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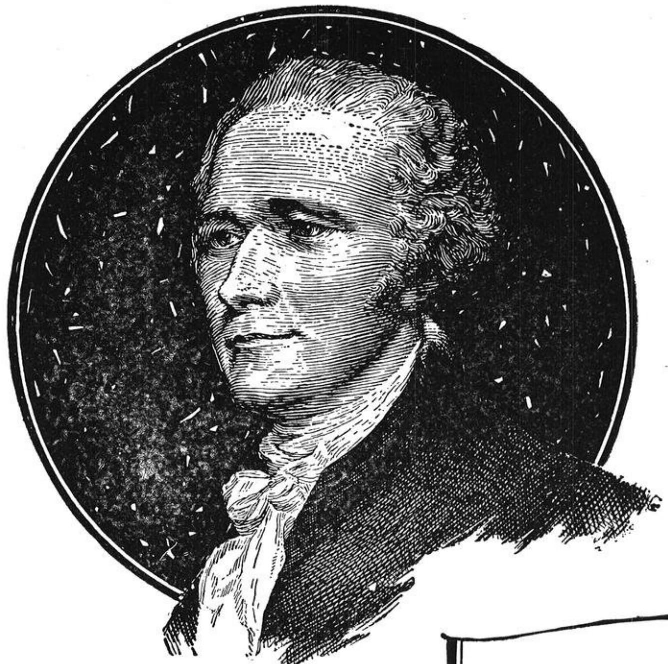

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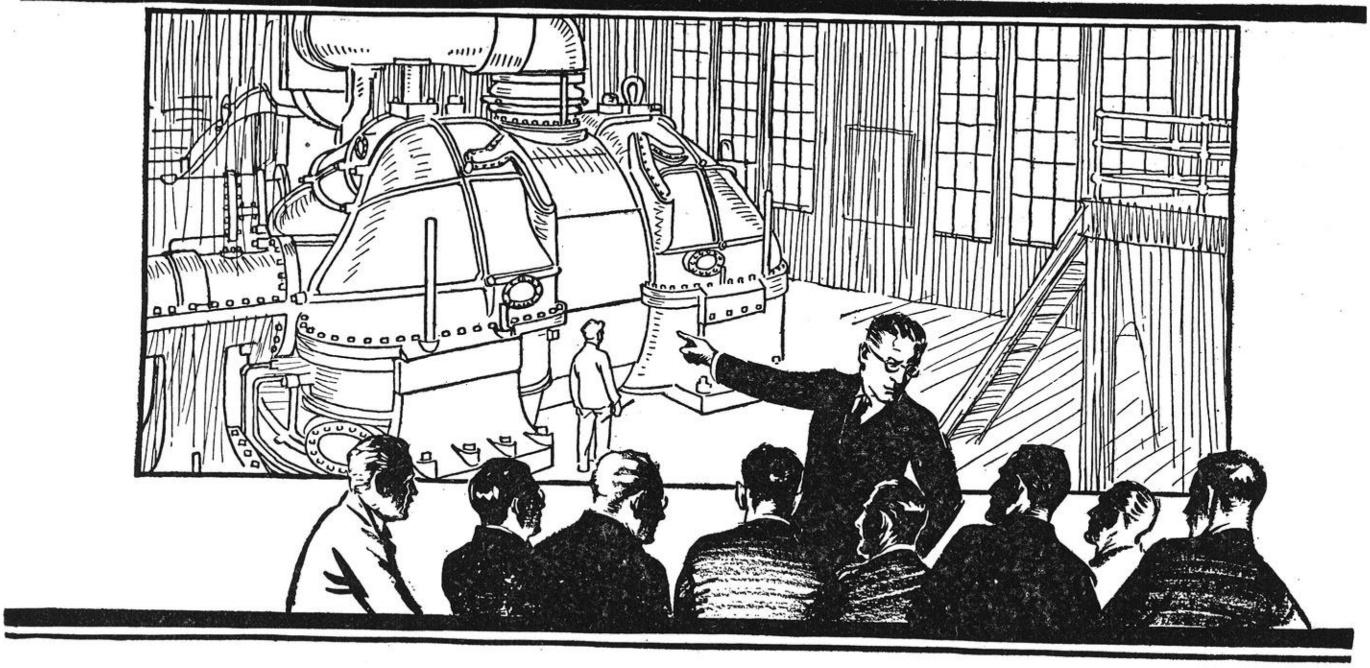


The Wisconsin Engineer

UNIVERSITY OF WISCONSIN

VOL. XXVII, No. 8 MADISON, WIS. MAY, 1923

THE UNIVERSITY HEATING SYSTEM

By Gustus L. Larson

Professor of Steam and Gas Engineering

AND

John J. Novotny

Chief Operating Engineer of Heating Plant

Very few of us fully realize the growth and extent of the university, the many and varied problems met by the regents in providing the necessary buildings, equipment and other facilities, and the daily problems involved in maintaining these efficiently and economically.

At present there are 113 university buildings on the campus, including the new State of Wisconsin general hospital which is now under construction. Seventy-one of these buildings receive their heat from the cenral heating station located on University Avenue. The others, if heated at all, receive their heat from small, isolated heating plants located in or near the respective buildings.

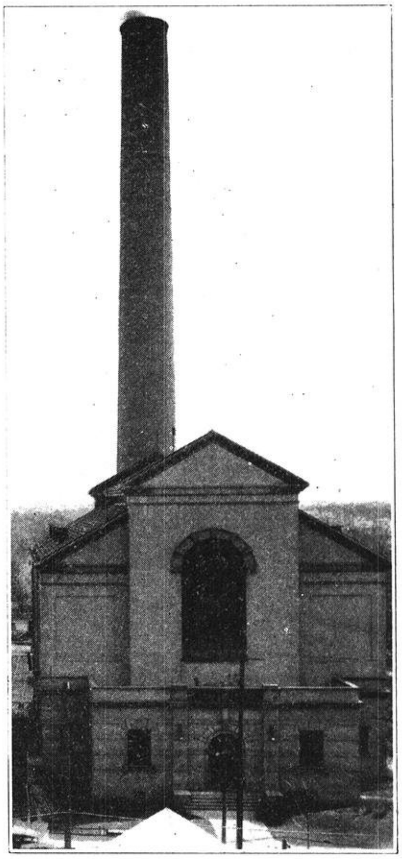
The average student or professor on the campus gives little thought to the matter of how the heating of his class-room or office is accomplished, and few, if any, have any real conception of the thought and care required in economically keeping all the buildings of such a large institution at a comfortable temperature under all conditions of weather. This article is written with the hope that a discussion of this problem may prove of general interest.

Historical Sketch.

In order that some of the features relating to the subject under discussion may be better appreciated, a diagram has been prepared (Fig. 1) showing the cubical contents of buildings and the square feet of equivalent radiation at the university in the chronological order of the construction of the buildings. The curve of student enrollment from 1899 up to the present time is also shown on this figure.

Previous to 1885 the heating was obtained from stoves, furnaces, and other systems in the separate buildings, and data covering that period is not of immediate interest.

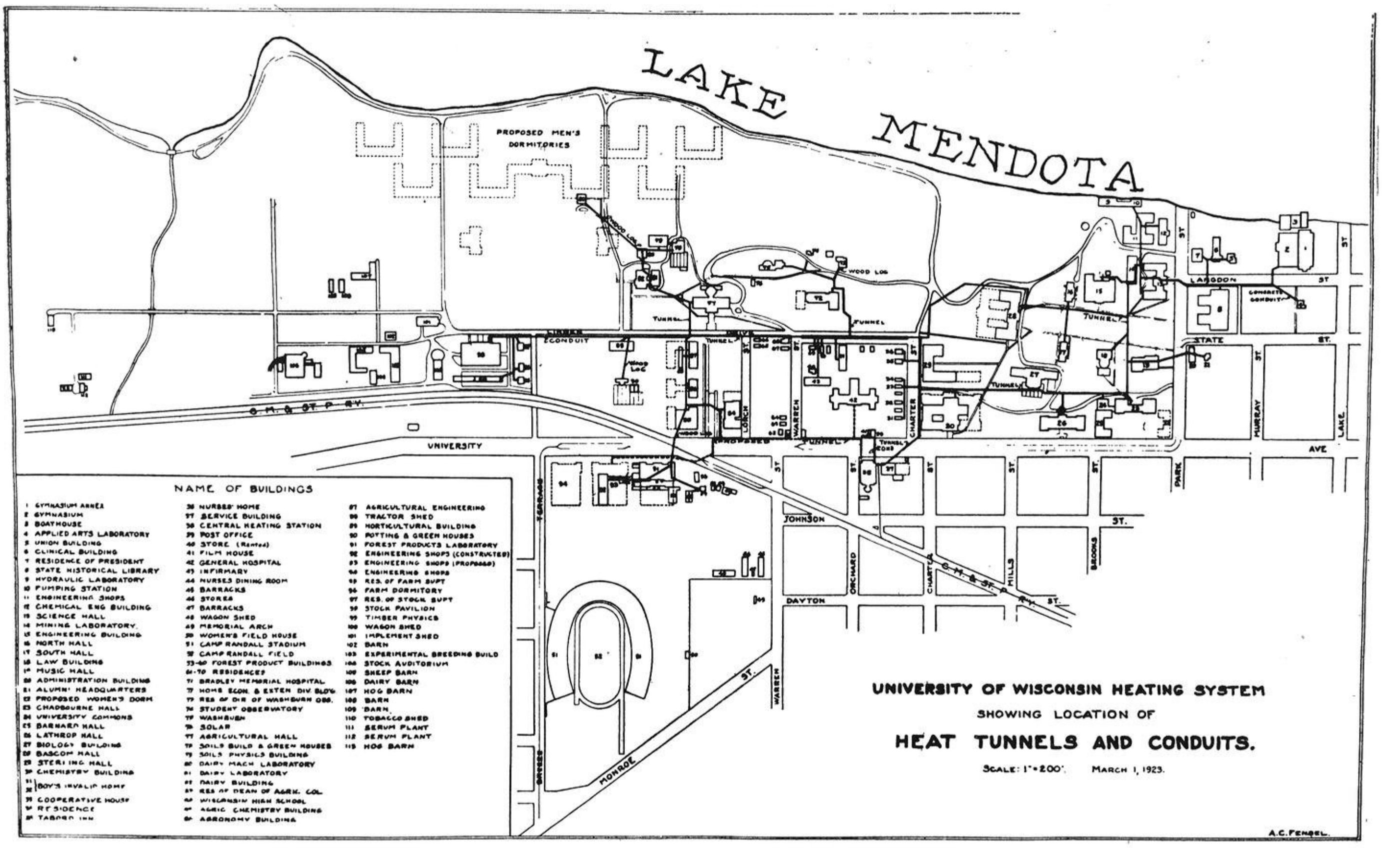
Professor Storm Bull, one time professor of steam and gas engineering, was identified with the work of the heating plant from about 1890 until his death in 1908, and the successful solution of the problems met during this period, and the plans for our present heating station and equipment are the results of his work. Upon the death of Professor Bull, Professor H. J. Thorkelson, then associate professor of steam and gas engineering, became consulting engineer for the heat and water department of the university. The heating station as it now stands was completed under Professor Thorkelson's direction. He showed a ready grasp of the problems involved and he established such a record in the administration of his duties that the regents naturally turned to him when they were seeking a new business manager for the university in the fall of 1914.



The University Heating Station. *It was put into operation in 1908 and heats 71 of the 113 university buildings.*

The map shown herewith gives some idea of the general layout and the length of the heat transmission lines at the university. The length from east to west is over one mile. The left hand, or western group, is used by the College of Agriculture and the right hand, or eastern group, by the other colleges of the university.

What is now the mining and metallurgical laboratory (building No. 14 on map) was the original central heating station. It was erected in 1885 and was enlarged twice before being finally abandoned for the present station. The plant, when first constructed, was connected to only a few of the university buildings; later, it was extended in size and capacity and connected to other buildings. In fact, it was not until 1898 that all the buildings on the eastern or upper cam-



pus were so connected. The first boilers installed were 50-horse-power units, but, as additions were required, larger and larger sized units were selected, and when, in 1906, the installation of more and larger units in the steam, electric, and hydraulic laboratories necessitated more boiler capacity, it was decided to purchase a 350-horse-power water-tube boiler. This boiler was removed to the present central heating station in 1908 and four additional boilers of the same capacity were installed there. It may be of interest to note here that the original 350-horse-power boiler above mentioned is to be scrapped this summer to make room for a larger units of 546-horse-power.

The present dairy machinery laboratory (building No. 80 on map) was originally erected as a heating station for the college of Agriculture in 1896.

Present Heating System

The two old heating stations above mentioned were well located for the purposes intended, but the present heating station is fully as centrally located for its work and has the additional advantage of railroad facilities, effecting a saving of perhaps 50 cents a ton for hauling coal. As the university consumes over 20,000 tons a year, this item of itself is quite important.

The present plant contains nine 350-horse-power Babcock & Wilcox water-tube boilers with space at the present time for one additional boiler of the same capacity.

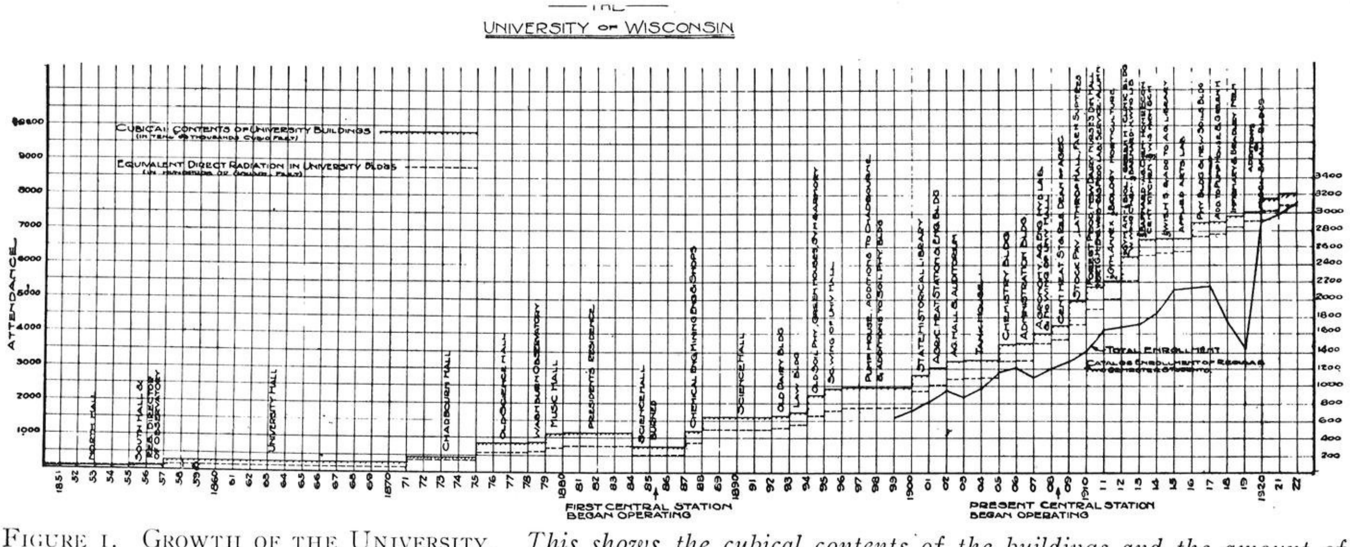


FIGURE 1. GROWTH OF THE UNIVERSITY. *This shows the cubical contents of the buildings and the amount of equivalent radiation in the chronological order of installation.*

The steam is generated at 150 pounds pressure and is distributed at that pressure to the university pumping station, steam and gas engineering laboratory, forest products laboratory, and several other points where high pressure steam is needed for power purposes. The steam used for heating the buildings is reduced at the station from 150 pounds to pressures varying from 10 to 1 pound depending upon the weather conditions. The pressure in the heating mains is regulated so as to have at least one pound pressure at the buildings farthest from the heating station. There is a gauge at the university gymnasium (building No. 2) which electrically records its pressure at the heating station. The pressure at the heating station is regulated according to the reading of this gage.

The heating station chimney, which is of Custodis brick construction, is 250 feet high and 14 feet in internal diameter. It is designed for an ultimate capacity of 6000 boiler horse-power. This is sufficient to serve twice the boiler capacity that the present station now contains. It was the intention of the original designers to duplicate the present station on the south side of the stack whenever it became necessary to go beyond the capacity of the existing plant. This plan probably will not be followed out as the development of modern automatic stokers will make it possible to develop the full capacity of the chimney in the existing station. This chimney has been called the "10,000 student chimney," the basis for its design being that it should be of sufficient capacity to serve the heating station in the not far distant future when there will be 10,000 students enrolled in the University.

The fuel burned is Illinois coal, usually from Franklin or Williamson Counties. This coal contains 30 per cent or more of volatile matter, making smoke prevention very difficult. The Roney stokers which now feed the boilers were the best to be obtained at the time the plant was built, but there has been remarkable progress in the art of building stokers during the last decade, and the present equipment will be replaced by more modern stokers as rapidly as conditions will permit.

The main heating lines, shown in the map are in concrete or brick tunnels which vary in cross section from 7 x 7 ft. to 6 x 6 ft. Branch lines, running from the main tunnels to the buildings, are laid in concrete conduits of a size just sufficient to accommodate the pipe.

There are, on the campus, approximately two miles of tunnel large enough to walk in, and over a mile of concrete conduit. These tunnels and conduits contain approximately 10 miles of piping ranging from 16″ to ½″. The larger tunnels, including piping complete, cost about $20.00 a foot before the arrival of our present high prices. Recent estimates on proposed new tunnels show a cost of approximately $50.00 a lineal foot.

Operating Records

Fig. 2 reveals an interesting record of economical operation. From the year 1912-13 up to the present school year, the radiation connected to the heating station increased from 233,000 to 308,000 sq. ft., or 32 per cent. The cubical contents of buildings connected

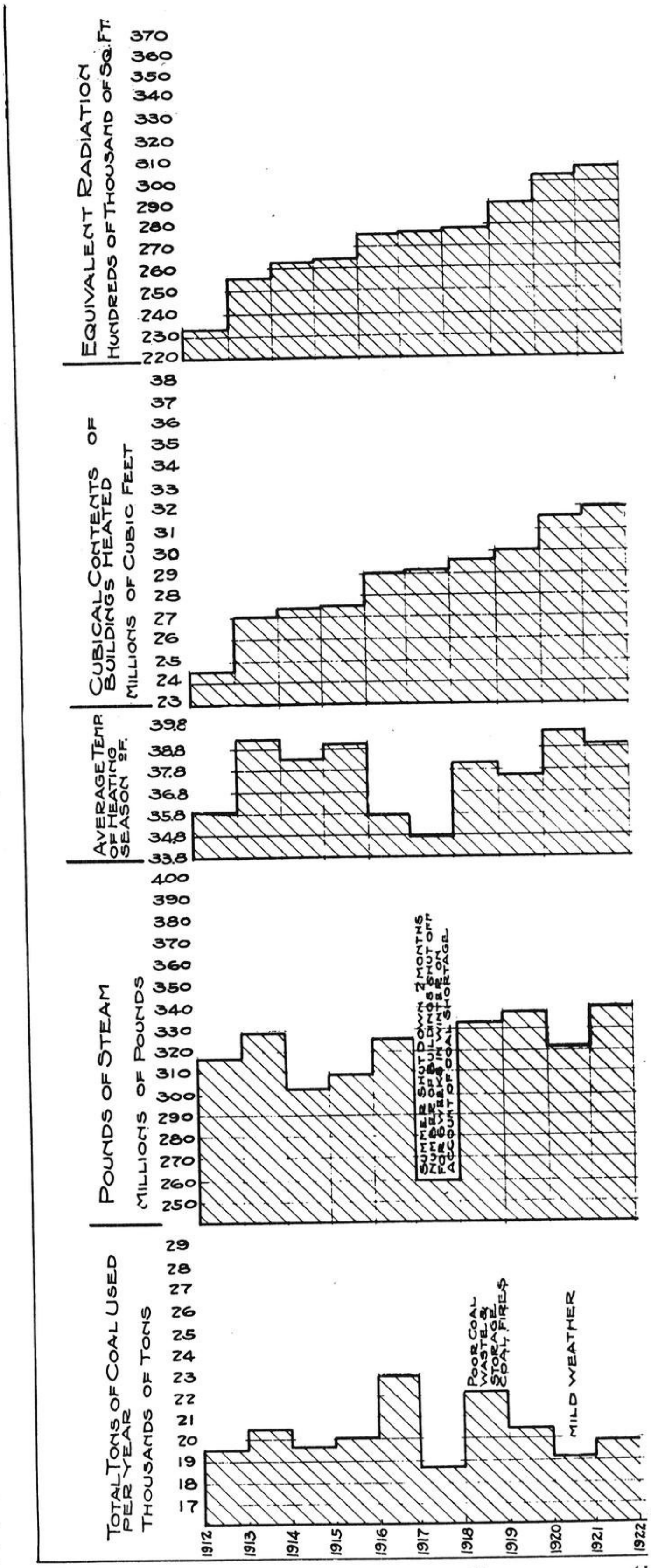


FIGURE 2. A RECORD OF ECONOMICAL OPERATION. *Although the cubical contents of buildings connected to plant and the surface of radiation have increased 31 and 32 per cent respectively, the coal consumption has remained stationary.*

to the plant increased in that same time from 24½ million to 32 million cubic feet, or 31 per cent. It will be seen, however, that the tons of coal burned have remained practically the same.

The school year 1912-13 had a considerably lower average temperature during the heating season than the year 1921-22, and a more true comparison would be between the years 1913-14 and 1921-22, since these two years had approximately the same average temperature during the heating season. This latter comparison reveals the interesting fact that, while the load on the station was 17 per cent greater in 1921-22 than in 1913-14, the coal consumed in 1921-22 was 2½ per cent less than the amount consumed in 1913-14. Furthermore, the winter of 1921-22 was slightly colder than the winter of 1913-14 as will be seen from the temperature chart on Fig 2.

YEAR	1918-1919	1919 1920	1920-1921	1921-1922
SQ. FT OF CONNECTED EQUIVALENT RADIATION	278,907	290,399	303,816.75	307,648
TOTAL GROSS CUBICAL CONTENTS	29,347,612	30,236,510	31,641,878	32,013,233
CUBIC FT PER SQ. FT OF RADIATION	105	104	104	104.2
TOTAL COST OF HEAT & WATER	$183,460.49	$206,820.90	$215,975.57	$199,868.57
RATIO OF THE HEATING LOAD TO TOTAL LOAD	79%	79%	76.42%	73.1%
AMOUNT CHARGEABLE TO HEATING ONLY	$145,000.00	$163,500.00	$165,048.55	$146,103.92
COST PER SQ. FT OF RADIATION	$0.52	$0.564	$0.546	$0.476
TOTAL NUMBER OF STUDENTS IN ATTENDANCE	4176 A	7294 A	7471 A	7756 A [illegible] B [illegible] C
COST OF HEATING, PER STUDENT A PER TOTAL COST	$43.90	$28.40	$28.90	$25.80
TOTAL POUNDS OF STEAM EVAPORATED EACH YEAR	333,220,360	336,999,300	320,237,980	339,233,529
TOTAL COST PER 1000 POUNDS OF STEAM	$0.55	$0.6150	$0.6744	$0.59
TOTAL STEAM PER SQ. FT. RADIATION PER SEASON	942	905	805	808
AVE. CONDENSATION PER SQ. FT. RADIATION PER HR. (ESTIMATING 8½ MO. OR 260 DAYS)	.162 lbs.	.152 lbs	.129 lbs	.1292 lbs
ACTUAL TONS OF COAL BURNED PER YEAR (AVERY AUTOMATIC SCALES)	22,162	20,429	19,183.35	19997.15
TOTAL COST OF COAL ACTUALLY BURNED AVERAGE COST PER TON	$93,000.00 $4.20	$104,450.00 $5.12	$114,524.60 $5.97	$112,000.32 $5.61
COAL COST PER 1000 POUNDS WATER EVAPORATED	$0.279	$0.31	$0.357	$0.33
POUNDS OF COAL BURNED PER SQ. FT. RAD PER YR	125.5	111.0	96.5	95.0
POUNDS OF COAL BURNED PER CU FT OF BUILDING	1.195	1.07	.927	.91
AVE. POUNDS COAL PER B.H.P. DEVELOPED (ASSUMING 31 lbs PER H P.)	4.12	3.75	3.71	3.65
AVE lbs OF COAL BURNED PER SQ. FT. GRATE PER HR.		20.251	20.767	19.66
AVE. TEMPERATURE DURING HEATING MONTHS (260 DAYS, SEPT 15 TO JUNE 1	39.9°F	35.6°F	42.5°F	39.01°F
AVERAGE POUNDS OF STEAM PER POUND OF COAL	**7.52**	**8.26**	**8.35**	**8.48**

A - FULL TWO SEMESTER STUDENTS
B - SUMMER SESSION STUDENTS
C - SHORT COURSE STUDENTS

FIGURE 3. DATA SHEET. *Note that the coal burned per boiler horse-power has been reduced, while the water evaporated per pound of coal has been increased. This increase in efficiency is largely the result of the installation of recording instruments.*

How Savings Were Accomplished

These savings were accomplished in two ways: First, by more careful operation in the power station itself; and, second, by stoppage of loss and leakage in the piping system and in the buildings. The increase of efficiency in the operation of the heating station is best shown by the tabulation in Fig 3. Note that in the four years tabulated, the coal burned per boiler horse-power has been gradually reduced from 4.12 pounds to 3.65 pounds, and the pounds of water evaporated per pound of coal have increased from 7.52 to 8.48 by gradual steps. This increase in efficiency is very largely a result of the installation of recording power-plant instruments such as steam-flow meters, recording flue-gas thermometers, feed water meters, etc. These, in conjunction with automatic coal scales on each boiler, made it possible to establish a daily operating chart which reveals at a glance just what is being accomplished from day to day. Thus poor operation is quickly and readily checked, and it has been our experience that men operating the plant take far greater pride in their work when they can actually see the results of their efforts.

The evaporation per pound of coal has also been helped by the fact that the condensation, which was formerly wasted from a number of buildings, has been returned to the heating plant. This has been accomplished during the past four years in such buildings as the stock pavilion, chemical engineering building, clinic and union buildings, pump house, horticultural building, and a number of others. This has resulted in a higher temperature of the feed water entering the boilers and consequently a reduction in the coal required per pound of steam. The installation of water softener for treating the feed water resulted in less scale on the boiler tubes and consequently higher efficiencies. Special attention has been paid to keeping the boilers in the best of operating conditions at all times. Complete efficiency tests on the plant by engineering students has aided greatly in locating sources of loss.

Fig. 2 shows that although the connected load on the plant increased 32 per cent during the ten years shown, the steam generated increased only 8 per cent. This reduction in steam consumption has resulted from repairs on the distribution system and careful supervision of the use of steam in the various buildings.

During the past four years, more than six carloads of pipe covering have been placed on the pipes in the tunnels and other places. Many hot water tanks, which were formerly bare, were covered with insulation and placed under thermostatic control.

Co-operation of the custodians and occupants of

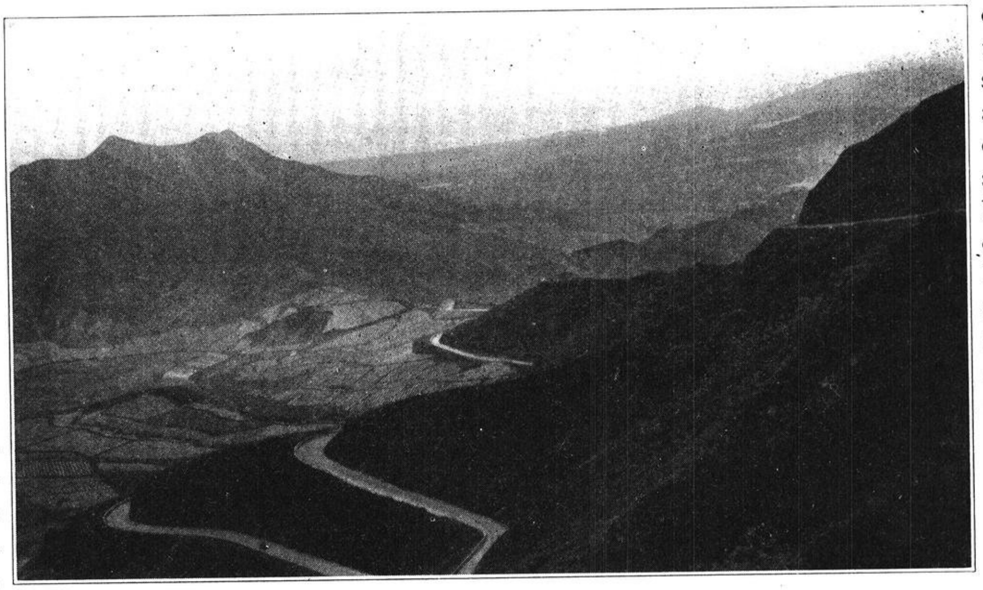
(Continued on page 154)

A TRIP TO THE HAWAIIAN ISLANDS

By F. E. Turneaure

Dean, College of Engineering

My trip to the Hawaiian Islands during the past winter was one of the most interesting I have ever taken. I have traveled quite a bit in Europe, and must say that for a visit of two or three weeks, the Hawaiian Islands is perhaps the most interesting place to visit I have ever seen. Peculiarities of climate, topography, and geology, and of the inhabitants themselves go to make up a combination which presents so many differences from what we are accustomed to that a stay of two or three weeks in the islands is very interesting and enjoyable. The only drawback is the time required to get to the islands. We think of them, perhaps, as being comparatively near our western coast, but, as a matter of fact, it requires more time to reach Honolulu from Madison that it does to reach Liverpool, and the cost is about the same. For my own pleasure, a good deal of the ocean trip might well be dispensed with,—and I am not such a bad sailor at that.



Mountain Road and Pineapple Fields. *One piece of highway now being constructed is costing about $100,000 a mile for bridges, grading and surfacing.*

Our party sailed from San Francisco, December 20, on one of the boats of the Matson line, the principal line operating between San Francisco and Honolulu. This Company furnishes weekly service each way, and has been operating regularly for so many years that it is looked upon by Atlantic navigators as a sort of ferry-boat proposition. We were on the great Pacific six days going over and seven coming back. Not because of our crossing the international date line did this difference arise, but because of the occurrence of a tremendous storm on the return trip, despite the reputation for mildness of temper which the Pacific Ocean has. Our experience was perhaps the exception that proves the rule.

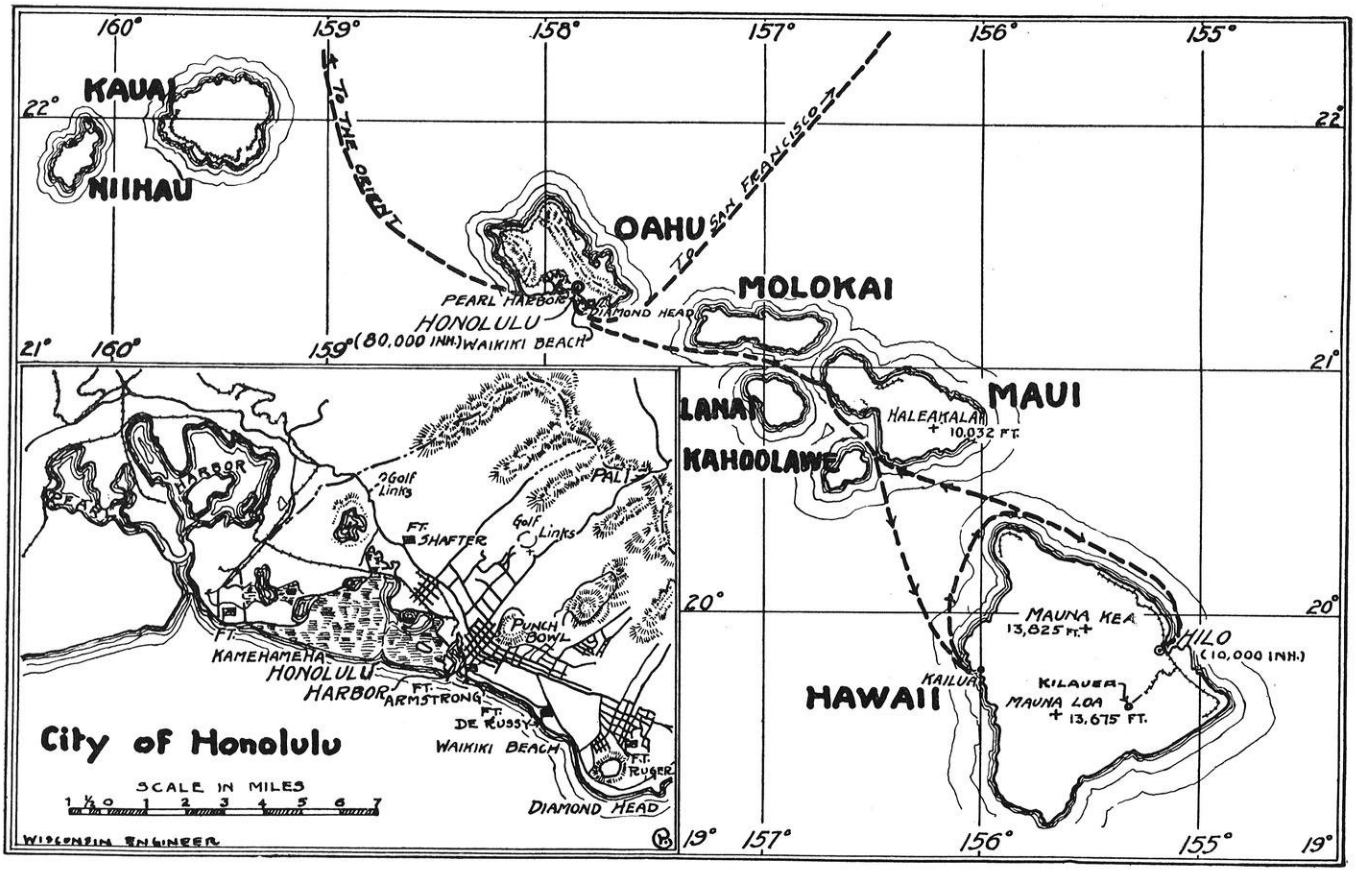
But the trip over was not bad, in spite of the general monotony of sea travel. As Hawaii is the "cross-roads of the Pacific", the passenger list is likely to be made up of considerable variety of races and nationalities, and our group was no exception. Chinese, Hawaiians, English, Australians, New Zealanders, and several other varieties were present. The Matson boats are not noted for their style, everything being very plain and simple; but nothing could prevent our friends headed for New Zealand and Australia from following their ancient custom of dressing up for dinner; they probably would not feel at home otherwise. These English are certainly a stubborn lot. Christmas Day aboard was quite an event. The passengers had already been on board sufficiently long to become well acquainted, and a lively masquerade dance was carried off in good shape, including all sorts of traditional ship stunts arranged by the master of ceremonies. Land was sighted about noon the sixth day in the shape of the round top of a mountain rising above the clouds. This was identified as the extinct volcano Haleakala, on the island Maui, some 10,000 feet high. Diamond Head, the fortified point near Honolulu, was sighted about five o'clock, and we landed about six, with our program already made up for the most economical use of our two weeks' stay.

The Hawaiian Islands are in the tropics, latitude about 20°, about the same as Cuba and Mexico City. The group consists of four main islands lying in a string running N. W.—S. E., with 25 to 40 miles of clear water between successive islands. The largest is Hawaii, from which the name of the group is taken. This is to the extreme S. W. end, and is an island about 100 by 70 miles in size. Toward the northwest is Maui, next Oahu, on which Honolulu is situated, and the most northern is Kawai. The population of the territory is about 250,000, of which 80,000 are in Honolulu, the principal port of the group. Transportation between islands is afforded by side trips of the Matson boats and by an inter-island boat line, with bi-weekly service. A trip on one of these inter-island boats is very interesting from the fact that they are quite small, and on account of the prevailing wind direction, have to travel in the trough of the waves most of the time. The physiological effect is very much the same as crossing the English Channel.

The history of these islands is very interesting indeed. Inhabitated by a race similar to that in the South Seas, the islands were practically unknown until 1778 when rediscovered by Captain Cook, and named the Sandwich Islands. Missionaries came in about 1820, and thereafter other whites came in considerable numbers. The natives were a rather peaceful, good-tempered people, and became civilized very rapidly, so that the islands soon came to be a center of considerable trade, and the cultivation of sugar cane was early introduced. The most important event in the history of the natives which is on record appears to be the unification of the people of all the islands under the great King Kamehameha I in 1795. He and his descendents ruled things pretty efficiently until a Republic was organized in 1894 and the territory finally annexed to the United States in 1898. In the museums of Honolulu are preserved many very interesting relics and other exhibits connected with the history of the islands in the form of household utensils, textiles, feather robes, fishing apparatus, and of paintings and statues of the old ruling family. A fine statue of the aforementioned king occupies a prominent place in front of one of the public buildings.

The Hawaiian Islands are comparatively new, geologically speaking, and are still in the making. They are of volcanic origin, and constitute a big lump in the ocean, rising some seven miles above its bed and about 2½ miles above sea level. Although they are of volcanic origin, the only active volcano is Mauna Loa on the island of Hawaii. Extinct craters are quite common, there being two large ones adjacent to the city of Honolulu,—one Diamond Head, already mentioned, and the other, called Punchbowl, almost in the heart of the city.

Another factor which gives the islands their unique interest is the amount and variation in the rainfall. The islands lie in the trade wind belt of the tropics, where the wind is constantly blowing from the northeast. They are also subjected to heavy rainfall, but on account of the prevailing winds and the mountainous topography, most of the water falls on the windward slopes, so that it easy to pass in a distance of ten miles from a region of heavy rainfall and thick, tropical jungle, to a desert of sand and cactus. The city of Honolulu itself has a varied rainfall, depending upon locality, from about 30 inches to 150 inches per year. The city is located on the windward side of the island of Oahu, which at this place is only about ten miles wide, but has the usual mountain ridge in the middle. The tops of the mountains are nearly always covered with clouds, and more or less rain falls nearly every day. But although the wind blows from the mountains, it is generally unable to bring the clouds with it, as they are apt to disappear before they spread over the city. Frequently it happens in the afternoon that the wind will carry the clouds as far as the center of the



THE HAWAIIAN ISLANDS AND HONOLULU. *The Hawaiian Islands are new land, geologically speaking, and are still in the making. They are of volcanic origin and constitute a big lump in the ocean, rising some seven miles above its bed.*

city, and there will be a light shower, but with the sun still shining on the western side, giving a very beautiful rainbow effect,—"liquid sunshine", as it is called. We observed this interesting phenomenon three or four times in the week we were there. This general rainfall condition prevails in all the islands, with a maximum rainfall of about 500 inches a year near the tops of the mountains in Kauai. One result of this tremendous rainfall on the windward side is a very heavy erosion of the mountains, producing very deep gorges and steep slopes. This condition, however, depends somewhat on the geological age of the island, and the island of Hawaii, with its still active volcano, is comparatively new, so that the erosion there is less than in the older islands.

Honolulu is very largely an oriental city. In a population of 80,000, not more than 20% are whites, the rest being made up of native Hawaiians, Japanese, Chinese, Portugese, Koreans, Philipinos, and a few other varieties. The Japanese constitute nearly half of the entire population. A few of the large stores on the main street are conducted entirely by whites, and some of the banks as well, but on stepping from the main street into the side streets, one finds himself among exclusively Oriental stores. We did not get so far away as to be unable to make ourselves understood, as the business people talk English when they have to, but there is nothing American or European to be seen in many of the streets, excepting a few words in English on some of the shop signs. Honolulu is really a beautiful city. It has many wide streets and boulevards, usually lined with palm trees of several varieties and other tropical species. In our hotel grounds, there were many cocoanut palms, and walking about under the trees on a windy day was not altogether a safe diversion. One of the most interesting parts of the city is the famous Waikiki beach, where the natives ride surf boards and visitors go out in outrigger canoes. It is great fun watching the surf bathers ride in on their surf boards, standing erect and sliding down the crest of a wave for perhaps a quarter of a mile before stopping. The broad beach is due to the existence of a coral reef about half a mile offshore, along the lee side of the island, a condition characteristic of all these islands.

The city is well supplied with public schools, and has a college and a University, the latter attended by about 400 students. A visit to one of the large public schools was a very interesting feature of our program. This school is attended by about 1200 pupils from all the different races in the city except Caucasian. All but about a dozen, however, were native born and prospective voters. It was certainly interesting to see the little Japanese and Chinese children on the exercise ground taking part in the special flag exercise which is carried out once a week, and in which several little speeches are made and the flag is raised while all the children stand at salute. Many of these children hear no English at home, so the school is the only place where they can learn the language. In spite of this

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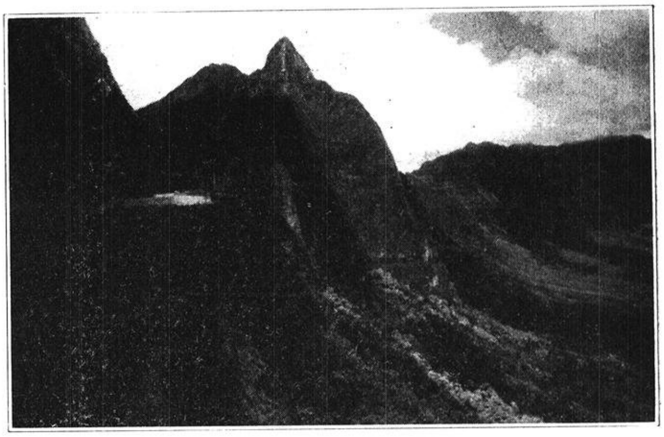
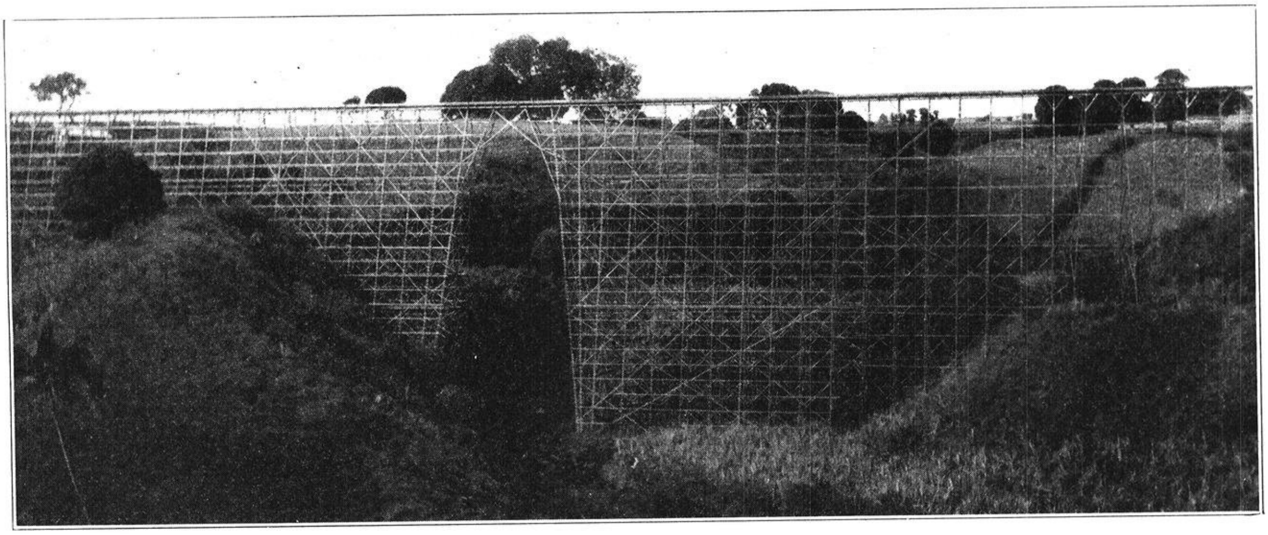


MOUNTAIN SCENE NEAR HONOLULU—THE PALI. *One result of the tremendous rainfall on the windward side of the mountains is a heavy erosion, which produces deep gorges and steep slopes.*



CANE FLUME ON HAWAII. *Cane is transported from the fields to the mills by means of flumes, which are carried over gorges on trestles up to 200 feet high.*

THE 1923 ENGINEERS' PARADE

By L. T. Sogard.

Junior Civil

Kidnapping, a libel suit, and column upon column of editorials in the Cardinal followed in the wake of what proved to be one of the most successful, notorious, and laugh-producing parades ever staged by the "rough necks" who reside on the north side of the Hill. Despite the fact that the Law Shop and the Weatherman were in cahoots all spring in a mad endeavor to queer it, the parade paraded, much to the embarrassment and humiliation of the rest of the world. From start to finish, from St. Pat to the lawyers' fire-proof coffin, the parade was a huge success, and then some embryo Brisbane endeavored to score the engineers in an editorial in the Cardinal; but replies from loyal plumbers came in so thick and fast that the Cardinal began considering the feasibility of renting additional office-space.

First in the line of march were the "civils" with a ten foot, tin transit so wonderfully constructed that Ray Owen has endeavored to get an option on it. With a beer-bottle plumb bob, a twelve foot stadia rod, and a sixteen foot slide rule, these aspirants to the county-surveyorship laid out the line of march.

St. Pat is Kidnapped

Following, came the patron saint of plumbers and steamfitters, ST. PAT, himself, riding in a mule-drawn hack and surrounded by a private bodyguard armed with ten-cent ball-bats. With red-beard, clay pipe, and green robes, he was hailed with more gusto than a home-run in the last game of the World's series. But herein lies a tale; a story of revenge, woe, and victory. With the multitude of red-headed Irishmen available, the parade committee was at a loss to know just whom to honor with the St. Pat-ship. Finally it was decided to hold a popularity contest, and seven candidates were listed as being the eligibles. Voting, at ten votes for a cent, was started and for a week and a half the polls were open day and night. Bill Gluesing and "Steam and Gas" Pat lead to the last day, when the chemicals stuffed the ballot box with enough money to get a first mortgage on the Engineering Building. The result was that John Rutherford was elected; but here Fate stepped in—the chosen saint never rode in the carriage of honor. While the parade was in progress, the "laws" had Rutherford out in Middleton doing a song and dance for their amusement, for he was shanghaied body and baggage, while enroute to the parade. However the lawyers overlooked a few minor details, namely, that there is more than one red-headed engineer and that red wigs and green clothes, though scarce, aren't half as hard to find as an honest lawyer. E. T. Bellew, chemical, was corralled, dressed up, and stuck in the hack, as good a St. Pat as has yet kissed the Blarney stone.

Ags, Commerce, L. & S., Medics, and co-eds all came in for their share of the panning. The art-school's best model, D. F. Schmit, graced one float while paint-slingers endeavored to depict on canvas her many poses.

"Our Klinnic", where SERVICE is the pass-word, was hoisted onto a truck and pulled through the streets, while the doctors handed out the coveted excuses as fast as they were applied for. The pretty nurses caused a high percentage of fatality and since the parade several engagements have been broken.

The prize individual stunt was the Man and Nature enthusiast, Homer Steel, who wandered hither and yon with a butterfly net endeavoring to catch an elusive doodle-bug fastened to a rod inserted in the back of the naturalist's neck.

A float, by the Wisconsin Engineer, put the rest of the campus periodicals in their proper places. The Lit was in a coffin, a clown on crutches was labeled "Octopus", and the Country Mag wore overalls. A tall black-bearded Israelite represented the Commerce Mag, and a scoop-chaser impersonated the Cardinal.

Libel Suit Threatened

A dancing act, labelled for proper identification, was the cause of a threatened libel suit by the proprietor of a local dance hall, the following week. The A. S. C. E.'s got more publicity than they craved. Only after a public apology in the Cardinal, was the matter dropped.

Thus was the 1923 parade the cause of more trouble, excitement, notoriety, and advertising to the engineers than all of the "Well, well, well's" ever bawled at the law school.

THE PRIZE WINNERS

A large number of prizes were donated by Madison merchants. The awards were as follows:

Beard Contest

First—Charles Hartling—whipcord breeches.

Second—M. W. Miller—pipe.

Engineering Societies

First—Tau Beta Pi—Heaven and Hell—brief case.

Second—Chemical Engineering Society—Ticket Sale—cake.

Third—A. S. C. E.—Burlesque Dancers—six pairs of hose.

Fourth—A. I. E. E.—Goat Glands—pressing ticket

Fifth—A. S. M. E.—Mechanical Wives for He-men—pipe.

Individual Frosh Stunt

First—G. E. Millard—Anatomical Engineer—polyphase sliderule.

Second—A. E. Gesteland—Engineer at Work—student lamp.

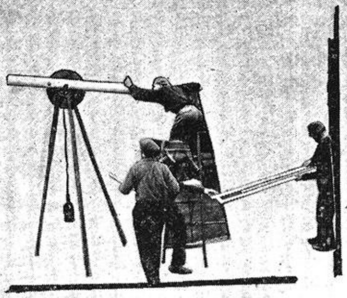
Fraternity and Organizations

First—Y. M. C. A.—Our Klinnic—silver loving cup

Second—Signal Club—Art for Art's Sake—silver loving cup.

Third—Triangle—Cave Man and Tea Hound—boxing gloves.

THE ENGINEERS' PARADE



Laying Out the Line of March

A.S.M.E Matrimonial Float

The Clinic Revealed

The King of Student Publications

Naughty, Naughty! but then it's for Art's Sake, you know

Why Sousa Never Comes to Madison

Individual Stunt

First—H. J. Steel—Man and Nature—fountain pen.

Second—W. L. Tietjen — Forty-Niner — corduroy pants and cap.

Group of Two or More on Foot

First—B. Ahren's Baptist Civils—Laying out the Line of March—two boxes of cigars.

Second—A. J. Larson's Group—Take-off on Laws—meal ticket.

Best Float Not Listed Above

First—H. J. Gregg—Monkey Wrench—$10.00 auto service.

Second—Youngberg and Hoffman—meal ticket.

Third—A. F. Roller—Strand pass.

Fourth—J. C. Lotter—flash-light.

Fifth—L. C. Crew—Crew and McCoy as Co-ed Horse-back Riders—studs, links, and tie.

A 4,000-VOLT OUTDOOR SWITCH STRUCTURE

By Edgar D. Lilja

Junior Electrical

It has been the practice for several years to install transformers and high voltage switching equipment out of doors, but this article will attempt to describe what appears to be the first outdoor installation made for voltages as low as 2300 and 4,000. This construction is an attempt to do away with the complicated concrete work which is part of the present day switch-plant construction.

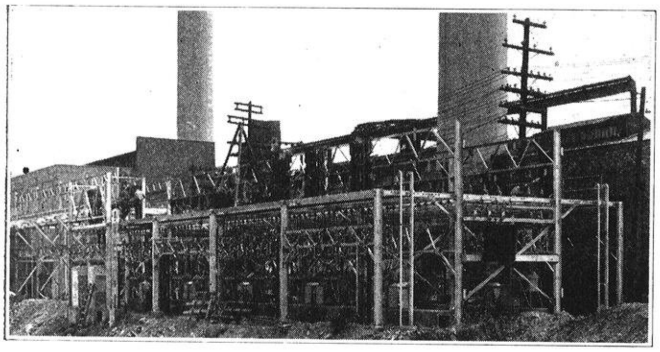


Figure 1. General View of Steel Switch Structure at Rockford, Illinois. *The framework is 176 feet long and is divided into four bays, one for each of the four generators.*

The plant for which this switching station was designed had originally used indoor switch equipment. This served the purpose for ten years, during which time the demand for power increased to 20,000 k.w., making necessary new additions to the switching system. The usual method of providing the necessary room for this apparatus would have been to construct a new separate building, and then to rebuild the main bus bars and the switching equipment.

Instead of erecting such a building with its many concrete compartments and then rebuilding the apparatus, it was decided to construct an outdoor steel structure in which might be placed all of the switching apparatus. In-as-much as this was the first attempt at building such a station, it was necessary to make a careful study of the needs of the plant, and then make original plans to fit these needs. In addition to being able to care for the equipment then on hand and the new apparatus which was to be installed in modernizing the plant, the structure had to be designed with a view toward future expansion.

The structure, as designed, contains the apparatus for the control of four generators, eleven circuits, six motor-generator sets with starting equipment, and two banks of step-up transformers. The entire framework is 176 feet in length, and is divided into units, called bays, one for each of the four generators. The structure rests on concrete foundations. The runway on top of the framework, which makes the reactors and the current and potential transformers more accessible, rests on porcelain insulators bolted to the steelwork.

The electrical apparatus installed in the structure includes all of the circuit breakers and generator and load switches except those which provide connection for local plant power. The structure provides an excellent place for lightning arresters, being well away from the main plant.

Control of the outdoor switches is centered on panels inside of the main plant. The panels are of the usual push-button type. Red and green signal lamps adjacent to the push-buttons indicate whether or not the power circuits are closed. The solenoids in the outdoor switches are energized with 110-volt direct current from a special motor-generator set. There is a storage battery floating on the system at all times to insure continuous service. The underground lines for the control circuits are laid in one and one-half inch iron conduit. The fuse boxes for these circuits are placed in a special weather-proof cabinet, near the center of the yard, under the structure.

The main circuits leading from the generators are also underground. Each phase passes through either three or four-inch fibre conduit, laid in concrete. Figure 2 shows the method of bringing up these leads from the underground ducts. The ducts are supported by concrete columns with steel corners for protection.

Each phase divides into two branches. The inside branch leads up to a bus bar running over to a current transformer which is in the middle of the steel-work. A bus connects the other side of the transformer with one side of an open knife switch. The other side of this switch is connected to an oil switch. From the oil switch, connections are made to the main bus bars. All

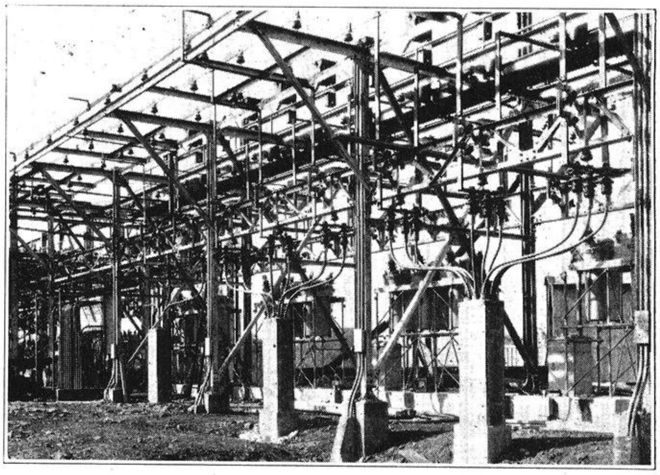


Figure 2. Method of Bringing up Generator Leads. *Each phase divides into two branches. The inside branch leads to a bus bar running over to a current transformer. The outer branch is connected to a transfer bus through a disconnecting switch.*

(Concluded on pagt 153)

Cake Eater
—model of 1900

He was called dude and dandy then, but you recognize the type.

He majored in haberdashery and took his degree with honors in soxology.

As if that were not enough, he evolved some variations on the cake walk which made them stare.

He even found time to develop a remarkable proficiency on the tandem bicycle, and on Saturday nights he was good enough to bring pleasure into Another's life by wheeling away to the "Ten-Twent-Thirt."

To crowd all this into four short years would seem enough for any mortal. Yet in spite of his attainments there are times, in after life, when our hero wonders.

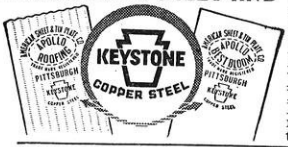
The glory of his waistcoats has long since faded, while his books are still fresh and clean. Did he perchance put too much thought into the selection of his hats and too little in what went under them?

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Western Electric Company

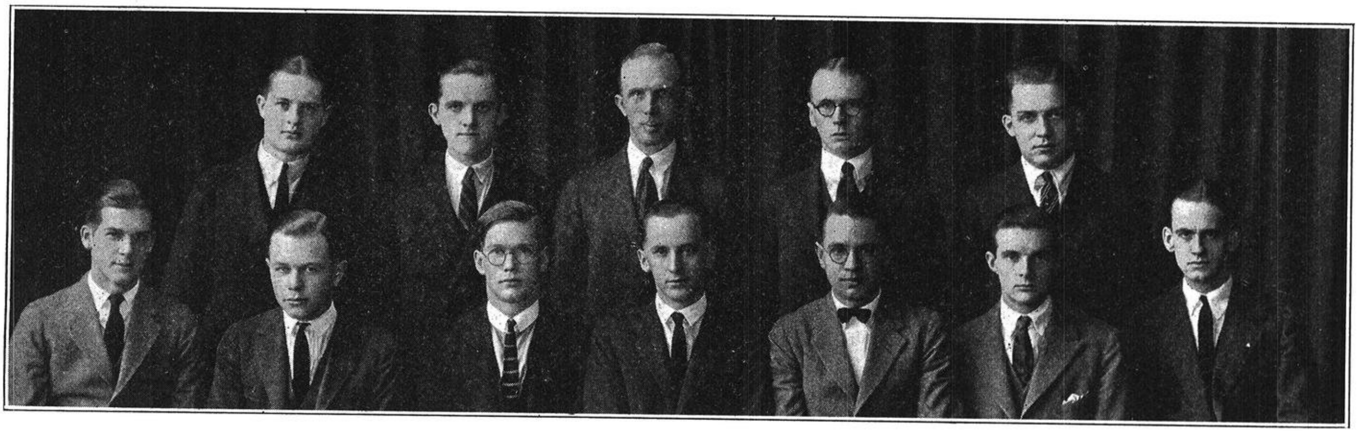
Since 1869 makers and distributors of electrical equipment

Number 28 of a series


KEYSTONE
COPPER STEEL


HIGGINS'
AMERICAN
INDIA INK

EDITORIALS



THE STAFF

Gregg *Bruhnke* *Caldwell* *Steen* *Senger*

Smart *Rusch* *Holmes* *French* *Sogard* *von Kaas* *Blanch*

FOREIGN FIELDS FOR ENGINEERS South America, Australia, Asia, and Africa all offer great opportunities for the engineer. South America, the closest country, is the one first considered by adventuresome graduates wishing to travel. The fabulous riches of South America have barely been touched. Professional men, foreign engineers particularly, are welcome. There is great activity, especially south of the equator, and much has been accomplished within the last score of years. Four railways cross the Andes, and there are two more under construction. Buenos Aires, a large village forty years ago, has had subways for over ten years, has two million inhabitants, and is recognized as one of the most beautiful cities in the world today.

There is work to be done,—work everywhere; the possibilities are unlimited, but there are several stumbing blocks. The first one is the language. The graduate going to South America on his own hook may not find work, and then,—what to do? There are family ties to be considered, friendships that must be neglected, new acquaintances to be made, new customs and standards to be learned. In any case our advice to the graduate is not to leave the U. S. without a contract. Then he is assured work. When his contract expires he will know the language, the country, and the people, and he will know what he wants and what he can do.

—B. M.

THE LAKE LEVEL CONTROVERSY Under the leadership of Wisconsin, several of the Great Lakes states have joined in an effort to make Chicago reduce the amount of water now taken from Lake Michigan for the purpose of flushing her raw sewage up the Chicago river to the drainage canal. Wisconsin claims that drawing off the water has lowered the level of Lake Michigan and damaged lake ports. The further charge is made that Chicago is violating an order of the War Department, which fixed the amount of water below what is now being taken.

Chicago admits the latter charge, but claims that the War Department has no jurisdiction. In regard to the lowering of the lake, Chicago likewise admits that the level has been lowered slightly by her use of the water, but maintains that a condition of equilibrium has been reached and that water may continue to be drawn off at the present rate without any further lowering from that cause. Furthermore, the Chicago Sanitary District (the corporation directly in control of Chicago's drainage canal) offers to furnish the money necessary to construct control gates in the St. Claire river that will put the lake level back where it used to be and keep it there in spite of fluctuations in rainfall in the Lake Michigan drainage basin.

There appears to be no good reason why this matter cannot be adjusted amicably; it is an engineering problem pure and simple. Unfortunately, in its present status it smacks more of politics and litigation than it does of engineering. No good can come of treating it as politics.

WATCH YOUR STEP WHEN SPEAKING PUBLICLY The controversy between William S. Murray ,engineering chairman of the Super-Power Survey, and Robert M. Bruere is of considerable interest to engineers. Mr. Bruere made a statement that electric heating would follow the general use of electric lighting. The statement appeared in an article on *The Coal Disgrace and the Way Out* in a recent edition of the *Nation*. Mr. Murray chose to ridicule the statement in a letter to the *Nation* published on April

(Continued on page 152)

ALUMNI NOTES

Joseph P. Schwada, c '11, was appointed city engineer of Milwaukee on April 17. Mr. Schwada is a native of Milwaukee and worked in the engineering department of the city and for the Milwaukee Electric Railway & Light Company prior to his graduation from the civil engineering course at Wisconsin in 1911.

JOSEPH P. SCHWADA

From June, 1911, to January, 1912, he was field engineer and inspector for the Wisconsin Railroad Commission, engaged on grade separation surveys, plans, and estimates. He left that position to become structural designer in the department of bridges and buildings for the C., M. & St. P. Ry. at Chicago. In the fall of 1912 he was appointed instructor in structural engineering at Wisconsin. He resigned early in 1916 to accept a position with the Wisconsin state department ment of engineering where he had a varied experience, largely in the field of appraisal work.

In February, 1918, he was granted leave of absence at the request of the U. S. Shipping Board to work on concrete ship design and construction for the Emergency Fleet Corporation. He was assistant in charge of concrete-ship design at Washington and Philadalphia from February, 1918, to February, 1919, and inspector and assistant resident representative in charge of concrete-ship yard at Jacksonville, Fla., from February, 1919, to October, 1919. During this period (summer of 1918) he carried on a three-months investigation of concrete ships in ocean service, measuring and studying the effect of strains upon the hulls. He was recalled to Wisconsin in 1919, and continued with the state department of engineering until May, 1921, when he was appointed engineer in charge of design and construction of the Riverside Pumping Station at Milwaukee.

CHEMICALS

Frank Cirves, ch '21, is chemical engineer with Van Shaack Bros., Chicago, Ill.

Presley D. Holmes, ch '20, gives his address at 1814 Juneway Terrace, Chicago, Ill.

Waldemar Velguth, ch '20, was married to Gertrude Elaine Jones, of Flint, Michigan on April 5. Velguth is with The Buick Motor Co..

O. B. Westmont, ch '20, announces the arrival of a son, Arthur Wells. Westmont is with the Carborundum Company, at Niagara Falls, N. Y.

CIVILS

Howard Buck, c '17, has been appointed head football coach at Lawrence College, Appleton, Wis.

W. B. Newing, c '22, can be reached at 700 Maryland Ave., Milwaukee, Wis.

Philip K. Schuyler, c '21, assistant engineer with the North Carolina Highway Commission, has an article on the use of the churn drill in making sub-soil examinations for bridges, in the March number of the North Carolina Highway Bulletin.

Lewis R. Sherburne, c '20, sends the following new address: 1527 Chambers St., Milwaukee, Wis.

Vincent G. McGraw, c '20, can be reached at 81 Forby St., Elmhurst, L. I.

Dwight S. Fowler, c '17, who has become associated with E. B. Parsons, of Jefferson, Wisconsin, has opened an office at Watertown, Wisconsin.

O. Laurgaard, c '03, CE '14, city engineer of Portland, Oregon, recently sent Dean Turneaure a copy of a report on a water front development project for Portland which he has prepared. It is an eleven million dollar project that has for one of its prime objects the rehabilitation of a large district immediately adjacent to the river, making it available for high class retail business, hotels, and office buildings.

Donald Greenwood, CE '14, who has been with the South Dakota Highway Commission in the capacity of designer and assistant engineer of plans for several years, has resigned to accept a position with the Illinois Central Railroad, Chicago Terminal Improvement Department.

Herman Larsen, c '13, is in the Engineering and Contracting business, at Boonville, Ind.

O. R. Moe, c '12, writes as follows: "I left the University in the year 1912, after having taken three years of the civil engineering course, going to Albany, N. Y. with the Delaware and Hudson Company. I began with that Company as a chainman and went through the various positions until the latter part of the year 1917, when I assumed charge of the Engineering and Valuation Departments of this system."

ELECTRICALS

Willard A. Kates, e '21, recently took a position with Day and Zimmerman, Inc., of Philadelphia. He intimates that he has ventured upon matrimony, but fails to offer any details. Address: 4627 Sansom St., Philadelphia, Penna.

W. H. Snider, e '20, is assistant electrical engineer with the United Light and Railways Co., Davenport, Ia.

Ray Hardin, e '15, is with the Bertman Electric Company, at Lake and Des Plaines Street, Chicago, Ill.

MECHANICALS

A. B. Hawkins, m '21, announces a change of address from Camp Kearney, Cal., to 4156 Colonial Ave., East San Diego, Cal.

E. B. Williams, m '19, sales engineer, may be addressed at 301 Cambridge Ave., Milwaukee, Wis.

Roy Phipps, m '11, who recently returned from engineering work in the Orient, is now with the Chain Belt Company, at Milwaukee.

MINERS

F. S. Turneaure, min '21, is with the Geology Department of the Associated Oil Company, at Oil Center, Cal.

William F. Uhlig, min '22, is at 4418 Magoun Ave., East Chicago, Ind.

CAMPUS NOTES

EARL L. CALDWELL

THE PARADE

We planned a fine parade; excitement mounted high;
And then a million tons of snow descended from the sky.

We could not buck the drifts; we picked another day;
Another million tons dropped down to where the first lot lay.

Again we tried our luck, when April rolled around.
The weatherman turned on the hose, and our parade got drowned.

Nor did that end the grief; the worst is yet to come;
The lawyers stole our patron saint and put him on the bum.

And when the show is o'er, another blow descends:
The Cardinal assails our taste and says our stunt offends.

Alas that is not all; we faced a libel suit
Because somebody did not like a float that we thought cute.

Perhaps our tails should drag beneath our load of sins;
Instead we heave a soulful sigh for folks who have thin skins.

Still we desire to please, and so next year we'll bear
A single lily in a vahse, when we go round the Square.

—Malt Basin.

SLOGAN FOR REMAINING WEEKS "Sheath your Sheba; grab your slipstick."

"Here's where I tickle that old gal—Lena," said the radio fan as he sat in at his crystal set—H. D. M.

TAU BETA PI ELECTIONS

Tau Beta Pi announces the election of the following new members:

Honorary Member
PROFESSOR GUSTUS LUDWIG LARSON

Juniors

David John Greiling—*mechanical*
Frederick John Mollerus—*mechanical*
Edgar David Lilja—*electrical*
Walter Arthur Kuenzli—*chemical*
William Edwin Ouweneel—*chemical*
Wallace William Drissen—*mechanical*
Floyd Dwight Johnson—*electrical*
George Fredrick Hrubesky—*mechanical*
Joe Rosecky—*mechanical*
Warren Alexander Mason—*mechanical*
Edward Carl Bopf—*electrical*
Floyd Arthur Nelson—*mining*

We'll Be Over; We're Coming Over.

According to Professor L. S. Smith, no written work is required in the German universities. attendance at lectures is not compulsory, and the examinations are given once every two years.

WISCONSIN SCHOLARSHIPS AWARDED

Seventeen freshmen engineers have been awarded Wisconsin Scholarships for the current year. Fifty of these scholarships are granted by the Regents each year to men and women first-year students who are registered as residents of Wisconsin, who have shown worth and ability, and who are in need of financial assistance. The scholarships consist of cash awards of $100 each.

"Don't be discouraged," says a corn-fed philosopher, "Noah was six-hundred years old before he thought of building the ark."

IT MUST HAVE BEEN A DUMPY

PROFESSOR OWEN (in topog)—"Define line of sight."

OZZIE FLINT—A line of sight is a straight, imaginary line determined by the objective lens and the optical delusion of the telescope."

CROWN A TRUCKLOAD OF THEM

This year we put our co-ed engineer on the throne in the parade; next year we will *crown* a lawyer and put him there.

A. I. E. E.

When the A. I. E. E. closes shop for the school year on May 23, it will finish with a record for good meetings. Through the efforts of S. M. Coe, who served on the program committee, a number of good speakers have been obtained and the electricals have turned out to hear them.

"Automatic and Semi-automatic Generating Stations" was the subject of a talk by C. V. Seastone at the first meeting after the spring recess. Mr. Seastone, who is associated with D. W. Mead and has done a great deal of hydro-electric work, had many views with which to illustrate his talk.

The last meeting in April was addressed by C. A. Andree, who gave the electricals some idea of the kind of treatment which they would receive should they enter the employ of the Bell Telephone Company. Mr. Andree, being a Wisconsin engineering grad and a member of the A. I. E. E., knew just what features of the work would appeal to the electricals. He brought these features out strongly, not forgetting to mention the big desks and the call-buttons.

The final meeting of the year will be a social affair. An attempt will be made to have all business cleared up before this meeting.

WHEN I WAS YOUNG I THOUGHT THAT

"Calculus" was a Greek god.
"Slip-sticks" were the same as chop-sticks.
Isaac Newton was a cookie.

—B. Fish.

PROFESSOR SMITH GOES TO SPAIN

Professor L. S. Smith, accompanied by Mrs. Smith, left Madison on April 16 to attend the fourth International Good Roads congress that will be held in Seville, Spain, from May 7 to 17, and at which Professor Smith will read a paper on "The Relation of Modern Traffic to the Planning of Streets". Following the meeting, he will look over highway conditions in Italy, France, Spain, Norway, and Sweden and return to this country about July 1.

BOOKS AND THEIR AUTHORS

"Deportation in Free America"—C. A. Rutherford.

"The Beautiful and the Damned"—Professor D. W. Mead.

"Junior Class Solidarity"—Professor W. S. Kinne, editor, assisted by the faculty.

"To Have and Toe Hold"—George Hitchcock.

"Smiling Through"—J. E. Mackie.

"The Design and Construction of Parade Floats"—L. A. Schmidt.

It takes a good man to buck a heartless weatherman, the nefarious lawyers, the censorious Cardinal, and Prof. Kehl and still maintain such a cheerful smile as does J. Everett Mackie, erstwhile chairman of the 1923 Engineers' Parade.

PROFESSOR MCCAFFERY BADLY HURT

Professor R. S. Mc Caffery, of the mining department, slipped and fell on the street on April 16 and broke his arm. The break occurred in the shoulder joint and was of such a nature that it was necessary to operate and nail the broken parts together. Professor McCaffery spent ten days in the hospital and for a further period was confined to his home.

A CLOSE RACE

"The shafts of two motors, one 40 H. P. and the other 60 H. P. were connected directly," said Professor Jansky to his class in electrical engineering. "Both motors were shunt wound, self-excited, and connected in parallel to the same power line. The motors were wired so that they would rotate in opposite direction if not connected directly. When the switch was closed the motors rotated. Which one of the two motors acted as a generator?"

Sherm Green: "The one that the current came to first."

THE ENGINEERS' DANCE

By E. L. Caldwell

The Annual Engineers Dance was held at the Candy Shop on the evening of April 28th. The Slipstickers proved loyal to their college and turned out a goodly crowd, which, being augmented by men of other colleges, filled the Candy Shop to capacity and the hearts of the committee to gladness.

Last year the reporter wrote of the excellence of Jess Cohen's Orchestra, and this year he is tempted to boost Jess's outfit to the skies. The spirit of the evening was undoubtedly directly proportional to the music of the orchestra, whose unified work brought out the most of every dance number. May next year's committee name the same choice.

The natural beauty of the Candy Shop where the dance was held was "reinforced" with the balloons. paper caps, and serpentine paper. During the intermission, Ev Mackie and Carroll Robb put out some wicked harmony—too little, in fact, as they registered in fine style with Cohen at the piano. Now, having mentioned the Committee and its good work, it is time to say, that:

"Rufe" Phillips made an energetic chairman, "Gene" Silver handled the publicity effectively, "Eddie" Lilja did a fine job with the lighting, and "Larry" Sogard designed the cover and got out the nifty programs.

It was good to see the chaperones enjoying themselves. Professor "Reddy" Millar saw our girl once and tried to rope her with serpentine; and Professor Otto Kowalke passed us three times in one lap—of the floor.

We nearly forgot one of the features. They turned the lights out every once in a while, and that was very, very hard to take—because you couldn't tell when they would come on. Who couldn't have a good time under all those glorious circumstances!

ATHLETICS

BIG TEN BALL SEASON OPENS

With a bright sun, a warm spring day, and plenty of peanuts and pop, Wisconsin rooters helped the Badger team pry the lid off the 1923 baseball season on Friday afternoon, April 20. The Big Ten season opened with a victory, the Cardinal trimming the Hoosier nine 8 to 3 in a game fraught with errors on Indiana's part. The Badger crew, with Pickford on the mound, played bang-up ball all the way through and hit consistently. The Hoosier blunders were responsible in part for the lopsided score, for the Indiana pitcher put up an excellent game.

Playing errorless ball, the Badgers won their second conference game, 6 to 4, from Chicago on Friday, April 27, but dropped the third game to Michigan, at Ann Arbor, on the following day. Johnson, on the mound for the Cardinal, had an off day and the Wolverines, as a result of hits bunched in the first, third, and sixth innings, won 11 to 3.

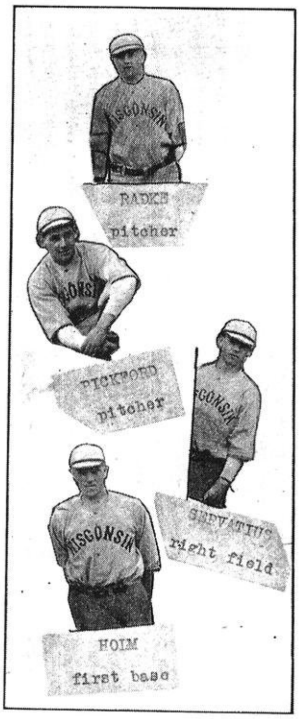
ENGINEERS PLAY ON BALL TEAM

Prominent on Coach Lowman's ball team are four engineers, two of whom have been the mainstays of the Badger pitching staff. Walt Radke, junior civil, is playing his first season of varsity ball, and as relief pitcher finished the Chicago game and saved Wisconsin from utter disgrace at the hands of Michigan when he was sent to the mound at the end of the sixth frame, following the erratic work of Johnson. The diminutive slabman pitches good ball and if he continues to do as well as he has thus far this season he will develop into a dangerous man for the Wisconsin's opponents.

Jerome Pickford, chemical senior, has been a regular hurler now for two seasons. Though not exceptional, he is a good slabman. His work in the Indiana game kept the Hoosiers to three scores, while his work in the first eight innings of the Chicago game kept the Maroons constantly worried.

'Way out in right field one may see Johnny Servatius do a tall prance whenever anything that looks like a baseball comes out via sky, ground, or both. He plays with both eyes wide open and gets under flies with more alacrity than a soldier can display at mess-call. Servatius is a miner.

The tall, agile bird at first base is Harold Holm, senior electrical. Holm can scoop them up when they are low, pick them off when they are high, and gobble them up when they come wide, all with equal dexterity. He swings a mean bat, also. In the Indiana game ke knocked the pill way over into the football field and circumnavigated the diamond 'ere the return of said ball.



ENGINEER BASEBALL ARTISTS

ENGINEERS NUMEROUS ON GYM TEAM

The gym team, which recently won the Big Ten Championship at Ohio State, is composed chiefly of engineers and is also captained by a plumber, Dean Kitchen, chemical senior. Other members of the team are Frank Kubosch, chemical; Frank Bumer, civil; Norman Koch, mechanical and erstwhile fancy diver on the varsity swimming team; Walter Porth, mechanical; and Merrill Hansen, chemical.

ENGINEER TRACKMEN GET LETTERS

Three of the four W's awarded indoor-track athletes went to civil engineers this spring. Bill Hamman, Ralph Spetz, and Brown Donohue were the lucky men.

ENGINEERS ON GYM TEAM

Koch *Kubosch* *Hansen* *D. Kitchen* (Capt.) *Porth* *Bumer*

EDITORIALS

(Continued from page 147)

18, in which he made an analysis of costs between furnace and electric heating at the present time and ignored the advancement in the art.

Mr. Bruere, in his response, gives data to the effect that his original statement was not entirely futuristic, and he also cites several instances in which Mr. Murray made and acknowledged incorrect statements in connection with the Ontario Hydro-Electric Project.

Mr. Murray's attack seemed to be something of a defense of private ownership, and was uncalled for in connection with the article published by Mr. Bruere. Engineers have a reputation for basing statements on facts, and men as prominent as Mr. Murray should be careful in preparing papers for public consumption.

—A. C. F.

A TRIP TO THE HAWAIIAN ISLANDS

(Continued from page 143)

handicap, they do learn to speak very well indeed, with a somewhat peculiar accent, but quite correct grammar. The teaching staff is made up of various races, all working together very harmoniously. It was extremely interesting to watch the instruction in writing given by the aid of music, and the principal remarked that they found the phonograph a very real help in many ways. More than half the children in the public schools are Japanese, and not more than 10% Caucasians.

We were fortunate in becoming acquainted, on the boat, with the City and County Engineer, Mr. Ohrt, who was just returning from a Highway Engineering Conference at Kansas City. I learned that he was a Cornell graduate, but a native of the islands. He took pains to show us about the city, and took us out to an inspection of some highway work he was doing across the mountains on the other side of the island. In this particular work, he was expending about $100,000 per mile for bridges, grading and surfacing, an expenditure that would stagger people in this country. However, not many miles of road of this character are needed. A narrow-gauge railroad runs from Honolulu around the north end of the island through a desert country on the west side to a very productive country on the east side. Railroads have been built on all the four principal islands, but the motor truck is very useful for the short haul traffic characteristic of the country.

The chief products of the islands are sugar and pineapples,—in fact, these are the only products that amount to anything in the way of commerce. There are only about 500 square miles of tillable land in the islands, but the production in dollars is very great, as sugar is a very intensive crop in Hawaii, the yield being something like 2½ tons of sugar per acre. Pineapples are raised on a large scale, and production is rapidly increasing. These products are so valuable that the total exports from the islands to the United States amount to about $175,000,000 per year. As the imports are only about $75,000,000, there is a profit of about $100,000,000 for a population of 250,000. Some business to be produced from an area smaller in size than Dane County! The sugar plantations are highly developed, and have involved a large expenditure of capital. A single plantation will be perhaps 10,000 acres in area, and include a sugar mill and industrial railroad tracks running throughout the area, and require large annual expenditures for fertilizer, labor, and often water for irrigation. Many of the plantations on Oahu are irrigated from artesian sources, and Honolulu receives its supply from the same source. Most of the water is pumped, and the quantities are enormous,—nearly sufficient, on this one island, to supply the city of New York.

After visiting Honolulu and vicinity, we sailed for Hawaii to see the volcano in action. On the way, we passed the island of Maui, and had a fine sight of its mountains and gorges. Here the boat discharged a lot of passengers, most of whom were teachers going to attend a teachers' convention. We sighted Hawaii early in the morning, and for about two hours sailed along the windward side of the island and enjoyed the fine sight of the cane fields and the mountains of Mauna Loa and Mauna Kea, extending 13,000 feet above sea level. From our point of view, the canefields looked like a strip of green grass extending from near the shore line for three or four miles up the slope of the mountain, with a strip of brush and jungle beyond, and then the bare mountain side with a cap of snow. Along this coast, rainfall is so abundant that the cane is transported from the fields to the mills by means of flumes, supplied by water from various streams coming down from the mountains. These flumes in many places are carried over deep gorges on trestles 150 or 200 feet high. A railroad also runs along near the coast line, but as the coast is very steep and rocky, the construction of the road involved a great deal of expense in heavy cuts, tunnels and trestles. A fifty-mile trip on this road is a fine introduction to the island.

Hilo, a small town of about 10,000 inhabitants, is the port of this island. Being on the windward side, it has a heavy rainfall of about 200 inches a year, and last March the fall was about 60 inches. Fortunately, it was comparatively dry while we were there. From Hilo, a good automobile road extends up the slope of Mauna Loa to the active crater of Kilauea, about 4000 feet above sea level. This road runs most of the distance through a very interesting tropical forest, in which tree ferns 20 or 30 feet high, and many other varieties of tropical flora abound. The scarcity of good merchantable timber in such tropical forests is rather noticeable, but I believe this is rather characteristic of the tropics. Tree ferns and heavy undergrowth seem to strangle the growth of trees, and in many places, large tree ferns and other varieties of parasitic plants may be seen growing in the crotches of the larger trees. There is so much moisture that vegetation will grow almost anywhere.

The crater of Kilauea is located on a shoulder of the

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.

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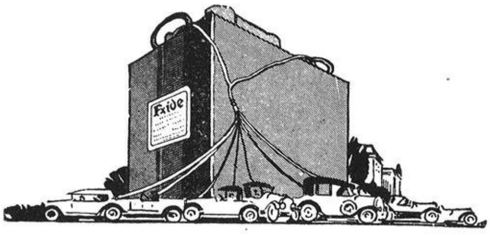

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larger mountain of Mauna Loa, which is the famous old volcano of the Sandwich Islands of our geographies. This crater is about three miles in diameter, and for the most part consists of old lava, over which a path extends to an opening known as the fire pit, or a crater in a crater. This fire pit is about 1200 feet in diameter and about 1000 feet deep, but at the time of our visit, was filled about half full with hot lava boiling up and flowing around, making a wonderful sight. The large crater is nearly surrounded by a high, rocky cliff, on the high side of which is located "The Volcano House", a very good tourist hotel. On the low side, the lava overflows about once in two years, but without danger to the hotel or its surroundings. Fortunately, this volcano is very mild-mannered. When it erupts, all that happens is an overflow of lava which, however, may be somewhat troublesome as it sometimes acquires a velocity as high as 20 miles per hour on its way to the ocean. No explosion of gas or blowing out of ashes seem to take place from this volcano, so that it is a very safe exhibit for tourists. We visited the fire pit both in the daytime and at night, but of course at night the spectacle is much more impressive. At the time we were there, the lava was rising about five feet per day, and was expected to overflow in two or three months. Besides the main crater, there is a string of non-active craters five or six miles in length to the east of the main crater. Some of these old craters are partly grown up with trees, others with nothing at the bottom but black lava. The peak of Mauna Loa is nearly 10,000 feet above the hotel, and some tourists make the climb to the summit, but it did not seem attractive to us, as the slopes are very flat,—about 10 per cent,—and there is not much pleasure in climbing that sort of a mountain: nothing but hard work. After spending about two days at the volcano viewing the craters, steam cracks, and sulphur banks, we returned to Hilo and sailed for Honolulu. I can strongly recommend to any tourist in Hawaii a visit to the volcano. It was the most interesting feature of our trip.

The Governor of the territory is Mr. Wallace Farrington, brother of Professor E. H. Farrington of the Agricultural Department, University of Wisconsin. He has been in the islands since a young man, and until he became Governor, was publisher of a daily newspaper. He is exceedingly cordial, a thorough-going Hawaiian, and is certainly well liked by the people. We happened to be in Honolulu at the time a reception was given at the Governor's house in honor of the Irish poet, Padraic Colum, who was spending some time in the islands studying Hawaiian traditions. We attended the reception, and heard a very fine program of music and speeches by native Hawaiians, especially arranged for the occasion. There were no ukeleles on the program. Not the least interesting feature of our visit was a U. W. luncheon arranged for our benefit. There were 17 University of Wisconsin folks present, including Colonel Haase, Miss Farrington of Honolulu, Miss Radke of Madison, "Buck" Bellows of football fame, and the live wire, Kim Tong Ho, of the Chinese American Bank. No need to describe the bunch, as they were all Wisconsin.

Politics in the islands is a very interesting subject, and bound to be more interesting in the near future. At present, a majority of the voters are of the native Hawaiian race, with Caucasians second. In a few years, however, the Japanese descendants will be the most numerous, and a good deal of speculation is rife as to what will then happen. However, it appears to visitors as though the varieties of people on these islands get along together wonderfully well and that they all have the interests of the islands at heart. It may not be many years before the territory becomes a full-fledged state. This is the ambition of the people.

We sailed for home just two weeks after we landed, and as the boat left, the official band gave us the usual parting salute by playing the Hawaiian good-bye song "Aloha", with most of the passengers wearing wreaths of flowers and throwing ribbons of paper to the friends on shore.

A 4000-VOLT OUTDOOR SWITCH STRUCTURE

(Concluded from page 146)

generators are connected in parallel to the bus, which runs the entire length of the structure. Connections from this bus are made to the separate load circuit switches.

The outer branch is connected to a transfer bus through a disconnecting switch. This is for use in case it is desired to make repairs on the oil switch. All generators, motor-generators, and circuits have a similar arrangement. With this system of disconnecting switches, it is possible to transfer any of the apparatus from the main bus to the auxiliary bus through an auxiliary oil switch which is large enough to take care of the largest generator in the plant.

Oil switches on all circuits and other apparatus are protected by overload relays and three per cent reactors. While the generators are non-automatic as regards overload, they are protected by a system of current transformers connected differentially. This system protects the generators in case of a break-down in the generator winding. In case such a break-down should occur, an unbalanced load is thrown on the current transformers, causing them to operate a relay which trips the main oil switch, and opens the field circuit. This prevents further damage to the windings.

In installing bus bars of the length used in this construction, the question of expansion had to be considered due to the extreme changes in temperature to which they are subjected.

Suitable expansion joints, consisting of a group of copper ribbons in a bow-shaped form to allow motion of the main bus bars were installed in the main runs. All branch taps were made with three or four-bolt clamps consisting of one brass plate and one iron plate. The brass was used to prevent the formation of a magnetic circuit. If both of the plates were made of iron, serious heating would result due to eddy currents and hysteresis.

No exact comparison of cost and maintenance data has been made with the indoor systems generally used, the new system having been used but a short time. So far, the installation has proved a success. It has withstood severe weather tests. Because the work is open it is more fire-proof than the indoor compartment construction can be. It allows the dissipation of heat, and the air forms an excellent insulator for the electrical parts. Not being walled in, the apparatus is more easily repaired. There is the difficulty of working outside in severe weather to be taken into consideration, however. The future of the outdoor switching station is yet to be determined.

The writer is indebted to Mr. R. M. Bert, electrical superintendent, in charge of construction, for the pictures shown and for assistance in preparing this article.

THE UNIVERSITY HEATING SYSTEM

(Continued from page 140)

buildings and prompt calls for service when needed have helped greatly in reducing the steam consumption. Close supervision of and repairs of all traps, regulator valves, return pumps, etc. have been essential to economy. The repair of pneumatic and hand control valves in as many buildings as possible during the summer has lessened the number of calls during the heating season and has resulted in better service and less waste.

The installation of condensation meters at the general library, horticultural greenhouses, Chadbourne Hall, and especially the installation of a steam-flow meter at the Forest Products department have resulted in more economical use of steam, since the steam is paid for on the basis of meter readings.

Future Plans

On St. Valentine's Day, February 14th of the present year, the heating station was subjected to the greatest heating demand in its history. On that day 150.15 tons of coal were burned and 2,319,240 pounds of steam were generated. The amount of coal burned on that day would be sufficient to heat the average home for at least ten years. Of the nine 350-horse-power boilers in the plant, seven were in service for the full 24 hours, one was maintained with a banked fire so as to be ready for an emergency, and one was down for repairs.

The seven that were in service averaged 92 per cent of their rating for the 24 hours, and at certain periods of the day all of them were considerably overloaded. The new hospital with its 36,000 square feet of hot water radiation and the new service building addition, will add very considerably to the connected load of the plant. If, when these buildings are connected, we should have a day such as February 14th, it would tax the present capacity of the heating plant to its very limit.

Realizing that these conditions would exist when the new hospital is completed, the legislature two years ago was asked for appropriations for two new boilers and stokers. Eighty-eight thousand dollars is now available for that work. Two 546-horse-power boilers will be installed within the next six months. The stokers will be the most modern available, probably of the forced draft type, either under-feed or chain grate. These stokers will be able to burn enough coal to operate the boilers at 300 per cent rating if necessary.

Regarding the future of the steam distribution system, the present plan is to continue to construct all main lines of tunnels of sufficient size to walk in, with laterals leading to the buildings of smaller concrete conduits. It has been possible to lay out these tunnels so that the connections to the older systems can be made conveniently and economically. Future tunnels, when needed to accommodate future buildings, will be so laid out as to obtain a very direct path for the steam and at the same time secure a loop from the heating station. Referring to the map it will be noted that there is already a loop around the major part of the eastern campus. The present legislature is being asked for approximately $100,000 to complete a similar loop around the western section of the campus. The proposed tunnel is shown by a dotted line running west along the north side of University Avenue. With this completed, the distance of steam travel to the Forest Products laboratory will be reduced to nearly one third, and a loop will be completed which will make it possible to feed steam from two different directions to most of the buildings on the campus. This will give a reliable transmission system and one that can be cut out at different points for repairs with little inconvenience.