (D) to 26 9/16″, the outlet velocity was greatly increased by the reduction in width of outlet from 20″ to 11¼″. The No. 6 elbow was selected as the model for the half-scale concrete elbow. This large size concrete elbow (Fig. 17) was tested (Fig. 16) over the same range of velocities as the small elbows.

Tests for Friction Pressure Loss in the Large Scale Elbow Model

General Statement. A large scale model compound elbow was constructed of concrete at the outlet end of the experimental duct (Fig. 16, 17 and 19). This model, like the duct, was to one-half scale dimensions, and hence exactly equivalent to the experimental duct in air carrying capacity. As a result of the work done on the small scale compound elbow models in the laboratory tests it was evident that the small elbow (6) with deflecting vane caused the smallest friction losses, and the large scale elbow was, therefore, made of the same proportions as elbow (6). In order to duplicate the effect of a reasonable length of down-cast shaft, and provide for a suitable reading station, it was necessary to provide for a transition section

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Heating and Ventilating Research

(Continued from Page 151)

(Fig. 16) of 10 ft., and a rectangular shaft section 2′ 6″ x 7′ 6″ of 35 ft. between the end of the experimental duct and the elbow (Fig. 17), the outlet of which discharged vertically into the air. This outlet, not visible in Figs. 17, was of exactly the same shape and area (Figs. 12 and 16) as the experimental duct.

Method of Testing. Air was supplied by the fan and motor equipment, as in the previous tests on the experimental duct, and a new static pressure reading station, No. 1, was installed just half way in the 35 foot horizontal connecting duct. This station was equipped with piezometer ring and four drilled plates (No. 60 drill) and was exactly 17½′ ahead of the first turn of the compound elbow. At the same time the readings were taken at Station 1 of static pressure, other readings were taken at Station 3 of velocity and static pressure, and another set of static pressure readings was taken at Station 1. This made it possible to determine the air volume at Station 3, and also get the friction pressure loss and coefficient of friction in the experimental duct between Stations 1 and 3, as well as determine the head lost in the compound elbow in inches of water.

Results of Tests. The frictional loss in the model elbow is shown in Fig. 19, first for the case with deflecting vane in place, and second for the case with this vane removed. As in the tests of the small elbow model of these same proportions, the effect of the vane is very marked in reducing the friction loss. Although no tests were run with the vane in any other position but the one shown, it is probable that equally good results would be secured if the vane was moved a little nearer the center of the duct. against velocity of flow of air in the entering rectangular duct, and represents the piezometer ring pressure at Station 1 corrected for 17½ feet of straight duct. The relation between the friction head lost in the elbow, and the velocity head of the air in the duct entering the elbow is shown on the small chart in Fig. 19, and will prove very useful in making allowance for the compound elbow The location, one third of the way across the entering air stream, as shown, is however, very effective.

The loss of head (Fig. 19) in inches is plotted losses when velocity head of the air entering the elbow is known. It is only necessary to multiply the velocity head of the air flowing in the downcast shaft by the ratio *hl hr* given on the small chart in Fig. 19 to get the friction loss in these special elbows. Moreover, it will be noted that this ratio is practically constant for the concrete model elbow tests, at the velocity heads or velocities which were used in these tests. An exactly similar procedure may be followed in arriving at the compound elbow losses in the actual full size tunnel ducts. It has already been shown that the head lost for a given velocity in the half scale compound concrete model elbow is almost identical with the head lost in the full size elbows which are dimensionally similar.

Consultant on Ventilation for the Tunnel Commissions of New York and New Jersey. The other members of the Engineering Experiment Station who have been actively engaged on both of the investigations discussed herein are A. P. Kratz, Research Professor in Mechanical Engineering, and V. S. Day, Special Research Assistant Professor in Mechanical Engineering.

J. J. Devore, min., '22, is with the Maewhyte Company, manufacturers of wire ropes. He travels through the mining districts of Illinois, Indiana, and Kentucky.

L. Andrews, min., '24, is with the Dwight P. Robinson Company. He was in construction work on the building of the Colfax Plant of the Duquesne Light and Power Company of Dequesne, Pennsylvania. He is now engaged in the testing of the new 30,000 kw. turbo-generators being installed in the Colfax plant.

The Development of the Gothic Arch in France and England

(Continued from Page 133)

points equidistant from the impost with liernes. A central space was thus left which was filled by continuing a number of radients and adding liernes. A vault thus constructed, however, was not of the pure fan type. It was necessary first to replace rings of straight liernes with circular horizontal ribs and to add one ring above another until practically the whole space to the vault crown was filled. Thus in certain of the fan vaults at Peterborough, Fig. 8, there were three such rings, leaving but a small diamond shaped space which was largely filled in by the boss of the bay.

The one structural advantage of the fan vault lies in the fact that it could be built of practically horizontal courses in a manner to exert very little outward thrust: while the substituton of the curved for the straight liernes did away with the awkward angular intersection characteristic of lierne vaulting. Altogether, it was quite a clever and beautiful, if not logically structural, type of vaulting, well suited to the taste of English builders with their fondness for intricate decoration rather than structural problem.

And now we come to the example which marks the culmination of this type of English vaulting, namely, that portion of Westminister Abby known as Henry VII's Chapel. An earlier instance of a similiar scheme is found in the Oxford Divinity School. Here heavy transverse ribs, in the form of depressed, four centered arches, are visible, as in normal vaulting, and give some sense of security, notwithstanding the coniod pendants which hung from the vault thus apparently dividing it into three bays. At Westminster, however, the transverse ribs pierce the vault where they meet the pendants and disappear from view. Between the pendants and the wall conoids the transverse ribs become mere skeleton arches. The pendant is a voussoir of the transverse rib, which beyond the pendant does not appear on the under side of the vault. This pendant strengthens the vault by weighting its haunch. Between the pendant and the support, the springing transverse rib, is stiffened by a member which arises to meet the wall conoid, and by the tracery with which the intervals are filled. The upperpart of the pendant thus built into the transverse rib is suspended only in appearance. Thus, from a structural standpoint, the idea is sound but greatly involved. From an architectural point of view it is indefensible, for in architecture, the stability must be apparent as well as real. These suspended masses of masonry, if not actually disturbing the beholder, must excite his curiosity as to how they are held up. Such curiosity is not the feeling that architecture should awaken, for in good architecture, structural forms are not necessarily elaborate, nor are they necessarily concealed or falsified in appearance.

This ostentations chapel of Henry VII serves perfectly as an example to show what extreme paths the French and English builders were travelling at this late period in the Gothic style, and who can say which was the better path? One English writter deprecates the French style thus, "The French method of web construction was scientific and artistic: it was good construction and was pleasing to the eye. But when a method is perfectioned, progress and invention stop, satisfaction is the enemy of improvement, and this is what happened in France. Their builders had commenced in 1120 with simple cross ribbed vaults of the quadripartite type; and to these, with few exceptions, they adherred for nearly three centuries." Perhaps he is right but there is still another side to the question.[1]"

French art in the earlier Middle Ages was essentially religious and thus we find that in the churches architecture had its greatest triumphs. To the unlettered vulgar, the churches were the visible embodiment of all that was holy; the Paladium to save them from all that was evil. Every person was interested in their building so we find that in the construction of St. Denis, the nobles and gentle folk, freeman and slaves, men and women harnessed alike to the cart to draw the stones to the edifice, while the officials leaving their proper duties, cleared the way. The French, then, were, undoubtedly, more embued with religious zeal fervor than were the English. Where the builders of England worked towards a wonderful, though mechanical, coronal for the church which disturbed the beholder and aroused his curiosity, the French designer developed his facade—the natural place for ostentation and show—and, believing that the interior of his church was for worship, strove for simplicity, height, and soaring qualities which would cause the mind of the worshipper to transcend the earthly and dwell for a time at the seat of the Mighty.

However, there is a tremendous amount of good to be derived from both the French and English work. So let us hope that our architects, with an ample and well-rounded knowledge of the past excellencies of form, but regarding that bygone art as their tutor, rather than their model, will strive for the solution of the problems of the present.

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[1]Bond, "English Church Architecture," Vol. I., p. 327.

The Development of the Gothic Arch in France and England

(Continued from Page 158)

But if they express the demands of our age the most direct and sensible way, regardless of precedent or authority, they will find themselves really working in the true Gothic spirit. If a man is honestly fired by the spirit of his work, and labors on this principle, the work that he does will have the qualities of good and true Art.

The Delaware River Bridge

(Continued from Page 114)

cost will far exceed the estimated cost. In fact in this case estimated costs were practically doubled in both Pennsylvania and New Jersey, due to an increase in real estate values dating from 1921 when construction was started. The expenditures for the bridge, approaches, piers, engineering, damages, profit, and other contingencies, coupled with $11,000,000 spent for real estate will bring the final cost of the improvement close to $37,000,000. It is felt by the engineers, however, that this great expense is justified by the increased transportation facilities for the manufacturing cities, the alleviation of traffic tangles, and the tremendous saving of time due to the replacement of the present system of ferries.

The men of the University of Illinois might not find amiss, a short story of the progress of the man who is in charge of the construction of this bridge. Montgomery B. Case, senior resident engineer, was born at Monmouth, Illinois, in the year 1882. His preliminary schooling was in Nebraska and his vacations during school years were spent in engineering work, mostly with various railroads. He entered the University of Illinois in 1901 and graduated with the class of 1906. Ralph Modjeski addressed the engineering students of the University the spring of 1906 and this address inspired several seniors to go into bridge work. Case learned from Professor Baker that there were a few jobs open on Modjeski's bridges on the Willamette and Columbia rivers in Oregon, and succeeded in securing one of these. Since that time has has been employed on Medjeski's staff almost continually. However during the period from 1908 to 1910, Mr. Case worked on irrigation projects in Nebraska, and drainage works near Burlington, Iowa. In 1910, however, he returned to work for Modjeski on the Cilio bridge project. This bridge was built for the Oregon Trunk Railway, and spanned the Columbia River near Portland. Following the competion of this project, Case was identified with the construction of the multiple arch, reinforced concrete bridge over the Maumee River at Toledo, Ohio; and with the bridges at Cincinnati, Keokuk, and Poughkeepsie. During the war, however, he served in the United States in the building of the United States Nitrate Plant No. 3.

Following the war, Case spent a year with the Penascola Ship-building Company, and went from this position to the building of another bridge at Cincinnati, Ohio. When this work was nearing completion in December of 1921, Case was appointed senior resident engineer in charge of the Philadelphia-Camden bridge already described, which bids fair to bring more fame to the name of Case:—Bridge Builder.

Illinois Central Electrification

(Continued from Page 121)

service and different portions of the line. Direct current signals have been in use, but signal circuits will be changed to alternating current operation during the process of electrification.

A. C. Distribution System

The catenary structures will carry three-phase four-wire 100 2,300 volt transmission lines for supplying the signal system. Each of these will be fed from the sub-stations furnished by the Commonwealth Edison Company. Initially there will be duplicate lines along the electrified part of the main line, and a single circuit on the South Chicago Branch.

Duplicate three-phase lines will be installed from Randolph Street to the 69th Street sub-station, and a single three-phase line from there to the end of the initially electrified zone. Future provisions include an additional line between 69th Street and Harvey, the point of steam-electric change-over for future through passenger and freight electrification.

The transmission lines will be provided with feed from both ends in every case, and will in general be sectionalized at mid-points between sub-stations. Initially there will be from four to twelve No. 1 H. D. copper triple-braid weather-proof wires along each section of the electrified route. All design is for the ultimate use of No. 2 2 0 wires. These will be carried on four-pin and six-pin angle iron cross arms erected upon tops of catenary structure columns. Wires will be supported at the normal heights of thirty-three feet and thirty-six feet, and will have a normal sag of six feet in a 300 foot span. Resulting maximum tensions in wires will be 1,900 and 2,500 pounds for each No. 1 and No. 2 wire, respectively.

Control Cables and Messengers

In addition to the catenary and transmission wiring and signals, the catenary structures will

(Continued on Page 162)

GOOD LIGHTING OF INDUSTRIAL PLANTS SECURES SAFETY AND EFFICIENCY.

The Code of Lighting for factories, mills and other work places of the State of New Jersey makes excellent recommendations of daylight for the proper lighting of industrial buildings.

Adequate daylight facilities through large window areas, together with light, cheerful surroundings, are highly desirable and necessary features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the viewpoint of maximum plant efficiency.

Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employe.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

Shades may be eliminated and most efficient lighting obtained by the use of Factrolite Glass.

If interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

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Illinois Central Electrification

(Continued from Page 160)

support the multiple conductor cables for signal control circuits. There will be up to thirty-two No. 14 wires, in one or two cables, carried from an extra high strength steel messenger varying from 3/8 inch to 1/2 inch in diameter. Along some sections of the line two messenger and cable assemblies will be used. These messengers will have a normal sag of sixty feet for the 300 foot span, and the resulting tension under heavy loading will be from 5,100 to 7,500 pounds for the several sizes. North of 70th Street these circuits will be carried in a duct line instead of on an aerial cable.

Wire loading is based upon a maximum condition of ice one-half inch thick on all wires and hangers, with a wind pressure of eight pounds per square foot of projected area, including the ice. This pressure corresponds to an indicated wind velocity of seventy-two miles per hour. As an alternative condition of maximum loading to cover extremely heavy winds, coincident with which there will not be heavy ice coating, a pressure of twenty pounds per square foot of projected area, corresponding to about 119 miles per hour indicated velocity, is assumed.

Loading on flat surfaces of structures taken as twelve and thirty pounds per square foot for the two conditions, and ice on structures is not considered.

The minimum temperature of still air is taken as twenty degrees below zero Fahrenheit, and a zero temperature coincident with maximum ice loading.

(To be continued.)

Lester Selig, min., '22, is located with Dryers Incorporated, manufacturers of dryers and other machinery used in the sugar refinery industry. He is engaged in original research work in actual plants.

S. P. Gluskoter, min., '22, formerly at the Waukegan Plant of the Public Service Company of Northern Illinois, has been transferred to the Crawford Avenue Station of the Commonwealth Edison Company.

WHAT THE YOUNG MAN WILL WEAR

The Cutter: "How in the world did you manage to sell that suit which turned out such a terrible misfit?"

Clerk: "A young man thought it was 'collegiate'."

Charley My Boy (to waitress in restaurant): "Have you frog legs?"

Waitress: "No indeed, it's rheumatism that makes me walk this way."

Design in Power Plant Lighting

(Continued from Page 147)

4 to 11. The most common fixture used in the power plant is the standard of the Reflector and Lamp Manfacturers Association, usually referred to as the RLM fixture, see Fig. 4. The elliptical angle reflector shown in Fig. 5 is used at the boiler stokers. Where a wide distribution of light was desired, a flat cone reflector, pictured in Fig. 6, is used. A gas and vapor proof fixture is shown in Fig. 7. Fig. 8 shows a moisture and dust proof fixture, which was installed in toilet and shower bath rooms. The fixtures shown in Figs. 9 and 10 were used on the coal conveyors and generator lead tunnels, respectively. The gooseneck fixture shown in Fig. 11 was used over walkways and where the ceiling lights were inadequate. Acid resisting fixtures were used in the storage battery room to prevent corrosion by the acid fumes. Powerful flood lighting projects mounted on poles and on buildings, are used to light the yards about the power plant.

Modern practice in the power station is to have the lights divided into two systems, the normal lighting and the emergency lighting. About three-fourths of all lights are on the normal, or alternating current, circuits; the remaining lights are on the emergency, or direct current, circuits. The emergency lights are burned along with the normal lights, and ordinarily one would not realize that there are two separate lighting systems. All lights on stairways and about exits are on the emergency circuits. In the Weymouth station the emergency lighting is completely isolated from the normal; separate cabinets, separate conduits, and individual control being used. When generating equipment is damaged in any way, and the lights go out, the emergency lights supply sufficient illumination for the repair of the damage. The current for the emergency lighting system is obtained from a small direct current generator or from storage batteries.

Despite all that the illumination engineer can do to provide proper illumination for the power plant, stations are often poorly lighted because the operators do not maintain the lighting in an efficient condition. The depreciation factor of 1.5 allows for a decrease of 50 per cent in the lighting initially installed. When one considers that where dust and smoke exist the depreciation in light output is 40 per cent in four weeks, the importance of this safety factor can be readily seen. The five principal causes of light depreciation are, in the order of their importance: First, dirty lamps and reflectors; second, darkened walls and ceilings; third, ageing of the lamps; fourth, improperly made replacements; fifth, unobserved burnouts. The reason for the neglect in maintainence is the gradualness with which the above causes bring about a decrease in light. Systematic maintainance requires that the fixtures be wiped at regular intervals; that they be thoroughly washed every third or fourth wiping; that aged and burned out lamps be replaced promptly; and that monthly tests be made with the foot candle meter to determine the amount of depreciation. The cost of systematic maintainance is merely one of labor, and is insignificant when compared with the expensive waste of light from dirty equipment and dirty walls. If the illumination engineer knew before hand that the lighting system would be properly maintained, he could use a much lower depreciation factor, and thus he would greatly reduce the initial cost. But as long as this inefficiency in maintainance exists the engineer must make allowance for it.

"What have you in the shape of automobile tires?"

Salesman Sam: "Funeral wreaths, life preservers, invalid's cushions, and doughnuts."

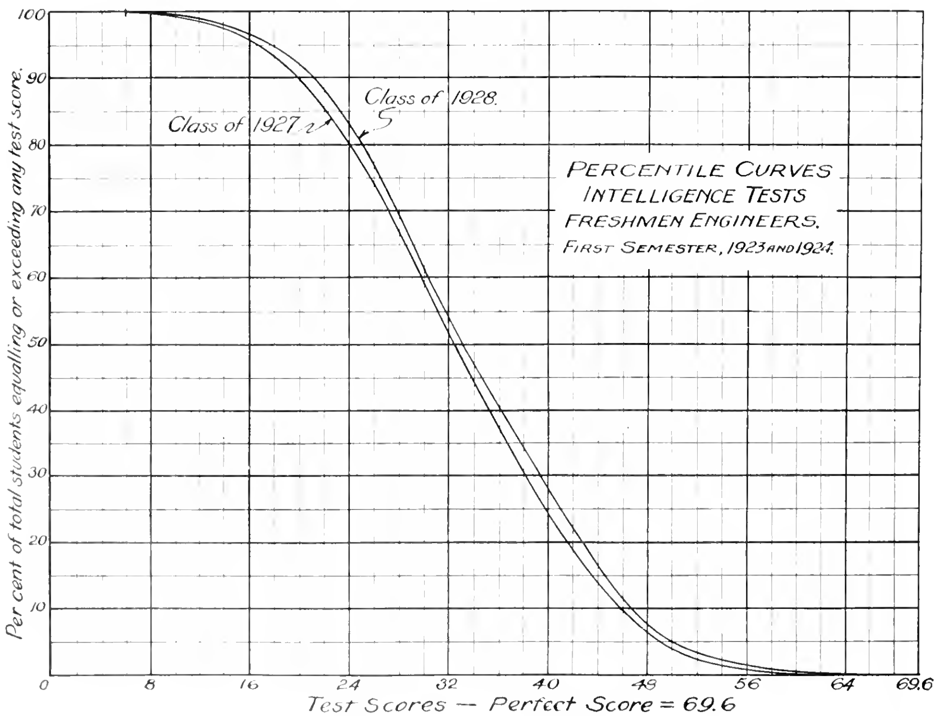
The Use of Engineering Intelligence Tests

(Continued from Page 131)

has ever used before. He begins to evaluate his endeavors, his preparation, and his abilities in comparison with his fellowmen, when he finds himself, let us say, in the lower sixth of the posted list of five or six hundred men. To the examiner and student alike, such a rating can suggest only one course of action, namely, find the causes of the poor showing and remove them at once if possible. It may turn out that the student's preparation is wholly inadequate or, unfortunately, that he is entirely unsuited to college work. In any case a diagnosis should be made before surgical operations are undertaken, instead of the reverse as often happens. In the diagnosis, intelligence tests are symptom finders. Any more extended use of intelligence tests, in their present state of imperfection, is, in the writer's judgment, wholly unsound practice.

It may not be too great a sin of digression to point out here the very grave fallacy many have supported, of assuming that the law of normal distribution of intelligence test grades, or any other grades for that matter, may be utilized without let or hindrance in any individual case. The law is useful and, within certain limits, infallible in determining the characteristics of a group and in comparing trends and tendencies in any particular field or period of time. It is neither scientific nor moral for one to run the pointer of selection along a normal distribution curve to the spot where John Doe is plotted as a result of an intelligence test, and then attempt to forecast the future prospects of John Doe. An aching tooth may have placed Doe in an unfavorable position on the distribution curve. A transposition of the tooth will have a tremendous effect on Doe. His transposition on the curve will have an almost negligible effect on its properties. More subtle and important biological transformations may occur in John Doe's anatomy than the extraction of teeth. A case in point recently came to the writer's attention.

Mr. ———, a student in Engineering, had made an indifferent record in his studies well up into his junior year. All ratings and judgments pointed to an unsuccessful future for this young man. Then the unexpected happened. Almost overnight, Mr. ——— vaulted clear over the top of the normal distribution curve and alighted well within its

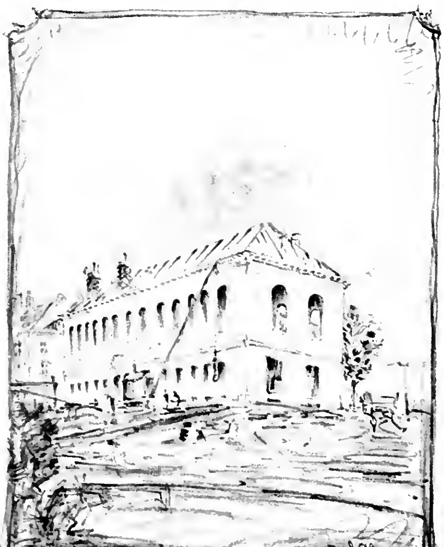


highbrow limits. In speaking of his spectacular movement in a recent visit to the college, he gave it as his firm conviction that the cold and apparently unfriendly analysis of his case by the writer in his junior year had so stirred the depths of his anger, unstirred before, perhaps, that some sort of an internal transformation occurred which made it easy for him to surmount obstacles previously insurmountable, and which later led him out into a successful professional life. The instance may be called an isolated one, yet it goes to prove what was said earlier, namely, that it is unsound in principle to apply group characteristics to the individual case.

The accompanying diagram shows the percentile curves of the classes of "1927" and "1928", based on the results of the administration of the same intelligence test to each class about two weeks after it entered the college in the fall. Like other distribution curves, the percentile curve is useful in detecting trends and tendencies. It is clear from the curves shown that our entering student timber is becoming better qualified to maintain college standards of work; at least such is the case if we may judge from the results of such tests. Scholastic achievements bear out this conclusion.

THE TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS



May

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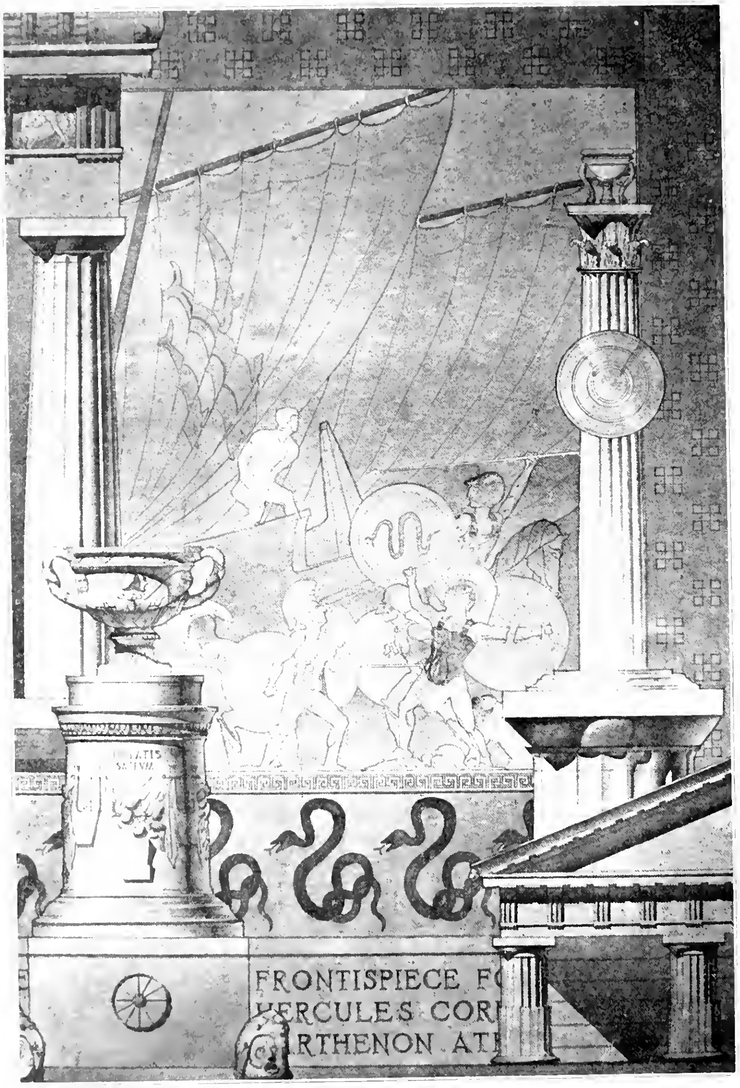

H. G. GUINNEY — *Medal*

Courtesy of the 1925 Arch Year Book.

THE TECHNOGRAPH

Published Quarterly by the Students of the College of Engineering—University of Illinois

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Prevention of Mine Fires and Explosions

Donald P. Buchanan, min. '25

Coal mine explosions may be divided into three classes,—gas, coal-dust and a combination of the two. They may be further classified as to their origin, whether naked light, mine fire, or electric arc.

Gas explosions, though by far the most common, are not the serious hazard that is represented by coal-dust. Due to their very frequency and their property for igniting coal-dust their elimination is, however, an important factor in mine safety.

The most common inflammable mine gas, methane, is contained in the coal seam and in the coal measures immediately above and below the coal. Its limits of explosibility are from 5.5 to 14.5 per cent. Sudden outbursts of methane occur rarely, large quantities not being given off except when a territory caves liberating the gas from the strata above and below the coal and probably from the non-obtainable pillars of coal in the territory due to pressure. In many regions, as in Illinois, such caves are erroneously known as "squeezes." True squeezes are rare and usually occur in old room-and-pillar workings, as differentiated from the modern panel room-and-pillar system. These usually give off small quantities of methane mixed with a greater percentage of nitrogen than normal air, the oxygen having been partially consumed by oxidation in the slowly squeezing territory.

Marsh gas or methane is the only inflammable gas liberated by the strata. It issues from the strata into the mine workings where it accumulates in quantities unless removed by a ventilating air current. The most gaseous seams are those that are overlaid with a compact rock, such as slate or shale, that is impervious to gas and not traversed by faults, which would allow the gas to escape. Gas is liberated most freely by a virgin seam and from a freshly exposed face of coal. Hence, new workings generate more gas than old workings because, in the old workings, the gas has mostly drained from the strata and escaped. Accumulations of any explosive gas in a working mine are due almost wholly to the short-circuiting of the ventilating current. The rapidity of diffusion of two gases is directly dependent upon their relative densities. Methane diffuses rapidly into the mine air, but since diffusion takes place only at the surface of contact, and is therefore limited, it is often liberated faster than it is taken away. Being lighter than air it tends to accumulate at the roof. Hence the necessity for an ample ventilating current in gaseous workings.

When such a body of gas has collected, due to short-circuiting of the air current because of a door being left open, an unusually bad fall of rock in an air-course, or some similar cause, its ignition is an easy matter. Explosions of this sort are known to have originated from naked lights, defective safety lamps, electric arcs from motors, pipes or cigarettes, and mines fires. Hundreds of special causes are claimed, as a fall of a roof in an Alberta mine striking sparks from the rails. This last and similar theories appear rather far-fetched although they are, in reality, perfectly possible.

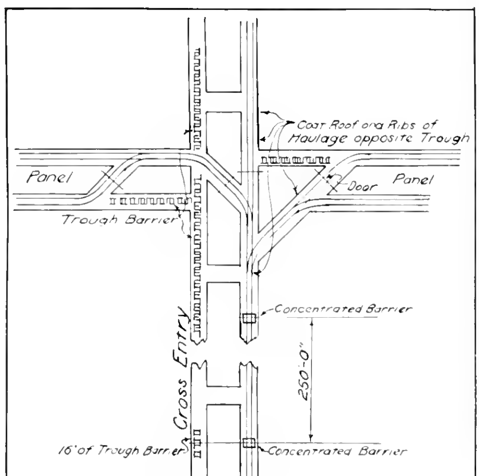
The conditions necessary to an explosion are simple: first, an inflammable gas mixed with such an amount of oxygen as to bring it within the explosive limits, and second, a rise in temperature sufficient to ignite the charge. The effect of an increased pressure on an inflammable gas is to increase its explosive limits. With an appreciation of the ease with which an explosion may be ignited and with the horror of such disasters as the Cherry mine fire in Illinois and the Stag Canyon explosion in the New Mexico, in which 259 and 263 men lost their lives, still fresh in our memory the importance of combating them becomes the paramount mining question of the day. To scientifically cope with this hazard it is necessary, however, that the action of an explosion be thoroughly understood.

A gas explosion is little more than a conflagration, in reality, due to the comparatively slow rate of combustion. The velocity is so slow that its destructive force is slight compared to a gas explosion propagated by coal dust. A quantity of 250,000 cubic feet of air per minute properly distributed is sufficient to render harmless the gas in the largest mine in Illinois. Such a quantity usually has 0.1 per cent to 0.2 per cent and rarely has more than 0.5 per cent of methane on the main return air current, but with this 0.5 per cent rate a quantity of 1,800,00 cubic feet of pure methane is generated during each 24 hours. At these figures the mines generating the greatest amount of gas have in the return air current a content of one part methane and 200 parts air. This gives a big factor of safety considering that the closest explosive mixture to this content is one part methane and 17 parts air. The danger, however, is not in the entire mine having an explosive mixture of gas but that one very small part of the mine may accumulate an explosive mixture due to an accidental or careless short circuiting of the air required for that small part of the mine. Another danger is due to the assistance the 0.5 per cent methane may give to the initiation and propagation of an explosion.

A gas explosion is confined to the territory containing the gas and the territory affected by the explosion is small when compared to an explosion propagated by coal-dust. The first generally affects the person lighting the gas, the second usually wrecks the entire mine killing most or all of the persons in the mine. The territory of the first is easily explored and the men affected soon taken out. The territory of the second is usually the entire wrecked mine requiring provisions to be made to get down one of the shafts, re-establishment of ventilation, hazardous exploration, fighting fires in the gas laden mine, and often the sealing of the whole or parts of the mine.

The action of a dust explosion is of two kinds, detonation and retonating. The detonation or shock wave is the original impulse of the explosion. It may travel at a velocity of 2,000 feet per second and with an accompanying pressure of 125 pounds per square inch. The retonation or return wave may exert a pressure of 100 pounds per square inch. The detonation wave is preceded by a pioneering wave which is a rush of air which brushes the fine film of coal dust from roof, ribs, and timbers. It is this cloud of fine dust in suspension that propagates the explosion from one part of the mine to another.

The danger of coal dust has long been appreciated, but the remedies employed until quite recently can be classed under two ineffectual and false heads: first, that of removing the dust, and second, that of rendering it inexplosive by the application of water. That the first is a waste of time has been conclusively proved by the Bureau in its experimental mine at Pittsburgh. It was shown here that it is impossible to clean a mine thoroughly enough to prevent a dust explosion. The gallery was cleaned with shovels, brooms, and a vacuum cleaner, and the timbers were thoroughly cleaned with camel's hair brushes, but when the detonating cannon was discharged the resulting coal dust explosion was terrific. The Pittsburgh Experiment Station further determined that 0.032 ounces of fine coal-dust per cubic of air or approximately one pound of dust per 100 cubic feet of air would propagate an explosion. Under working conditions where dust is constantly being made from blasting, machine undercutting, the grinding action of car wheels, and innumerable other sources, it is obviously impossible to keep the mine clean enough to prevent dust from propagating a gas explosion. A mine that is knee-deep in coal-dust is, perhaps no more dangerous than a mine that is as clean as it is possible to make one.



Location of Panel

The experimental mine tests of the Bureau showed that the anthracite dust will not propagate an explosion, that Illinois bituminous dust containing 12.82 per cent incombustible matter and no gas present did not propagate an explosion. The tests showed further that dust containing 58.17 per cent of incombustible matter with 1.1 per cent gas present and dust containing 66.73 per cent incombustible matter with 2.2 per cent gas present both propagated explosions. The dust along the floor of the haulage roads is higher in incombustible matter than any other dust in a mine and presents the least dust hazard, but an analysis of such a dust from a typical mine made by Bureau engineers in 1919 showed that it contained but 47.45 per cent incombustibles.

Profuse watering of haulage roads and trips of cars aids slightly in the prevention of explosions, but is of no benefit insofar as stopping an explosion is concerned. If it were possible or practical to keep a mine wet then watering would be beneficial, but this is impractical for the following reasons:

(1) Rashing or spalling of ribs.

(2) Falling of the roof.

(3) Swelling and heaving of a fireclay bottom.

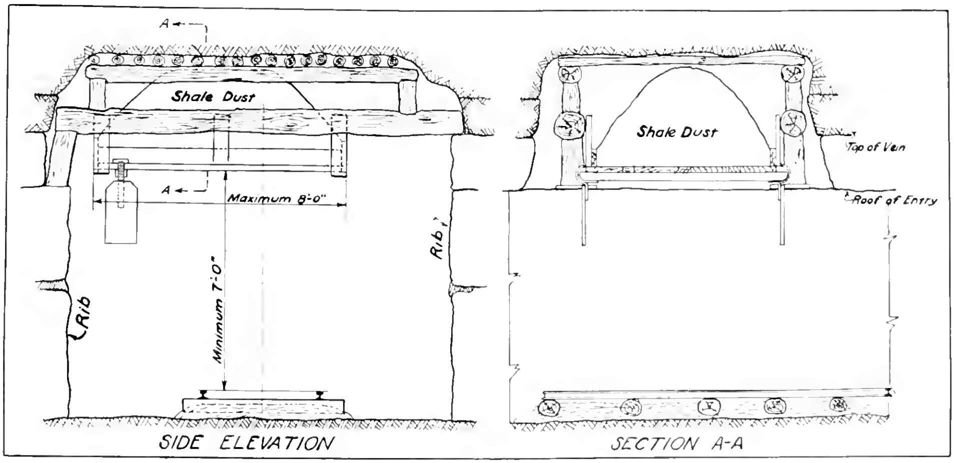
(4) Impossibility of an equal and efficient distribution of water.

Considering air passing through a mine during the winter months when the average outside conditions in Illinois are as follows:

Outside temperature......30 degrees F.
Outside relative humidity...63 per cent.
Barometric pressure..14.7 lbs. per. sq. in.
Inside temperature........70 degrees F.
Relative humidity of return air
100 per cent.

A quantity of 10,374 gallons of water is taken out of the mine per 100,000 cubic feet of air in excess of that taken in with the air. A mine passing 250,000 cubic feet of air per minute will take 37,346 gallons or 156 tons of water out per day in excess of that taken in. It would require the even distribution of this amount of water per day of 24 hours just to replace the amount of water of which the mine is robbed by the air current.

For years the mines of Great Britain and Europe have been protected against the propagation of explosions by th eplacing of a non-inflammable or inert rock dust in them. This has been effected by dusting the ribs and roof of haulageways and by placing concentrated barriers of stone dust in the air-courses and haulageways so that the pioneering wave of an explosion will blow it into suspension together with the coal dust. The action of this non-inflammable dust is to cool the flame of the explosion beneath the kindling of coal-dust, thereby limiting the explosion to the territory of its ignition. In recent years a few mines in this country have



SECTIONS SHOWING THE LOCATION OF DUST TROUGHS

been so protected with great success, and within the last two years the Bureau, which has been studying the subject for a long period, has broadcast information regarding this system with the result that its adoption is now becoming far more general than heretofor.

Various kinds of dust have been used successfully, the characteristics of a good dust for this purpose being first, that it shall be non-inflammable, second, from 150 to 200 mesh in size so as to float readily in the air, and third, that it shall not be particularly deliquescent. The usual rocks used are limestone, shale, and dry adobe clay.

The usual systems of protection are the concentrated barrier, troughs, platforms, and blowers for rock dusting the ribs. A concentrated barrier consists of a drop-bottomed box with a capacity of one-half ton or greater and equipped with a trigger discharge which is operated by the force of the pioneering wave. By placing one of these between each pair of panels on the main entries explosions are limited to the panels in which they originate. A battery of dust troughs balanced in notches so that the force of an explosion will overturn them is placed opposite each of these barriers in the air course and at the mouths of worked-out panels. These are cheaper than concentrated barriers and easier to erect, but the advantage of the barrier lies in the fact that it does not interfere with haulage.

The newest development in shale dust protection is the employment of portable blowers in coating the roof and ribs of both main and panel entries. This has proved to be a most effective and economical method of further limiting the explosion zone and reducing the hazard by making road dust less dangerous. In the early days of rock-dusting, shelves and platforms of dust were employed, but experience has shown that these compact piles of dust are not thrown into suspension by the blast of a small explosion and that little faith can be placed in them.

The reliability of shale-dust can be seen from a typical explosion in a protected mine. The Old Ben Coal Corporation mines have been so protected since 1917; many explosions have occurred during this time, and a typical one is described in the following extract from the safety engineer's report:

"The third explosion occurred on January the 14th, 1921, on the night shift of January 13th at mine No. —, West Frankfort. This mine and all other Old Ben naked light mines used enclosed lights exclusively from quitting time on the day-shift or when the shotfirers using naked lights come out of the mine until starting time the next morning, and smoking is prohibited. On this occasion 41 men were in the mine and 21 men including the night boss assistant were in the immediate vicinity of the explosion. A panel in this vicinity had recently caved and this was being carefully watched for the generation of gas it being inspected every one to three hours, but practically no gas had been found prior to the explosion, and no greater quantity of gas was found there after the explosion even though all brattices and doors had been blown out and ventilating currents sweeping within 300 feet of the edge of the fall. Nine of the twenty-one men working between two shale dust zones, four men were in by the innermost of these two zones and eight were just out of by the outermost. The men were scattered along a distance of about 700 feet of entry cleaning roads and gobbing dirt in old rooms. The cleaning of the roads caused consider- rock dust. the men working between the zones were taking a rest one lighted a match for a smoke which either lighted the dense cloud of coal-dust directly or ignited gas causing the explosion. Coal-dust immediately propagated the explosion, the flames severely burning the men who were between the two shale-dust zones, two of them dying after. The flame was extinguished in each direction by the first shale-dust zone encountered, and none of the men who were on the other side were either burned or injured. The force of the explosion was sufficient to blow out 25 wood stoppings and four doors. Shale-dust was in evidence everywhere. The men were all covered with the shale-dust and looked more like millers than miners. Those who were saved were very enthusiastic in their praise of the shale-dust saying that their lives were undoubtedly saved by it.

The men who were in the flame affected zone stated that the flame there was soon extinguished by the shale-dust brought there by the reaction of forces and that the very high temperature was soon lowered making breathing less difficult and the temperature bearable.

"The work of rescue was not difficult as compared to the usual work of rescue after an explosion since it was possible to travel direct into the entire explosion affected territory with very little bratticing, for the territory was not unbearably hot or gaseous and no fires had been started. The men who were in the other parts of the mine were very probably saved by the prompt action of the shale-dust for coal-dust had already entered into the explosion and in all probability would have propagated it throughout the mine had it not been for the intervention of the shale-dust. The electric safety lamps made it possible for all who were able to get out unassisted to get to fresh air at once and made the finding of the others relatively easy since their lights were not affected by the explosion."

Methods of explosion prevention may be summed up as follows:

(a) An adequate ventilating system.

(b) Regular inspection of the workings. A thorough inspection for the day shift is made in Illinois not more than four hours before starting time, and inspections of old works and working places are also made during the day shift.

(c) Enclosed lights. Electric cap lamps universally employed by every person in the mine with a consequent prohibition of smoking would go far towards preventing explosions as they nearly all originate from a naked flame.

(d) Treating the mine with non-inflammable rock dust.

Langley Memorial Aeronautical Laboratory

R. E. Peterson, m.e., '25

This article was awarded second prize in the Schaeffer Engineering Essay Contest

Before the World War, scientific knowledge of aerodynamics and airplane design was confined mostly to European centers of learning. At present, however, America is not dependent upon foreign knowledge; but, on the contrary, leads the world in active aeronautical research. Most of the credit for this achievement is due to the National Advisory Committee for aeronautics.

This committee consists of twelve members appointed by the President. The committee includes such eminent men as Orville Wright, Rear Admiral Moffett, Major Patrick, Dr. Stratton, Professor Durand, and others, all serving without compensation.

Most of the problems suggested by the committee are submitted for solution to the Langley Memorial Aeronautical Laboratory at Hampton, Va. The government maintains this laboratory by appropriations of Congress. The buildings occupy a square block at Langley Field, which is located near Hampton. The laboratory group consists of a large main building, two wind tunnel buildings, two dynamometer laboratories and a hangar. The main building, which is of brick and stone construction, contains the main offices, library, physics laboratory, instrument section, photographic department, machine shop, drafting room, and cafeteria.

There are about eighty men employed by the laboratory. Nearly all of the personnel are college graduates. There are men from Yale, Massachusetts Institute of Technology, Michigan, Illinois, California, Rensellaer, Minnesota, Purdue, Maine, Penn State and many other institutions of learning. These engineers are all young men who are very much interested in aeronautics.

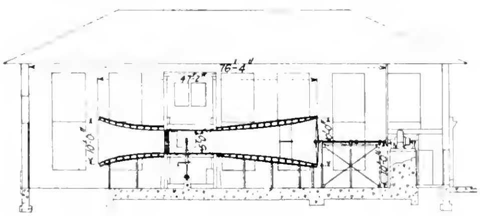


Fig. 1. Wind Tunnel

The organization of the laboratory consists of five general divisions: (1) wind tunnel, (2) power plants, (3) flight test, (4) technical service, (5) property and clerical.

The wind tunnel work invariably attracts the attention of visitors. A wind tunnel is a long chamber through which air is blown at a high velocity by means of a propellor, see Fig. 1, and in which the aerodynamic performance of various designs and members in flight is investigated.

In the central portion of the tunnel, a model of the member to be tested is placed. By means of delicate balances the various reactions to the wind stream are measured. By the principle of relative motion it makes no difference whether the member sails through the air at 100 miles per hour, as in an airplane; or whether it is stationary and a wind of 100 miles per hour velocity blows against it, as in the wind tunnel.

There are two wind tunnels at Langley Field, the atmospheric and the variable density tunnels. The atmospheric wind tunnel has perhaps the highest steady speed of any tunnel in existence. Useful wind velocities of 110 miles per hour have been attained. A general idea of the tunnel construction may be obtained from Fig. 1. The tunnel is of the venturi type, being five feet in diameter at the throat and ten feet at the ends. Cypress wood was used in the construction of the conical portions, which are highly polished on the inside.

Figure 2 shows the experimental chamber at the throat of the tunnel. A model airplane is shown in position for a test. The opening shown in front of the model is closed by a cover during tests. The cover has windows in it for observation and photographic purposes.

Below the air passage are the balances for measuring forces acting on the model when subject to wind velocities. At the right are various controlling and recording devices. The honeycomb shown in the air passage straightens out the air current before it strikes the model. The propellor is driven by a 200 h. p. direct current motor with a speed range of 1 to 1,000 r. p. m.

The models tested are constructed accurately to scale by a group of men who are very skilled in precision work. A 1 : 24 scale model of a Curtiss "Jenny" has been used for numerous tests in co-operation with the flight test division.

For a long time investigators obtained results which varied widely from flight tests due to the fact that the "slip stream" or current behind the propellor was missing in model tests. This has been obviated with fair success by the use of a propellor driven by a belt enclosed in a stream line casing.

The variable density wind tunnel is the only one of its kind in the world. The development of this tunnel is due to Dr. Max Munk, noted mathematical

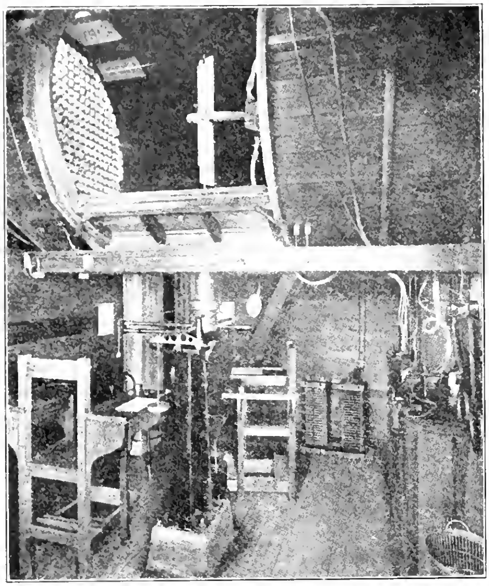


Fig. 2. Experimental Chamber

expert on aeronautics. Compressed air is used instead of air at atmospheric pressure. The theory involved is that an increase of pressure is equivalent to an increase of size of the specimen tested. Thus a model 10 inches long in an air stream having a pressure of five atmospheres is equivalent to a model 50 inches long in atmospheric pressure. The tunnel is 15 feet in diameter and 36 feet long. Inasmuch as pressures of 300 pounds per square inch are used the walls are made of steel plate two and one eighth inches thick. This massive tank was made at the Newport News shipyard and transported to Langley Field on a special barge. The air is simply recirculated at constant presure, approximately, by the propellor. The balances inside of the tunnel are operated by electric motors which move the weights across the scale beams. The operator merely looks through a small window and manipulates a switch board.

The power plant work has been chiefly an investigation of oil injection. Engineers feel that the possibilities are quite promising for a satisfactory aircraft oil engine. A single cylinder "universal" oil engine has been experimented with. The compression of this engine may be varied while the engine is running by means of a telescoping head. The timing, inlet and exhaust valve, lifts, and injection characteristics may also be varied during operation. Thus the correct engine design for highest efficiency may be determined for any given set of conditions.

Fuel injection consists of forming a spray by forcing oil through a nozzle under high pressure. Very little information was available concerning the nature of the spray and the effect of the shape of nozzle; so an investigation was undertaken. A photographic apparatus was built by which pictures may be taken at the rate of 5,000 per second. The illumination is obtained by means of electric sparks. Thus a gradual development of a spray may be studied by means of photographs. The effect of the shape and size of nozzle, the temperature and viscosity of fuel, and the temperature and pressure of the air may also be investigated.

The laboratory is unusually well equipped for instrument work and a number of fine instruments have been produced. A recording manometer, which is used in flight tests, gives a continuous photographic record of the pressures at 80 different points on the surface of the aircraft. By means of tests with this instrument many failures have been accounted for, pressures at certain points being 300 per cent greater than computed values. Designs have thus been altered to make aircraft safer. Results of such a nature are obviously of incalculable value.

Pressure distribution studies have also been made on airships of the dirigible type. The labo-

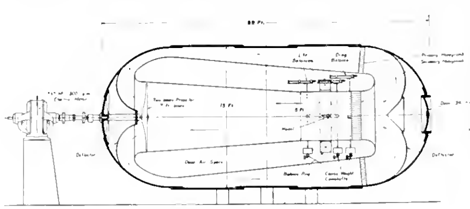


Fig. 3. Variable Density Tunnel

ratory has a number of models upon which curved surfaces representing pressures have been constructed. The pressure distribution is quite different than would be ordinarily expected. The results of these tests have been incorporated in the design of the Z-R 1, under construction at Lakehurst, N. J. It is hoped that a disaster similar to that of the Z-R 2 which collapsed in England, due probably to inadequate design information, may be avoided.

(Continued on Page 216)

Electrification of Illinois Central Terminal

J. S. Thorpe
Distribution Engineer

Editor's Note: *The first part of this article describing the power supply system to be used on this project appeared in the March issue of the magazine. Part II, dealing with catenary structures, concludes the article.*

Part II.

The layout and design of catenary supporting structures must provide for their extension for future electrified tracks, although initially they must be applied economically for only suburban tracks. The effect is that structures must be at present designed with the view of serving the entire right of way along a large portion of the electrified route. This right of way is a minimum of 200 feet wide, with portions 250 and 300 feet wide, exclusive of electrified yards. Bridges having up to six columns and up to 200 feet length without expansion joints, will be used. Individual bents will ordinarly span up to four or five tracks, with lengths of 60 to 70 feet, but longer bents will be used frequently, with a single span in a few instances for the entire right of way width of 200 feet.

Complete rearrangement of tracks within the terminal district is being made preliminary to electrification, so as to provide for the ultimate maximum utilization of the right of way without extensive changes after electrification. Along a considerable portion of the right of way this has the effect of practically reconstructing the railroad. Since the normal track spacing of 13 feet does not allow room for columns of catenary structures, a track spacing of 17 feet is provided for columns at appropriate intervals where possible.

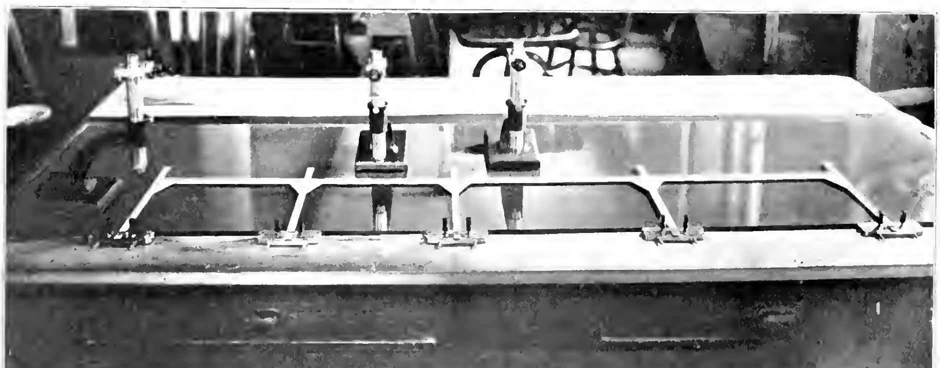
North of Kensington, on the main line, built up columns and trusses of latticed-angle construction, will be used. On this part of the line will be the greatest number of electrified tracks, with practically all structures having more than two columns, and with the longest spans. In addition to the heavy catenary loading, certain of these structures will carry signals for various tracks.

South of Kensington and on the Blue Island and South Chicago branches, structures will be made up of Bethelem "H" sections for columns and cross-beams. This portion of the main line will have only two electrified tracks initially and single columns with brackets will be used. Between Kensington and Harvey, about 6 miles, additional columns and cross-beams will be joined to the initial columns, for additional tracks electrified. On the branch lines, having only one or two tracks, single columns and brackets or two-track portal structures will be used.

The structure of rolled sections will not be used for bridges with cross-members continuous for more than one bent. Occasional three-column structures required for combined signal and catenary used along the main line south of Kensington will be of the built up type.

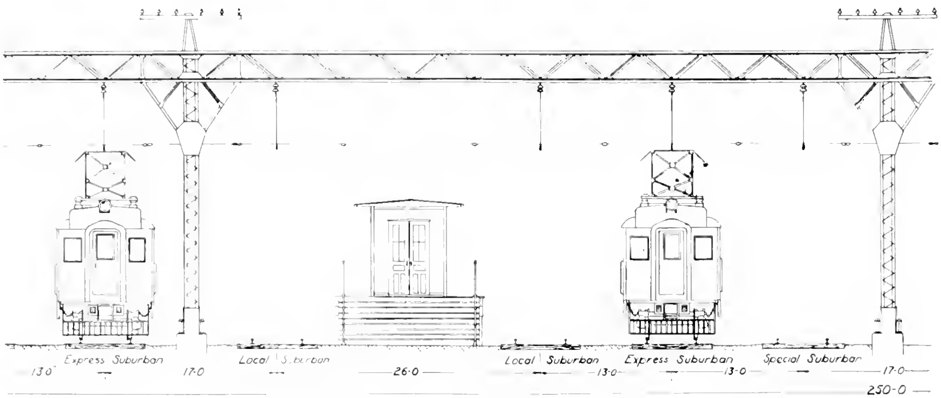
Use of Models in Structure Design

In addition to the normal loads of wires and



Use of Beggs Apparatus with Model Catenary Structure cables, and the ice and wind loads referred to, structures are designed to carry additional loads of 1,000 pounds along the track due to a broken catenary messenger, this load to be limited by the sliping of the cable at heavier loads. In view of the heavy values of loads assumed, and the infrequency of their probable occurrence, a maximum calculated stress of 20,000 pounds per square inch is allowed in the structural steel.

Certain standard sections for trusses and columns have been adopted for all built up bridges. The sections adopted for the columns consist in practically all cases of four 4″ x 4″ angles laced, with a depth across of 15, 16 or 18 inches back to back, while sections for the trusses are four 3½″ x 3½″ angles, legs out and laced inside, with depths of 3, 4, 5, and 6 feet over all. Using these sections, a careful preliminary design has been made for each type of bridge to be built, differences in loadings being met by the use of angles of different thicknesses.



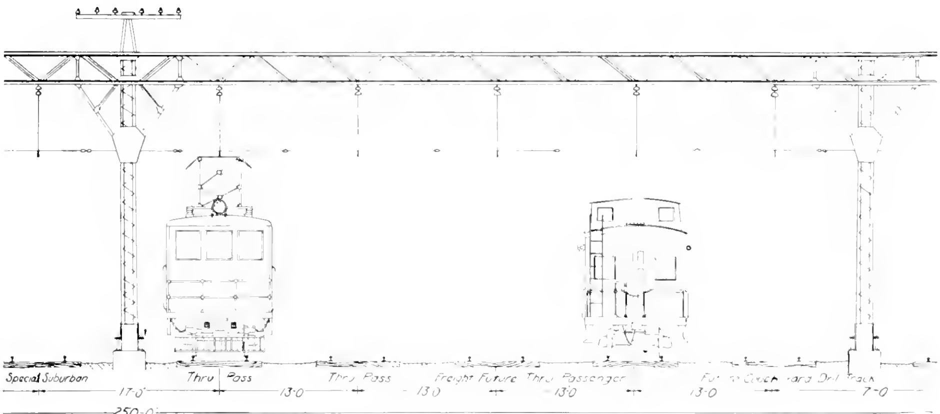
TYPICAL SECTION OF CATENARY STRUCTURE

The stresses in bents of the types used for these structures are statically indeterminate, and their exact calculations for structures of more than two columns is impractical on account of the time and labor involved. A mechanical solution of statically indeterminate structures recently developed by Professor G. E. Beggs, of Princeton, and presented in the Proceedings of the American Concrete Institute for February, 1922, seemed admirably suited to this problem, so a set of Begg's apparatus, consisting of six deformeter gauges and three microscopes, was purchased. In general the mechanical solution of a bent consists in obtaining the relation of deflections at various points on a cardboard model of the bent, to a known deflection made at the base of each column in turn. By Maxwell's Theorem of Reciprocal Deflections, this relation is also that of reaction to load, so if the deflection ratios are plotted in a smooth curve drawn for each column the result is a set of influence lines for the reactions at the bases of the columns.

The first step, then, in the mechanical solution is the cutting of a small scale model of the bridge in question from a thin sheet of high grade card board. In order that the members of the model may have the same relative stiffness as in the steel structure which it represents, the width of the various members are cut to vary as the cube root of the moment of inertia of the corresponding members of the structures. Only the reactions due to the vertical loads, curve pull, and cross-track wind are determined by means of the model, since the effect of a long track wind can be taken care of by a simple analysis. The scale of the model is such that the total length of those five and six spans does not exceed 72 inches.

When the model is finished it is laid flat on a sheet of glass and "floated" on small steel balls. A deformeter guage is screwed to the table top at the foot of each column and the movable half of each gauge is fastened to its column by means of a clamp or a small pin depending upon whether the column is to be considered as fixed or pin ended. These deformeter guages are merely mechanical devices for making a given small horizontal or vertical movement of rotation, by inserting very accurately machined plugs of several sizes between bearings in the fixed and movable parts of the guages. The microscopes referred to above are provided with a graduated field and a movable cross hair for measuring accurately the small deflection of the model.

As an example of practice let it be required to obtain the influence lines for the horizontal reaction at the base of the first column of a three column bent. The base of the first column would be moved horizontally through a known distance by means of the guage, all other column bases remain in their normal positions. The vertical displacement of the two truss span and the horizontal displacement of the three columns would be measured at a number of points along the center lines of these members. When these readings are divided by the known movement of the base of the column, and the results plotted, the required influence line can be drawn as a smooth curve through those points. Confusion is avoided by plotting the curves for the columns separately from those of the trusses.



Typical Section of Catenary Structure

When a complete set of influence lines for reaction is prepared, the computation of the maximum moments and shears in the structure due to any system of loads becomes simply a matter of stastics. If the sections used in the original design are shown to be stressed, it is, of course, necessary to change them by using thicker angles. Obviously any large change of section destroys the original ratios of stiffness of members and invalidates all influence lines based on the model, but such large changes are not common and an attempt is always made to maintain approximately the same relative moments of inertia in making a revision.

The results obtained with the Beggs apparatus have been repeatedly checked by statics and found to be correct in that respect.

Foundations for Catenary Structures

While vertical loads on foundations will be comparatively small, high transverse values result from the assumed wind loading and curve pull. For single columns with bracket for the two tracks, the maximum load will be across track, and for bridge structures it will, in general, be along track.

For general application, a special poured foundation of concrete pile form has been developed. See Figure No. 5. The foundation is poured into a steel shell driven by an ordinary pile driver. Its diameter is 24 inches, considered as the practicable limit for driving. Its depth will vary from about 15 to 22 feet below the top of rail, to provide for the varying conditions of load. It is reinforced by 12" 25 lb. to 35 lb. channels, arranged in pairs, for practically its entire length. Bearing for the column is provided by a rectangular cap three feet high and three feet or more along each side. The four anchor bolts for the column attach and transmit their load directly to the reinforcing by an adapter made of angle or channel shapes. The design provides steel to take all tension. The shell is driven to the desired depth by means of a mandrel with driving head and point projecting beyond the bottom of the shell. A five-ton hammer is used for driving. The mandrel is lifted out, reinforcing inserted and concrete poured. A concrete mixer mounted on a flat car, in a work train with cars for materials, expedites the concrete work. The shell is pulled by means of a special derrick immediately after pouring, and the concrete thus allowed to completely fill the hole. Perfect side bearing is assured. The concrete may be allowed to partially set before attachment of anchor bolts and pouring of the cap.

Tracks have been raised at a number of places for grade seperation, sand having been used for elevation. At many other locations, the original ground is naturally sandy. Driving of the shell is therefore generally easy. Since rows of foundations are beside the same track for a considerable distance, driving and pouring operations on adjacent foundations can be done simultaneously.

(Continued on Page 217)

Development of Copper Wire Annealing

Alfred J. Shute, m.e., '26

This article was awarded first prize in the Schaefer Engineering Essay Contest.

It is not commonly known that copper wire as used in electrical apparatus must be annealed before being put on the market. Yet it is the process which brings out the familiar physical characteristics of the wire. The layman knows that some steels are softer and more ductile than others, and that in most cases such as with cold chisels, etc., this degree of hardness is due to the degree of anneal. To him copper wire suggests merely a soft easily bent or stretched metal. He would undoubtedly be very surprised at the hardness and stiffness of a piece of unannealed copper wire. Yet it is the process which is of utmost importance in the production of copper wire, since the properties by which it passes inspection or is rejected are here brought out and controlled.

Practically all copper wire which is produced for commercial needs is fed into wire drawing machines as one quarter inch rod, and is gradually drawn down through dies, step by step, to the required finished size. This drawing process produces great stretching and exerts a tremendous pressure on the wire as it is pulled through the dies. Internal stresses are thus set up and as a result, a hard wire is produced which does not withstand any considerable stretching. The annealing of this hard wire allows the internal stresses to become neutralized and permits a growth of the crystalline structure.

The fundamental principle involved in copper wire annealing is a simple one. The hard wire is merely heated to 550 or 600 degrees Fahrenheit, is held at that temperature for five minutes and then cooled. This is seemingly a very simple process; and it would be if only the requirement were soft wire. But ordinary heating and cooling in open furnaces produces highly oxidized wire instead of the bright and shiny wire which is put into the furnace. From an open furnace as mentioned, the annealed wire would be totally covered with a black or gray oxide, but the wire would be soft and probably passable as for its other physical properties. The requirement thus arises for a furnace wherein the bright wire may be heated in the absence of air. The muffle type of furnace fulfills this requirement and is the type in which all copper wire is annealed, and with which I had the opportunity for experiment while being an assistant to the engineer in charge of annealing processes at a large wire mill.

It was the engineer's job to produce bright annealed wire. One muffle furnace of the commercial type had been installed, but when put to the finer task of copper wire annealing, it did not produce results which were believed to be the best obtainable. With the order to produce bright annealed wire, the engineer started out.

The black and gray color on the surface of the annealed wire showed a combination of the copper with oxygen. The furnace used was so designed with a water seal, that no atmospheric oxygen could enter the muffle or chamber in which the wire was heated. This was accomplished, inside of the furnace, a large bell shaped heating chamber which is called a muffle, and which is open only at the bottom.. The bottom is closed only by a water seal as shown in Fig. 1. In order to put a charge of wire into the muffle, it is placed on the elevator platform outside of the furnace and then lowered into the water below the bottom of the muffle; the furnace is then moved as a unit over the submerged load which is then raised out of the water and directly into the heated muffle. The furnace is oil fired and is kept within close temperature limits, to 550 degrees Fahrenheit in the muffle and 950 degrees in the combustion chamber. Thermocouples, with automatic registering potentiometers, chart the muffle and combustion chamber temperatures continuously. After 25 minutes of heating, the load is slowly lowered and the furnace is moved over clear of the submerged annealed load and to a point over the new load which is ready to be raised into the muffle for heating. In this way the furnace does almost continuous annealing; the manual labor required in loading and unloading the platform being done while a charge is being heated in the muffle. This type of furnace I have described merely as an introduction to the idea of heating in muffle furnaces, and is not the furnace upon which our main experiments ran.

It is easily seen that wire which has been annealed in this commercial type of muffle furnace is discharged well wet by the water from the water seal. This wet wire oxidizes in a few days and therefore cannot be stored; but the moisture was found to be very beneficial for wire which was to be paper covered. It was for the immediate paper covered wire needs and for the annealing of wire which was to be drawn to smaller sizes that this furnace was kept in operation.

The requirements for dry, bright annealed wire brought about the development of a steam sealed, muffle type furnace as shown in Fig. 2. This type of furnace excludes air from the muffle by keeping it filled with steam to the extent that steam issues from the discharge end of the furnace. The furnace consists of the charging end which is attached to one end of a ten foot long by two feet square cast iron pipe or muffle, the oil fired combustion chamber which surrounds the muffle, and the discharge tube. Spools of hard wire are fed into the charging end where hydraulic rams push them slowly through which surrounds the muffle, and the discharge tube, where the hot wire is cooled in an unoxidizing atmosphere of steam. The cooling tube is of such length that the wire is discharged at the steam temperature of 212 degrees Fahrenheit. This design of furnace was brought about after experiments on a quarter size model had confirmed results.

For the first experimental charges which were run through this furnace the cooling was turned on full, the combustion chamber was fired to 950 degrees Fahrenheit and the steam turned on full at the muffle. In order to determine the time required for the spools to reach the required temperature of 550 degrees a fully wound spool was drilled through the body of the wire and a thermocouple inserted, the long leads allowing readings to be taken while the spool was in the furnace. As this test spool was slowly pushed through the furnace at a measured rate of speed, its temperature rise was periodically noted and corresponding graphs ploted for record. From a study of these graphs, a correct rate of speed for operating the furnace was determined.

The first load of spools which passed through the furnace with the adjustments mentioned were closely examined for oxidation, water stains, thorough anneal, and the percentage of elongation of the wire before breaking. Sample spools of wire were unwound to the core, each layer being examined for the defects mentioned. These first spools showed bad defects due to muffle leaks, and water marks from steam condensation. Repairing of all probable sources of air leaks, and reducing the amount of cooling water fed to the tubes brought out a fair size wire but not what was expected. It was at this stage of the job that thoughtfull experiment was required to bring out bright annealed wire, as slight variations in condensations at any point on the annealing process produced the slight defects upon which the inspection department based their grounds for rejection. The removal of the initial glaring defects in the wire proved simple enough, as for example the heavy oxidation first met with. This immediately suggested air leaks, which when found and repaired, removed the heavy oxidation mentioned. The slight defects remaining, such as fine pin spots of discoloration, low elongation, or the tendency of the layers of wire to stick together, required considerable watchfulness and experiment to find their causes and remedies. It was here that the temperature of the muffle, temperature of the wire, time required in heating up, amount of steam in the muffle, amount of soak in

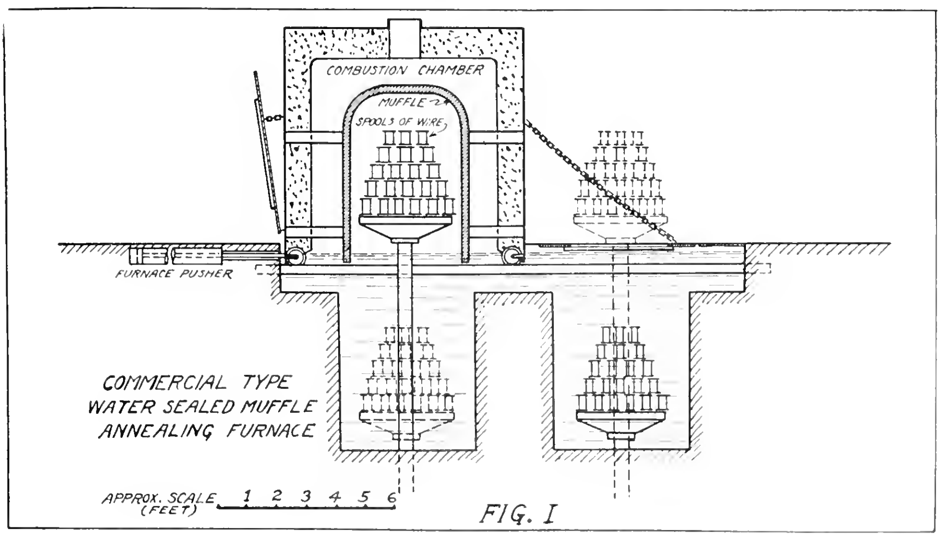


FIG. I

the charging end, chemical activity of the water in the charging end, rate of rise of elevators, and the discharge temperature of the wire, had to be carefully studied to note the particular effect that each had upon that wire.

The following paragraphs will show to what extent and manner our experiments ran in getting corrective data for the furnace so as to eliminate such defects as speckled oxide, discoloration, sticki ness of wire on the spools, low elongation, and

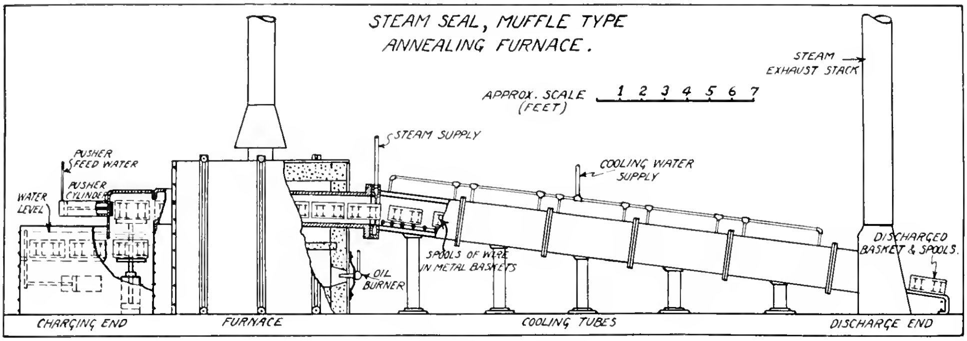


FIG. II

oxide forming in oddly patched or otherwise perfect spools of wire.

At the charging end of the furnace the spools are lowered by hand into a basket which is submerged in the muffle sealing water. A hydraulic pusher now pushes the basket onto the elevator which lifts it out of the water and into the muffle. Experiments traced the spots of oxide on the wire to this point of the furnace operation. It was found that fifteen minutes of soaking time was required here for the spools before elevating them into the muffle. This was for the purpose of removing small bubbles of air from between the layers on the spool, which if not removed, left spots of oxide on the finished wire.

Fast operation of the elevator showed a rapid displacement of water at the water seal of the muffle. Test showed that bubbles of air were in this way entering the muffle. A maximum elevator speed was therefore set for the operator.

The combustion chamber and muffle come next in the series of operations in the furnace. These parts comprise the main body of the furnace and are not easily altered. In these parts, however, possible corrections in design were watched for and recorded for use on later designs. The temperatures maintained in the combustion chamber and muffle were of vital importance. An extremely high temperature might be obtained, permitting rapid heating

heating of the wire might be used. Studies of our data brought out facts which indicated the correct temperature to use. The length of the cooling tube and the rate of cooling in the tube entered in the data which determined these temperatures. These temperatures were decided upon, were then set for the operator and, thereafter, measured and checked automatically throughout the day by a recording potentiometer and a thermocouple.

Probably the greatest problems came at the cool-

of the wire, or a lower temperature with slower ing tube. It had a total length of twenty-eight feet, and an addition of sixteen feet was contemplated. In this length of travel of the wire it had to cool from 550 degrees to 212 degrees Fahrenheit; this loss in heat being taken up by the steam which filled the muffle and tube. Contrary to ordinary practice, steam proved to be a success, but it offered difficulties due to its condensing on the wire and therefore leaving water stains. Various experiments as to the correct amount of steam to use were tried to remove this defect. Too much steam discharged the wire at too high a temperature causing oxidation after the wire left the furnace. Too little caused the water stains mentioned, and allowed air to enter the tube, causing oxidized wire. Graphs were plotted, showing the air content of the tube throughout its full length, for various amounts of steam fed in. These gave a basis for the determination of a correct steam supply.

However, obtaining the data for the correct operation of the furnace for the standard run of wire did not complete the engineer's task. It was found that running different sizes of spools of wire to be annealed, required different adjustments and speeds of running. These were determined by calculation from previous adjustments and by further experiment. A chart was then made which give the fur-

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A Modern Water Softening and Iron Removal Plant for Springfield, Illinois

L. G. Straub, M. S., '21
Burns & McDonnell Engineering Company

Unique circumstances, under which the water softening and iron removal plant for the city of Springfield, Illinois, was designed, have been cause for the development of many innovations in water-works engineering. When completed the plant will have a normal capacity of twelve million gallons per twenty-four hour day.

The public water supply was originally installed with its source on the Sangamon River at a point about two miles north of the city. However, the raw river water was very turbid and generally unsatisfactory for domestic use. Fire protection was probably the primary purpose of the supply at this time and quantity rather than quality was the deciding factor in the layout.

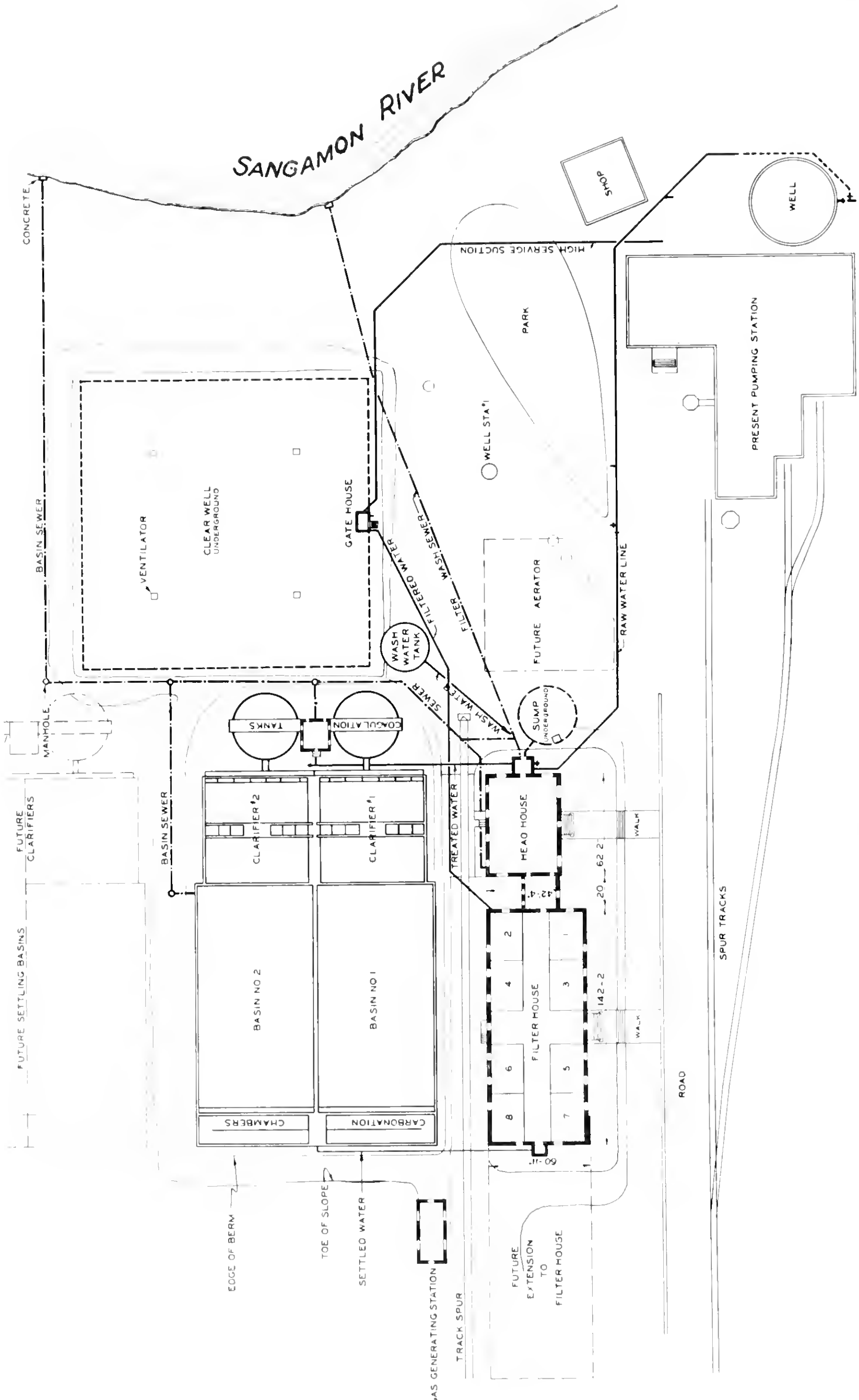
As the city grew, the desire for better water caused improvements and changes to be made from time to time. At present the chief source of supply is from shallow wells located in a water bearing sand stratum on the banks of the Sangamon River, neighboring the early river intake. In addition to the well supply, water is obtained from two infiltration galleries having a combined length of about 1,753 feet.

Discharge lines from the wells and galleries are connected to a large brick lined well now serving as a storage reservoir. The well is fifty feet in diameter and about fifty feet deep, and has a normal storage capacity of about one-fourth million gallons. A few hundred feet below the receiving well a low concrete dam is built across the river. The dam was installed with the object of retarding the flow of the ground water toward the river, thus making available a greater yield from the wells and infiltration galleries and also providing river water for boiler purposes and possibly also for city use in case of extreme consumption.

Water from the wells and infiltration galleries is, in general, considered of safe sanitary quality though that from the galleries probably varies considerably with large fluctuations of the river stages. During high stages some river water may enter the gallery with inadequate purification. The river receives not only surface drainage from small communities and farms but the sewage and drainage from Decatur, Taylorville, and the southeast portion of Springfield. Hence the river water is dangerously polluted although contamination will be greatly reduced when proposed sewage improvements are carried out.

Characteristics of the well water at Springfield are typical of shallow ground water supplies of Illinois. It has a hardness of about three hundred parts per million. Most of this hardness is easily removed, about sixty per cent being attributed to calcium bicarbonate, twenty-five per cent to magnesium bicarbonate and fifteen per cent to magnesium sulfate. The water from the wells and galleries also contains an average of something over two parts per million of iron.

Architect's Drawing of New Waterworks



Plan Showing General Layout of Plant

The ill effects of hard water have been long recognized in both industrial and domestic use. In steam plants trouble is experienced by the formation of boiler-scale. Soap forms insoluable precipitates in hard water, necessitating the use of larger quantities before a lather can be produced. Sugar-making, dyeing, laundering, and the like all show disadvantages with the use of hard water.

The iron content, though apparently small, has been the source of much annoyance and large expense to the consumer as well as to the water department. When the water comes in contact with air, the dissolved iron which is in the form of ferrous salts, is oxidized and settles out as a reddish-brown deposit. Mains, service, connections, and meters have continually been clogged and required cleaning or replacement. These waters have likewise been detrimental in laundry use, as rust spots are produced upon clothes by the oxidation of the ferrous salts. When the rate of consumption was large the deposits of iron oxide were stirred up, giving the water a turbid appearance, uninviting for drinking purposes.

Though the source of supply from the wells and galleries yields sufficient water for present needs of the city, it is probable that some time in the future the Sangamon river will need to be relied upon to meet increased demands. Hence the new treatment plant has been designed with the idea of removing both iron and hardness from the underground water and the turbidity and hardness from the river water. Since the permanent hardness or that due to sulfate is small no attempt will be made to remove it from the water. By lime treatment, it will be possible to remove practically all of the temporary hardness due to calcium bicarbonate and some of that due to magnesium bicarbonate. Alum will be added to aid in coagulation.

Water will be pumped by vertical centrifugal pumps from the old receiving well into the treatment plant through the dosing well where the lime and alum solutions are to be added. From the dosing well, the water will flow by gravity through the entire plant. It will be first conducted to the coagulation tanks where, by mechanical agitation consisting of paddles revolving in the tanks about a central vertical shaft at the rate of one-half revolution per minute, it will be thoroughly mixed with the lime and alum solutions.

From the coagulation tanks the water will flow to the clarifiers where most of the sediment will be deposited. These basins are each sixty-three feet square and fourteen feet and three inches deep near the walls. The bottom will be formed to the shape of an inverted cone having a slope of one to twelve toward the center. Sluge will be raked to the center by means of revolving mechanism driven by a vertical shaft. Power will be transmitted to the shaft by an electric motor supported above the water on concrete arches spanning the basins. Sludge which is raked to the center of the clarifiers will be removed by two Dorrco diaphram pumps which are arranged to discharge into the sewer or return sludge to coagulation tanks where unspent lime may be used.

After passing through the clarifier, which is to provide a one hour and forty minute retention period during normal flow, the water will flow over skimming weirs into two settling basins, each of which is 70 feet by 137 feet in plan and is 15 feet deep. The water will be retained three hours and fifty minutes in these basins which will allow about five per cent of the sedimentation to occur, giving a total sedimentation of about ninety-five per cent. About ninety per cent of the sludge will be removed in the clarifiers.

The water next will flow over skimming weirs into carbonation chambers where free alkali is removed and the small amount of calcium carbonate remaining in suspension is redissolved by adding carbon dioxide obtained from coke ovens. This recarbonizing eliminates incrustation in pipes of the distribution system due to traces of alkalinity which would otherwise remain, and also renders the water more palatable.

A forty-two inch pipe will conduct the recarbonized water to a central distributing flume located under the operating floor in the filter house. Four rapid sand filter units on each side of the distributing flume will be enclosed in the building. Each filter unit, when operating at a normal rate of two gallons per square foot per minute, will have a capacity of one and one-half million gallons per twenty-four hour day, making a total filter capacity of twelve million gallons per day. Water will enter the top of the filter and pass through thirty inches of sand and eighteen inches of graded gravel. Under-drains consisting of three inch perforated cast iron pipes will be connected to a central concrete flume which will conduct the filtered water to the pipe gallery, where it will pass through rate of flow controllers of the Venturi type.

A large concrete flume under the pipe gallery floor will collect the discharge from the controllers. The filtered water will flow from this flume into the clear well through a 42- inch cast iron pipe. Chlorine will be added to the water at a point on this pipe line. Pumps will take suction from a sump in the clear well for the city supply.

The head house is designed with special provisions to aid in handling the large quantities of

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The Physical Significance of Hardness

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To find out exactly what hardness is and to state its measure, in the fundamental units, is a work of science which no one has thus far attempted. The absence of any theory of what constitutes hardness is significant of the complexity of the characteristic of materials which is denoted by the term. The hardness of ivory is different from the hardness of lead, and this again is different from that of rubber, yet any definition of hardness which is to be as scientifically correct as temperature, density, or elasticity, for example, must be applicable equally to all substances.

The concept of hardness originates from a sense of resistance offered by material to the action of an approximately static force. As to its character, there is a diversity of opinion; the engineer believes it fundamentally important, while the physicist does not recognize it as one of the more essential properties of matter. There seem to be two general classes of hardness; superficial hardness, otherwise referred to as resistance to abrasion; and penetration hardness, otherwise referred to as deformation hardness. Both of these are spoken of as resistance to penetration or deformation of shape. A definition of hardness to cover both kinds might be stated as follows: Hardness is the cohesive resistance of the molecular aggregate structure of a material to any deformation of form. For the engineer this definition is probably worthless, because he deals not with limited structures uniformly loaded, nor with large aggregates in which there are highly localized strains, but rather with the combination of the two. Mechanical limitation such as dimension, manner of application of the stress, together with its magnitude and duration are factors of an indefinite character. The result of this indefiniteness has given us many definitions for hardness, depending upon the personal aims of each individual. Among these, may be mentioned hardness, as determined by scratch, wear, rebound, impact, crushing, bending, penetration, and deformation. Let us take up each of these in the order named.

Scratch Hardness

Scratch hardness is probably the oldest, and may be defined as the property or quality whereby one material abrades another, the scratched material being the less hard. Testing materials with a file has been used for years by machinists and heat treators. The minerologist uses the Moh scale, diamond 10, sapphire 9, gypsum 2, talc 1; the high numbers being harder than the lower numbers. Referred to this basis, the engineer uses a file test giving a hardness of 7, 6, or 5 to such materials as are scratched by a file of a certain type. Copper has a hardness of three and wrought iron four and a half by this method. But can a scratch give a true value of hardness? It is questionable, for it depends:

1. Upon the operator's personal equation.
2. Pressure at which the tool is applied.
3. Type and character of the tool.
4. Angle at which the tool is ground and the angle at which it is applied to the work.
5. Speed of application.
6. The uniformity and character of material.

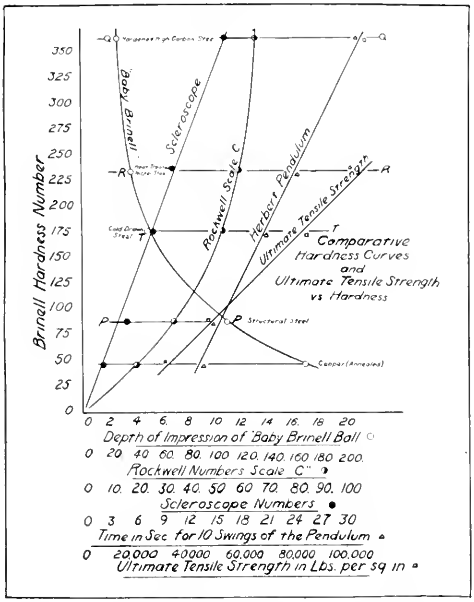
Further, "diamond cuts diamond," "glass cuts glass," depending upon the molecular arrangement of the material and the chemical analysis of the specimens. In itself a scratch is not a proper indication of hardness. It may be considered a measure of a surface property only, the skin hardness of a material.

Wear

Hardness is also defined as the resistance to wear as determined by the amount of material removed in thousandths of mm.; the degree of hardness is thus fixed if worn off under a fixed load in proportionate times. May one conclude from a scratch test that resistance to wear of a piece of steel shafting is predetermined? Hardly, because after the first few thousand revolutions of the shaft its surface is no longer in the original state, it is polished and though probably not measurable by any of our present methods, is harder than before, because of finer grain of structure. Ductility is probably a better measure of the resistance to wear than hardness, for some materials.

Rebound and Impact

In a ball bearing industry, the height to which the specimens rebound, when dropped upon a fixed plate properly hardened, has been taken as a measure of hardness. This is not truly a hardness test, but rather an indication of the resilience of the material. It measures the energy stored in both the material being tested and that upon which rebound takes place. Almost any impact hardness test is either of the resilient or semi-resilient type. In a hardness test, in the usual sense of the term a permanent deformation is produced. Impact is usually accompanied by a rebound which depends upon the rate at which the compression wave travels into the specimen and the impacting medium. Thus, rebound is a function of the duration of impact. The scleroscope measures the height of rebound of a standard weight when allowed to fall a given height upon the article to be tested. Comparison readings can only be made with the sclerscope when testing like articles under like conditions.



Some of the conditions that effect its readings are: size and thickness of piece to be tested; flatness, condition of surface, such as rough, ground or polished. The fact that rubber, glass and hard steel may give the same reading again emphasizes the fact that rebound hardness should be comparative readings of like materials tested under like conditions.

Crushing and Bending

Still another test makes use of the crushing of specimens. In this case, the fracture is examined microscopically and the hardness judged therefrom. The degree of packing and smoothness of fractured surface determine the hardness in this case.

For wires and small sectional specimens, the resistance offered to bending is often taken as a measure of hardness. In such cases, it is customary to determine the number of reversals, to which a given specimen may be subjected without rupture, by bending through definite angles. The lower the number, the harder the material. In any crushing or bending test ,the resulting decision must be dependent upon the prehardening by the working of the materials while testing. But such tests have a significance from which conclusions as to the preliminary hardness can be drawn.

In connection with crushing and bending tests are correlated other properties of materials especially, brittleness, ductility, plasticity, and tenacity. These will not be further discussed here for lack of space.

Penetration

Resistance offered by materials to penetration is more generally said to be the definition of hardness. In measurements of the type which require the surface to be penetrated, it is necessary that the elastic limit of the material be exceeded. Once the proportional limit has been reached, further deformation of material takes place and gives in reality the deformation hardness; this type of hardness is usually measured by any of the indentation devices such as the Brinell, Rockwell and the Herbert pendulum. In practice these hardnesses are all dependent upon the deformed state; that is, the material ahead of a penetration device is packed more and more once the proportional limit is exceeded and becomes harder to the point of rupture.

It is found impossible to correlate penetration hardness with the physical properties of some materials such as manganese steel, certain bronzes and duralumin, when rolled, hammered, worked or hardened. Can a penetration test lead to a true hardness? It would appear likely ,if deformation were carried out to the yield point so rapidly that the resistant force at this point would be a true measure of cohesive resistance. But one cannot uniformly load a portion of the material at a point just below the rupture, neither can the true deformation at this point be measured.

In general, no restrictions are placed on the time of application of the stresses for hardness testing. A simple consideration of the time required to accelerate masses to a given velocity calls to mind the fact that it is very important even though such masses be of molecular magnitude. It requires time for displacement of molecules to occur.

Sometime ago an investigation was made of complaints that the readings on the Rockwell "C" scale, using a sharp cone shaped diamond point for the penetration test, were not consistent, even on the same surface of one specimen. Tests were made on pieces of brass having very coarse crystallization; the crystals could be seen by the naked eye. The tests were made by taking from one to four readings on single crystals. It was found that some crystals showed a Rockwell hardness of 18 to 20,

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The Engineering Student and Summer Work

T. W. Oliver, c.e., '25

The college student who goes into summer work as rodman or instrument man in the engineering department of some city, is too prone to accept the existence of the various projects on which he works in an unquestioning and matter of fact state of mind. Things are going along at a good rate when he arrives, and his job seems to him to be a daily routine of making level circuits check out, or of keeping stakes set ahead of several impatient construction gangs; and a very trying job it seems to him at times too.

But all unbeknownst to him, this particular project on which he works had had quite a history all of its own, and by the time he works on it, he is only one of a whole host of people involved and interested in that same bit of construction.

Take a storm sewer project as an example. The engineer and contractor didn't all of a sudden rush out and start building a storm sewer at a furious rate just because it happened to be a fine day. Not at all, for it may be safely said that nine times out of ten, the beginning of any piece of public construction is the completion o fa similar project somewhere else. Folks travelling about see it and say among themselves, "That's what we ought to have." And if the college engineer had been hanging around the street corner of a Saturday night several years before construction was started, he could have heard scraps of conversation pro and con regarding that same job. Or if he had been in the right pool room that night, he might have heard the owner of the grocery store built up on stilts in a low lying lot, telling the proprietor of the pool room all about it. And if he had gone gone down the street a way, he could have heard wage rates for that job discussed by a group of laborers gathered in front of the local "Labor Temple." If he knew the right people in somewhat higher walks of life, he could have traced much of the talk back to "Coulter & Ralstons" realtors. And if he could have kept tab on property conveyances, he'd have known that they had acquired most of the low ground along the logical route of the main sewer, which land would rise greatly in price upon construction of said sewer.

Nor had the city engineer been idle all this time. Some day when work was slack, he went out with a few helpers and ran out the extreme limits of the tract of land which would be drained by the proposed sewer, describing it by reference to street and lot lines. Later a few interested property owners, to start the ball rolling, circulated a petition to build a storm sewer—where? The engineer had anticipated this need, and in the petition was embodied the legal description of the area to be drained. This petition was presented to the city commissioners, the city council, or the board of local improvements, dependent upon the type of city government and state laws. This board may have at once caused to be published in the official paper a resolution to the effect that "the construction of a storm sewer in the following described tract of land is an improvement necessary to be done," and instructed the city engineer to prepare plans and estimates. Dependent upon local laws, the board may have allowed a certain interval of time as fixed by law to elapse before calling for bids on the project, which allowed the possibility of filing a remonstrance against construction, or they may may have called a mass meeting of interested property owners. At this mass meeting, the whole affair would be discussed pro and con for the guidance of the board in their actions, the engineer being present with facts, figures, estimates, common sense, and a nimble wit. This last is most necessary, for at these meetings some clever citizen with ideas of his own concerning engineering problems, will be sure to ask simple questions which are hard to answer. Nor should the engineer hesitate or stammer in answering while on his feet before this body of interested property owners.

The student should not fail to attend a meeting of this general character should an opportunity present itself, for he will get an entirely new point of view from which to consider the relations between himself, his profession, and the public which trusts its problems and money to the hands of the engineer. Hitherto he has probably thought of his specific duties to an employer, but after such a meeting he will catch a vision of himself going about among his fellow men as a representative of the engineering profession, and he will look beyond the employer, and see his duties as being toward the public whom he serves. Incidentally, after the meeting is over, he may decide that the public mind is a minus quantity. This is really not the case, however, for public improvements are made sooner or later, and in the final analysis such improvements always originate with the people.

Then when the student engineer arrives on the job, all of this has transpired, and some of the things which he sees taking place have their roots very far back, and he must fit in and find his place in this scheme of things. He does this by performing detail, routine tasks in which he cannot get very far astray, or really "gum up the works" very badly no matter what errors he may commit. Later, work involving small decisions may be sent his way, and this is an index to the success with which he is handling his job. He may be asked to check details which will bring him in touch with the original design problems, and it is here that he may be painfully shocked and surprised. He is likely to see good, rational formulae from standard texts, ignored, and in their place substituted queer-looking mathematical expressions of methods; strays or waifs from somewhere, sombody's brain-child, somebody's pet method. If his "boss" has such a hobby, the student should not attempt to enlighten him as to better and more rational procedure, rather he should steer clear of any argument, or even discussion of the matter. The later course is much safer. It may seem serange to the student, how stubborn a man may be on such a point, but he should remember that this engineer has built many sewers so designed which probably are yet giving good service, and that the responsibility for the job rests on the engineer in charge. What he chooses to do is no concern of the humble engineering student, or the lowly rodman. However, such an incident will enlighten him on some of the many sins committed in the name of engineering.

There is small likelihood that the student will use his newly acquired stock of knowledge in assuring the chief engineer that his sewers are designed large enough. Rather he will be learning new things, for he will probably be doing field work, and will be in close touch with the construction end of things. He will be able to appreciate the local conditions which dictate the use of this or that material, or this or that method of construction. He will learn much of the details and possibilities of manual labor from watching teamsters, brick masons, and the "common labor" men, he will note how this or that foreman gets things done, he will see how the contractor handles his different foremen, and he will see ho wthe engineer in charge of construction manages to make the various contractors fulfill the spirit and specifications of their contracts.

There is one thing that it is possible for a student to gain from summer work which he can gain nowhere else except on actual construction, and which will give meaning and point to many of his later college studies; namely, the ability to visualize the scene of a public improvement before construction has begun, and even before the preliminary design has been started. The man working over the plans of a large office building must carry in his mind's eye all the numerous conditions which the building must serve, and a conception of the general scheme of the ideal structure which will fulfill all these conditions. He must strive to make the actual building approach the ideal as nearly as possible. The engineer serving a city must be able to see a certain district or portion of that city before and after a street plan or a drainage system has been placed there. No man can combine into a harmonious whole all of the conflicting elements of any type of design until he has this ability. He must be able to perceive the modifications made necessary in the whole of a project, by a change in any of its several parts. The student should cultivate the ability of looking beyond the raw earth and yellow clay of the construction period, and seeing the finished structure or improvement. He will not be able to acquire this faculty in the course of even two or three summer's work, but if he intends to become a successful designer or creator he should begin to look for these things.

The college student will be most impressed by the absolute and unqualified nature of the loyalty demanded of him in his seemingly unimportant position, loyalty to the men with whom, and for whom he works. He will surely talk of the work which is in progress, and he will find that politics, business, contractor, engineer, inspector, foreman, and the public, are all mixed up in such a way that a thoughtless word brings unexpected results in unthought of quarters. And he will find that sincerity of effort and absolute loyalty in all of his relations with his "job" will go far toward atonement for such small errors of computations as he is sure to make, and hat openness and frankness will firmly establish him in the eyes of his employer and all men with whom he has dealings while on summer work.

EDITORIAL

The Senior on Employment

L. R. Ludwig, ry.e.e., '25

The long period of education for some of us is very near the close, and we are looking forward to the next step, a place in the outside world. What kind of a place are the senior engineers looking for in which to release their energies? What are the chances of finding the desired work? Only a few of us know exactly the division of the complex field of engineering for which we are best fitted. The majority have a somewhat indefinite idea of the kind of employment to seek because the realm of imagination which almost alone must be depended on cannot picture exactly any vocation in all its phases.

The solution to this difficulty is usually and properly met in selecting work which one enjoys doing or the field where one's interests are keenest. First then, the senior is seeking the kind of work which appeals to his imagination the most. It is seldom that financial remuneration is the primary immediate factor. The next problem is to find a going concern with whom work would be desirable. First of all the concern should be progressive and financially stable. It should handle staples, that that is, be a basic industry and this for the surety of the man's future who is to take its job. The character of its personnel and management is important. How fast can a man progress in a concern? Can promotion keep pace with ability? One more important consideration is the facilities available for training. Is a man to be placed in one particular rut or will he be moved about and be given chances to learn more of his chosen field?

These matters settled it is good to inquire into the mind of the senior for his attitude toward industry. First of all I doubt if the average senior believes the world to be his without a struggle. A high school senior might well be a most supreme creature since he looks forward to a financially and otherwise protected continuation of his academic work. The college senior, however, is to find himself in strange waters where he knows but little of the sailings. His is a new field to properly subdue the most extravagant spirit. The sheer size of his undertaking and the desire to make four years of college count overshadow the glories of being a senior.

This kind of psychology does not lead to the expectation of high salaried jobs the first season. The college man realizes the necessity of reaching first base before proceeding to second. He does expect to make that college education count, however, not in enabling him to start from first base instead of home plate but in rounding the bases faster. The

(Continued on Page 220)

Clippings from the Editor's Desk

With the publication of this issue of The Technograph the magazine has turned another year in its varied career. It is probably with a sigh of relief that several saw the last work on the issue finished. The pleasures of magazine work are numerous but trouble is unlimited. However, in singing their swan song this year's management wish the best luck to their successors and hope the engineers will do their best to help when help is needed. We feel that some advancement has been made this year but at best it is a slow process and only the future will decide how much it actually was.

—T—

In this same line of a farewell piece the editor wishes to publicly thank a large number of people for their help. The work of both the business and editorial staff assistants has been good. However, a lion's share of the credit goes to the steady work of L. R. Ludwig, who stepped in frequently and pulled the magazine out of difficulties. The advice and help of T. W. Oliver has also been invaluable. The co-operation of the various departments of the college, principally through their departmental representatives, has been fine and accounts for a large amount of the success of the magazine. In short everyone has played their part when and as expected.

—T—

April and May seem to be the open season of job hunters. Before long probably everyone will probably know where they will be this summer and most of the seniors will have a good idea of when they take off their coats and get into a job for an indefinite time.

—T—

Those of you who are returning next year and are in some interesting work should keep the Schaeffer competition in mind this summer. Take some notes and plan to enter an article of your own in it. The winning articles of this year are published in this issue, and should be a good guide to the character of article that is desired. The winning article by A. J. Shute has been very well arranged and presents a rather difficult subject in an interesting manner. The difference in quality between the two best articles is very slight and both authors are to be congratulated on their work.

In this issue there is the announcement of the establishment of another fraternity within the college. It appears that the old saying should be revised to fit the engineers—in the spring the engineers' fancy turns to thoughts of new fraternities. That is, no doubt, a rather poor pun, but it seems to fit the case. Now we have the physics department holding the field alone as the only one in which there is not an honorary fraternity. We sincerely hope they are able to withstand all future attacks of the disease.

—T—

The Technograph staff or office should have a poor standing with the Hospital Association. This semester's record is two cases of scarlet fever and three of mumps. The magazine still comes out, limping a little and somewhat tardy, but present never the less.

—T—

There seemed to be a dearth of general activity around the college this past month. Maybe the engineers' dance was too strenuous. All of which reminds us that the final report on the dance, while not complete, has been outlined to the Engineering Council. From the present indications there will be a safe balance when everything is settled. That is welcome news because only so long as expenses are met will the dance be allowed. Don't miss the next one!

—T—

It has been suggested that we get out the hammer again against smoking on the campus, especially in the engineering group. It doesn't seem to do any good to remind the offenders that Burrill avenue and the alley between Engineering Hall and the Physics Laboratory are on the campus, they totally ignore it.

—T—

In this issue of the magazine there is a short collection of abstracts of speeches given at various initiation banquets this spring we would have liked to have a complete collection but this was impossible. For those who heard them at first hand there may appear to be no point in publishing them; but it should be remembered that only a small fraction of the engineers ever hear any particular one of these numerous banquet speeches and many of them are too good to confine to a small group.

He that studies books alone, will know how things ought to be; and he that studies men, will know how things are.

—COLTON.

COLLEGE NOTES

Abstracts from Recent Speeches

EDITOR'S NOTE: *The following are a series of extracts from speeches given at various initiation banquets of some of the engineering fraternities this spring. While it is difficult to give the same expression to an idea when it is put in writing as when spoken it is hoped that the following will show the general trend of thought in the College of Engineering.*

The Profession of Engineering

DEAN M. S. KETCHUM

A profession differs in several essentials from a business or a vocation. The first requisite for a profession is that there shall be a body of knowledge underlying the profession that cannot easily be acquired by an amateur or picked up by an apprentice. The second essential is that there shall be an association of men in the profession working together with common aims and ideals which constitute their code of ethics. This code of ethics defines the relations and responsibilities of the members of the profession to each other and to the general public. The professional man has an obligation not only to his colleagues and to the younger men who are just entering the profession, but to the general public as well, to see that the ideals of the profession are maintained.

Properly, there are no profits in a profession, the principal aim being to render service. The professional man gives one type of service, his very best, regardless of the compensation received. The greatest compensation that may come to him is to gain the esteem of his colleagues, and through them, the esteem of the general public. Character, executive ability, and an understanding of men are essential to men in all professions as well as to men in business.

If the engineer is to make a success as a professional man, he must be trained in that body of knowledge which underlies his profession; he must continue to keep abreast of the growth of that knowledge; and he must associate with his colleagues in that profession. The professional man does not exist independently of his colleagues in the profession. While it is important that the engineer shall have broad culture, it is absolutely essential that he shall have intensive training in the fundamentals of his profession. A broad training will help the engineer who has a good technical foundation, but will be of little value to the man who is indifferently equipped with the essential training for his profession.

Vectorial Ideas

PROF. C. C. WILLIAMS

"Ideas, like vectors, must have magnitude, direction, and point of application. As an allustration of point of application; the consolidation of railroads was not taken seriously until a man like President Ripley of the Santa Fe railroad began to talk about it. The same was the case with the league of nations and President Wilson. Many theorists had proposed such a league, but President Wilson, a practical responsible statesman, gave the idea a point of application.

"The engineer combines and arranges vectors for a resultant. He must do the same with the ideas—for results. Much of the work of the executive engineer will consist in giving direction and point of application to the ideas of subordinates. It is not true that only men of general training are leaders of thought and in responsible positions. Fifty years ago this was probably true but it is not true now of any unless it be of politicians. Leaders are outstanding men of the professions and nowadays most often specialists. Our economic fabric and social organization today are the products of specialists, and the pitiable muddle and lack of leadership in our legislatures is due to the absence of specialists in our legislatures. Many of the legislators of general training are not only not leaders but are miserably poor followers. Their general knowledge does not enable them to comprehend the complex economic organization of the country which is the product of specialists. One difficulty in the United States today is that we have an engineering civilization and a lawyers' governmen.

Experiences of a Recent Graduate

J. L. WHITTEN

An honor key should mean that the wearer is a personable and an accomplished man. Employers are interested in the honors won by students. The honor key is no key to success, but it often indicates what a man may be expected to do.

The student should not wait for a position to turn up, he will get more results by going after things. He should select and examine firms for which he might wish to work. A letter to these firms is far better as a first step than a personal interview. Follow up by means of an interview. Look over the town while on this interview, also the men with whom you will work and associate. Attach no great significance to starting to work at a relatively high, or a relatively low salary. Work for a goal some ten years distant.

As to nature of work, do not think that it is necessary to work at that for which you think that you are peculiarly fitted or educated. Bump around in work different from your chosen line. Keep up with the literature of your profession, old texts from college, new texts, magazines, etc. As for initiative and self reliance, do not try to appear that which you are not, but—try anything once.

Ideals and Realities

PROF. A. C. WILLARD

The engineer,—a man with submerged ideals,—does not tell the world that his profession is justified only when all is given for the sake of service to the whole of mankind. The engineer has not enough dealings with the unreal, the ideal. He should read the old philosophers and metaphysicians for their wealth of ideas. It is surprising to find in their writings ideas that are commonly thought of as being peculiar to these modern times. Even though the New Atlantis is most highly idealistic, Francis Bacon there set forth a whole procedure to reform the world by science. It is enlightening to know that such a man had long ago, outlined the whole field of natural knowledge or science. The engineer should read more in the field of the unreal, the ideal, the imaginative. Commonly, courses of study leave these things too much to the individual, with an all too frequent, consequent loss to both the man himself, and his profession.

Seniors—Invest in Yourself

PROF. W. M. WILSON

To the senior who is about to conclude his college work—predetermined promotion for definite accomplishment will no longer be your lot. Promotion will come only when a man's work is worth more than his salary. The student of engineering should become an expert in his particular field of endeavor. This requires study as well as work. You are your own best investment. Your parents have invested in you; you have invested in yourself. Continue to increase the investment and then make yourself pay dividends by making a success in your profession.

New Bulletins Issued

Bulletin No. 145, "Non-Carrier Radio Telephone Transmission," by Hugh A. Brown and Charles A. Keener.

The purpose of this bulletin is to set forth and describe the fundamental principles of a new system of radiotelephone transmission which the authors have developed. The first pages are devoted to a non-technical discussion of the subject in its various aspects, and to reasons for introducing the new process. The remainder of the pamphlet is given to a technical explanation of the theory of the new method, and to the problems which had to be solved in the course of the experiment. This new method of transmission, as developed by Messr. Brown and Keener, is different from the conventional method in that the latter uses a continuous radio frequency wave upon which is superimposed the modulated speech wave, while in the new method there is sent out a radio frequency wave only at the time when speech or music is taking place in front of the microphone. The new system has many advantages over that in use today. Its efficiency is much higher, and actual broadcasting tests, using both methods, have proved that the non-carrier is excellent as regards reproduction of speech and music. Other advantages are: economical simultaneous communication, and in the receiver: reduced volume of static, minimum of interference between stations, and more efficient detector action. In conclusion, the authors state that the apparatus as developed is capable of improvement, and they believe that a more intensive study of the problem will bring about further betterment in transmission from the standpoint of economy and simplicity.

Bulletin No. 146, "The Total and Partial Vapor Pressures of Aqueous Ammonia Solutions," by T. A. Wilson. The complete understanding of the operation of the absorption ammonia refrigerating machine necessitates a knowledge of the following:

(a) The total vapor pressures of aqueous ammonia solutions over the whole range of temperature and concentration covered in the machine.

(b) The partial vapor pressures exerted by the separate constituents in the vapor above aqua ammonia inside of the same range.

(c) The heats of solution of various aqua ammonia vapors in aqua ammonia of various concentrations at the different temperatures.

Although the thermodynamic properties of pure ammonia itself have been accurately determined experimentally, the corresponding properties of aqueous ammonia solutions have received(relatively little attention; and very little has been done towards the determination of the total and partial vapor pressures of aqueous ammonia solutions. Such figures as have been up until now available are limited in range, and this reduces very greatly their practical importance for the purposes of the engineer.

The determination and calculation of the total and partial vapor pressures of aqueous ammonia solutions, and their application to the absorption ammonia process illustrated by a concrete example are the subjects which are dealt with in Bulletin No. 146 of the Engineering Experiment Station of the University of Illinois, entitled "The Total and Partial Vapor Pressures of Aqueous Ammonia Solutions."

Copies of Bulletin No. 146 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Bulletin No. 147, "Investigation of Antennae by Means of Models," by J. T. Tykociner. The most essential facts of a radio station are the transmitting and receiving antennae, and the radiation and the propagation of electromagnetic waves over the surface of the earth constitute the fundamental phenomena underlying radiocommunication.

Every antenna consists of a system of wires supported on masts or towers and extending above the surface of the earth. During the process of radio-transmission electromagnetic waves are detached from the antenna and forced to radiate into the surrounding space.

When the dimensions of antenna in use at some of the large transmitting stations are considered the difficulties in the way of experimental investigation of the properties of different forms of antenna become at once apparent. Large antennae are built only for practical purposes of radio communication; once erected, such plants must be commercially operated, and under ordinary conditions not much time is available for scientific investigation. On account of the expense invovled it is not generally feasible to build a full size antenna for experimental purposes only, and with such antennae there would also be considerable technical difficulties in connection with varying some of the elements of the system while maintaining the others constant.

These considerations have led to an attempt to use scale models of antennae for purposes of investigation of all the properties of radiating systems and the study of all antenna characteristics in a special laboratory.

Bulletin No. 147 of the Engineering Experiment Station of the University of Illinois, entitled "Investigation of Antennae by Means of Models," contains a discussion of the theoretical considerations involved in the use of such models, and a description of different models with which experimental work has been done at the University of Illinois. A special type

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ILLINI ENGINEERS

ROBERT COOLEY TOWER
gen. '25

One of the best known engineers about the campus is "Bob" Tower. He has been very active during the past four years. During his first two he served on the business staff of The Daily Illini. In his junior year he was local advertising manager of the paper. He was in the chorus of the opera, "The Red Widow" two years ago. This year he has served on several of the Union committees, the Dad's Day and the Dance Supervision. He is a member of Sachem, Pi Delta Epsilon, and Theta Tau.

SIMONICH

WILLIAM GEORGE KENNEDY
e.e. '25

During his four years here at Illinois "Bill" has been one of the busiest men on the campus. His work outside of the class room has included two years as a member of the Glee Club and during the past year a member of the varsity quartet of the club. He has served in various forensic capacities and as president of the Adelphic society and president of Eta Kappa Nu. Also two years on the Engineers' Dance committee are credited to him. His scholarship has been sufficient to make Tau Beta Pi. Besides he is a member of Sigma Tau, Pi Mu Epsilon and Phi Delta Gamma.

TOWER

LOUIS JAMES SIMONICH
e.e. '25

Louie is another of the athletic electricals. He is playing his second year as first base on the ball team and is also listed in the lineup as Capt. Simonich. The left field fence has been the only thing in the outfield to stop a number of Louie's smashes this year and if he keeps it up he should rank high in the Conference batting averages. He is a member of the Tribe of Illini and Theta Tau.

KENNEDY

ILLINI ENGINEERS

CARL VICTOR ERICKSON
m.s.e. '25

Collegiate baseball is not as popular with some student bodies as are other sports. That is except where they have forgotten how to turn out championship teams. Erickson has worked behind the bat for the Illinois penant chasers for the past two years and has played consistent ball. Besides this he has been able to make several of the Engineering societies through his good scholastic standing. He is a member of Chi Epsilon, Mu San, and Sigma Tau.

PETERSON

MARSHALL SAMPSELL LUTHRINGER
e.e. '25

The so-called "major sports" are not the only ones in which Illinois ranks high. We are quite accustomed to winning the wrestling championship with regularity. Luthringer has been the regular man to enter the ring in the 135-pound class during the past two years and in that time has lost only one bout, by a decision. During the past semester he has served as president of Eta Kappa Nu.

RUDOLPH E. PETERSON
m.e. '25

The College of Engineering feels highly honored to have one of its men lead the senior class in scholastic standing. Peterson, with an average of 4.863 for three and a half years, will deliver the valedictory on Class Day. Besides a lot of hard work on the books Peterson found time to win second place in the Schaeffer contest this year. He is a member of several honor societies in the college, namely, Tau Beta Pi, Pi Tau Sigma, Pi Mu Epsilon, and Theta Tau.

ERICKSON

LUTHRINGER

Fraternity Activities

Sigma Tau

Sigma Tau, honorary engineering fraternity, held their spring initiation the evenings of April 22 and 26. The informal initiation was held, as usual, along the Sangamon river. The formal initiation was held at the Inman Hotel and was followed by an banquet in honor of the new men. Prof. H. J. MacIntire served as toastmaster and took charge of the program consisting of several short speeches. A. C. Tossetti, '26, welcomed the new men. F. B Powers, '26, replied on behalf of the recent pledges. This was followed by a short history of the organization by J. A. Tomasek, '26. Prof. F. B. Seeley gave a talk entitled "Short Trips" which was very interesting. Prof. H. E. Babbitt took as his topic, "Advice" in which he did as he promised to try to do; present old material in a new form.

The following members of the faculty were initiated at this time: Prof. H. E. Babbitt, Prof. F. B. Seeley, G. B. Banister, J. L. Berner, D. R. Conner, R. J. Crossett, R. A. Dollinger, P. W. Emley, R. C. Hageman, W. L. Hunt, W. T. King, J. E. Luhrs, H. G. Mason, R. W. Morgan, F. B. Powers, H. K. Pritchard, S. I. Rottmayer, W. E. Schroeder, P. E. Soneson, R. D. Wilson.

Eta Kappa Nu

Eta Kappa Nu, the honorary electrical engineering fraternity, held its initiation banquet on Thursday April 2 at the Inman Hotel. As a part of the banquet seven new members were initiated. They were W. L. Branch, '26, P. S. Emely, '26, E. F. Hettel, '26, W. Hickman, '26, W. C. Webb, '26, and F. E. Leib, '26. Professor A. R. Knight acted as toastmaster of the evening. The speech of welcome was given by M. S. Luthringer, '25, president of the local chapter and was responded to by W. C. Webb. Prof. E. H. Waldo spoke on "Getting the Most Out of Eta Kappa Nu" and Prof. E. B. Paine, head of the department of electrical engineering gave a few remarks.

Tau Beta Pi

N. J. Alleman, m.e.
C. D. Anderson, gen.
J. N. Demmler, m.e.
R. L. Dugger, e.e.
L. D. Fetterolf, cer.
J. G. Lynch, gen.
W. E. Lynch, e.e.
E. M. Sabota, e.e.
P. E. Soneson, a.e.
E. F. Stahl, gen.
J. C. Voorhees, c.e.
J. D. Voorhees, c.e.
H. E. Weaver, e.e.
J. J. Weiler, a.e.
W. V. Woodward, e.e.

The juniors whose names are listed above were initiated by Tau Beta Pi, honorary engineering fraternity, on April 7. The initiation banquet was held at the Inman Hotel, Champaign. Following the banquet a program of speeches was given. J. L. Whitten spoke on "Experiences of a Recent Graduate"; Prof. C. C. Williams had as his topic, "Vectorial Ideas," and Prof. A. C. Willard concluded the evening with a talk on "Ideals and Realities."

The officers for the past semester have been; president, A. J. McMaster; vice-president, W. G. Roesch; secretary, W. S. Clayton; treasurer, R. E. Peterson.

Phi Alpha Lambda

At a special meeting of the officers of the General Engineering society the lack of unity and co-operation among the general engineers was discussed quite fully. The present society was shown to be inefficient and unsuitable for the purpose of organization. The remedy suggested was to create an honorary general engineering fraternity such as exists for the other departments of engineering. Acting upon the above idea a constitution and ritual work were drawn, mostly through the efforts of B. R. Herr, '25. The petition was signed by sixteen juniors and seniors in the department and was passed on by the council.

The following men signed the petition:

E. B. Brady, J. J. Brownlee, W. E. Beach, J. W. Coleman, C. W. Goodman, B. R. Herr, H. H. Hill, L. M. Kandelin, J. G. Lynch, L. E. Manuel, E. P. Mahoney, G. L. Osmanson, A. C. Rehm, M. A. Rowley, F. Rueb and H. L. Stearns.

The officers elected for the coming year are: president, F. Rueb; vice-president, J. G. Lynch; secretary and treasurer, H. P. Arkema; corresponding secretary, J. J. Brownlee.

This fraternity will be something for the underclassmen to work for and will assist in the better co-ordination between the general engineering students and the faculty. Dean Jordan expressed himself as being quite favorable to the organization especially since membership will be limited to ten initiates a year, initiates to be selected from the upper third of the junior class, which will enable the fraternity to keep its honorary nature.

Phi Alpha Lambda will be officially organized and installed at a banquet on May 19, and from then on will take an important place in the Engineering college.

Scarab

Scarab fraternity has found it advisable to keep in close touch with the faculty and alumni members, not merely work for them but work with them. In this way we can find out, what to expect in our future development, and also what the public expects from us.

At one of our recent meetings, Prof. C. E. Palmer gave a very interesting talk on "The Architect and the Engineer." He illustrated the relation between the architect and the engineer from the early ages to the present time; closing with some practical pointers on construction work.

Last month the Scarab Sketch Exhibit was displayed to the public in the corridors on the fourth floor of Engineering Hall. This exhibit contained drawings rendered in water colors and studies in pen and ink, done by students outside of school. All chapters sent in a number of interesting pictures.

On February 24 a smoker was held at the Sigma Pi house in order that the members could become better acquainted with their fellow students. At this time Prof. O. G. Schaffer of the landscape department and Prof. C. E. Palmer explained to the guests the purpose of the organization.

The annual Scarab Bronze Medal Competition was started Saturday, March 7. The following men qualified for the final project: sophomores,

(Continued on Page 208)

Contemporary Engineering News

Rubber Bearings Developed.

Bearings made of rubber are the latest development in this line. The bearing is made of an outer shell of metal with an inner lining of hard and resistant grade of rubber. Spiral grooves are cut in the surface to allow the flow of water which is the lubricant. The bearing is particularly adapted to installation as the propellor shaft bearing on vessels which run in waters carrying much solid material, as no harm can be done to either shaft or bearing by any abrasive material which may get into the bearing. The grit is pressed into the rubber, rolled into a groove, and washed away by the stream of water. The bearing may also be used on pumps and turbines which handle material containing silt. The dark, wet conditions under which it works are beneficial to the rubber, and there is little deterioration.

Micarta Airplane Propellors.

Wooden airplane propellors are being replaced with others made of micarta and metal, with a gain in lightness, strength, and efficiency. The micarta propellors can be made much more cheaply and quickly than the wood, because their manufacture is merely a matter of heat and pressure treatment of the micarta in a phosphor bronze mold. The metal propellors are made of an alloy of magnesium, twenty-five per cent lighter than duralumin, and have passed all the tests that they were subjected to.

New Building Material.

Another building material has just come on the market. It has a gypsum base, and has the advantages of strength, quick setting, and excellent insulation, both for sound and heat. It is quick setting; forms may be removed in about thirty minutes, thus expediting construction by a re-use of forms and minimizing the cost of them.

Electrical Telemeter Developed.

Another instrument just perfected by the Bureau of Standards is the electrical telemeter. This new instrument has the advantages of small size of the attached element, and ready portability. It will stand rough handling, and the deformations are recorded on in permanent form on a roll of photographic film. The recorder may be at some distance from the member whose stresses are to be recorded, making it suitable for such purposes as obtaining records of the stresses in airplanes or dirigible members while the craft is in flight. The principle of the instrument is a variation of electrical resistance of a carbon pile when compressed by the change of length of the member to which it is attached. The carbon pile forms one leg of a Wheatstone bridge, and the unbalance is recorded by a galvanometer which, by means of a small movable mirror and moving film, makes its continuous line record in the usual way. The principal difficulty in the evolution of this instrument was the exacting requirements of the carbon piles. A high grade of searchlight carbon is used, in the form of small annular rings, the machining of these being the most delicate operation of the whole construction. Two types of this machine are made, one for beams and the other for cables.

Chicago Uses Superpower.

On the eleventh of last December the peak demand for electric power in Chicago was 668,000 kilowatts, or nearly one million horsepower. The twenty-four hour energy demand was over ten million kilowatt hours. The new Crawford Avenue plant in Chicago, now in partial operation, will, when complete, have a capacity nearly as great as the total possible power available from the much discussed Muscle Shoals plant.

There is now an interconnection between central stations in Illinois, Indiana, Kentucky, Michigan, and Wisconsin by means of which power may be transferred to meet the demands.

Rusting of Concrete Reinforcement.

The University of Wisconsin has just published the results of some tests on the rusting of concrete reinforcements that have been carried out in the past twelve years. Samples of various strengths and proportions were mixed, some with pure water, and some with salt water, the reinforcing rods embedded in them in blocks of standard sizes, and the blocks were then laid away to await the results. The samples were alternately immersed in water and then dried, at intervals of a week, and broken open at intervals to see how much they had rusted. The results show that concrete which is made with pure water, and is made in such proportions as to give a non-porous structure to the set material, will be practically free from rusting of the rods.

Navy to Use 80 K. W. Vacuum Tube.

The Bureau of Engineering of the Navy Department has awarded a contract to the General Electric company for the manufacture of an 80-kilowatt electron tube transmitter. This powerful radio-telegraph transmitting device will, when completed, be installed at either one of two high powered naval stations, San Diego or Mare Island. It is understood that three of these 80-kilowatt tubes are being manufactured.

New Engine Head.

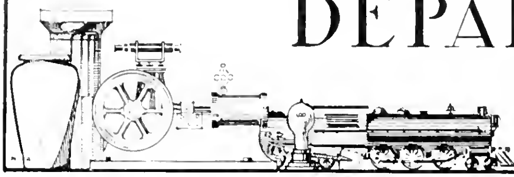
Another development in the internal combustion engine line is that of the Ricardo head. This head increases the efficiency of combustion by causing an increased turbulence of the cylinder gasses during the compression stroke. This enables greater compression pressures to be used without preignition, faster ignition of the fuel, or more rapid burning. This increases the thermal efficiency and gives more rapid acceleration and smoother operation of the engine.

New E. E. Lab at Minnesota.

The University of Minnesota has just completed its new Electrical Engineering Laboratory, and now can boast of being practically the only midwestern school that has really adequate instruction facilities in this subject. The building is complete in every detail, and is large enough to take care of many years' expansion.

H. A. Webber, arch., '97, has formed a partnership with a Michigan civil engineer. His address is 1101 First National Bank Building, Detroit, Michigan.

Fred Rostel, e.e., '99, is assistant general manager of the Pabst corporation in Milwaukee.



DEPARTMENTAL NOTES

Architecture

The Annual Banquet of the Architectural Society was held at the Urbana-Lincoln Hotel on Wednesday evening, April 15. One hundred and twenty-five members enjoyed the sumptous repast and the speakers of the evening. Alfred Granger, prominent architect of Chicago and a warm friend of the department here, gave a short talk, telling about the new Architect's Club house in Chicago, and invited all students of the department of architecture to make the club their headquarters when visiting Chicago. He reiterated his interest in the work done by the students here, and added that the architects of Chicago looked to the department of architecture of the University of their feeder, from where the future architects of Chicago are to come. The main speaker of the evening was Prof. Gabriel Ferrand, of Washington University at St. Louis, who is considered one of the finest instructors of design in the United States. For ten years Professor Ferrand was teacher of design at the Carnegie Institute of Technology but for the past four years has been in charge of the department of architecture at Washington University. His talk was very interesting and instructive, in which he discussed architecture as a fine art, describing it as the greatest of all fine arts. He made an appeal for an architecture which would be distinctly American, one which would be an expression of modern requirements and construction instead of the present practice of trying to make the historic styles play ridiculous parts in our buildings of today. His speech was warmly received and thoroughly enjoyed by all present.

Beaux Arts Design

Three second medals were awarded to students of the department on the Beaux Arts Archeology problem, "A Bedroom in the Empire Style." This award, which is the highest in its classification, was won by Harold Naegle, Mary Worthen, and Willard Frasier. First mention was awarded to John W. Gregg, Witmer Vollentine, and Ralph Kloppenburg on the same problem. On the senior problem, "A Water Gate," Homer Phieffer was awarded first mention. Prof. L. C. Dillenback was present in New York for both of these judgments.

Professors L. H. Provine and Rexford Newcomb attended the American Institute of Architects Convention in New York City April 21. Professor Newcomb has been just recently elected president of the Peoria Chapter of the Institute.

The students of the department are now engaged on their last Beaux Arts problem for the year. The seniors are doing "A Building for the Exhibition of Building Materials." The juniors and sophomores are both working on the same problem, "A Beach Club." This is the first project which the sophomores have taken, but they are sailing into it in great style.

On the last sophomore problem, "An Entrance to a City Hall," Buford Pickens was awarded first mention, the rest of the class receiving second mention.

The Allied Arts Exhibition was held the week of April 20 on the fourth floor of Engineering Hall. Work done by students of the Art and Design Department, the Architectural Department and Home Economics was displayed.

Ceramic

The annual sophomore inspection trip was held on April 4. The entire sophomore Ceramics class and a few from the junior class left the city at seven o'clock and arrived in Danville shortly after eight o'clock. Two of the Western Brick Company plants were visited. The students obtained a good idea of production of face brick on a large scale, as the Western Brick Company is one of the largest face brick manufacturing companies operating in the country at the present time. The General Refractories Company was also visited. This company makes a very high grade of refractory brick. The party returned about five o'clock.

The department has recently received two new driers. One is a small Carrier dryer for research use. The dryer is arranged so that there is absolute control of humidity and temperature. Temperature may be controlled to one degree Centigrade, and humidity to one per cent. The cost of this dryer is about $1,500. The other dryer is a Grinel, for use in the pottery laboratory.

A new motor-driven cross-breaking machine has recently been set up in the high-temperature laboratory. This machine is the only one of its type in use. The advantage of this machine over the older ones, which were operated by hand, is that the motor is driven at a constant speed, and consequently the load is applied at a constant rate. It will measure cross-breaking loads up to three hundred and fifty pounds per square inch.

Mr. T. N. McVay expects to complete a new Dialotometer within the next few days. This machine was designed for the determination of the co-efficient of expansion of cement.

A new piece of apparatus has been recently set up in the physical laboratory. It is in reality a large type of calorimeter and is being used for several important determinations. The specific heats of various types of clays are being determined. The apparatus is an isolated kiln system and experimental work is going on now to determine the heat necessary for any particular clay to produce vitrification.

S. B. A. C. S.

The student branch of the American Ceramics Society was very fortunate in being able to hear a series of three lectures by Mr. Bleiniger of the Homer Laughlin Pottery on March 18 and 19. Mr. Bleiniger in his first lecture pointed out some of the advantages of a tunnel kiln such as those used by the Homer Laughlin Company. He also showed that a tunnel kiln, although very economical for some types of products, was not the best in all cases.

In his second lecture Mr. Bleiniger gave some idea of the research carried on as a general factory practice. He stated that it was very hard to draw a line of distinction between the ordinary routine testing, which must be carried on in a factory, and research work. In his final lecture he told of some of the fields open to the students of Ceramics after graduation.

Mr. Bleiniger is a graduate of Ohio State University and was for a short time instructor in Ceramics here in the University. Up to a short time ago he was connected with the Bureau of Standards, from which he resigned to take his present position with the Homer Laughlin Company.

At a meeting of the Society March 19 W. P. Whitney, '25, was elected president for this semester to fill the vacancy left by Harold Bopp, who graduated in February.

Civil

The highway department has recently installed new equipment which greatly facilitates both the work in the laboratory classes and research. A constant temperature electric oven for making the volatilization test of asphalt is one of the new pieces of apparatus. In order that all specimens may be subjected to equal intensities of heat, they are placed on a motor driven revolving shelf within the oven. The temperature range is from 20 to 180 degrees Centigrade, although the test is made ordinarily at a temperature of 163 degrees. There is a new multiple unit electric furnace which has a safe working temperature of 1,750 degrees Centigrade, but which will work as high as 1,850 degrees. A centrifuge of maximum speed of 3,600 R. P. M. has been added to the list of equipment for the testing of asphalts and oils, and a ductility machine which breaks three specimens at one time materially speeds up the ductility tests which are ordinarily made on a machine which breaks but one specimen at a time.

R. A. Culp, '25, is working on a thesis which has for its object the study of highway signs with reference to the best possible color combinations, the most efficient shape to be used, the most advantageous location on the highway, durability, and the amount of information which may be put on the sign. An attempt is being made to arrive at some fundamental principles and some interesting results may be expected.

H. L. White, graduate in chemistry, and junior in civil engineering is continuing the study of the oiling of earth roads as first outlined by Professor Wilson in Circular Number 11, which appeared in the summer of 1924.

J. E. Keranin, undergraduate fellowship of the Austin Western Road Machinery Co., is making a study of gravel roads. The section of road under investigation lies north of Danville, in Vermillion county. Various stretches of the road are being prepared and maintained by different methods, and interesting results are expected.

A. S. C. E.

March 19, Dr. M. M. Leighton, of the Illinois State Geological Survey spoke before the student chapter of the A. S. C. E., concerning the relation of geology to engineering. Dr. Leighton rapidly outlined the scope of the study of geology, presented a brief history of the geological epochs in the United States, and pointed out the relations of geology to civil engineering. The lecture was of great value to those students who had not been able to take a course in geology while here at the University.

March 5, Prof. C. C. Williams spoke to the student chapter of the A. S. C. E. at their regular meeting, taking as his topic, "Civil Engineering as a Vocation." Professor Williams stated that, "He knew of no means whereby a man's probabilities of becoming a successful engineer might be foretold. In general, qualities may be discerned in any individual which are characteristic of the engineer, but it rests entirely with the individual as to what he will make of himself." "The resolution to become an engineer, made while seeing fully all of the difficulties and limitations imposed upon the individual by the profession, marks the engineer as well as any other quality."

Data on an interesting series of column tests which complement those of Professor Talbot's made since 1904, will be available in June. The major portion of these tests are being made by E. M. Brickett, '24, who is working on his masters thesis. The effect of type reinforcing, amount of reinforcing, and length, upon the strength of columns will be noted. In order to acquire data, columns of lengths varying from five to twenty times the diameter, with different amounts of spiral and longitudinal reinforcing, have been made. The columns used in these tests are mostly eight inches in diameter, with a few twelve inch ones. Test columns are made in the laboratory at the rate of one a day, the curing consisting of twenty-eight days under wet burlap. Some idea of the tremendous amount of work being done may be gained when one knows that anywhere from five hundred to fifteen hundred strain gage and deflection measurements are being made on each column tested.

Mr. Richart, assistant research professor, is conducting a series of tests on twelve inch columns to study homogenity of columns, the effect of shrinkage and eccentricity, and also to compare the strength of twelve inch columns with those being tested by Mr. Brickett. In order to study the homogenity of columns, columns twenty diameters in length are sawed with a carborundum saw, the pieces being tested as before.

The effect of eccentricity is determined by loading columns off center, determining the deflection, and taking strain gage measurements.

Twenty columns are being tested to determine the effect of shrinkage. These columns are cured in the usual manner, then placed in an oven and dried at moderate temperatures for two or three weeks, readings of weights being taken at intervals. It is expected that the steel will be stressed to 15,000 pounds per square inch by the shrinkage, and the columns will fail in a manner different from the ordinary column.

These tests cover some much discussed points and will no doubt uncover some interesting facts.

Electrical

E. E. Society

The E. E. Society was privileged to hear Prof. A. C. Willard, head of the department of mechanical engineering, at a special meeting of the society held Wednesday evening, March 4. Professor Willard spoke on "Choosing Life's Work" and gave many helpful hints on how to choose a life occupation. He advised all men to be on their toes all of the time and to be ready to use anything and everything that they had learned. Two short business meetings of the society were held in the E. E. laboratory on the Friday evenings of April 3 and 17. At the last meeting means were discussed for getting the underclassmen of the department started on the E. E. show.

New Equipment

A new three-phase alternator has been received at the E. E. laboratory. This alternator is to be driven by the new Reliance, variable speed, direct current motor described in this column in the last issue. The alternator is capable of delivering three-phase power at 110 volts, 25 cycles, 220 volts, 60 cycles, and at any other frequency between 10 cycles and 80 cycles with the various corresponding voltages. A new transformer has also been received which operates at 25 cycles and has a voltage of 110-220 volts as an ordinary transformer and a ratio of 110-440 volts as an auto transformer. Various frequencies and voltages are obtainable by the use of this transformer so that it may be used in connection with the new alternator and motor mentioned above.

The university has recently been the recipient of money for a fully equipped, modern radio broadcasting station through the kindness of B. H. Sullivan who has given the station in memory of his father, Roger C. Sullivan. The design, erection and equipment of the station has been placed entirely in the hands of the Western Electric Company of Chicago. Representatives of the company have been present on the campus to look over the situation and plans for the station are under way.

Electrical engineering seniors and juniors have been very fortunate this year in the opportunities given them to interview representatives of the various companies employing electrical engineering graduates. Representatives from all the larger companies have been present at the E. E. Laboratory for interviews and many of the smaller companies have also been represented. Several of the companies have sent, as their representatives, graduates of the department who are now employed by them in the various branches of their work.

The convention of the American Institute of Electrical Engineers held recently at St. Louis was well attended by men from this university. Professors E. B. Paine, Morgan Brooks, E. H. Waldo, and E. A. Reid, and L. A. Mollman and R. J. Callen, seniors, all of the department of electrical engineering and Prof. W. J. Putman of the department of theoretical and applied mechanics were in attendance. L. A. Mollman and R. J. Callen gave reports on the convention to the seniors of the department and Professor Brooks reported having seen a number of Illinois graduates at the convention.

A new bulletin is being prepared, giving the results of the experimental work on the various kinds of radio transmission systems recently carried on by H. A. Brown and C. A. Keener, of the department of electrical engineering. Mr. Brown has also been engaged with Dr. C. T. Knipp of the physics department in research work with vacuum tubes.

The freshmen enrolled in the department of electrical engineering were given several glimpses of engineering work as a part of their weekly engineering lectures recently. The freshmen, who receive only preliminary instruction during their first two years in the course were divided into three groups and placed under the supervision of faculty men who conducted the tours and lectures. One group under Prof. E. A. Reid was taken to the E. E. laboratory where it was broken into small groups about the laboratory and shown the use and purpose of the various pieces of apparatus. Several demonstration experiments were performed to give the men an idea of the work done in the laboratory. A second group heard a lecture on "Illumination" by Prof. A. R. Knight in 221 Engineering Hall. The third group under the guidance of C. A. Keener, of the department of electrical engineering, made an inspection of that section of the university heat tunnel between the Power Plant and the Transportation Building. The heat tunnel is about six feet high and about five feet across and carries the heat, light, telephone wires, gas and water from the Power Plant to the buildings on all parts of the campus. The tunnel is warm due to the heat pipes and is well lighted by electric lights.

Mechanical

Oil and gas power week was observed by the student branch of the American Society of Mechanical Engineers at a meeting held on April 22, 1925. The meeting was well attended.

Papers were presented by F. F. Kennedy, '25 C. F. Hennes, '25, and J. A. Tomasek, '26. Kennedy spoke on the "Drilling and Transportation of Oil." Hennes gave a very comprehensive outline of the fuel resources of the country. Tomasek covered the power end of the field and discussed recent improvements in Diesel engine design.

Professors A. C. Willard, A. C. Kratz and V. S. Day, who are members of the staff engaged in the Warm Air Furnace Heating Investigation, presented their annual report on this work, to the convention of the National Warm Air Heating and Ventilation Association at Cleveland, April 15 and 16. Much progress has been made in this investigation during the past year. An important part of the report dealt with the work done in the new Warm Air Heating Research Residence during the past winter.

The National Warm Air Heating and Ventilating Association has co operated with the Engineering Experiment Station in this research work for a period of six years. At the Cleveland Convention it was voted to continue this work.

The investigation of the efficiency and durability of spur gears, which is being carried on under the direction of Professor Ham, is rapidly nearing completion. The investigation has been in progress over a period of two and a half years. All experimental work has been performed by J. W. Huckbert. The results of the investigation will be published in bulletin form in the near future.

Railway

P. M. Gault, of Chicago, assistant signal engineer for the Illinois Central Railroad, and S. C. Hofman, of Champaign, signal supervisor for the same railroad, conferred lately with the department of railway engineering concerning an experiment which is being carried on jointly by the signal department of the railroad and the department of railway engineering of the University. Six signal relays, four line and two track, were furnished by the railroad together with other necessary material for the experiment. The signal contacts, whicht operate from a ten-volt, thirty-watt alternating current furnished by a transformer, and work by an electromagnetic action are subject to considerable wear. The purpose of the experiment is to find the best material to use in these contact points. The closing of the contact points complete the circuit and turn on the colored signal lights. The materials will all be furnished by the railroad and the investigation done by men of our department.

A new one-arm semaphore block signal has been set upon the first floor of the Transportation Building. The signal is electrically operated and was purchased from the General Electric Railway Signal Company.

Mr. Morris, assistant mechanical engineer of the Nickel Plate railroad, has been interviewing seniors with view to positions in the mechanical department of that railroad.

N. Steffanoff, '24, and R. McCune, '22, who are now working in the mechanical engineering department of the Illinois Central Railroad are assisting in the operation of the Dynamometer Car which is owned and operated jointly by the railway depart-

(Continued on Page 208)

GRATITUDE

"Are you the man who saved my little boy from drowning when he fell through the ice?"

"Yes."

"Where's his mittens?"

A FRATERNITY

You and two or three others that collect twenty-five or thirty more to make the things pay.

JUSTICE

"Is it right that he gets by big with the women?"

"No, it's not right, but he does.'

SPRING, BEAUTIFUL SPRING

He (poetically): "Wither away, my pretty maid?"

She (in the same strain): "O, wither away yourself, fair sir!"

"Why didn't you answer that letter I sent you in vacation?"

"I didn't get it."

"You didn't!"

"No, and besides I didn't like some of the things you said."

—Beanpot.

ENGINEERS WILL ATTEND

The dance will be held in the Lewisburg Fireproof Garage.

A SIX OR AN EIGHT?

"Why do you call your car "Flapper?"

"Streamline body, swell paint job, pick up, all kinds of speed, keeps me broke, warms up quick and is always ready to go."

College Wit: "Give me a yard of pork, please."

Butcher: "Boy, bring this gent three pig's feet."

THE FAMILY SKELETON

Two colored men were discussing family trees.

"Yes, suh, man," said Ambrose, "I can trace my relation back to a family tree."

"Chase 'em back to a family tree?" said Mose.

"Naw, man, trace 'em, trace 'em—get me?"

"Well, they ain't but two kinds of things dat lives in trees—birds and monkeys; and you sho's ain't got no feathers on you."

Aunt Jemima: "Is you gwine ter let dat mewel do as he please? Wha's you' will power?"

Uncle John: "My will power's all right. You jest come out here and measure dis mewel's won't power."

PERFECTLY UNDERSTOOD

Mother: "What do you mean by putting your thumb to your nose and wriggling your fingers at those little boys?"

Willie: "Don't worry, ma—they know what I mean."

Student (to clerk in drug store): "You needn't look at that check so hard, it'll be back in a few days and then you can look at it as long as you want to."

When a doctor makes a mistake he buries it.

When a judge makes a mistake it becomes the law of the land.

When a lawyer makes a mistake it is just what he wanted because he has a chance to try the case over again.

When a preacher makes a mistake—nobody knows it.

But when an engineer makes a mistake—goodnight!

THE COLLEGE BAKERY

A four-year old loaf made with lots of dough and covered with a heavy crust.

A girl swears she has never been kissed. No wonder she swears.

A SLIGHT ERROR

Sullivan: "Isn't that Casey over there kidding that colored dame?"

Sweeney: "Oh, my gosh! I just knew he'd be making a fool outa himself if he ever went out alone. He's color blind."

Friend Wife: "John, dear, what are you opening that can with?"

Hubby: "A can opener, of course."

F. W.: "From what I heard I thought you were opening it with a prayer."

EVIL DAYS

"What's the matter now, Grumps?"

"My daughter is wearing knickerbockers and my son is taking a girl's part in the college play."

That's nothing, Blondy Wessman wears knickers too!

HIS SHORTCOMING

First Co-ed: "Do you ever allow a man to kiss you when you are motoring with him?"

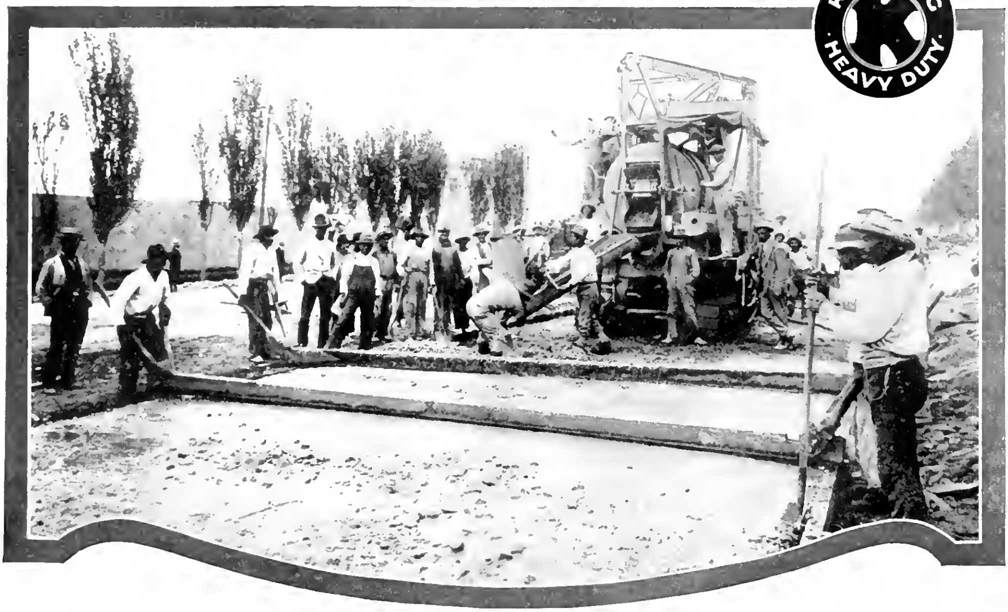
Second Ditto: "Never. If a man can drive safely while kissing me, he's not giving the kiss the attention it deserves."

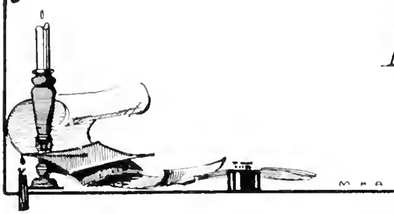
THOUGHTFUL PAPA

"Ikey, what for you go up dem stairs two at a time?"

"To safe my shoes, fader."

"Dot's right, my son; but look out you don't shplit your pandts."





ALUMNI NOTES

McClure Managing Thirty-eight Mines

O. D. McClure, m.e., '91, has made a name for himself in the engineering field by his improvement and management of the Cleveland Cliffs Iron Company's thirty-eight mines. When McClure went to the company twenty years ago, the mines were operated by wasteful steam plants fed by coal which was hauled all the way from West Virginia. He immediately saw the inefficiency of this system and sought to convince the officers of the company that the mines should be electrified. It took him two years to get them to his way of thinking.

As a beginning of his task, McClure built a concrete dam across the river that ran by the mines when the temperature was thirty-five degrees below zero. He followed this dam up with three others, making in all four dams at which were built hydro-electric plants. In addition to these a big reservoir was built in the hills to store the flood waters from melting snows. McClure, personally, directed not only the mechanical but also the civil and electrical engineering work of the entire project.

Mr. McClure is also not without artistic ability. His power plants lack all the ugliness common to such structures and are designed and maintained in a way that is pleasing to the eye. He is married and has two sons of high school age. With all his work and responsibilities, McClure finds time to serve, by way of recreation, as president of the Board of Education of Ishpeming, Michigan, where he is located.

E. J. Irving, min.e., '09, recently installed a large pump at the plant of the Calumet and Arizona Mining Co. at Warren, Arizona.

G. E. Wright, arch. '12, is now assistant supervising architect of the University. He was formerly an architectural designer.

F. A. Kirkpatrick, cer. '14, is employed as an efficiency engineer for the West Coast-Porcelain Manufacturers. He is located at Millbral, California.

Fred Hornlsohl, a.e. '17, has been appointed superintendent of building construction of the University.

C. A. Stone, cer.e. '17, is now teaching mathematics at the University of Chicago. He was formerly with the Basic Products Co., and more recently taught in the Maine township high school, Des Plaines, Illinois.

G. A. Sladck, cer.e. '17, is engineer for the Beaver Falls Art Tile Co.

F. L. Hunter, cer. '16, is superintendent of the plant of the Beaver Falls Art Tile Co.

J. W. Wright, cer.e. '17 is with the Zwermann Co., Robinson, Ill. He was recently married to Margaret Morgan of Champaign.

R. P. Brown, cer.e. '18, writes many bulletins and pamphlets for the National Lime Association for which he is construction engineer.

M. L. Cotta, m. and s.e. '20, now lives in Portland, Oregon. He has just recently returned from Canton, China, where he was resident architect for the Canton Christian College.

L. L. Battey, e.e. '21, has joined the staff of the General Electric Co. and is located at its Salt Lake City office.

G. J. Keck, arch. '20, formerly of the department of architecture will spend next year abroad.

E. J. Guardia, arch. '21 is now in Panama City, Panama, where he is designer of concrete bridges for the Panama City highway department.

J. R. Welsh, c.e., '24, is with the L. E. Myers Construction Co., Gurgeon, Kentucky. He is supervising the construction of a rock fill dam, which is to be 280 feet high and will contain 2,000,000 cubic feet of rock.

An exhibition concerning the life and work of the late *E. M. Burr*, m.e., '78, is now being installed in the College of Engineering. Burr developed an internationally known line of precision machinery.

Martin E. Jansson, c.e., '23, former editor of The Technograph, is now in Wanaque, New Jersey, working for the North Jersey District Water Commission on the construction of a number of dams. The project consists of the creation of a reservoir seven miles long and two miles wide by the damming up of a valley with two concrete and six earth dams.

Illinois Engineers are taking a prominent part in the construction of the Delaware River bridge across the Delaware river between Philadelphia and Camden. Besides *B. B. Case*, e.e., '06, the senior resident engineer in charge of the construction, *Ralph Modjeske*, chief engineer of the bridge commission, received an honorary degree from Illinois, and *Russell G. Cone*, e.e., '22, is a junior engineer on the project.

Clark Bullard, arch., '09, is practicing architecture with his father and uncle in Springfield, Illinois. The firm is known as Bullard and Bullard.

A portrait of *Prof. A. N. Talbot*, c.e., '81, veteran professor in the College of Engineering, is to be presented to the University.

E. J. Blakeslee, m. and s.e., '11, has moved his headquarters from New York to Pittsburgh. He is employed by Stone and Websters, consulting engineers.

A. E. Tarracciano, e.e., '14, is with the Western Electric Co., Chicago.

I. Anderson, m. and s.e., '15, is a division engineer for the Sante Fe Railway at Mareedine, Mo.

H. E. Austin, m.e., '15, is chief engineer of the American Creosoting Co., of Louisville, Kentucky.

A. L. Barnes, arch., '15, is an architect in Harrisburg, Illinois.

I. N. Clover, m. and s.e., '15, is located in Cincinnati as assistant county sanitary engineer.

Rodney L. Bell, c.e., '09, is now in the hard roads construction business with headquarters at Paris, Illinois.

College Notes

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of condenser particularly suitable for the work which was developed in connection with these investigations is also illustrated and described.

Copies of Bulletin No. 147 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Departmental Notes

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ment and the Illinois Central. They are making tonnage rating tests on the Indiana Division, between Effingham and Indianapolis.

An interesting collection of old rails is being made by this department. They show the early rails and the development of rails in this country from the advent of the first railroad to the modern steel rail. The roads contributing to the collection are the Illinois Central, Burlington, M. C. & St. L., and the Chicago and Northwestern. As soon as the collection is more complete and historically arranged it will be displayed in the Transportation Building. Much other early track equipment is being furnished by these roads which together with modern equipment on hand makes rather a complete collection of track roadway equipment.

Fraternity Activities

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F. J. Serpico, W. Jones, and Robert Isebarger; juniors, H. J. McKee, and T. P. Sumarkoff. The problem for this competition is a base for an equestrian statue. The final drawings must be turned in by April 9.

Another get-together was held March 11 at the Triangle house. Prof. T. Bailey talked about the Scarab Competition, G. E. Wright explained the future campus plan and Prof. I. L. Peterson concluded with the responsibilities of Scarab.

For this year Scarab fraternity selected the following candidates for membership. Landscape department: J. E. Kell, '27, H. E. Platt, '28; architecture: M. E. Grogan, '27, G. S. Keith, '26, W. P. Kramer, '26, W. C. Jones, '27, E. W. Vollintine, '26; architectural engineering: C. N. Bullard, '27, G. M. Butzow, '27, R. T. Reichel, '27, J. W. Ruettinger, '27, W. B. Rude, '27, E. M. Stephens, '27, W. W. Weeks, '26, J. W. Gregory, '27, W. L. Edholm, '26, F. Confer, '27, and F. M. Lescher of the faculty.

Mu San

Mu San, professional municipal and sanitary engineering fraternity, held a dinner and business meeting for the election of officers on March 18, 1925. The officers elected were C. V. Erickson, '25, president; H. E. Schlenz, '27, vice-president and treasurer; and H. A. Vagtborg, '26, secretary. During the month of April two business meetings were held in which plans for the remaining part of the year were discussed.

Mu San announces the pledging of Prof. V. R. Fleming and C. L. Hopper, '27.

Keramos

Keramos initiated the following men the evening of April 29: Mr. E. G. Bourne, of the department staff, W. H. Halloin, '25, C. L. Thompson, '26, K. B. Strong, '26, Charles Wolfe, '26, J. G. Baer, '26, A. G. Roeske, '26, W. D. Kimmel, '26, R. G. Mills, '26, J. S. Geiger, '26, J. P. Breen, '27, and G. G. Hohman, '27.

Here's to the picture on my desk,
Here's to the other picture on my desk;
May they never meet!


FBR

Phi Eta Sigma

Twenty-eight engineers, two less than last year, are eligible on a basis of their grades for their freshman year, to Phi Eta Sigma, freshman honorary society. As was the case last year, the Engineers make up over thirty-five per cent of the total eligibilities, this, indeed, speaking well for the scholastic ability of the men of our college. To be eligible one must have made an average of 4.50 the first semester of his freshman year.

J. P. Breen, cer. '27, R. S. Doak, e.e. '27, M. M. Gerber, c.e. '27, and G. G. Hohmann, a.e. '27, have an average of 4.5 for their first year in the university starting the first semester of 1923. These were formerly associate members but are now eligible for initiation. K. B. Johnson, arch. '28, and S. Soga, c.e. '27, entered the second semester 1923-1924 and have an average of 4.5 for their first semester in school.

Engineers entering the university the first semester of this school year either without credit or with less than twenty hours of transferred credit and who have an average of 4.5 for the first semester are: A. C. Baumann, e.e.; H. C. Bear, gen.; W. M. Bertholf, cer.; G. E. Buchanan, phys.; L. E. De Turk, a.e.; W. G. Greubel, a.e.; R. G. Hart, c.e.; F. E. Holmstrand, e.e.; V. P. Jensen, c.e.; G. R. Just, m.e.; H. W. Knerr, c.e.; R. F. Lotz, m.e.; E. F. McDonald, e.e.; N. R. Miller, c.e.; E. B. Noel, e.e.; M. Rebuffoni, e.e.; J. C. Springer, e.e.; E. W. Suppiger, c.e.; E. F. Todd, m.e.; R. H. Tull, e.e.; G. H. Turner, m. and s.e.; and E. T. Wheeler, cer.e.

Pi Tau Sigma

Pi Tau Sigma, national honorary mechanical engineering fraternity held formal initiation and banquet at the Inman Hotel Thursday evening, April 29, 1925.

G. S. Mican, '25, acted as toastmaster. R. B. Hall, '25, president, gave the address of welcome which was responded to by S. I. Rottmayer, '26. Prof. A. C. Willard, Prof. J. A. Polson and A. H. Heineman also spoke. Mr. H. O. Croft, the new honorary member, spoke on "Incentive in Engineering."

Mr. W. L. Abbott, chief operating engineer of the Commonwealth Edison Company and for eighteen years a trustee of the University, was unable to be taken into membership at this time, due to illness.

The new members are: Mr. H. O. Croft, S. I. Rottmayer, '26, J. F. Luhrs, '26, R. H. Stone, '26, W. E. Schroeder, '26, R. C. Hageman, '26, R. W. Shields, '26, E. D. Ponzer, '26, G. Banister, '26, W. W. McIlwain, '25, I. O. Sklovsky, '25.

H. E. Wessman and *E. C. Hartman*, both c.e., '24, have been selected as the first two students in civil engineering whose names will be placed on the Ira O. Baker tablet. This honor is awarded them for scholarship and student activities.

R. W. Booze, e.e., '12, is doing engineer work for the Illinois Power and Light Corporation. His present address is 1533 Illinois Merchants' Bank Building, Chicago.

The civil engineering library of the late *John A. Ockerson*, c.e., '73, has been presented to the University. Mr. Ockerson was a noted authority on the Mississippi River.

G. E. Tebbets, c.e., '99, is at the Richmond, Virginia, office of the Chesapeake and Ohio Railroad.

Thos. Wray, e.e., '00, is manager of the home distributing shops of the Western Electric Co. His present address is 718 North Lombard Avenue, Oak Park, Illinois.

Modern Water Softening and Iron Removal Plant for Springfield

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chemicals required. Three lime bins, each having a capacity of two car loads, are to be filled with crushed quicklime delivered in carload lots. The cars will be unloaded by a power shovel into a hopper from which the lime will be taken to the bins by means of a bucket elevator and screw conveyor. From the bins the lime will be handled by gravity to the weigh hoppers, lime slakers and, mixing tanks. Alum will be stored on the second floor of the head house. It will be taken to the second floor by means of a hydraulic elevator. The alum will be fed into the dosing well by dry feed machines. The head house also contains a large chemical laboratory, office and chlorine room.

In times of extreme high stages of the Sangamon river the flood water will rise within about four feet of the top of the basins and first floor of the buildings. This fact and the waterbearing sand foundation at the site of the plant gave rise to many unusual structural features.

The clear well, a box-shaped structure one hundred and eighty feet square, is covered with eight feet of earth to balance the bouyancy of the ground water with the reservoir empty during high stages of the river. The floor and roof are of a heavy flat slab design. Shear in the concrete and bond between the reinforcing steel and concrete were controlling factors in the stress analysis.

An inverted continuous beam and slab foundation is used to support the head house. Four continuous beams, two being four spans long and two three spans long reach sixty feet across the entire length of the building. The beams are fifty-five inches deep and have an average width of about forty inches. The space between beams is spanned by a twenty-one inch reinforced concrete slab over which sand fill is placed to the depth of the beams. A four-inch slab over the fill forms the basement floor of the head house.

The filter house is a one story building and extends deep into the ground, especially along the central pipe gallery. Hence, the hydrostatic uplift due to ground water is very great. The floors of the filters are beamed in such a way that the weight of the sand in the filter beds is utilized in holding down the pipe gallery. At the center of the building, just back of the front entrance, two counterfort anchors, each twenty feet long, extend eighteen feet into the ground below the pipe gallery floor. These anchors are constructed to counteract the uplift on this portion of the building.

Arch bridges, over each of the clarifiers to support the mechanism for driving the sludge rakes, are a marked departure from the usual type of installation. The structures are through bridges, having the horizontal component of the arch thrust taken up by horizontal tie rods. The floor is suspended from the arches by reinforced concrete hangers.

Construction of the waterworks improvements for Springfield have been in progress since the first of the year. The design and supervision of the work is under the direction of the Burns & McDonnell Engineering Company.

Art: "Are you doing any work in the nude these days?"

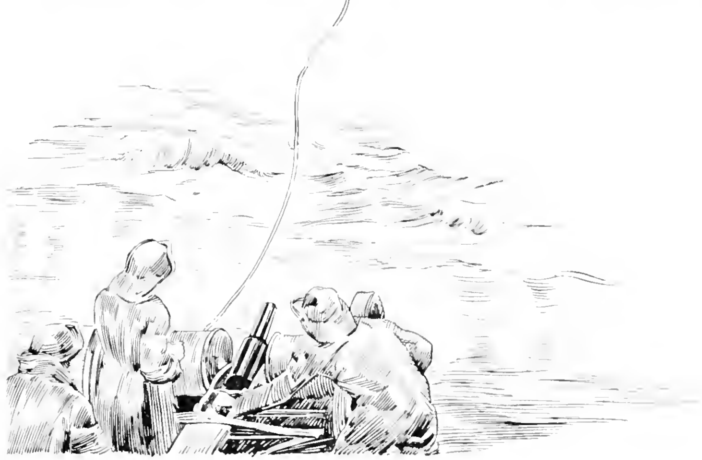
Tist: "No, but I will soon if I don't sell some of my pictures."—*Minnesota Techno-Log.*

Father: "Remember, son, beauty is only skin-deep."

Son: "That's deep enough for me. I'm no cannibal."—*The Ohio State Engineer.*

A Virginia gentleman of color tells us that he doesn't hit his wife any more since he got fined in police court.

"Noosah, from now on when dat wife zassperates me, I'se gwine kick her good—den she can't show it to the judge."—*The Michigan Technic.*



Physical Significance of Hardness

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other crystals gave readings as high as 10; in some cases such variance was noted for crystals side by side. This was further verified by testing a transverse section of cold rolled steel shafting. The Rockwell readings showed a gradual increase from the center toward the outside, whereas the Brinell tests showed the same hardness across the section. This partially explains the lack of consistency between Rockwell readings as compared with the Brinell; the difference being due to the fact that the Rockwell "C" scale indicates the hardness within a comparatively small area tested, while the Brinell with its comparatively large ball gives an average,—what might be called an integrated reading, over a fairly large area.

The accompanying curves* show, the correlation between the Brinell hardness number and three other popular hardness tests, also the relation between the ultimate tensile strength and the Brinell number. These curves may not be conclusive because of the few specimens tested, but they prove that the hardness number is a general index of the ultimate strength and that there is some relation between the various hardness tests as used today.

Since strength and hardness are, in general, dependent properties, hardness tests form a convenient method of estimating the tensile strength of machined or other parts from which it would be impossible or not feasible to cut a test specimen. After experience has demonstrated the kind of material to be used for a given service and the treatment to be given the material, a hardness test may be used as a "control" test to insure the correct material and proper heat treatment and thus form a convenient way of determining whether the desired properties are being obtained.

With the present and increasing competition among manufacturers, it is essential that their products be turned out uniformly and up to a given standard for hardness or temper. The product can be checked with a standard only by means of a testing machine that will give reliable results. The service which the machine will render depends upon the judgment and care of the operator in its operation and maintainance. File tests, fracture tests or rebound tests are fairly satisfactory in certain cases. But if a heat treater were told to temper an article to "file readily," it would not have a fixed value or even one varying within close limits; also the property of the article to "file readily" would be greatly influenced by the type of file used and the operator using it.

There are enough and to spare of so-called "hardness tests" and nothing can probably be gained by devising any more. If a certain Brinell number, scleroscope number, Rockwell number or scratch which is found to be associated with the quality of the material which is satisfactory for a certain purpose, then the particular number or width can be used as an acceptance test for the material. In spite of all efforts which have been made to justify the several tests by scientific considerations they still remain empirical determinations of an unknown quantity. If hardness is wanted in a material for the resistance of abrasion, the amount of abrasion produced under given conditions is the only true measure of the kind of hardness required. If penetration is to be resisted, as in the case of armor plate, some kind of penetration or indentation test is suggested. If, on the other hand, hardness is taken as an indication of tensile strength or of chemical composition, it is surely better, whenever possible to determine these properties directly.

For a number of years various experimenters have tried to find a correlation between physical hardness and magnetic hardness, as measured by the action of the material in a strong electrical field, especially for iron and steel. This is still a live issue and may eventually prove the solution to the hardness question.

The ease with which certain so-called tests of

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Physical Significance of Hardness

(Continued from Page 214)

hardness can be applied to finished material without injuring it, and the numerical results obtained, tend, by reason of their attractiveness ,to disguise the fact that hardness is an unknown quantity and is one which may or may not be correlated with the properties desired. The subject of hardness will probably never be put on a scientific basis until the physicist has come to some agreement as to what property of the molecules or combination of molecules gives this quality to a material.

*Data obtained in the Laboratory of Applied Mechanics, University of Illinois, under the direction of Prof. H. F. Moore.

Langley Aeronautical Laboratory

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An apparatus has been devised which records every movement of the "joy-stick," or operating lever, and also the forces exerted upon it. Comparisons of controllability and maneuverability may thus be investigated scientifically. Other instruments which have been developed at the laboratory are accelerometers, gyro-turn indicators, chronometers, and stability indicators.

Considerable high altitude work has been done by the flight test division. Super-chargers have been used in this connection. A super-charger is a device which compresses air and supplies it to the engine to compensate for rarity of atmosphere at high altitudes. The laboratory has produced a successful super-charger based on the Roots cyloidal blower principle. Altitudes of 34,000 feet have been attained by means of this super-charger.

The flight test division has thirteen airplanes of ten different types for test purposes. Two regular pilots and six mechanics are maintained for the work. The Air Service at Langley Field and the Naval Base at Norfolk, Va., also co-operate with the laboratory.

The National Advisory Committee for Aeronautics has achieved results of which the nation should be proud. Aircraft are indispensable for military purposes and it is hoped that in the future the commercial and transportation value of aviation may continue to increase. Research shall always accelerate our progress in the conquest of the air.

WILLING

The bargaining for the cow had been going on leisurely for an hour. Finally the prospective purchaser came flatly to the point.

"How much milk does she give?" he asked.

"I don't rightly know," answered the farmer who owned her. "But she's a durn good-natured critter, an' she'll give all she can."

—*American Legion Weekly.*

Illinois Central Electrification

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Along a portion of the South Chicago Branch, bed rock occurs within several feet of the surface of the ground. At certain other locations, the natural ground is too hard and compact to permit driving the 24-inch shell satisfactorily. At still other locations, it is impracticable to use a work train on account of the present tracks not being sufficiently close to the foundation locations or it not being feasible to vacate desired tracks.

At such locations, shallow rectangular side bearing or gravity type foundations are being used. Loads are such that for two track brackets construction the gravity foundations have a length across track of 12-feet, and contain about 7½ cubic yards. An equivalent side-bearing foundation contains about the same yardage and has a bearing area of about 65 square feet, maximum working earth pressures being taken at 5,000 pounds per square foot. The gravity type is generally preferabel where track spacing permits its installation without shoring the tracks.

A concrete mix of 1 : 2 : 4 is used for the driven foundations and caps of dug foundations. A 1 : 3 : 5 mix is used in the body of the dug foundations of large sections.

Underground Conduit

North of 70th street, an underground conduit line is being installed to carry telegraph, telephone and signal wires and other miscellaneous circuits such as supervisory control for sub-station and tie-station operation. This will ultimately be extended to Kensington (115th street).

The line is vitrified clay conduit, encased in concrete. It contains eight ducts. Man-holes are spaced at intervals of approximately 500 feet, with additional man-holes where man-holes are not adjacent to signal bridges or other outlets. Pre-cast reinforced concrete man-holes are being used throughout. In view of the fact that some of the man-holes are being installed between tracks with 13 foot centers, the pre-cast form is especially advantageous and economical. In order to use a minimum number of different types of man-holes, they have been cast with a thin section of suitable size in each side, which may be knocked out to provide for present or future laterals. At some sections of the line, on account of the low level of the road-bed adjacent to Lake Michigan, the man-holes are provided with drainage by connection to a net work of drainage lines installed for the roadway.

Annealing Copper Wire

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nace operator exact data for adjustments to make for the various classes of work to be annealed.

By these tests, experiments, changes in design, and from a study of all data as the experiments progressed, the engineer in charge, whose order was to produce bright annealed wire, was turning out annealed copper wire which was equal in brightness to the hard wire supplied to him.

The successful completion of this furnace permitted unlimited production of wire in the mill due to the storing quality of the dry wire. As a result, estimates were started on a similar furnace of a much increased capacity. New problems again confronted the engineer; this time involving the extensive floor space required for such a furnace. Underground cooling tubes, and vertical charging mechanisms had to be considered, thus showing the extent of engineering problems in what may be thought to be a simple annealing process.

Lady: "Which end shall I get off at?"

Conductor: "It's all the same to me, lady, both ends stop."

She: "So you've been deceiving me."

He: "Why, what do you mean?"

She: "No, don't attempt to deny it. I saw a memorandum on your desk to buy new ribbons for your typewriter."

"What did your father die from?"

"Throat trouble."

"Oh, yes, I remember now. They hung him."

"I have the whole explanation in a nutshell," said the prof.

"I suppose he means his head," muttered the stude.

A multi-millionaire, as he climbed into his limousine, snarled at a newsboy:

"No, I don't want any paper. Get out."

"Well keep your shirt on, boss," the newsboy answered. "The only difference between you and me is that you're makin' your second million, while I'm still on my first."

A Londoner was coming out of the gate after viewing his first baseball game, when he was stopped by a newsboy. The American scoreboard had recorded that both teams had made a run in the first inning and hadn't scored since.

"Say, Mister, what's the score?" cried the newsy.

"Really, I don't know," came the reply. "But it was some place up in the millions when I left."

The Senior on Employment

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graduate is a new tool with a cutting edge and he wants the place to use it to the best advantage where the results of his labors will be appreciated. In return from those four years he feels entitled to a keener consideration from the man higher up, because he is potentially capable of greater things, else why the educational process?

One works well because of the incentive of progress. A man out of college is not afraid to work and get his hands soiled if he can see the future attached to his labors. The positive knowledge of this future, however, is not always clear, and human faith particularly in an inanimate corporation has its limitations. Too often a young man works hard for a few years to become discouraged and quit, because it seems that a man in industry is in need of distinct self-advertising powers to get ahead. Industry seems satisfied to train men that they may be overlooked. How often do we read the biographies of great executives who tell us that they constantly scan their employees for future leaders? How often are potential leaders overlooked by these same executives?

In summing up, if the senior obtains a job in the field of his major interests with a progressive and sound company, and if his merit is watched so that he moves up in accordance with his ability which is trained by education and responsibility, his future with a bit of hard work should be assured.

UNBELIEVABLE

Hogan: "An' what's me temperature today, ma'am?"

Nurse: "One hundred and a half."

Hogan: "Will ye listen to that? An' in the dead o' winter too, bedad!"

ANOTHER CHANCE

Professor (in the middle of a joke): "Have I ever told the class this one before?"

Class (in chorus): "Yes."

Professor (proceeding): "Good! You will probably understand it this time."

INDUSTRIAL LIGHTING CODES.

In order to protect workers from accidents and eye sight damage, no less than five states, New York, New Jersey, Pennsylvania, Wisconsin and Oregon have now in force lighting codes for industrial establishments. Other states are now considering the adoption of an industrial lighting code, and it seems only a question of time when all the states will adopt such a code.

Proper lighting of work places is not only of great importance to the operators working therein, directly affecting their safety and eyesight, but it is a factor of equal importance to the employer, as quality and quantity of output are deciding factors of profit or loss in the operation of the plant.

The introduction to the Wisconsin code reads as follows: "Insufficient and improperly applied illumination is a prolific cause of industrial accidents. In the past few years numerous investigators, studying the cause of accidents, have found that the accident rate in plants with poor lighting is higher than similar plants which are well illuminated. Factories which have installed approved lighting have experienced reductions in their accidents which are very gratifying.

"Of even greater importance, poor lighting impairs vision. Because diminution of eyesight from this cause is gradual, it may take the individual years to become aware of it.

"This makes it all the more important to guard against the insidious effects of dim illumination, of glaring light sources shining in the eyes, of flickering light, of sharp shadows, of glare reflected from polished parts of work. To conserve the eyesight of the working class is a distinct economic gain to the state, but regardless of that, humanitarian considerations demand it.

"Finally, inadequate illumination decreases the production of the industries of the state, and to that extent, the wealth of its people. Factory managers who have installed improved illumination, are unanimous in the conviction that better lighting increases production and decreases spoilage."

The Wisconsin Commission has adopted a rule to the effect that, "diffusive or refractive window glass shall be used for the purpose of improving day light conditions or for the avoidance of eye strain, wherever the location of the work is such that the worker must face large window areas, through which excessively bright light may at times enter the building."

A glass is now available which meets the above requirements. It properly diffuses the light and prevents sun glare passing into the building and is known as Factrolite.

Engineers of to-day are making a thorough study of illumination, so that they may be able to plan and lay out industrial plants, to scientifically increase their efficiency to as near the maximum as possible. This accomplished the engineer is not only doing something worth while for his employer, but is doing quite as much for himself by coming into prominence with modern ideas.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

220 Fifth Avenue,

St. Louis. New York. Chicago.

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