The Wisconsin engineer. Vol. 28, No. 4 January 1924

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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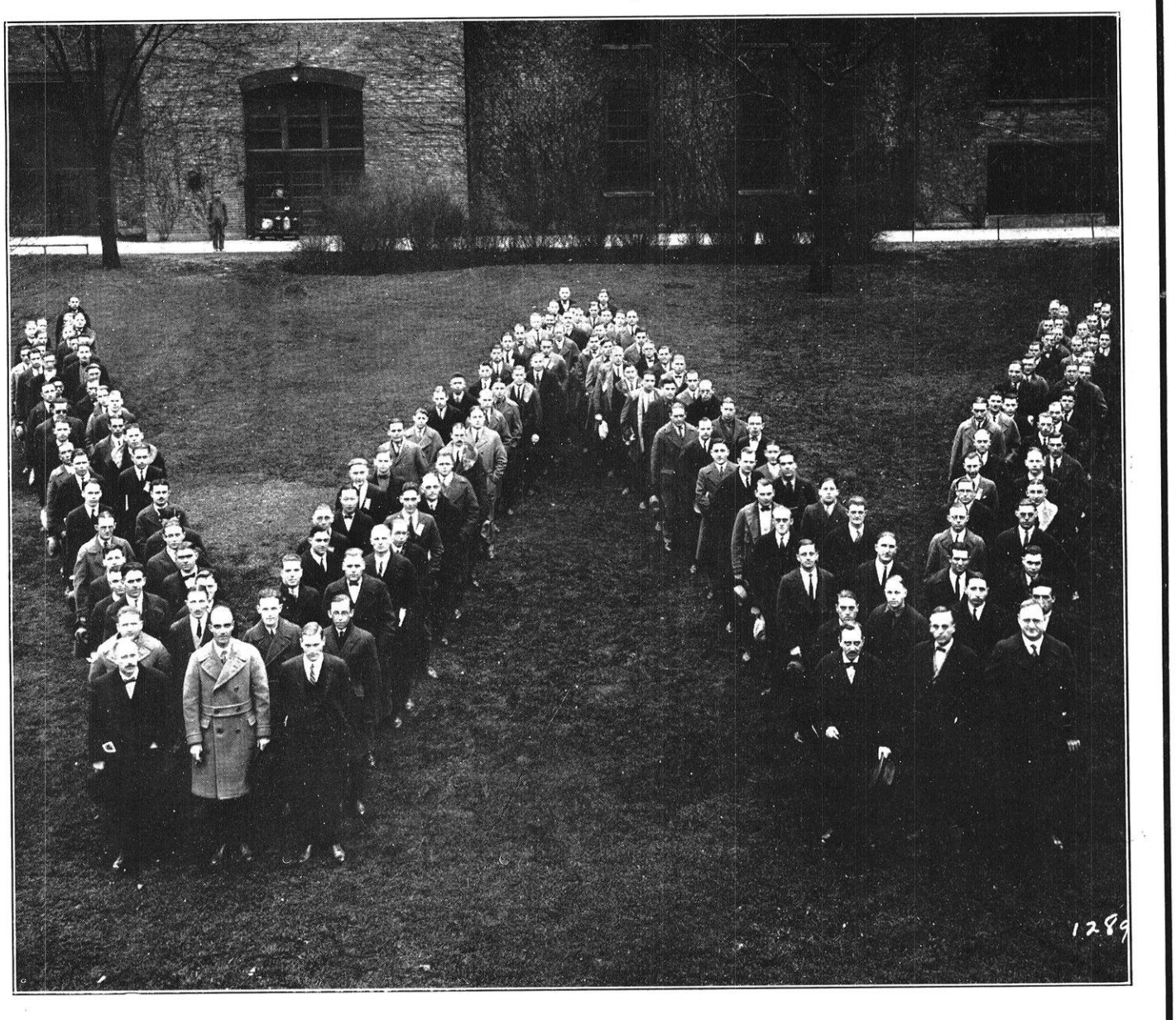
The WISCONSIN ENGINEER

Published by the Engineering Students of
THE UNIVERSITY OF WISCONSIN

VOL. XXVIII MADISON, WISCONSIN, JANUARY, 1924 NO. 4

Member Engineering College Magazines, Associated



The
WISCONSIN ENGINEER
Founded 1896

25c A Copy

Published monthly from October to May, inclusive by
THE WISCONSIN ENGINEERING JOURNAL ASSOCIATION
306a Engineering Building, Madison, Wisconsin
Telephone University 177

$1.50 A Year

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VOL. 28 JANUARY, 1924 NO. 4

 Entered as second class matter Sept. 26, 1910, at the Post office at Madison, Wis., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized October 21, 1918.

The Wisconsin Engineer

UNIVERSITY OF WISCONSIN

VOL. XXVIII NO. 4 MADISON, WIS. JANUARY, 1924

TRUNK LINE ELECTRIFICATION

By James Theron Rood

Professor of Electrical Engineering

The electrification of the existing steam railway lines is the greatest work now facing the engineering world. Tremendous single hydroelectric developments, such as that of the St. Lawrence River, marvelous bridges like those soon to be constructed between New York City and New Jersey over the Hudson and over the bay at San Francisco will come to completion, from time to time, but the greatest, wide-flung engineering project of the near future, dealing, as it does, with stupendous construction and operation problems, is that of electric rail transportation. It is a question which concerns not simply the United States or even America alone. It will tremendously influence transportation on every continent and in practically every country in the world. Ultimately there will hardly be a rail line or system that is not directly concerned in it. The developmental work, no matter where done, will, in each case, help to bring about in the world a better and better system of electric railway transportation. It will be the carrying on of the pioneer work of Stephenson to higher and higher stages of perfection.

If this is not to be merely a dream, a phantasy of some visionary, then electrification must justify itself in terms of dollars and cents, either directly in transportation costs or else in some other way to which the world gives such valuation. Of this there can be no question. Like the question of making two blades of grass grow where one sprung before, electrification must transport two passengers or two tons of goods where only one had previously been carried, or else it must carry the one at a lower cost than ever before. As compared with steam traction, electrification must show more transportation for less cost. In other words, it must, primarily, give a smaller cost per passenger-mile or per ton-mile of transportation if it is to justify its being. This it may do through higher schedule speed in miles-per-hour, giving more frequent service; through faster acceleration and quicker braking, permitting faster local service as well as closer headway between trains; through greater drawbar pull, allowing the running of longer and heavier trains at relatively high speeds, especially in mountainous districts, and at the same time reducing the train operation labor charges; through the lowering of maintenance charges of locomotives, cars, and tracks; through the more certain continuity of operation of the electric locomotive as compared with the steam locomotive, particularly in regions having severe winters. Other conditions, such as freedom from smoke or safer operation through a tunnel, may at times dictate the electrification of part of a system or terminal, but other than this, every projected electrification must show that increased returns will be had. The cost of an electrified railroad will always be greater than that of a steam line and the capital for such extra construction cost can only be had if it can be shown that it will be justified, that the increased overhead charge arising from this added cost will be more than offset by the gain in net revenue resulting from the electrification.

There are chiefly two things today which stand in the way of rapid expansion of electrification. The first is that of cost of construction and the accompanying difficulties of financing. Before the war broke out, a number of roads had their plans practically completed for early electrification. But the great rise in cost of materials and the practical impossibility of obtaining the capital required has forced the laying aside of the plans for the present. The high cost of junking the present steam locomotives also adds to this cost. If it were possible to transfer such replaced locomotives to systems not yet electrified, and so on until they were completely worn out, this added cost could be largely done away with. Theoretically such locomotives could be passed from road to road with each electrification, finally passing to the scrap heap, or else retained for use on such railway branch lines where electrification would not pay. Practically it can not be worked out as easily as this, since each road or system at present seems to feel that there must be some particular type of steam locomotive especially fitted to its requirements. Possibly a greater extent of government direction which seems likely to come about may serve to reduce this absurd condition.

The second, and, in many ways, the more serious obstacle lies in the fact that the engineers can not come before the bankers or the investing public today and say that there is a one best system of electrification. The most they can say is that there are two or three systems now in operations each of which is giving good results, both in operation and in financial returns. But if there is no best system, how can the ones who put

up the money know that perhaps over night a new, better, less expensive type of electrification may not come into existence? Then where will their investments be? The unbiased engineer has to admit the truth of this. He must freely admit that there is at present no wholly satisfactory electrification system, taking as a whole, transmission, motor, and control. How shall the motor be mounted—concentric with or off set from the driving axles? And if off set, what shall be the method of drive—gear or connecting rod? With such questions not yet satisfactorily answered, it is no great wonder that the investing public has not come freely forward, especially since in their partial knowledge of the conditions they seem to feel that some invention or improvement may come about which will bring to pass at once a really best system and that therefore their investment in the old, unimproved system will become lost. And it is not beyond belief that such a discovery may come about.

The first electric locomotives used on the Baltimore and Ohio railway were of the storage battery type and were used to draw trains through a smoky tunnel. They were not a success from the point of view of cost of maintenance and they seem to have made it clearly evident that storage battery electrification is a practical impossibility. Again, quite extensive experience has been had with the gasoline electric locomotive, where a constant speed gasoline engine drives an electric generator which supplies electric energy to motor drives on the trucks. Here, too, the cost of maintenance has been too excessive to make the system a success for any thing except, possibly, special operating conditions, such as a short branch line carrying little or no freight.

There then remains only the systems supplying to the locomotive external electric energy through some method of current collection, third rail, or over-head system.

Two direct current systems have been tried out so far, using the direct current series-wound motor. Here the current may either be generated as direct current and be fed directly into the overhead or third rail system, or it may be generated as alternating current, preferably three-phase, carried over high tension transmission lines to substations, where it is converted to direct current, and then fed to trolley or third rail. The first way is not very satisfactory since the trolley or third rail drop makes it necessary to have generating stations at frequent intervals. This makes the system very expensive, since the stations would be relatively small and therefore relatively high in operating costs because of higher first cost per kilowatt capacity, lower operating efficiency, and higher labor charge per kilowatt-hour output. The higher the direct current voltage, the farther apart can the stations be put; and the greater their individual capacity, the lower the unit construction and operation costs. The 600-volt system requires stations to be placed at intervals of about twelve miles, but with voltages of 1200, 1500, 2400, or 3000 the spacing can be greatly increased.

The system of alternating current generation with substation conversion has the great advantage that only one or more large stations need be built. On the other hand, through the use of substations, the total required kilowatt capacity of apparatus on the system may be increased from 50 to 150 per cent over that of the straight direct current system. The substations are expensive to build, are costly to operate on account of the high labor charge, and there is an energy loss in the conversion from alternating to direct current that may run from 15 to 50 per cent. The use of rotary converters rather than motor-generator sets has cut down somewhat the energy loss as well as the cost of construction. The new type of automatic substation coming into use has reduced the cost of construction as well as the cost of maintenance.

From the standpoint of starting and running torque as well as of speed control, both starting and running, the series-wound, direct current motor is superior to any other known motor for traction purposes. At present, however, it is limited to about 750 volts per motor, this limit being set by inherent commutation conditions. For higher voltages, the motors are used in series, and the generators supplying the current must also be series connected. Inherently this is a rather poor arrangement but it has worked out rather surprisingly well.

At present the highest trolley voltage in use, that of the Chicago, Milwaukee, and St. Paul road, is 3000. But even this voltage is not high enough, and closely spaced substations are required. What is wanted is direct current systems carrying voltages of the order of twelve to fifteen thousand. A direct current motor has recently been experimented with which will operate at 12,000 volts, but it is of the separately excited type, a motor which does not have a starting torque satisfactory for railway use. If, however, there could be developed a direct current, series-wound motor capable of operating at 10,000 volts or over, substations could be largely done away with; large capacity, low unit cost generating stations could be erected; the overhead and feeder copper could be greatly reduced, and a lower cost, higher efficiency electrification would be possible. Whether such a high voltage series motor will ever be available is questionable.

One type of single phase, alternating current electric railway system, and one type of combined single phase, three phase system are in present use; neither of them is wholly satisfactory, largely on account of the characteristics of the motor used. The New York, New Haven, and Hartford line uses 11,000 volts, single phase, with overhead current collection from a single wire,—the two rails forming the return circuit. A low potential, series-wound, alternating current motor with its magnetic circuit completely laminated is fed from an auto-transformer placed on the locomotive. The system, though not ideal, is fairly satisfactory. The chief trouble is in the series, alternating current, commu-

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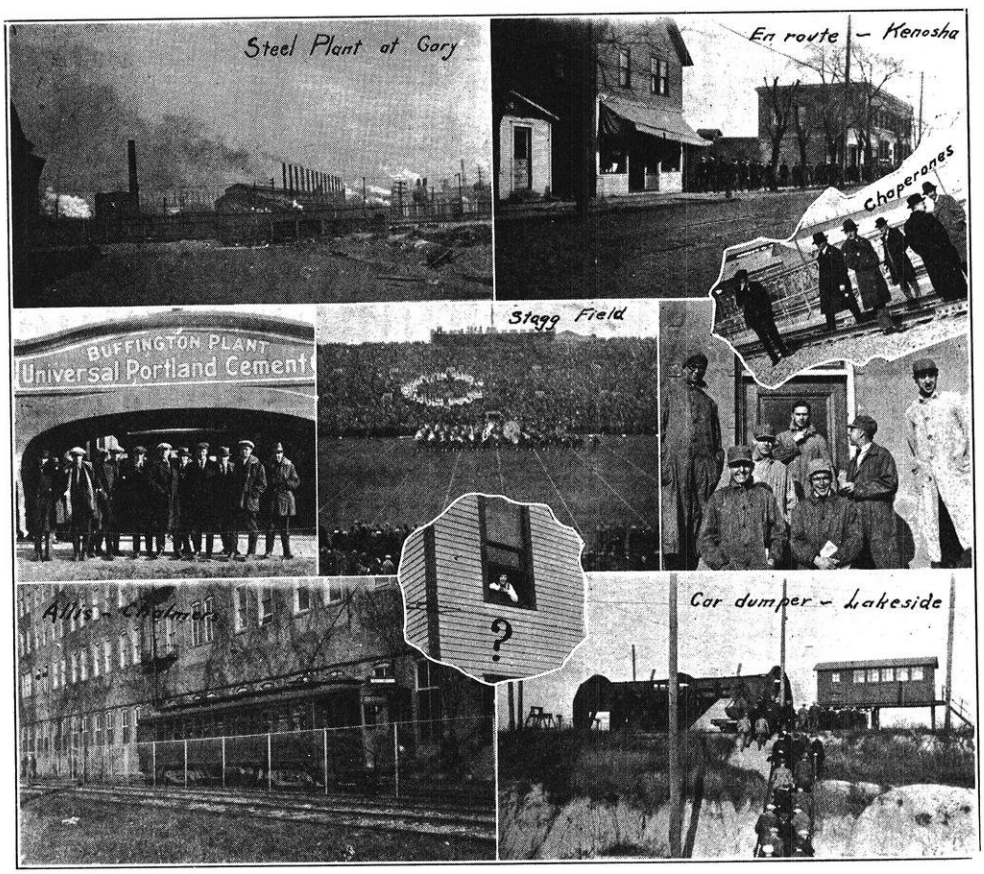
THE ENGINEERS WESTERN TRIP

By Frederick J. Mollerus, *Senior Mechanical*
And
Earl M. Plettner, *Senior Electrical*

The mechanicals were up on the second floor of the E. B. (at least a part of them were) working at Steam and Gas 105, figuring away for fare-thee-well as is the custom there, (?) when in walked Gus Larson with a stack of mimeographed notes. "Well," said Gus, "Here is the dope on the trip. It speaks for itself; just read it. All I want to say is that you fellows should remember to uphold the fair name and reputation of Wisconsin (howl of delight intercedes here), behave like gentlemen, and remember to keep your coat tails from getting clipped in the swinging doors." (sky-rocket for Gus)

About two days later, Pat Hyland mentioned to a couple of M. E.'s that he was going on the trip. "Well," asked the M. E.'s, "Do you know what Gus has to say about that?"

"Yea," said Pat, "He's a fine fellow to advise the boys; you usually find him at the other end of the bar." And there you have it; these two chaperones nobly assisted by Mc Naul, "Johnny" Price, "Ken" Scott, and "Eddy" Bennett started the boys off on the western inspection trip, "western" in the sense that we went eastward, but west of where the eastern trip went. And we went west of east, but east of here with the best gang of chaperons that ever went to the Columbia down in Chicago, or to any other Columbia.



Just to Recall the Trip.

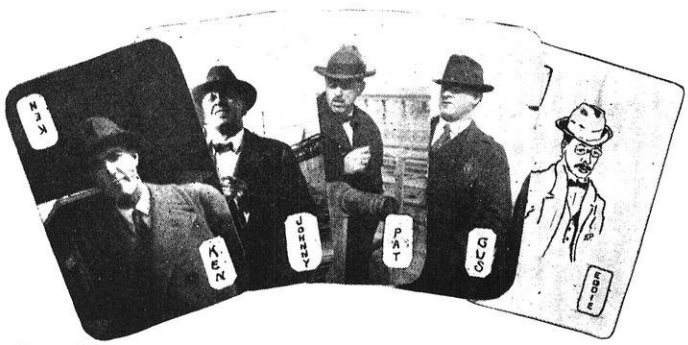
In Milwaukee everybody spent nice quiet evenings expecting to spend all spare money when Chicago was reached. "Hot Dog" Czerwonky got a part of the gang together one evening to go out and let Milwaukee and Marquette know that Wisconsin was in town, but even that went no further than a few yells at one of the show houses. The boys claimed the show was so bad that it took the pep out of them. Pat, Gus, and Johnny were not in evidence either evening in Milwaukee but no doubt they were out looking up old acquaintences. Gus told us before we left Madison that in the old days they used to go through the Pabst Brewery as a regular part of the trip and watch the raw materials start at the top, come down step by step, and finally come out as the finished product. Incidentally, sampling the product was a standard feature of the trip.

Milwaukee is a great manufacturing center and we were out to see it. Allis-Chalmers interested us the most, due no doubt to its reputation, and also to the fact that we got a free feed there. The famous Nordberg Company showed us how hoists and Diesel engines were made and operated (See remark about Koch later.) The Nash and Lafayette Motors finished the day. By the zeal that Alberts showed at the Lafayette plant we should judge that Harry is going to give us a ride in a Lafayette some day.

When Quammen arrived at the Lakeside station the next morning, we saw the thing that Milwaukee is now becoming famous for—the pulverized fuel power house of the street railway company. "Bill" Schubert, senior M. E., was one of our guides. Bill is an old timer at Lakeside and was all set and loaded with information when we got there. Bill told us everything from the fact that the efficiency of the boiler, furnace, and grate is 88% to the fact that by rearranging some of the apparatus during the preceding year, they had

increased the overall efficiency of the plant by forty percent of its former value. Gus Larson emphasized that in general this was the sort of thing that we should do in order to have a good power plant, and then in order to show us what not to do, he took us over to the Commerce Street station of the same company.

In Kenosha we visited the American Brass Company where we were greeted by a pretty young stenog. who opened a window and yelled, "Hurrah for Eckersall," and then sought refuge in the arms of the nearest pen-pusher. After seeing how brass rods, channels, and tubes were made, we hiked over to the Simmons plant to see how beds were made. After seeing the works,



Our Faculty Shepherds. *A full house — Three electricals and a pair of mechanicals.*

Pat Hyland amused himself for a while by bouncing around on a newly designed grade "AA" bed spring, guaranteed to be as fine a spring as any man cares to sleep on. Pat said that the spring was O. K. Some of us think that Pat could get a royalty if it were called the "Hyland" spring, and if Pat's signature and picture were placed on the rear page of the Saturday Evening Post. Pat is sure that a bed spring is a good problem in design. You unfortunate junior mechanicals! The spring cutting machines are a good problem in automatic machinery for the senior mechanicals according to the same authority, so it behooves them to be careful also.

After passing through Wilbur Glenn Voliva's home town without getting pinched, the gang reached Waukegan, but failed to see the marrying parson. After being exposed to an atmosphere saturated with the famous wire-drawing lubricant known as "sour flour water" and to an acoustic rehearsal of the great world war in the nature of a few dozen nail machines hitting on all six at the American Steel and Wire Works we were pretty tired. Most of us slept on the way to Chicago.

When we hit Chi. the boys were more or less awake during the daytime, but all were there at night. The Passing Show took its nightly quota until Rosecky saw it and started to pass judgment upon it. From then on the ticket scalpers began filing bankruptcy papers. Joe claims that after he gets out of Wisconsin his first real job will be to produce a good show,—one that will knock 'em all dead.

Some time was spent at the Buffington plant of the Universal Portland Cement Co. We assured ourselves that Prof. Withey must have worked for this concern when he originated the famous "53" definition about the "calcining to insipient fusion an intimate and properly proportioned mixture of agillacious and calcareous materials with no additions --etc. etc." This concern treated us royally by handing out coveralls and caps of various sizes and descriptions (see picture), so that we were quite minus the college aspect when we went through the shops. After we got into the plant the dust was so thick that we couldn't see a light fifty feet ahead and we soon knew just why we got the "uniforms". That, with a visit to the Western Electric Company just about finished the trip for us.

Why We Didn't Stay Longer

A mechanical at the Gary Steel mills asked what was done with the "ignutz" (He has passed to a better world so we will mention no names.) 'Tis said that an outraged "ignutz" turned livid with internal heat, and up and socked him. (Good work, ignutz).

Electrical—looking at a commutator upon which a steel ring had been shrunk to prevent springing of the segments, necessarily dividing the brush into two parts— "Is this the negative brush and this the positive?" (alternately pointing at the two parts of the brush). When this boy was last heard from he had joined the House of David to hide his face from the sight of mankind.

Bopf — At the American Steel and Wire Works looking at the D. C. motors, "At what power factor do these motors operate?" One more like that, Bopf, and you're elected!

And again at the Lakeside plant—*Bopf*—inspecting a magnetic separator—"What is the efficiency of this separator?"

Attendant, "Why, efficiency, what do you mean?"

Bopf, "How much coal is removed with the iron?" (Bopf explained later that he was mistaken on the magnetic properties of coal)

Some of the Western Pilgrims

To "Smoky" Smonjeski goes the prize to be awarded the best note taker. The first morning, at the Falk Company, he asked the guide enough questions to make a veteran department store floor walker cash in,

(*Continued on Page 86*)

THE RECLAMATION OF CRANK CASE OIL

By William E. Ouweneel

Senior Chemical

Although petroleum is one of our most recently discovered natural resources, it is one whose extinction is already being seriously discussed. The Geological Survey reports that a big fraction of the domestic petroleum is gone. Whether the fraction is one-third, as present knowledge seems to indicate, or is one-fourth or even one-fifth makes no difference in the consideration demanded by the situation". Although it is well known that the annual production of petroleum has increased greatly, the figures in table 1 may aid in realizing its surprising growth.

Table 1.

Annual Production Of Petroleum In The United States

1880	26,000,000	barrels.
1890	45,000,000	barrels.
1900	63,000,000	barrels.
1905	134,000,000	barrels.
1910	209,000,000	barrels.
1915	281,000,000	barrels
1920	442,000,000	barrels.
1921	472,000,000	barrels.

The actual consumption for 1921 was 530,000,000 barrels, indicating, if we neglect the difference in reserves at the beginning and end of the year, that about 11% of our supply was imported.

In the western part of the United States there is an abundance of oil shale, but the process of extracting and refining the oil is still in the experimental state, and shale oil must be regarded as a product of the future rather than as a means already available for supplementing the petroleum from the wells.

In 1921, 12,600,000 barrels, 42 gallons each, of lubricating oil were consumed in this country, while in 1922 the amount rose to 14,900,000 barrels. Assuming that there are 12,000,000 automobiles in this country, it is quite safe to say that one-third of the lubricating oil, or about 5,000,000 barrels annually, is used in automobile engines.

When in use the properties of lubricating oil change for several reasons. Oil which is circulated by force-feed lubricating systems thru high-speed machinery becomes more viscous with use; this is said by some to be due to oxidation, and may eventually form a tarry deposit known as sludge. Crankcase oil in auto engines deteriorates mainly because of carbonization on the walls of the cylinder and dilution by the "heavy ends" of the gasoline vapor which escapes by the piston and is absorbed by the oil. The "heavy ends" also lower the flash point of the oil. Probably some cracking of the lubricating oil occurs which tends to dilute it, but the amount so formed is negligible compared with the amount of vapor which escapes from the cylinder. Crankcase oil is peculiar in that it becomes less viscous upon use and that it carries minute carbon particles in suspension. It is quite likely that all oils which become heated in use are subject to oxidation which raises the acidity of the oils. Besides the chemical changes noted above, water, dirt, and grit may lower the quality of the oil.

In all suggested methods of recovery the reasonable assumption is made that "oil knows no fatigue". It is assumed that the portions which have not been carbonized, oxidized, or cracked are unchanged in physical properties. There are numerous appliances being marketed today which are designed to lengthen the life of oil used in high-speed machinery. They are used with force-feed circulation systems and usually include trays and filters which mechanically purify the oil. The oil flows slowly over shallow trays and drops the sludge and water. It finally passes thru a cloth filter and is then sent back to the machine.

Such a method of continous purification obviously could not be applied to an automobile. Such an apparatus must be quiet and, moreover, does not remove the main cause for deterioration in crankcase oil: namely, dilution by gasoline. An appliance has been devised to act as an "automatic, continuous, crankcase oil refiner". In this device the oil is drawn from the crankcase, passed thru a heater around the exhaust pipe, filtered, freed from volatile matter by its own heat, cooled, and sent back to the crankcase. The distillation takes place in a tank similar to a vacuum tank, and the vapors pass thru the carburetor to the engine. The tank is operated automatically much as the vacuum feed tank. The actual merits of this system appear to be somewhat in doubt. Improvements have been proposed to prevent the kerosene from reaching the crankcase, but these devices are not in general use, and it may be assumed necessary to remove the kerosene from used automobile oils in order to bring back the original viscosity.

Practical methods for the recovery of crankcase oil may be divided into two classes: (1) those treating the oil just as crude petroleum, and (2) those purifying the oil by means of steam.

Near Toledo, Ohio, a plant has been established which is now running 200,000 gallons of waste crankcase oil monthly. The oil is collected throughout adjacent states and after preliminary settling is shipped to the refinery. In the early part of 1923 they were paying about 8c per gallon for the waste oil, 4c in cash and 4c in products. It is claimed that the plant was unprofitable because of the low price of crude oil, 3-4 cents, but conditions are improving. It is reported

(*Concluded on Page 86*)

THE EASTERN INSPECTION TRIP

By Herman K. von Kaas

Senior Mechanical

Five-forty, Friday, November 16, 1923, saw thirty-four senior mechanicals and electricals, with Professors Rood and Aagaard as chaperones, crowding into their future home on wheels, stowing away suitcases and overcoats at random, and settling down for whatever the future, in the shape of the Eastern Inspection Trip, held in store for them. The aforesaid "home on wheels" was the Pullman car *Bayonne* which carried

Some of the Boys who made the Eastern Trip

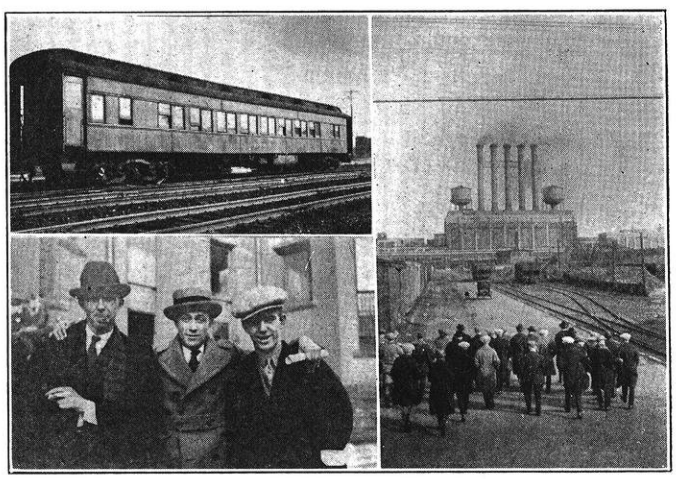
us "to Buffalo and return." Some of the crowd fell to playing cards, others including Baldy Caldwell, Dudley, and such budding,—or shall I say over-ripe—canaries fell to singing "I wish I had a Red Canoe", while the remainder of us fell into the role of audience. There were hilarious carryings on, but after we left Chicago the majority decided to get some sleep, which was wise in view of future developments.

The next morning at Detroit, we set our watches ahead an hour to synchronize with eastern time, and after a hurried breakfast were escorted to the plant of the Burroughs Adding Machine Company, where we had the opportunity of marvelling at the care used in manufacturing and assembling the myriad parts that constitute an adding machine. As it was the first inspection on the list, the gang took notes industriously. The inspection over, our guides threw open the sacred portals of the "Executives Dining Room" and set us up to a feed, —just like the kind the Mother makes when you get home for Christmas. It was well appreciated, and the spirits of some of the foot-weary ones again soared to heights illimitable. Such are the powers of a good dinner.

The Ford Motor Company was next in line. We climbed to the top of a double-decked bus, gave two varsity locomotives, and settled down to keeping out the gentle, icy breezes which seemed colder than anything Madison ever offered. Arriving at the "flivver hatchery" we went through the novel formality of certifying that we would not hold the company responsible for any injuries which we might receive while inspecting the home of the "Henries". This pleasant formality over with, we entered a bewildering jumble of conveyors and super-efficient methods that are used in the manufacture of the Universal Car. System, with a capital S, is the keynote of the plant, but, nevertheless, one possibility has been overlooked by the Company. It was pointed out by Dudley that they should load their box-cars on the run. The power plant was rather attractive in its super-spotlessness, and many regrets were expressed that it could not be inspected at closer range than the Ford rules seemed to allow. The combination gas-steam engines, which were used to drive current generators, were an unusual feature.

At the Connors Creek Station of the Detroit Edison Company, we visited the first of the many power plants we were destined to see during the course of our travels. The electricals had a lot of fun in the switchboard room, while the mechanicals enjoyed the information they elicited from one of the attendants who told us that their power factor varied from 90 to 110 per cent. We were duly impressed at the super-efficiency which the plant displayed.

Sunday morning found us at Niagara Falls, where the atmosphere and scenery both were saturated. I might say something about Canada, but Ontario is far from a stage of saturation, according to those who essayed a trial of the cup that cheers. The cheers were



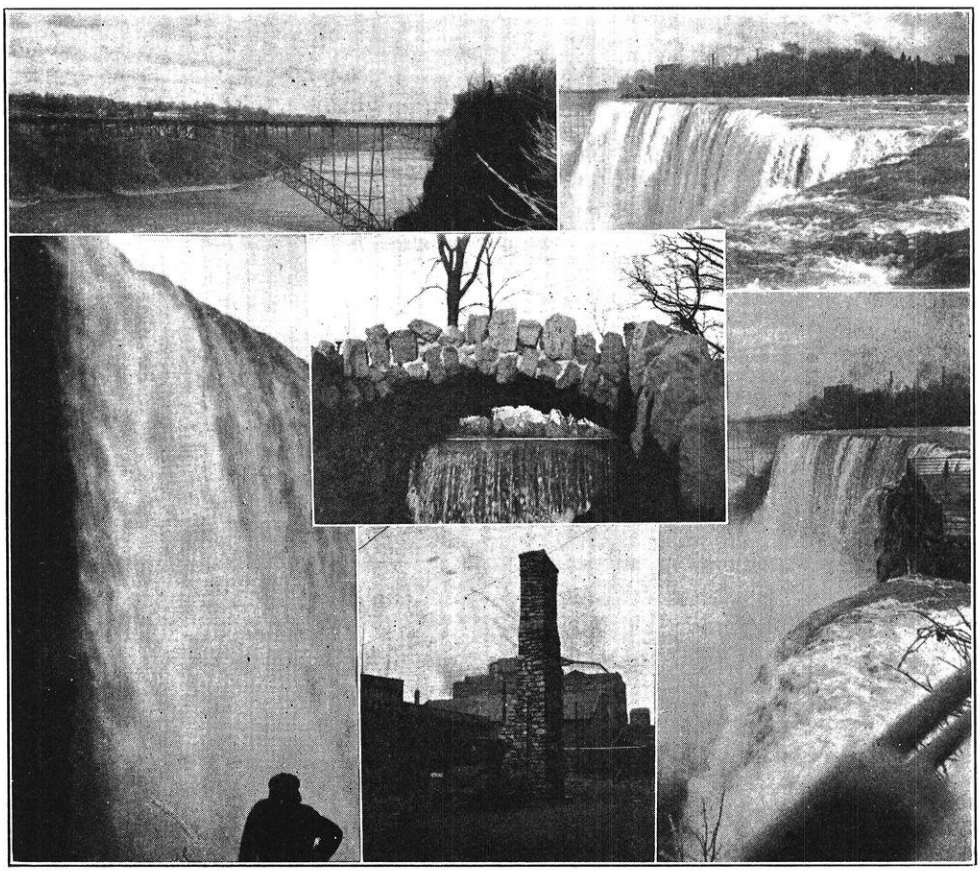
Our House, the Music, and Henry's Hatchery

weak. After a hasty survey of the falls, we bought tickets for the Gorge trip and then crossed the famous International Bridge and stopped at the plant of the Ontario Power Company. This was our first glimpse into the big hydro developments, and we showed interest accordingly. After going through the routine of dragging the electricals away from the switchboard room we again took one of the Gorge cars, and proceeded downstream to the Queenstown plant, the conductor tearing off parts of our tickets every half mile.

He couldn't have worked harder if he had been employed by Henry Ford himself.

The stories told by those who made the trip the year before prepared us for a two hundred foot climb down a flimsy stair case at the Queenstown plant, but Otis, the elevator man, has finally won out, and we found that vertical transportation had been provided. Queenstown is "some" place, and we were duly and lastingly impressed by the size of the project. The view from the gate house level to the power house at the bottom of the gorge was particularly impressive. This plant was operating under the highest head of any along the river,—305 feet on the turbines.

We looked over numerous other plants in and about the Falls and ended with a visit to "The Home of Shredded Wheat". We were all on the lookout for the delectably dimpled darlings" which French, of last year's crew raved about, but either Ziegfield copped them all, or French had poor eyesight. Mariotte, in particular, was quite thorough in his search, but his efforts were fruitless. Nelson presented his card to one of the biscuit packers, who unfortunately was interested primarily in her work. The plant is an excellent example of a modern sanitary food factory.



A Few of the Interesting Scenes.

Sightseeing at the Falls occupied the rest of the afternoon, and at seven we left for Buffalo, where we arrived in time for some of the ambitious ones to take in a show. Upon their return late at night, they had to make a thorough search of the Buffalo yards in order to find the Bayonne, which had been moved so that the battery could be recharged. During the two days sojourn at Niagara Falls, the storage battery had run down to such an extent that the lights were so dim that Miller could not differentiate between a king and an ace.

The next day we watched the manufacture of Pierce Arrow Cars, visited the Snow-Holly plant of the Worthington Pump and Machinery Corporation, where we were guests of the company for lunch, and took a look at the Bethlehem Steel Works at Sackawanna.

Pittsburgh — and we entered the land of soiled collars. Wisconsinites from Westinghouse met us at the depot, — Rufsvold, Clark, Kuelthau, and Stalker. After looking over the imposing array of Westinghouse products, ranging from electric locomotives to sewing machine motors, we had a get-together dinner at the big Westinghouse Cafeteria, with the Wisconsin men from the plant present. It was a real time, — and some of those old boys made us sit up and take notice when it came to singing Wisconsin songs. But talking of singing,— we were taken to the Westinghouse Broadcasting Station, KDKA, and given an opportunity to vent skyrockets and "Varsity" upon the ears of the entire nation.

After a long trolley ride, interspersed at intervals with outbursts of joyous song for the benefit of the rest of the passengers, we finally unloaded at McKeesport. Here we visited the National Tube Works, which, so far as steel making goes, were similar to Lackawanna Steel at Buffalo. The method of rolling pipe over mandrels was, however, novel and spectacular, and a good deal of time was spent in that department. The explosions accompanying the process were a continual source of delight. They caused Baldy to wonder what the poor workmen did for excitement on the Fourth of July.

A long sleepy ride back to Pittsburgh, all of us by this time learned to perfection the art of slumbering en route — a vigorous removal of the accumulation of dirt, which had showered down upon us, and we were

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A COMPARISON OF OPPORTUNITIES FOR ENGINEERING GRADUATES WITH LARGE AND SMALL PLANTS

By Joe Rosecky

Senior Mechanical

The engineering field is a very wide one, and different capacities are needed in the diverse parts composing it. No special system of engineering training can be arranged to meet all of its demands. The fact that all engineers do not become successful in the engineering profession can be attributed to lack of facilities for preparation. Not all graduate engineers will become engineers. Some will fail due to a lack of capacity or opportunity, while others will naturally drift to occupations allied to engineering.

Despite its very commercial and utilitarian character, a large manufacturing concern offers abundant opportunities for the graduate engineer. The success of an individual here depends mostly on his own ability. The advancement of men is an impersonal proposition to the executives. The man must make good if he is to get ahead. Because of the number of men employed, it is reasonable to state that only the men of exceptional ability or training will find in a large plant the opportunities they require. The average man is lost among his fellow employees. His work is only of average quality and the executive cannot distinguish it from the rest.

The large plants offer, however, a very diversified field. Much of the scientific investigation undertaken in engineering lines is made by large modern corporations. This field possesses a fascination all its own for the man interested in such work. The large financial backing enables them to afford large laboratories where all efforts are directed along research lines. Thoroughness is made possible in all the departments and the latest methods of production are used. One instance of the thoroughness with which problems are attacked is afforded by the case of the turbine. Millions were spent and are being spent in perfecting it, not in empirical experimentation but in practically testing the thermodynamic views of turbine engineers.

The large plant has been likened to a college, where the men pass from one department to the next. In sifting out the good men, the whole group of newly employed graduates are passed upon and the men found lacking in ability are transferred to other departments. Thus in time the graduate engineer taking an apprentice course has had experience in all the departments, and if he has shown a fair degree of intelligence is allowed to stay in the department in which he wishes to specialize. The work itself is of an impersonal nature, consisting greatly of routine work—work that does not often require much education. The fact that large companies employ men for such positions is largely accounted for, noting that it is practically their only means of selecting their executives.

They are sometimes accused of exploiting college graduates, of offering opportunities in no way comparable with those open to them in a smaller plant. The accusation, while having some justification, is fundamentally wrong since it furnishes the only practical means of obtaining the necessary high calibre men. The personal relations existing between employees are not as close as they are in smaller plants. The range of acquaintanceship is many times limited to only one department. So too is the acquaintanceship with the manufacturing methods employed in the plant. It is true that the college graduate does not get into personal touch with the executives. Its large scope makes it practically necessary for him to obey others until he is promoted into the responsible positions himself. In this way he is cramped in the working out of his own ideas—again proving that exceptional ability is required for success. It is natural that his ideas must conform with the general policies of the concern. In concluding the discussion of the opportunities offered by a large plant, the question of salary might be briefly touched. In general the initial salary is less than in a smaller plant, but if the graduate has ability and is willing to work, his prospects are more attractive here, and he has practically unlimited room for expansion.

The small plant presents many features that are not present in a large one. The man of average ability is more apt to succeed in a small plant. Exceptional men are soon recognized and because of the relatively few men in responsible positions, are placed where their ability can be utilized. Here the men are less restrained since the policies of a small plant are not, as a rule, so constrained as in a large plant. The relationship existing between owner and employee is personal. This may often lead to petty jealousies among the employees. It should not be assumed, however, that all the responsible positions are held by friends or relatives of the owner, since it is to the advantage of the company to use the ability and foresight of its men to the best possible advantage.

The work is more diversified although the opportunities in any one field may be smaller. To a man naturally possessing the ability of mingling with men it offers, perhaps, a better opportunity to the graduate since it is by close relations between employer and employee that best results are obtained. For the research man the field in small plants is very limited—the only opportunities offered being those relating to the manufacture of finished ideas. Because of its peculiar nature, it offers more opportunity to the man who understands a process of manufacture as a whole

(Concluded on Page 84)

SUGGESTIONS FOR ENGINEERING STUDENTS

By L. T. Sogard

Senior Civil

An engineer's room is his office; his own study table is the place where he obtains most of his college training and knowledge. There, too, he forms his habits of studying, of attacking problems, of writing reports. Much of what occurs over that table in his four years at school will become a part of him, and there he will acquire many of his permanent professional habits.

Engineering students have much work to do and in order to do good work they must function efficiently. A few suggestions gleaned from the writer's four years at college, plus those he has gathered from observation of other engineering students, are presented in the hope that they may help others, especially underclassmen, in getting their school affairs in such shape that they may work to better advantage.

Order is essential. Chaos and confusion on the study-table boost the business of the movies and the pool-room. It takes all of the ambition out of a fellow to have to sit down before a cluttered table and endeavor to work. Have your books in some kind of a case or rack, within easy reach, and keep them *there* always, except when they are in immediate use.

When you buy supplies, get enough to last several months,—better still, a semester. Nothing is more exasperating to yourself, and to your roommate, than to be continually out of paper, report covers, pencils, and other material of which you use a great deal. Buy paper clips, fasteners, and thumb tacks by the hundred, not by the dozen. The chances of having them on hand are increased greatly thereby.

Almost everyone uses some sort of a loose-leaf, ring-binding notebook. To his notes therein he will often wish to add miscellaneous sheets which are not punched for the rings. The usual practice consists in forcing these sheets over the open edges of the rings with very unsatisfactory results. An inexpensive paper-punch will produce an incomparably better job and, furthermore, insure the permanence of the sheet. This is but one use of the paper-punch, a tool as invaluable to the engineers as a 30-60 triangle.

How often in the course of your four-year sojourn here, do you sign your name to problems and other papers which you turn in? In how many books have you scribbled your name? Figure it out and you will find that it totals quite a bit of penmanship and time. Yet for twenty-five cents you can obtain a rubber stamp of your own name which will speedily print it in a uniform and legible fashion. However, don't sign your checks with it.

There are certain places in your textbooks, particularly in handbooks, to which you wish to refer often. The easiest solution to what can be an arduous and exasperating task is to glue small thumb-tabs to those particular pages and label them. Reference to them is simplicity itself. If you are skeptical try it on your Cambria.

Glue is a prime necessity, yet there probably is more glue borrowed among engineers than cigarettes. It can be purchased in tubes, jars, bottles, and jugs ranging in price from ten cents to infinity. Why say more?

Unless your memory is exceptionally keen, jot down your assignments, tasks to be performed, and appointments to be kept. A little system in this is a great saver of time and worry. Have some sort of a daily date-pad on your desk on which you can note, at any time, for any day, anything from a reminder to buy some more shoestrings to an appointment with the governor of the state. Assignments, if kept together in chronological order, are a great aid in reviewing for quizzes. The practice of marking them in texts is often misleading and is of little value when the book is not followed in the order in which it was written. One engineer, whom I know, sits down at intervals and makes a list of the reports, problems, and other scholastic work to which he has been detailed. This he tacks up in front of him with the additional underscored warning at the bottom, "Work Like Hell". As each task is completed he scratches out its notation.

Next to the Pardon-Me-Have-You-A-Match fiend is the Say-What's-the-Date-Today roommate. Calendars are as free as the air. If you haven't got one on your wall you are either indifferent, dumb, or hopeless. But if you do own one, don't commit the unpardonable crime of asking your roommate the date—merely look at the calendar.

Clip-covers for loose sheets provide a satisfactory means of keeping current papers. Many carry their papers between the leaves of their textbooks. One has only to drop a book so filled but once on some windy day and he is immediately converted. Many use the leather portfolios, or brief cases, in which they can readily transport books, papers, slide-rule, and instruments. The suit-case effect is abhorred by many, but there is much in favor of them.

If you have notes, problems, or reports which you wish to keep for future reference, bind them in some manner. Any stationer will punch them and provide them with card-board covers for ten or fifteen cents if you will trouble yourself to take them to him. Some prefer a regular binding; this is more permanent but does not permit of further additions.

Much more could be said, but all engineers have some ingenuity and, doubtless, many have plans and ideas better than these. They should be taken in the light of suggestion and not as a working model. The satisfaction obtained by working with all of your materials and tools at hand and with some semblance of system can be truly appreciated by those who do and, more particularly, by those who didn't but now do.

EDITORIALS

L. T. SOGARD

OUR COVER The cover on this issue of the Wisconsin Engineer is taken from a photograph of the senior electrical and mechanical engineers who took the western trip. The photograph was taken at the Hawthorne works of the Western Electric Company.

THE ENGINEER, YESTERDAY AND TODAY Did you ever hear an alumnus of the engineering college talk of the old days when *he* was in school? According to him the plumbers of that day wore corduroy trousers and flannel shirts every day except Sunday. They smoked corn-cob pipes, and chewed plug-tobacco, and they grew hair in their ears.

A hardy crew; but one wonders whether or not these verbal (and verbose) pictures of our predecessors are not the fruit of the describers' imaginations. Did you ever read *Old Siwash* or *Stover at Yale* and compare the college life described therein with life on the Wisconsin campus today. The effect is much the same as a comparison between "then" and "now" in the engineering college.

However, the engineers of yesterday were much more clannish than those of today; their building was their castle and it was worth a co-ed's life to pass up its cigarette strewn walk and through its matched-scratched doors. The favored sons of St. Pat hooted their "shyster" neighbors oftener and took delight in being hard-boiled.

Today, the engineer differs little from the rest of the school. He wears white shirts, bow ties, and four-button suits with the rest of them. Only the protruding slip-stick remains to establish his identity.

Can this white-collar engineer step into the battle, which engineering offers, and fight his way as the old engineers have done? We think so. Clothes do not make the man and, certainly, clothes cannot undo him. When he has finished his schooling and has doffed "kollege-kut" for jumper, or boots and corduroys, he will have every chance for success that his predecessors had.

Old timer, don't pity the student-engineer of today. He will show his worth.

Vision is —
To see what others do not see
To see further than they see
To see before they see. JOHN R. MOTT

JOIN YOUR ENGINEERING SOCIETY Would you like to meet the fellows who are studying the same things that you are studying now, —or will be studying in a year or two? Would you like to get together and swap experiences; meet your "profs" when they are just real "guys" and not in pedagogical guise; or listen to tales of the engineering world told by men who have battled the game for years? If you would, join the student chapter of the professional society of your chosen branch of engineering.

Each of the five branches of engineering into which our college is divided has a student chapter of the national society of that branch. These student groups meet every other week in the evening from 7:30 to 9:00 o'clock. A short business meeting is followed by a program of engineering interest. There are talks by members of the faculty, practicing engineers, or by the students themselves; there are sometimes illustrated lectures; and, occasionally, there is a "movie" of some engineering development, obtained through the joint action of two or three of the societies.

Through the societies the student is afforded a contact with the engineering profession which he could receive in no other way. Furthermore, he becomes acquainted with men from the Freshman to the senior class; he makes friends within his profession with whom he may keep in touch in later life. Finally, the student chapters provide the stepping stone to affiliation with national organizations.

There is more to an engineering education than books and reports; if you doubt this, drop around some evening as a self-invited guest of the society. You will be as welcome as a check from home. Signs announcing the meetings are posted in the Engineering Building. Be on deck the next time your society meets.

"I hold every man a debtor to his profession, from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereto." FRANCIS BACON

ART ANTIQUES The art collection that adorns the halls and rooms of the Engineering Building is rapidly acquiring the interest and value that pertain to relics of antiquity.

For example, there is the picture of the superheated, nickle-plated, gilt-edged, brass-trimmed, double-umbil-

(Concluded on Page 84)

ALUMNI NOTES

F. D. BLANCH

CHEMICALS

Gerald Anderson, ch. '22, is a cadet engineer with the Wisconsin Public Service Corporation at Sheboygan, Wis. He was married to Miss Fern Anderson on Oct. 31, 1923.

Robert W. Cretney, ch. '21, was married to Miss Mary Shear on Oct. 17, 1923, at Radnor Heights, Va. Their home address is Monroe, Louisiana.

John B. Edwards, ch. '15, was married to Miss Virginia Cornwall on Nov., 17, 1923 at Ottawa, Ill. Their home address is 655 Tonti St., La Salle, Ill.

J. M. Gillet, ch '15, is now employed by the Victor Chemical Co., Chicago.

W. V. Hanks, ch. '23, was married, on December 29, 1923, to Miss Mary Haley, at Tulsa, Okla. He is now enrolled in the school of Chemical Engineering Practice of the Mass. Institute of Technology.

H. H. Tobin, ch. '23, is a cadet engineer with the Coal Products Co., at Joliet, Illinois.

CIVILS

Wm. G. Huber, c '20, is working on projects for dams for the West Virginia Power and Transmission Co. in the hydro-electric department of the West Penn Power Co. of Pittsburg. His address is P. O. Box 215, Davis, West Virginia.

Charles E. Jones, c '10, is with the Southern California Edison Co. at San Diego, Calif.

William N. Jones, c '05, C. E. '10, has the contract for the erection of a $3,000,000 hotel at Memphis, Tenn.

I. W. Mendelsohn, c '17, is with the U. S. Public Health Service as a sanitary engineer. His address is 420 Call Bldg., San Francisco, Calif.

John L. Savage, c '03, is chief desiging engineer for the Bureau of Reclamation, Denver, Colo.

Walter C. Thiel, c '22, gives his address as 405 West Fourth St., Long Beach, Calif.

ELECTRICALS

Jerome Gefke, e '17, is general problems engineer with the Wisconsin Telephone Co. at Milwaukee.

Harry Miller, e '21, is with the Menominee and Marinette Light and Traction Co. with headquarters at Menominee, Mich.

Ernest Morse, e '18, is a sales engineer with the Hayton Pump and Blower Co., Appleton, Wis.

Ray Paulus, e '22, is doing special development work in hydraulics at the West Allis works of the Allis-Chalmers Mfg. Co.,

Robert Siegel, e '21, is toll fundamental plan engineer for the Wisconsin Telephone Co. at Milwaukee.

GENERAL

Robert L. Rote, g '10, is engaged in general contracting at Monroe, Wis.

MECHANICALS

R. A. Grant, m '17, is a sales engineer in the condenser department of the Allis-Chalmers Mfg. Co.

Charles Higson, m '07, E. E. '13, is president of the Utah section of the American Institute of Electrical Engineers.

Fred H. Dorner, m '05, has recently been elected president of the Engineer's Society of Milwaukee.

A. B. Hawkins, m '21, writes from Tuscon, Arizona, that he was married to Miss Lucy Rogers '18, on Dec. 24, 1922. Their address is 843 East Lee St.

B. E. James, m '21, is the author of an article appearing in the December issue of the Electrical Journal. "Butts" is in the Motor Engineering department of the Westinghouse Co., at East Pittsburg, Pa.

Fred C. Stewart, m '23, is superintendent of grounds and buildings at Albion College, Albion, Michigan.

Harold Suhs, m '10, is head of the steam apparatus department of the Nekoosa Edwards Paper Co. at Port Edwards, Wisconsin.

Benjamin F. Wupper, m '23, together with **M. A. Giles,** m '22, and **Roy Anderson,** m '23, is studying patent law at George Washington University. His address is 1307 Clifton Street, N. W., Washington, D. C. He expects to spend two and one-half years more on the course.

FRED C. STEWART IS SUPERINTENDENT OF GROUNDS AND BUILDINGS AT ALBION COLLEGE

MINERS

Ralph Jourdan, min, '21, is an assayer for the American Smelting and Refining Co. at their Garfield plant at Garfield, Utah.

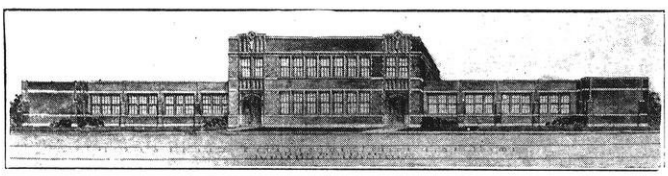
A. E. Montgomery, min. '22, gives us his address: J. O. Ross Engineering Corporation, 549 W. Washington St., Chicago, Ill.

Wm. F. Uhlig, min. '21, announces the arrival of a daughter, Miss Elenor Lucille, on Dec. 9, 1923, at 4306 Maoren Ave., East Chicago, Indiana.

Gilbert Wegner, min. '22, is an assayer at the Tooele plant of the International Smelting Co. at Tooele, Utah.

EXTENSION NOTES

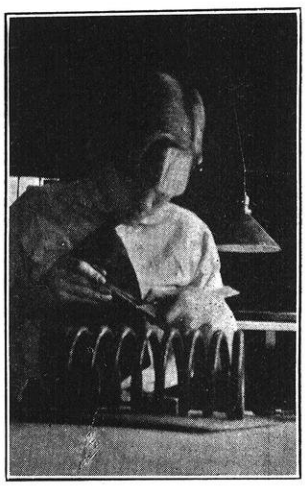
The Extension Division has recently enrolled for Course 222 "Refrigeration", Mr. Frederick Palmer of the architectural firm of Palmer and Maloney, Yakima, Washington. Mr. Palmer is a man of above 50 years and states that he has been in architectural work for 30 years in various capacities. He has further advised us that during the past year he has designed four school buildings, some heavy warehouse construction, besides other work of the same general character. The accompanying illustration shows one of the school buildings designed by this firm.



SCHOOL BUILDING DESIGNED BY PALMER AND MALONEY, YAKIMA, WASHINGTON. *Mr. Palmer is an Engineering student of the Extension Division.*

Nine years ago Mr. Palmer enrolled for the course in Heating and Ventilating and completed the 20 assignments in less than two months with a grade of 94. He also completed Course 418 with the Civil Engineering Department. He gives as his reason for taking the Refrigeration Course that fruit storage is a common problem in his locality and adds "I wish to keep fit in my line". We hope to be able to secure an article from Mr. Palmer for The Wisconsin Engineer.

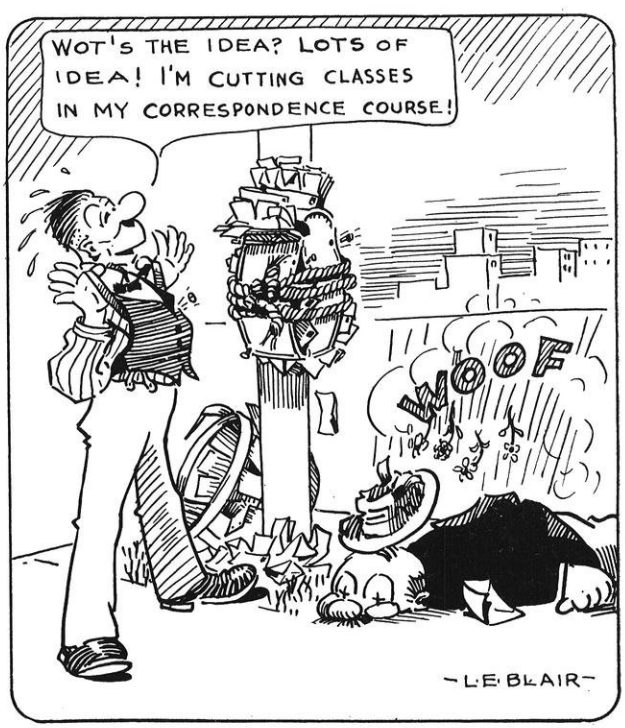
The annual University Extension Christmas party was held on the first floor of the University Extension Building on Friday afternoon, December 21. Professors Edgar B. Gordon and Lelia Bascom distributed the gifts. Refreshments were served by the ladies on the faculty.



TOBY TORBJARNSEN, ROCHELLE, ILL. *An Extension Student in drawing at work in his home.*

Marshall E. Graff, District Representative, has completed the organization of two classes in the paper mills at Mosinee. One group of men is registered for the course in Shop Sketching and the other for the course on The Manufacture of Sulphate Pulp.

Much interest is being shown in the engineering classes at the Nekoosa-Edwards Paper Company at



Port Edwards and Nekoosa. The Steam Engineering class under Professor Ben G. Elliott and the class in Electricity are making good progress.

E. L. Knebes, correspondence student in Civil and Structural Engineering, is Assistant Engineer of Milwaukee.

L. E. Chase, correspondence *graduate student* in Civil and Structural Engineering, is Assistant City Engineer of La Crosse, Wisconsin.

Earle W. Richardson, correspondence student in Civil and Structural Engineering, is Junior Engineer in charge of the Cost Department of Public Buildings and Grounds, Washington, D. C., under the Chief of Engineers, U. S. Army.

Merritt Hutton, correspondence *graduate student* in Civil and Structural Engineering, is a Consulting Mining Engineer in Denver, Colorado.

William Artingstall, correspondence *graduate student* in Civil and Structural Engineering, consulting engineer, Chicago, has been made consulting engineer with the Department of Public Works, Chicago, reporting directly to Col. A. A. Sprague, commissioner. His duties include handling the city's supervision of the Illinois Central terminal, Union Station, and other railroad terminals, in addition to all matters coming to the commissioner by special ordinance.

Among the engineering subjects offered in the evening courses of the Extension Division at Milwaukee for the second semester, none of which carry university credit, are the following:

Architectural Drawing
Electrical Design
Elements of Structural Theory
Estimating for Builders
Metallurgy of Iron and Steel
Reinforced Concrete
Shop Mathematics
Surveying

Whenever there appears to be a sufficient demand to warrant the starting of a class, the Extension Division is ready to arrange for it in practically any line of commercial, technical, or cultural work.

Mr. Nathan Harris, formerly Instructor in Highway Inspection and Highway Construction in the Milwaukee Extension Division classes, is now employed by the City Land Commission of Milwaukee.

The Engineering Data Sheet recently sent out to the fieldmen for distribution has received much favorable comment. This sheet, which is in blue print form, contains much valuable engineering data. A copy will be sent to any extension student or to any other person interested, upon request.

Engineers in Milwaukee will be especially interested in the course of six lectures by Professor Carl Russell Fish of the University of Wisconsin which has been arranged by the University Extension Division in cooperation with the City Club of Milwaukee. Some of the outstanding social, economic, and political problems of the day will be discussed from their historic background.

The following are the dates and topics of the lectures:

January 18 — The Problems of Economics, Finance, and the Social Classes. (How economics and finance are overturning social classes)

January 25 — Economic Units versus National Units. (The conflict of economic and national boundaries)

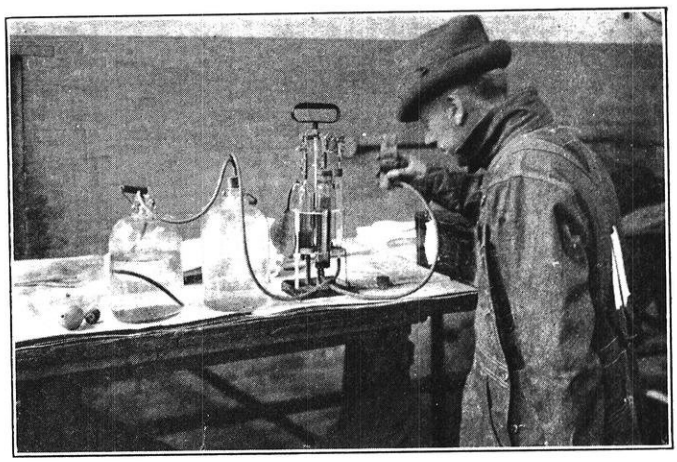
February 1 — Bolshevism, Facismo, and Normalcy.

February 8 — Migration or Population Movements.

February 15 — The Washington Conference and the Far East.

February 29 — The World Court and International Relationships.

Each lecture will treat of a separate subject and will be complete in itself. The lectures begin promptly at eight o'clock. Tickets may be secured at 471 Van Buren Street or at the City Club.



LABORATORY WORK BY CORRESPONDENCE. *An Extension student in Steam Engineering making a flue gas analysis during a boiler test conducted by an Extension Class at one of the plants in Appleton.*

The many responses which have been received in reply to the letter regarding the new cooperative plan with the Wisconsin Engineer have been most gratifying. Not only have many students sent in their subscriptions but many others have signified their interest as future contributors. The work in which Engineering Extension students are engaged represents many varied lines of endeavor, and many valuable and interesting articles should be forthcoming.

Mr. Mathew Hendrickson, a student in the Structural Design Course, was killed at a railroad crossing near Slinger, Wisconsin, on the evening of December 27.

ENGINEERING REVIEW

H. C. WOLFE

LIQUID OXYGEN USED IN BLASTING

Liquid oxygen explosive has been successfully used in Colorado by the Department of Interior in experimental mine blasting and road construction work at a cost of approximately one-half that of the gelatin dynamite required to do the same work. The experiments were conducted by E. D. Gardner, mining engineer of the Bureau of Mines, in co-operation with a representative of the Compressed Air Corporation.

A liquid oxygen explosive consists of gas black, wood pulp or some other carbonaceous material made up into cartridges and soaked in liquid oxygen. This explosive is detonated similarly to ordinary dynamite with cap and fuse or with electric detonators.

The liquid oxygen was obtained from a plant designed to furnish oxygen gas and was shipped to the point of use in Dewar flasks, which are made on the same principal as thermos bottles.

BELGIAN RADIUM

The new plant which has been erected near Antwerp to smelt the ore from the Belgian Congo, is expected to produce three or four grams of radium per month. As this quantity is in excess of the world's present demand, endeavors are being made to find industrial uses for the metal. The American ore mines have been closed for the present, owing to the comparitively rich content of the Congo ore which has enabled the price of radium to be reduced very materially.

ELECTRIC EQUIPMENT FOR JAPANESE EARTHQUAKE ZONE

The Westinghouse Electrical International Company has received orders for electrical apparatus to be used in reconstruction work in Japan totaling well over a million dollars. Other orders which will bring the total amount to approximately two million dollars are in course of negotiation.

KEEPING HEAT INDOORS

The question of keeping heat within buildings is to be a subject of inquiry by the United States Bureau of Standards. Tests are proposed whereby the properties of typical outside wall construction with and without hollow air spaces will be investigated from the thermal point of view. The importance of determining the most effective wall construction will be realized when it is known that if the heat losses through the exterior walls of buildings were reduced 10%, the annual saving of coal in the United States would be eight million tons. The importance of this figure is further appreciated when it is recalled that a further very great saving in motive power, railway equipment and team haulage would be affected by the primary saving.

REFUGE CHAMBERS FOR MINES

The United States Bureau of Mines has advocated that refuge chambers be built in the main sections of mines. After an explosion or during a mine fire men might retreat to these chambers and close themselves in until help arrived. Such chambers should be provided with drinking water, canned food, and compressed air. Small refuge chambers have been established in some of the coal mines in the Central States, where there have been many explosions during shotfiring time, and these chambers have saved lifes. The usefulness of these places has been discussed in Technical Paper 24 of the Bureau, entitled "Mine Fires."

MERCURY BOILER

The new mercury boiler is the result of ten years' experimentation by Dr. William Leroy Emmet of the General Electric Company. To transfer the stored-up power of fuel into mechanical energy, it uses everything at least twice. The fuel-gases are used for four distinct purposes before being allowed to escape up the smoke-stack, and the mercury is used over and over without being allowed to escape at all.

In the boiler process the mercury is turned into vapor in a boiler much smaller than those now in use for steam, and the vapor does its first work in driving a special mercury-vapor turbine. This cools the vapor only slightly, and it is still over three times as hot as boiling water when it goes into a condenser where it is cooled by water, just as in any ordinary power system. But the water used to condense it is turned into steam at a high pressure, carrying much heat. This is because mercury does not boil and vaporize below 677 degrees F., while water vaporizes at 212 degrees F. This steam, after going through a superheater, is sent into other turbines or engines of the ordinary type, just as though it came from prosaic boilers instead of the mercury condenser.

(Concluded on Page 84)

BRITISH RADIO FANS MUST PAY FOR BROADCASTING

It may appear surprising to Americans that radio broadcasting on a large scale has not yet been begun in Great Britain. The reason is that British Government authorities and the radio manufacturers have been making haste slowly in order to avoid what the London *Times* calls "the endless confusion which has occurred in the United States, where broadcasting has been allowed to grow haphazard." Broadly, the British scheme is to have all broadcasting done by a single organization which will be sanctioned by the Government, operated by the manufacturers of receiving sets, and financed jointly by both.

"The six principal manufacturers of radio equipment in Great Britain have incorporated a broadcasting company, stock ownership in which will be available to themselves and to any other manufacturers of radio receiving equipment in the British Isles," said Mr. Frank Gill, of London, European Chief Engineer of the International Western Electric Company and President-Elect of the British Institution of Electrical Engineers, who has just arrived in the United States. "The Broadcasting Company will have a capital of 100,000.00 pounds, which has been guaranteed by these six manufacturers.

"The question which is beginning to draw more and more attention in America as to who shall pay the very considerable expenses of operating broadcasting stations and furnishing satisfactory programs, has been solved in Great Britain in an ingenious way," said Mr. Gill. Over there, amateur receiving sets have always required a license from the Post Office Department, which has supervision over all forms of communication. This license fee is 10 shillings per annum, or about $2.20. The Post Office has agreed to pay to the Broadcasting company half of this annual fee. The Postmaster General believes it is to the real interest of the country that the Government should assist in providing first-class broadcasting service.

IODINE AS A CURE FOR GOITER

Following the conclusive proof by science that goiter is confined to those whose food supply is deficient in iodine, the authorities at Rochester, N. Y. have taken definite steps to eradicate the disease within the area supplied by the local waterworks. Early this year 16 pounds of sodium iodide were added daily to the reservoir, the amount of iodine in the water going to the consumers thereby being raised to one part in one billion parts. This treatment was continued for two weeks and is now being repeated. The cost will amount to about $2,000 per year, and the benefit to the community will be incalculable.

From a lab report on the Orifice.

A larger scale would still result in a straight line because the discharge in cu. ft. is constant threw-out the HOLE experiment.

Civil—Are you taking hydraulics too?
Electrical—No, hydraulics three.

ATHLETICS

E. R. SUMMERS

BASKETBALL

So far the thrills of the 1924 basketball season have been furnished by the relentless struggles between Hoosier and Badger. The Hoosier state has always been famous for netmen. In fact, Purdue, Indiana University, Butler, Franklin, and De Pauw could form a formidable jinx for any conference team. No squad realizes this fact any more clearly than does our own.

THE 1923-24 BASKET BALL SQUAD.

The basketball season started with a whirlwind just as the football season did. A 53 to 13 win from Millikin College showed the effectiveness of the short-pass machine. Perhaps Rollie Williams forgot to teach his boys all of the tricks of the game. If Rollie's team is the "son" of the short pass system, what could Meanwell's squad do to the "grandson"?

De Pauw, however, made things quite interesting for the varsity. Never was a more exciting game seen on the local floor. De Pauw, quite confident after winning an overtime game with Illinois, put up a wonderful fight. The faultless guarding of the Hoosiers, together with the uncanny ability of White, was almost too much for the Badgers. The short pass system seemed to be ineffective against the Hoosier defense. After three overtime periods, the game was called a draw because the coaches did not wish to injure their men by overexertion.

On December 19, the last day before Christmas recess, a nice surprise was delivered by the varsity in the form of a decisive victory over the famed Marquette quintet. Marquette, having defeated Wisconsin last year, was counting on another victory. Confidence did not come to their rescue this time, however, because they were forced to be contented with the small end of a 27 to 7 score. That was the night when the Meanwell machine was working to perfection.

The basketball season was progressing quite nicely, in fact, until Franklin arrived upon the scene and gave the Cardinals something new in the form of a basketball "pill". The Badgers had a 15 to 9 lead at the end of the first half. Then a bit of over confidence crept into the Meanwell camp. Two substitutes were put in the game. Franklin took advantage of the opportunity and squeezed the lemon hard. Several ringers were made in the last few minutes of the second half. Once started, the Franklin quintet could not be stopped, and they piled up a three point lead, making the score 21 to 18 before the gun cracked. In the second half Franklin made 12 points in contrast to the Badgers' 3 points. Franklin deserves its reputation as a wonder team; if the team cannot win the game in the first half, it is sure to pull the game out of the fire in the second.

Preliminary games were forgotten when the Badgers took on Indiana at Bloomington for the first conference game. After many thrills and breathless moments Indiana was nosed out by a 23 to 21 score. That score seems to be a popular one down at Bloomington. Those with good memories will probably remember that Indiana nosed Iowa out of the conference championship last year by the same score. Each year the score happened to be in the Badgers' favor.

Diebold, guard, cinched the game for Wisconsin

when he tossed in two field goals in the last few minutes of play. Gibson, playing his best game of the season, was responsible for the most of Wisconsin's points. Varney, Barwig, and Spooner were contented with one field goal each. Every man on the team succeeded in finding the net at least once.

Nyikos, stellar forward for Indiana, was the outstanding individual star of the game. He made 15 of Indiana's precious points. The next game he showed much more speed, because he abhors the idea of wearing his whiskers until spring. Oh yes, the members of the Hoosier squad did throw their razors away until they won a conference game. Some people are reckless!

ICE CARNIVAL

The annual Ice Carnival will be held on February 15. Gilbert Hoffman '24 was appointed as head of the event. Plans are being formed for the best ice carnival ever held on Mendota. The success of the event will depend, of course, upon the weather conditions. According to the theory of annual averages, an elongated cold wave could safely be predicted. Then skating, skiing, and tabogganing can reign supreme.

George Martin, grad, has been appointed director of winter sports by Coach T. E. Jones. Martin is an excellent skater as well as a good ski jumper. Since Wisconsin is so admirably located for winter sports, the athletic department feels justified in giving its aid to the winter sport enthusiasts.

About 20 hockey enthusiasts answered the first call of the coach. Never was so much enthusiasm shown over the sport before. Several of the varsity players from last year's team are back and ready for business.

The team has rounded into form quite rapidly considering the small amount of time that the rink has been in shape for practice. Conference games are to be played with Minnesota and Michigan.

ENGINEERING REVIEW

(Concluded from Page 80)

The adoption of the boiler for general commercial application is not expected just at present. Improvements and modifications are planned, based on facts to be obtained from the experimental unit installed by the General Electrical Company at its Hartford plant.

EDITORIALS

(Concluded from Page 76)

ical, compound fire-engine that hangs just outside the entrance to the steam and gas laboratory. Presumably there are still some who can thrill at the mind-picture of this old ark clanging its way down State street drawn by two galloping horses with eyes ablaze and nostrils distended, the driver - hero of all small boys - swaying in his seat with every lunge of the fiery steeds.

Another relic that shows the remarkable advances in engineering that had been made two decades ago is the "Black Diamond Express" with its five wooden coaches and its antiquated locomotive. This, no doubt, was palatial equipment in its day, but now, if it is in service at all, it probably has been relegated to some branch line run.

Obviously our college art department needs jazzing up a bit. The ideal thing would be some real honest to goodness paintings of engineering subjects; but such things come at about one hundred and fifty dollars a square foot. Therefore, we will have to be content with some less ambitious pictures. What shall they be?

—H. K.

A COMPARISON OF OPPORTUNITIES FOR ENGINEERING GRADUATES WITH LARGE AND SMALL PLANTS

(Concluded from Page 74

than to the man who specializes in but one line. Thus a man might be a recognized authority in one branch of the manufacture of an article, yet be a failure as an executive supervising its entirety. The chances of relative advancement are greater, but the chances of holding a better position are less in a small than in a large plant, i. e., a graduate might by persistent effort rise to be a general manager of a small plant, yet by the same amount of effort might have succeeded in obtaining a division superintendency in a large plant, which is decidedly a more lucrative and responsible position. The graduate of average ability shows the best degree of success by accepting employment in a large plant for a short time in order to get experience and then entering a small plant and making use of his training. The opportunities offered in a small plant require that the graduate have practical experience in order to be able to grasp them, and the experience gained in a large plant is often of great value. In as much as the small plants are not as strong financially as the large plants the jobs they offer are less secure. This security of position is a question of vital importance to the graduate who aims to work in a small plant. If he is resourceful and possesses a fair amount of ability he should be able at all times to secure a position in other allied plants.

In concluding it might be well to state that the question of opportunities is largely a personal one. To those possessing a love of home ties, the plant in the home town is often the best place. To others a large plant offers room for fulfillment of ambitions. In all positions men are needed who see not only tomorrow's needs, but those of the day following. Each graduate should remember that his particular opportunity is the little one that lies squarely in front of him and not the large one that he eventually hopes to find. Some are born to lead and others to serve—in whatever class he finds himself it is always up to the graduate engineer to do his utmost.

BETTER LIGHTING NEEDED IN INDUSTRIAL PLANTS.

In a paper read before the Illuminating Engineering Society, February, 1920, entitled, "A Survey of Industrial Lighting in Fifteen States," R. O. Eastman submitted some very interesting data regarding the lighting conditions in industrial institutions. The survey comprises some 446 institutions, in which lighting was considered by 55.4% as being vitally important, and by 31.6% as being moderately important, and by 13% as being of little importance. Practically 58% considered that lighting was as important as power in the operation of the plant, and a small proportion would give more attention to lighting than to anything else.

In considering the present condition of lighting as found in the various plants, only 9% ranked as excellent, about ⅓ ranked as good, 29% fair, 18.8% poor, 3.5% very poor, and 7.8% partly good and partly poor. It was found that the lighting in the offices was far superior to that in the shops; 19% being excellent, 36% good, 31% fair, and only 13% poor and none very poor.

On consulting the executives regarding what factors were most important in considering lighting, the following facts were revealed: Increase of production 79.4%, decrease of spoilage 71.1%, prevention of accidents 59.5%, improvement of good discipline 51.2%, and improvement of hygienic conditions 41.4%. Manufacturers who have good lighting appreciated its value largely from the standpoint of its stimulating effect upon output.

There is no question that any intelligent man who carefully considers the necessity for good lighting in an industrial plant, will agree that it is impossible for a person to do as good work, either in quality or quantity, in poor light as in good light, but yet the result of a careful analysis discloses the fact that only about 40% of industrial plants are furnishing good light to their workers and 60% are operating under poor lighting. It is hard to understand why such a proportion of concerns can be satisfied with a condition which is universally admitted to be a curtailer of efficiency and a prolific causer of accidents. The principal cause of this condition is that those in charge of such establishments have not given the attention to lighting that it demands. They do not know what constitutes good lighting, and in their absorbing interest of other factors of production have overlooked a vital one.

Every safety official should deeply interest himself in the lighting of his plant and insist upon good lighting as much as good goggles, good guards and other necessary accident prevention equipment. Every production manager should insist upon good lighting because the efficiency of the working force is increased by the condition of the lighting furnished. The plant physician should examine the lighting, for eye strain and eye fatigue are directly affected by poor lighting, as is the hygienic condition. Well lighted plants are invariably cleaner than poor lighted places. Plants equipped with Factrolite Glass in all windows are well lighted.

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

No. 5.

CAMPUS NOTES

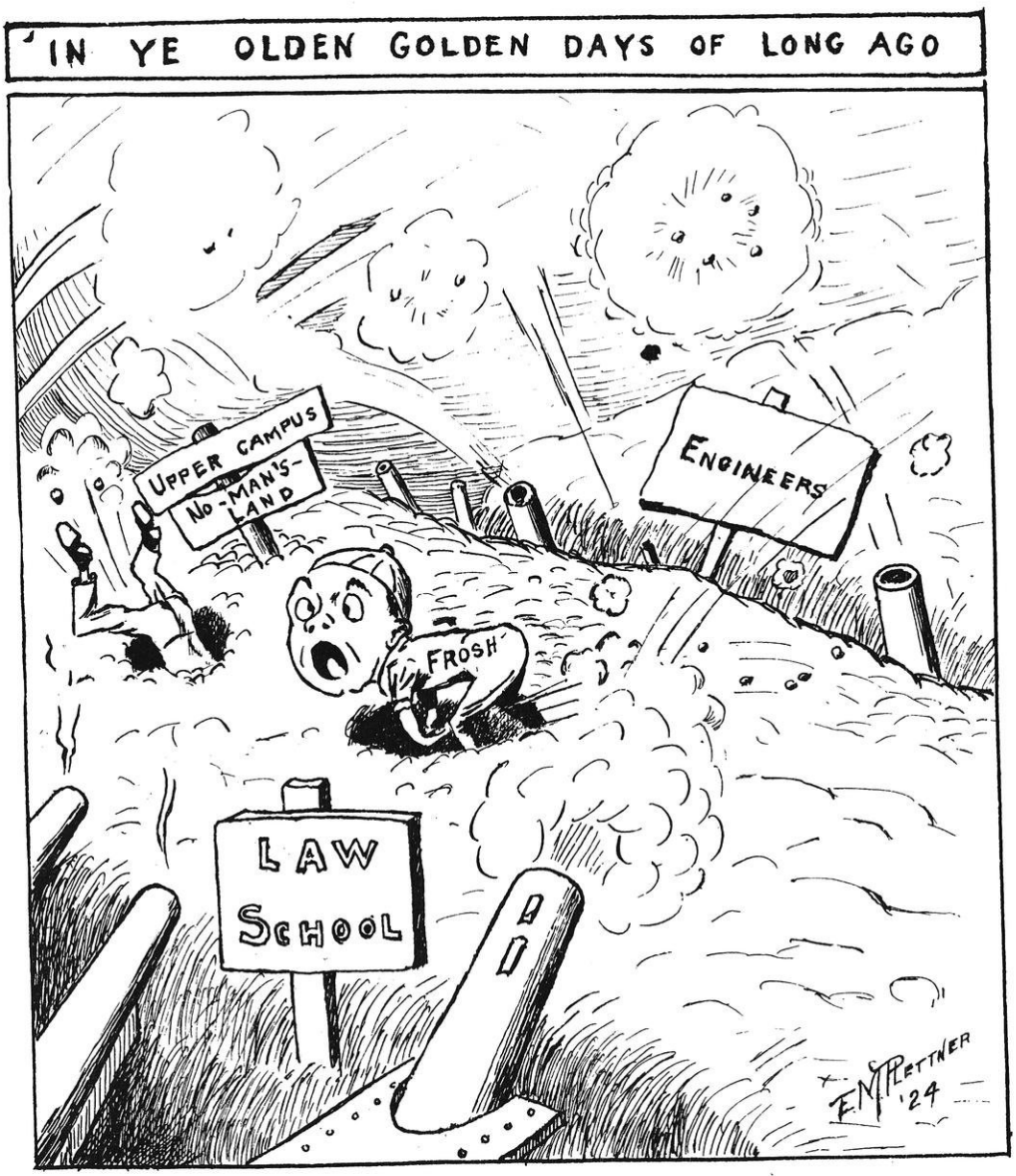
L. C. CREW

The educational programs which are broadcasted by the University Station WHA on Monday, Wednesday, and Friday evenings at 7:30 are under the auspices of the University Extension Division. These programs are planned to represent the work and spirit of the entire University and should be of interest to all extension students having receiving sets.

Some interesting and perplexing questions come to the engineering department of the Extension Division. A recent letter phrased in technical language asked for information concerning calculations to determine the strength of cylindrical containers. A request for additional information regarding the container brought his problem stated in non-technical language. He wrote, "How much pressure will it take to blow up a tomato can?" Another request asked for the "weight of the state capitol building".

1st Mutt: "What's Mechanics 53?"
2nd Mutt: "Ah, that's the Busting Lab!"

"Have you seen "The Covered Wagon?"
"No, why?
"I can get some good seats cheap!"
"How's that?"
"I know the driver!"



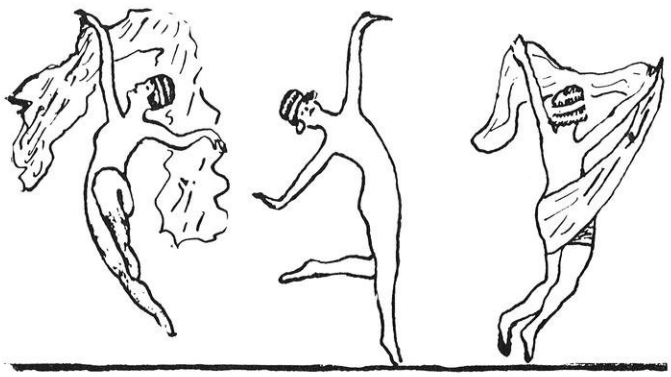
A pair of horn-rim specks, equipped with anastigmat, celluloid lenses goes to the sophomore civil who announced to a palpitating world that his observations demonstrate that the lenses on surveying instruments become clouded with age. Without a doubt his findings will cause the surveying department to order new instruments before old age renders the lenses of the present equipment so opaque that they no longer serve as lenses, but rather act as shutters.

JUNIOR DEFINITIONS

Cadaverous—Flesheating
Disseminate—to analyze
Gantry—Upper class of people
Dialectics—study of food

But it's all right, gang. We can't spell vacuum without Noah at hand no.—I just looked it up.

According to the Cardinal there are no girls taking engineering, but we notice that there are a lot of engineers taking girls.



CURVED MEMBERS ECCENTRIC LOADS VELOCITY OF STRESS

Professor "Pat" Hyland heard someone discussing the possibility of interpreting various emotions and ideas by means of so-called "interpretive dancing."

"Huh," snorted Pat, "I'd like to see one of those women interpret a mechanics problem." We'll be at the Parkway when they put that act on.

We can't see why jazz musicians should be paid $15 a day. Riveters, who get only $10 make almost as much noise and do something useful besides. —Ex.

THE RECLAMATION OF CRANK CASE OIL

(Concluded from Page 71)

that the plant obtains 10% naphtha, 10% kerosene, 20% gas oil, and 60% lubricating oil. The above figures must give the ratios of the products because it is stated that there is a 10% loss in the plant.

The Bureau of Standards has devised a method in which the oil is agitated at about 210 degrees F. with steam, the impurities being removed by distillation and coagulation. The waste oil is placed in a steam jacketed cylinder and heated to 200 degrees F. Steam is then injected which raises the temperature and agitates the oil. The progress of the removal of the kerosene is watched by the use of flash point tests. After preliminary agitation a saturated solution of sodium carbonate is added and thoroughly mixed for fifteen minutes. The oil is then allowed to settle for about 10 hours, keeping the temperature at 180 degrees F. or higher. At the end of the settling three layers are formed: clear oil, sludge, and water.

E. K. Morice, ch'20, used a method during his senior year here of combined filtration and steam distillation. His losses were large, and, in view of the Bureau of Standard work, it seems that solid particles can be easily removed in the sludge.

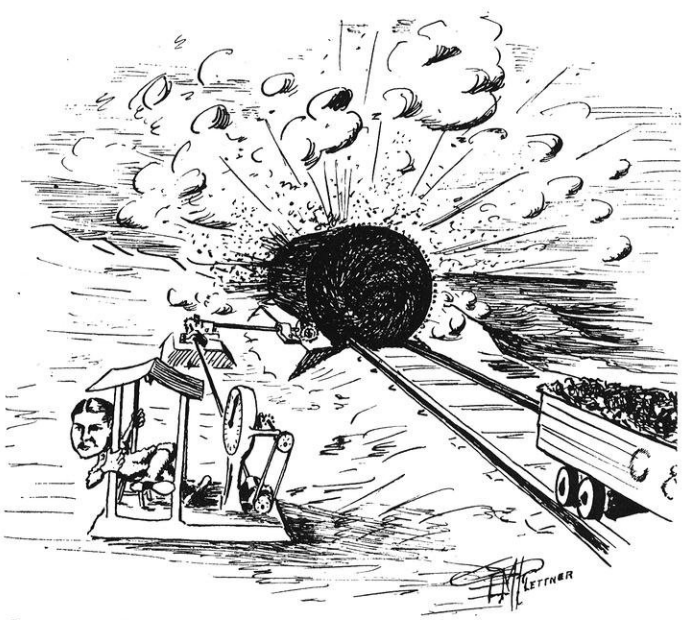
Herschel and Anderson, who performed the work at the Bureau of Standards which is referred to above, make the following conclusions from their work: "Used lubricating oil may be reclaimed by apparatus already commercially available and saved for further use. Such reclaimed oils will pass all commonly accepted tests for new oils such as flash point, viscosity, and sediment tests. It is more doubtful whether the reclamation process sufficiently reduces the organic acidity and sulphur content, but there is some doubt whether this is necessary. There is little possibility that the organic acidity will ever be high enough in an uncompounded oil to cause corrosion. It is often the case that high acidity is accompanied by readiness of emulsification, but exceptions have been found, so that the value of the test for acidity must lie in the possibility that an oil of high acidity will not prove durable in use. When more is known concerning the best test for durability of an oil, it may be necessary to modify reclaiming methods so that the reclaimed oil may meet such tests."

THE ENGINEERS' WESTERN TRIP

(Continued from Page 70)

but the guide down at Nordberg soon clamped the lid on his questioning. *Smoky*—gazing at a ladle in the foundry—"How much iron does that thing hold?"

Guide—"I can answer everything else---I know nearly everything, but that one has me stumped."



GREGG'S NEW AUTOMATIC DEVICE FOR CHECKING THE R. P. M. OF A CAR DUMPER

Gregg—After looking at the automatic car dumper at the Lakeside Power Plant (This being a device for turning a coal car upside down)—"How many R. P. M.'s does it make?" At this point Lake Michigan roared loud its indignant expostulation, and the sun hid its face behind a cloud and winked knowingly at far-off Arcturus.

The Gang "Ha ha ha". Smoky sort of forgot to take notes from then on. Incidentally, earlier in the afternoon the same guide asked us if we knew anything about hoists. When Rosecky admitted that he knew

something, the guide said if that was the case he could'nt tell Joe much, because he himself knew very little.

"Ole" D. J. Quammen has the following record acclaimed to be the best of the trip.

1. Missed car in Milwaukee for Allis-Chalmers.
2. Missed car in Milwaukee for Lakeside.
3. Caught car on the fly for the Falk Company.
4. Lost between the American Brass and the Simmons in Keno.
5. Missed train from Kenosha to Waukegan.
6. Arived late at Sears-Roebuck.

AT ALLIS-CHALMERS

To the original Norwegian work-dodger goes the solid celluloid flat iron with chocolate trimmings. The second prize consisting of an O'Henry bar goes to "Louie" Zamzow provided he gives Mollerus half. Now figure out the puzzle in the next conundrum.

Down in Kenosha, at the Simmons company, Pat Hyland and Gus Larson became so interested in bed room furniture that they had a special guide take them on a private trip through the shop. Pat has an awful liking for the green suites; Gus seemed to like everything he saw. Since no purchases were made we can safely presume that Gus couldn't decide and that Pat placed all of his money on the game. What we do want to know is why Mollerus, Quammen, and Zamzow also took the side trip? 'Splain dat pliz.

New yell originated in the big ten—
Yea, Kenneth!
Yea Scott!
Yea, Yea, Great Scott! (followed by great applause)

Now that Czerwonky knows how to make wall paper, advises from good authority indicate that he intends to put Sears-Roebuck out of business. "HOT DOG" is looking for three strong men to gather the working material, and also for a good salesman. There's your chance for the big job, boys. See "Scizzerwonk" for particulars.

Pat Hyland—"This is Fiske Street and that's Quarry. All right, about face!"

That's all from this gang. See you next year when the juniors show their stuff! "Auf Weidersehen."

THE EASTERN INSPECTION TRIP

(Continued from Page 73)

ready for the evening. The Pittsburgh Post invited us to participate in their radio broadcasting program, and we accordingly emitted "On Wisconsin", "Varsity", and a locomotive or two on the intangible ether. Following that we were the guests of the Pittsburgh Alumni at a smoker at the Fort Pitt Hotel, and had the time of our young lives. The alumni put on a great entertainment for us, with movies, talks, sandwiches, and coffee, so that we began to feel that Pittsburgh was not so bad after all.

The next day might have been called the day of power plants, we visited only two, but we "sure done 'em up brown". First was the Colfax Station of the Duquesne Light and Power Company, which is remarkable in having its own coal mine half a mile away, the coal being dumped from cars directly into the bunkers. A luncheon as guests of the power company, and our poor legs were again stretched—this time toward the West Penn Power Company's Plant. This is a mine-mouth plant, having an inclined conveyor connecting the bunkers and the mine. Forced draft is in vogue here, resulting in noticeably short stacks. Steam power plants offer delightful possibilities to one who enjoys climbing stairs, but we were not in that category,—and consequently, at the completion of this visit, when Professor Rood announced that we would take a side trip to the Alleghany Plate Glass Works, there was a noticeable lack of that spontaneous enthusiasm that betokens the veteran globe trotter. A trolley ride (Toonerville type) revived our spirits considerably, however, and we were fully able to appreciate the processes of plate glass manufacture when we arrived at the plant. In fact, some of the party, including Professor Rood, found things so interesting that they missed the train back and hence returned to Pittsburg an hour or so late. This delay must have taken place in the shipping department, where the array of girls in overalls was sufficient to bewilder the most confirmed misogynist.

At Cleveland we saw storage batteries made by quantity production methods at the Willard Storage Battery Company. Hoover, who asked whether they were doing any work with alternating current batteries, was informed that the plant confined itself exclusively to direct current batteries.

We had luncheon with the Wisconsin Alumni at the Big Ten Club, with the usual program of talks, songs, and varsity locomotives. The idea of the Big Ten Club was a new one, and showed possibilities for the alumni of different colleges to mingle. The group at Cleveland will long be remembered for their abundance of "pep".

After luncheon we were driven to Nela Park by the Wisconsin men, and given the opportunity of inspecting the interesting "University of Light". This is the home office of the lamp works of the General Electric Company, where all lamp experimentation for the Company is carried on. Two features were the model

store, and the model living room, both designed to illustrate good and bad types of lighting.

A delay of half an hour when ten minutes out of Gary raised the hopes of the gang,—visions of a long rest were substituted for expectations of another walking trip, but alas for the fond hopes, we got there with sufficient time, even for breakfast at the Y. M. C. A., during which the following enlightening conversation took place: "KVA" Miller, to Eaton "What state are you in?" Eaton "A state of depreciation." A street car ride across Gary, and we wondered at the vast power plant, with its long rows of blast furnace gas engines. The method of pressing car wheels was another attraction.

We left Gary, and arrived at Chicago, to witness the game; saw our team defeated; and returned to Madison—for sleep—a tired aggregation of plumbers. But all in all, fellows, it was a great trip, and we wouldn't have missed it for a great deal.

TRUNK LINE ELECTRIFICATION

(Concluded from Page 68)

tating motor. It has essentially the same characteristics as regards torque and speed control as the direct current series motor, but it is heavier per unit output, has a lower efficiency, and it has an inherent tendency toward bad sparking with varying load and speed. If it were not for these troubles, this system of electrification would be very satisfactory, since large capacity generating stations can be used; high potential is available for distribution, and no substations are necessary unless extra high voltage distribution is desired. Then simple, low cost, static transformer substations would be used. If a really satisfactory motor of this type is ever developed, this system of electrification would probably be the most satisfactory of all and might prove to be the standard system for world wide use.

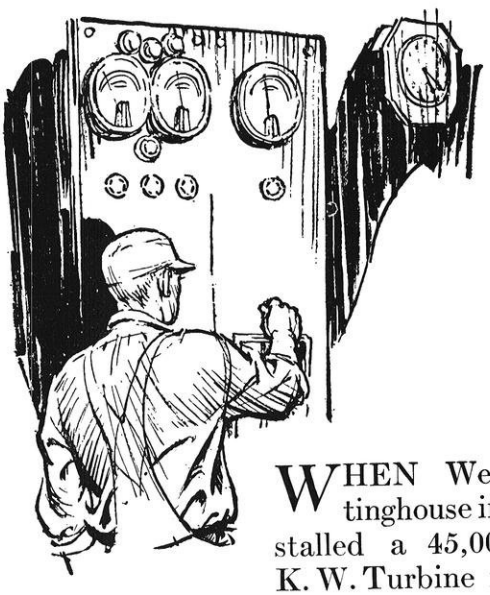
The three phase system of electrification uses two over-head trolleys and the track for the three legs of the circuit. The current is fed directly or through potential reducing transformers to the three phase, wound rotor type induction motors, which have an external starting resistance. The induction motor is less costly and more rugged than the alternating current series motor, and when used with external resistance, it gives good starting torque. It is also inherently self regenerating when feeding back into a line to which there is already connected a synchronous generator. This gives the best possible braking. The induction motor is, however, essentially a one-speed motor so long as the frequency of the current supply is constant. There has not yet been developed a variable speed induction motor, and while a constant speed motor might serve for freight haulage, it is not satisfactory where there is also passenger service. The two overhead conductors with two current collectors are also a source of danger and trouble. This alone will probably keep the system from becoming the commonly accepted method for electrification.

By mounting a single-phase to three-phase phase "splitter" on the locomotive and connecting it between the single phase trolley and the rail, it is possible to supply three-phase induction driving motors from a single-phase supply and thus get away from the troubles of a double overhead current collection. This system is in operation on the Norfolk and Western railroad, a coal carrying line. While it simplifies the current collection, this system still uses the induction motor, which seems to exclude it from general use on railways carrying both passengers and freight.

It would seem that alternating current is better than direct current for generation, transmission and collection, but that the direct current series motor is superior to any present alternating current motor for general traction purposes. Such being the case, it would seem that the advantages of both could be secured if some form of non-rotating a. c. to d. c. rectification could be developed in such a way that it could be mounted directly upon the car or locomotive, with or without a step-down transformer. Attempts to bring out such rectification apparatus have been and are being made, but so far they have not proved at all satisfactory. The mercury rectifier seems to offer the best possibilities, but up to the present it has not been possible to make it satisfactory in large enough capacities for railway work. Its rectification efficiency is too low to make it very satisfactory. It is possible, however, that some form of tube rectifier may be developed which will have sufficient capacity and suitable characteristics for this use.

From the foregoing it would appear that no really satisfactory system of electrification has yet been brought out, that none of the systems now in use completely satisfies the requirements, and that none of them in their present status can properly be taken as the standard system. Each system now running must be considered in the light of development. What is needed before standardization can come about seems to be (1) the development of a suitable high-voltage direct current motor with corresponding high-voltage generators; or (2) inherently better alternating current, series-type commutating motor; or (3) a variable speed induction type alternating current motor; or, (4) an equitable non-rotating a. c. to d. c. rectifier. Until one or more of these are properly developed, railway electrification as a nation wide project is hardly possible, and the reluctance of the investigating public is, in a sense, justified. But with the rapidly mounting cost of coal, the movement towards great hydroelectric developments, such as that on the St. Lawrence, and the tying up of transmission lines into a superpower system, will tend to stimulate railway electrification, and this, in turn, will sooner or later, bring about these desired improvements. There may then not be one single or standard system of electrification but two or more equally good. Then the question of electrification will no longer be a question but a settled fact and economic transportation raised to a point hard to be realized by those knowing only the present steam railroad methods of today.

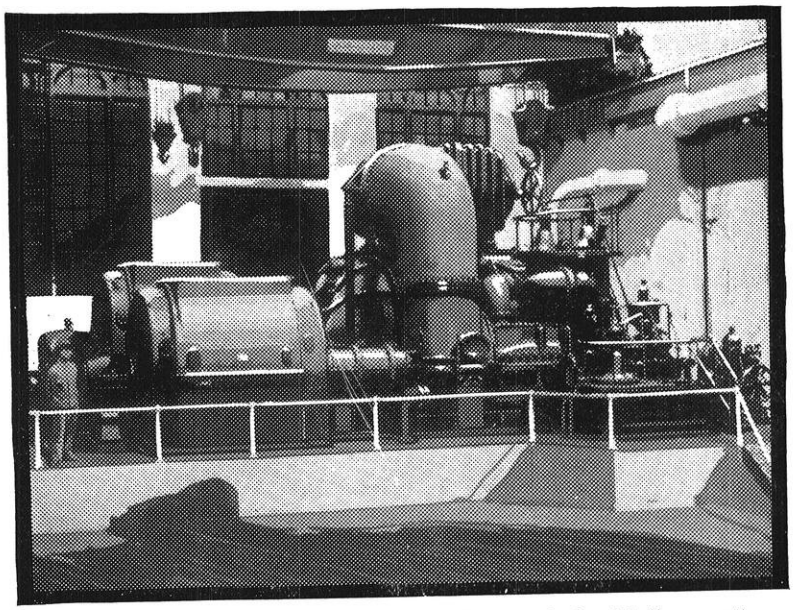
A Record Still Unbroken



At 5:20 P. M., March 8th, 1920, Westinghouse Turbine Established World's Record for Continuous Running.

What Engineering Owes to Good Workmanship

WHEN Westinghouse installed a 45,000 K. W. Turbine in the power house of the Narragansett Electric Light Company, Providence, R. I., early in December, 1919, there was no thought of more than the average weekly power house run. Abnormal weather conditions, however, brought so steady a demand for power, that the unit was not shut down until March 8th, 1920, after a continuous run of 84 days, 11 hours, and 36 minutes.



45,000 K. W. Westinghouse Cross-Compound Turbine Unit at the Station of the Narragansett Electric Light Company, Providence, R. I.

This was especially remarkable in that the unit consists of two turbine generator sets, each of which operates independently of the other, so that the result was the mechanical equivalent of operating a single machine continuously for 169 days.

If space permitted, many astounding figures could be cited—about the K. W. H. generated during this period, the water and coal used, the cooling system, the oiling system, etc.

For example, to keep the generators cool, over 18,000,000,000 cubic feet of air passed through them, which equals 2,000 times the total weight of the generators and their bed plates.

Equally impressive, oil was pumped through the self-contained lubricating system to the bearings at the rate of 600 gallons a minute. Had the oiling system failed for only 30 seconds, the bearings would have been wrecked, and other parts of the unit harmed!

There is interesting history back of the operation of Westinghouse Turbine Units of 3,000 K. W. and higher. Notable records have been made in many of the world's great power plants, performance that is a tribute to remarkable engineering and good workmanship.

Westinghouse

ACHIEVEMENT & OPPORTUNITY

WESTINGHOUSE ELECTRIC