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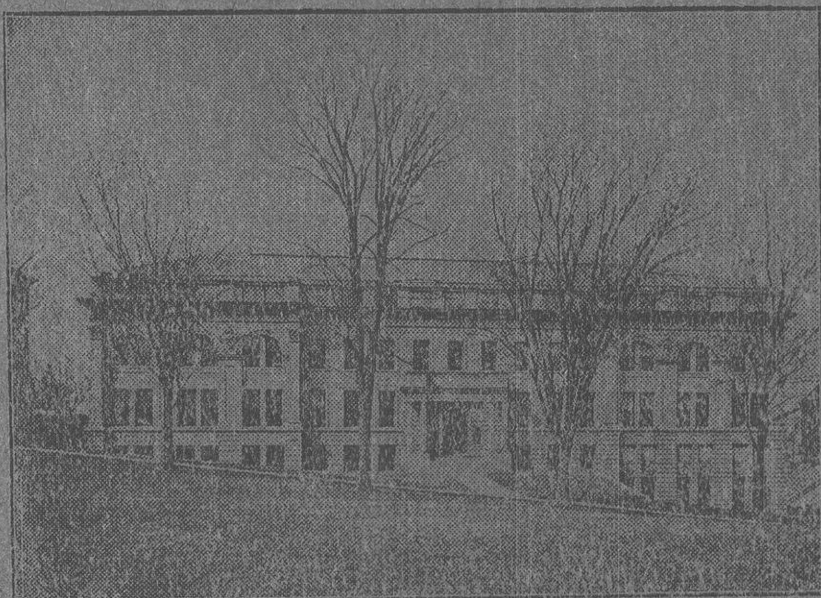

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ACTING DEAN F. E. TURNEAURE.

THE WISCONSIN ENGINEER

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RAILWAY FREIGHT RATES.

An address delivered by J. N. Faithorn, Vice-President of tbe Chicago & Alton Railway, and President of the Chicago Terminal Transfer R. R., before the College of Engineering of the University of Wisconsin, Jan. 23, 1903.

Gentlemen of the University of Wisconsin: Even those who have given but a passing thought to the development of the railroad traffic of this and other countries, cannot, upon reflection, havefailed to marvel at its tremendous growth during the past fifty years, and the object of my remarks this afternoon is to endeaver to convey, as well as I can, information as to the manner in which the adjustment of freight rates has been effected to keep pace with the constant increase in freight traffic consequent upon the development of new country, the establishment of new centers of industry, the increase of population, and the great expansion of the material wants of the people, so that to-day, while by no means perfect, in all its details, the system that prevails is reasonably adequateto meet the needs and exigencies of the business of the country.

While it has been my lot to be engaged in one capacity or another, with the traffic departments of railroads for now about thirty years, I must confess that I have not given traffic matters much thought as a student, and hence, my remarks are based simply upon my own personal experience.

Going back to the year 1870; the railroad situation of this country was then radically different in character to what it is at the present time: The mileage was not nearly as great, and while I have no figures at hand, it is entirely within bounds to say, that the total mileage was less than one-half of what it is at present, and furthermore, competitive lines were but comparatively few in number. The mileage was reasonably sufficient to meet the then needs of the people, but there had been no marked subdivision of the traffic by the building of competitive or parallel roads. Thus, for instance, there was but one line at that time from the Missouri River to the Pacific Coast, namely, the Union Pacific and the Central Pacific. Now there are six transcontinental lines. Sparsely settled districts, such as Iowa, Minnesota, Dakota, Nebraska, Kansas, Texas, etc., had railroads, it is true, but not in the sense that they exist now, and hence the traffic problems presented were comparatively simple, for the reason that there was not the competition between the carriers that naturally resulted later from the construction of competitive railroads. Even as late as 1883, or thereabouts, there were in the State of Kansas but thirteen points within its boundaries that were reached by two or more railroads. In the State of Nebraska there were but eight of such points. The reason I recall these facts is because at that time it was my duty to administer what was known as the Eight-point Nebraska Pool, and a colleague of mine performed a like service for the Thirteen-point Kansas Pool. To-day, I have not counted the number of junction points in Kansas, nor Nebraska, but I feel perfectly safe in saying that in the former State the number is not less than one hundred and fifty, and in the latter, probably seventy-five, or thereabouts. It will be readily seen, therefore, that the tremendous increase that has taken place in the competitive situation, has caused the Traffic Departments of railroads to assume more and more importance, until to-day, it is a recognized fact that the Traffic Manager has become an essential part of the railroad administrative machinery.

It naturally was the case that competing railroads first came into being in the more thickly settled portion of the country, and about the year 1870 it became evident to those in charge of traffic affairs in the Eastern States, that it would be necessary to establish a defined plan for the making of rates in that territory, and under the able guidance of the late Albert Fink, a system was evolved which to-day continues to govern, in a general way, the territory east of the Mississippi River, as far south as Cairo, Ill., and north of the Ohio River. In brief this system is as follows: Freight rates from the East to the territory within the boundaries defined, and also in the contrary direction, are ascertained by taking the rates from or to New York, as the case may be, and regarding the rates between that city and Chicago as representing one hundred per cent., rates between New York and other points being determined on a percentage relation to this Chicago rate. Thus, for instance, the rate from New York to Chicago, on any given article of freight, being represented by one hundred per cent., the rate from New York to Peoria, Ill., has been fixed at one hundred and ten per cent. of the New York-Chicago rate, and so with all of the various points throughout the territory spoken of. This system governs what might be termed the through rate adjustment. From Boston, Philadelphia, Baltimore, etc., the rates are on the same basis as New York, subject to various well defined differences in special cases. Rates between points comparatively near to each other, and within the boundaries of the same State, are reached frequently in another way, to which reference will be made later, but it will be observed that the scheme of rates above outlined is a complete one, and has the elasticity which is so essential to the proper relative adjustment through the territory covered. The rates thus established are made subject to a classification, known in railroad parlance as the "official" classification, the word "official" being used simply to designate the classification. In this classification is described the various articles transported by railroads and the number of classes is six, and known as First, Second, Third, Fourth, Fifth and Sixth classes.

Throughout the territory west of the Mississippi River from the international boundary line on the north to the mouth of the Mississippi River on the south, an entirely different system exists. In this territory, and for that matter, reaching as far east as Chicago, on business between that city and the West, the rates are made by what might be termed an arbitrary adjustment. There is no percentage scheme that applies, but rather the rates are expressed in actual figures, subject to well defined and understood differences as between the various points of origin and destination. To illustrate, the rate from Chicago to Kansas City on first class freight being known, the rate from St. Louis to Kansas City is also known, because of an established differential, which happens to be in this particular instance, twenty cents per one hundred pounds on first class freight. In other words, the rate from St. Louis to Kansas City is twenty cents less than the rate from Chicago to Kansas City on all articles listed as first class under the existing classification, which I will shortly refer to. The classes are known by the following numbers and letters: First, Second, Third, Fourth, Fifth, and A, B, C, D, E, and each class, whether numbered or lettered, carries its established differential, and this, of course, is not confined to the cities of St. Louis and Chicago, but also governs all other points and districts, such as Peoria, Springfield, Ill., and the numerous river points north of St. Louis, such as Hannibal, Burlington, Quincy, etc. There is a fixed relation between the rates from the various points and districts to the territory west of the Mississippi River, but that relation is, as before stated, determined by actual differences and not by percentage adjustment. These actual differences are not always the same to all points of destination; thus the rates from Chicago to what are known as Pacific coast points, namely, San Francisco, Portland, Los Angeles, etc., do not carry the same difference above the St. Louis rates as is the case to points in the States of Kansas, Nebraska, etc., but the principle remains unchanged.

In this territory the class to which freight belongs is determined by what is known as the "Revised Western Classification," a document which has reached quite voluminous proportions, and contains a description of almost every article that is likely to be shipped. The list is being continually added to through the medium of an organized body known as the Revised Western Classification Committee, made up of representatives of all the railroads in the territory heretofore described, and I might state in this connection that the same method of procedure obtains in the eastern territory already alluded to with respect to the "official" classification. Meetings of the committee are held ordinarily about once in six months, at which time all requests from shippers and others for revision of classification to suit their needs are considered and acted upon, with the result that the classification is continually being added to; perspicuity being the chief object sought to be obtained, thus enabling the railroad employe whose duty it is to receive and classify freight to act intelligently and without being required to exercise his own judgment any more than absolutely necessary.

I can recall as late as 1880 to 1882 that the Revised Western Classification, so-called, was contained on not to exceed four pages of print eight by ten inches in size. To-day the classification constitutes a book of one hundred or more of such pages. When the classification was small it was my duty, in the position which I occupied, to issue the Revised Western Classification from time to time, there being no committee then intrusted with the work, and the document was remarkable chiefly for the difficulty that the Receiving Clerk got into in endeavoring to interpret it, rather than for anything else.

The territory west of the Mississippi River, before spoken of, has been subdivided into three general divisions—the Western district, so-called, the Texas district, and the Pacific Coast district. Throughout the three sub-territories, however, the Western Classification governs, and rates are made, as before stated, on the basis of fixed differences between the various points of shipment, but in the Texas territory, for instance, which includes the State of Texas and Indian Territory, there are numerous exceptions to the classification, which apply only to that particular territory. These exceptions have been made from time to time to meet the traffic conditions. Thus, without referring to the map, it can be readily appreciated that the State of Texas can be reached by lines of travel through the medium of the Gulf of Mexico by vessels to the ports of New Orleans and Galveston, etc., and with a comparatively short railroad haul, freight can be moved from the eastern seaboard into Texas, whereas the lines running into Texas from the North and the Northeast can only handle such traffic by all rail. The effect of this has been to cause a very large portion of the State of Texas to be placed upon what a railroad man calls a "flat" basis. That is to say, rates to "Texas common points" from Chicago, St. Louis and the Eastern districts (the term "common points" means points reached by two or more railroads) are uniform in character. Thus, the rate to Dallas, Texas, from Chicago is the same as to hundreds of other points in Texas, many of which are hundreds of miles from Dallas, Texas, and nearer or more remote from Chicago than is Dallas; and in turn the rates from other points, such as St. Louis, etc., being made on a fixed difference below Chicago, it follows that the rates from such other points are also on a "flat" basis.

The Pacific Coast territory, which embraces the States of Washington, Oregon and California, is governed by the Revised Western Classification, subject to various exceptions, and in addition, in consequence of competition of vessels by way of Cape Horn and the Isthmus of Panama, rates to the fringe of cities along the Pacific Coast are lower in many instances than are the rates to points East thereof. Thus, for instance, on a given article of freight from New York to San Francisco, of a character readily transported by water, the rate would naturally be lower than from New York to Virginia City, Nevada, a point in the interior of the country. The general plan under which rates to those interior points are determined is by charging the rate to a Pacific Coast town, plus the rate from such Pacific Coast town back to the point in the interior to which the freight is destined. At first blush this might not be thought fair to the interior point, involving less transportation effort on the part of the carrier than to the Pacific Coast point, but the railroad companies involved have urged in justification of their action that to require the rate to the Pacific Coast point to be the measure of the rate to all other points East thereof, would compel them to forego endeavoring to compete with vessel transportation, thus benefitting no one but the vessel owner, but inflicting loss upon themselves, and it has been held by the courts and the Interstate Commerce Commission (hereinafter referred to) that such a rate adjustment is not unreasonable, provided the rates to such interior points are of themselves reasonable.

It should be understood that in addition to charges that are determined by the application of the classification and the rates established for the various classes throughout the United States, that many rates are made on specific articles, and these are known as commodity rates; thus it is the practice to accept grain, live-stock, lumber, cement and a number of other articles which are competitive between markets, etc., on what is termed a commodity rate basis. These commodity rates are made from time to time as the circumstances appear to render necessary, and in some cases the differences or differentials are fixed arbitrarily, or again the differential that would apply to the freight, if charged for at the class rate, is used in determining the relative rates from the various shipping points. Railroad companies are naturally very loathe to put articles into the commodity class, so called, excepting in extreme cases. It is interesting to note the efforts and arguments that are made by shippers who seek to have the property which they handle eliminated from the classification and class rates, and much of the time of a traffic manager of a railroad is spent in endeavoring to weigh in the balance the *pros* and *cons*, of such effort, with a view to adjustment of such questions for his road as will best conserve its interests and enable the mauufacturer or dealer to develop his business.

It will be noted that the foregoing general description of rate adjustment covers all of the United States, excepting what is known as the southeastern territory, namely, the country east of the Mississippi River from Cairo to New Orleans and south of the Ohio River. In this territory another system of rates prevails. The classification is known as the "Southern classification." The adjustment of rates on business from the territory north and west of the Ohio River is reached by the application south of the Ohio River of a uniform basis from all crossing points or gateways, such as Cincinnati, Louisville, Evansville, etc. Traffic, however, from the eastern country can reach this territory through the medium of the ports of the Atlantic Coast and the Gulf of Mexico, and therefore, rates exist in the southern territory upon the basis of competition of vessels to such ports as Newport News, Savannah, Charleston, etc., plus the short haul rail rates, thence to the interior of the country; the *all rail* rates to the southern territory being made to meet this competition, and, as in the case of the Pacific Coast district, it is the practice of the lines in this section to confine the application of what might be referred to as the low rates thus forced upon them to the points actually reached by the roads leading from the South Atlantic or Gulf of Mexico ports.

To illustrate: The rate from New York to Atlanta, Ga., might be lower than to a point nearer to New York, but not reached by a line from the Coast. This method of adjustment on the part of the southern roads has been the subject of more or less controversy, as to the validity of the general principle adopted, but it has been upheld by the courts of the land on the ground that, given a rate that is reasonable in itself for the service performed, no obligation rests upon the carrier to lower the rate simply because, in order to meet competition, it makes a lower rate to another point and yet performs more service in length of haul.

It will, therefore, be seen that the United States is divided into three grand groups, namely, the Eastern, Western and Southern, with a sub-division, more particularly of the Western group into the Western, Texas, and Pacific Coast subgroups.

So far, I have endeavored to outline in a general way, the systems prevailing throughout the country which have been instituted and maintained by the Railroad Companies themselves, but within practically the last thirty years there has gradually grown up a system of State supervision of railroad rates on traffic passing between points confined within one state, and to-day there is scarcely a state in the Union that has not its railroad law and maximum rates, and a schedule of rates is in effect in at least one state, namely, Texas, as a tariff of absolute rates which cannot be deviated from by the railroads, either by increase or decrease thereof. These states, also, by their properly constituted authorities have formulated classifications of freight, the same in general character as those spoken of heretofore, according to the location of the state, but frequently radically different in minor features, or where, in the wisdom of the state authorities it has been deemed advisable to, by this means, endeavor to foster a particular industry of the state. These state provisions and classifications are naturally a source of more or less perplexity to the railroad companies, as frequently they interfere seriously with the general scheme or rates established by such railroad interests, and an adjustment which ordinarily would be made by a railroad is prevented because of the failure of the state rate to coincide.

There is an axiom, if I am not mistaken, that says that "The whole is equal to the sum of its parts," and it can readily be appreciated that if a specially favorable rate within the boundaries of any one state exists, and given that this specially favorable rate, added to the rate outside of the state, makes less than the through inter-state rate established by the carrier, that there is great danger of the higher through rate being broken down, and hence the efforts of the railroads are naturally directed to the maintenance of the state rates, so called, on a plane at least sufficiently high to protect the integrity of the inter-state rates made by the railroads themselves. Simply to illustrate my meaning in this respect : The State of Iowa has what is known as a maximum rate schedule, and the shortest distance across that state between the Mississippi River and Missouri River, is, as I remember it, about 207 miles; hence it will be readily seen that the highest rate that can be charged by the railroad company between the point in Iowa on the Mississippi River and the point in Iowa on the Missouri River, which are 207 miles apart, is the tariff provided by the Iowa Railroad Commissioners for 207 miles. Now, in turn, it has been decided by the railroads, and has become, it might be said, an unalterable law, that whenever a rate prevails from any Mississippi River point between St. Louis and Dubuque, Iowa, both inclusive to Council Bluffs, Iowa, the same shall be applied from all of such Mississippi River points to Council Bluffs, Iowa, and it has further been settled, that in no case shall the rates from Chicago to Council Bluffs, Iowa, be more than a certain fixed difference or differential above the rate from St. Louis. Thus it will be seen that the rates applied by the Iowa Railroad Commissioners fixes the rates from Chicago to Council Bluffs, Iowa. This is simply an illustration. There are many parallel cases, and I might say further, in elucidation of the foregoing, that it is also an unalterable law from a railroad standpoint, that given a rate from Chicago to Council Bluffs, Iowa, no higher rate shall be made from Chicago to Kansas City, Mo., and as the rates to Kansas, City, Mo., fix the volume of the rates to "common" points beyond, based upon the fixed differences that I have referred to herein, it can be readily seen that a reduced rate to one point can freqnently prove very far reaching in its effects, owing to the conditions and precedents that govern the situation.

In addition to the protection of the state business by the state authorities, as spoken of hereinbefore, a law was passed by the national government and became effective in 1887, which is known as the Interstate Commerce Act. It has been amended somewhat since that time, but not in any sense curtailing the supervision of the national government through its constituted authority, the Interstate Commerce Commission. In general terms this act was passed to prevent discrimination as between individuals or between localities and to insure the application of reasonable rates. Unlike the state authorities the national government has made no effort by its law to establish rates as of themselves, other than to provide that the same shall be reasonable, excepting that it is provided in the law that no line may charge more for a shorter than for a longer distance over the same line in the same direction, excepting under substantially dissimilar circumstances. Special attention is called to the words "substantially dissimilar circumstances." This feature has been a bone of contention ever since the law became operative, and there has been great variance of view as between carriers themselves regarding same. For instance, some railroads have taken the view that there would be scarcely any condition that would, under the law, justify the application of a higher rate for a shorter than a longer distance over the same line in the same direction; other roads have considered that substantially dissimilar circumstances existed whenever there existed any dissimilarity, but it will be readily seen that throughout all this, competitive condititions are always at work, and hence if any one railroad between two given points is disposed to construe this provision of the law strictly, viz: that no greater charge for a shorter distance than for a longer distance over the same line in the same direction, shall be made, it follows that the competitive situation will force other railroads to do likewise, regardless of their views of the necessity of so doing under the law, so that it by no means rests with each railroad company to interpret this provision of themselves, but they are perforce compelled frequently to be governed by the construction placed on the law by another road, contrary to their own judgment, because of the necessity of preserving their rates on a competitive basis with that of other carriers. This feature of the Interstate Commerce Act, known amongst railroad people, as "the long and short haul clause" has proved to be a great leveler of freight rates of the country, and in this respect has tended to develop districts which would not have been so well developed had the old practice maintained of escaping from the competition of a rival whenever possible by increasing the rates to what a railroad traffic manager would consider a normal basis whenever he was relieved of competition.

Prior to the passage of the Interstate Commerce law the railroads of this country were practically unrestrained with respect to the making of railroad rates, other than the restraint brought about by the various state tariffs; neither was there any prohibition of pooling, so-called, pooling being the placing in a common purse of the earnings, or a portion thereof, derived from the traffic and their distribution on the basis as agreed upon, or, as sometimes was done, the actual tonnage itself was distributed over the various lines so far as such method was practical. There is no doubt that this system had the result to insure more or less stability of freight rates, although it was not an entire success in this respect, as there was a natural inclination on the part of all connected therewith to carry their respective proportions of the traffic, because of a well-grounded theory that otherwise on a revision they would be compelled to accept a smaller division, and this incentive frequently led to the disturbance of freight rates, the line running behind its proportion being anxious to build up its tonnage. With the passage, however, of the Interstate Commerce law, pools were prohibited and the railroad companies were forced to rely entirely upon agreements between themselves for the maintenance of freight rates on competitive traffic. The method adopted was a penalty to be paid from a fund established for that purpose, or to be assessed by the Chairman of the Association, whenever a member of the organization violated the terms of the agreement. This procedure continued until the Supreme Court of the United States decided that such combinations were illegal on the part of railroad companies under the Sherman Anti-trust law, and since that time I know of no agreement having been made between railroads covering the establishment of or the maintenance of rates upon competitive traffic. The method now in vogue is for the representatives of the various roads to come together as often as it seems to be necessary, to exchange views, etc., in order to reach an adjustment, but particular care is taken not to make agreements, and no line can be regarded as having violated any obligation by making a rate at variance with that of a competitor. The situation has really taken the same shape as obtains in other competitive lines of business, as, for instance, take the wholesale grocery trade of Chicago. It is probable that no understanding exists between the different merchants in this line of business as to prices to be charged for the various commodities that they sell, and yet as a general proposition they run practically the same, and so with the railroads, and judging by the experience of the last few years, or since the decision of the Supreme Court previously spoken of, while rates as a whole have been generally reduced on commodities moving in large volume, such as coal and other minerals, it has been my observation that the situation has not been materially affected adversely from the railroad companies' standpoint by the decision of our highest court. The railroads, however, have taken steps, by joint action, to insure their each knowing promptly what the other is doing, by making use of the rate sheets, etc., filed with the Interstate Commerce Commission, a joint representative of all roads in a particular group being stationed at Washington at the office of the Interstate Commerce Commission, who promptly, by telegraph, notifies the roads of the filing with the Commission of new rates, and giving particulars relating thereto. The Interstate Commerce Commission law provides that no rates can be reduced except by first giving ten days notice by publication, and the filing of the rate sheet with the Commission.

It will be apparent, however, from what I have said regarding the general rate adjustment and the various restrictions and complexities surroundiug same, that the traffic department of a railroad of any magnitude calls for something more than the ordinary standard of intelligence for the successful conduct of its traffic affairs. The road that is a laggard in recognizing the wants of its patrons and of those whose business is tributary to its rails will soon evidence the fact by lower relative earnings than are secured by more alert rivals, and a constant struggle is going on between minds sharpened by experience and conflict resulting from the determination to secure the best for their respective companies. The character of service also has a bearing, much more in fact, than formerly, and the railroad that, everything else belng equal, furnishes the best service will in the long run be more successful than its competitors, the services of which are inferior. A successful traffic department, however, must leave no stone unturned in its efforts to secure business, by solicitation and by such influences as can be brought to bear to secure the good will of those having freight to ship.

The young man who enters the profession, and I think the word "profession" is not inappropriate, has an illimitable field before him. He deals with all sorts of men and things. He cannot know too much about the business his railroad handles; how it is produced, what the competitive conditions are; whether favorable or unfavorable to his railroad in regard to the handling of such business, and it is those who by their natural aptitude and love of the business itself who ultimately succeed. Often the remark is made amongst members of the fraternity, that Mr. So and So, is a good traffic man, and if you ask what that implies, the answer in substance will be, that the person referred to is constantly on the look out for business for his road, that he is acquainted with the general rate adjustment, so that he could either do so himself, or direct others to properly quote the lowest possible rate applicable to the business; that he is at all times courteous in manner and possesses that indefinable quality which may be termed magnetism, which causes him to make friends among his business acquaintances. For the proper comprehension in these days, of the freight traffic business of a railroad of average size, and exposed to competiton, knowledge of the the details appears to me to be one of the greatest essentials.

The railroad traffic man who commences his career in a freight house and passes by successive stages through the various offices where the detail work is performed, provided he possesses the other qualities referred to, is the man who will eventually be considered as standing at the head of his profession. There is no royal road to learning in the Traffic Department of a railroad any more than in any other line of work, so far as my observation extends, and it is perhaps, because I am in love with my business that I feel justified in saying that no other field contains more promise for the intelligent, earnest, young man who feels that his sphere in life is railroad work, and in saying this I do not wish to be considered for a moment as disparaging for a moment the other departments of the business, but having had some little experience as an operating official, as well as a traffic representative, I am inclined to the opinion that the traffic department offers the best field for the development of those qualities which enable men to succeed because of their ability to rightfully judge human nature in its manifold phases, the personal element being ever present in dealing with the questions involved.

THE OPERATION OF A GAS WORKS.

BY W. A. BAEHR, DENVER, COLORADO.

This paper must necessarily be confined to an outline only of the processes employed today in a gas plant. In order to consider these logically, I will group the subjects under the following heads:

1. Coal Gas Manufacture.
2. Water Gas Manufacture.
3. The Station Meter.
4. Storage.
5. Photometry and Calorimetry.
6. Usual Simple Tests for Purity.
7. The Governor.
8. Residuals.

1. Coal Gas Manufacture.

The usual method of coal gas manufacture in the United States is by means of horizontal retorts, which in the larger and more modern plants are charged and the coke drawn by machinery. There are also some installations of inclined retorts in this country, together with a few in contemplation. I do not care to enter into the relative merits of inclines and horizontals; suffice it to say that the new coal gas plant of the Milwaukee Gas Light Company is designed to use horizontal retorts with complete drawing, charging and coal handling machinery, and this decision was arrived at by the Engineers of that large establishment after a most painstaking comparison of the merits of the two systems. They found that in the case of Milwaukee the horizontals with machinery showed a saving of many thousands of dollars per year over the inclines.

I will describe briefly a recuperative full-depth bench of six retorts each. These retorts are usually ⏢-shaped, open at one end only, and about 16″x26″ by 9 to 10 feet long. In the case of full-depth benches, they are charged and the coke drawn from the operating floor, which is usually from 9 to 12 feet above the cellar floor. The heat required to carbonize the coal is derived as follows:

A deep furnace at the bottom of the setting is filled with coke heated to incandescence. Through this incandescent fuel bed a moderate amouut of air is admitted, called the primary air. The inlet is so gauged that all the oxygen of the primary air is converted into carbonic oxide as follows:

$$C+2O=CO_2$$
$$CO_2+C={}_2CO$$

That is, the carbon at the bottom of the fire is first burned to CO_2, and this in turn, by passing up through the incandescent fuel bed, is converted into CO. The nitrogen of course merely passes up, and is heated to the temperature of the fire.

Now this CO, mingled with nitrogen, passes up through a furnace arch into the combustion chamber situated just below the lower retorts. On the sides of this chamber are several nostrils from which issue streams of secondary air, which has passed up through the recuperators on each side of the fur nace, and thus become heated.

The producer gas from the furnaces, on meeting this secondary air, burns to CO_2 around the retorts, heating them intensely. The waste gases pass down through the recuperators, giving off a portion of their sensible heat to the incoming secondary air. The formation of clinkers in the lower part of the furnaces is prevented by introducing water in the ash pan, and also by water falling from drip plates at the front.

The heat reactions taking place can be briefly described by saying that each pound of carbon converted to CO in the furnace requires 5.77 pounds of air, and the CO thus formed requires another 5.77 pounds of air to burn to CO_2 in the combustion chamber. The temperature reached in this chamber is about 2600° F., and that of the waste gases below the bottom retort about 2000° F.

The heat lost by decomposing the water in the ash pan into H and O is at once regained when the H burns to HO_2 again. The heat losses are caused by excess air drawn in the air passages, by opening the mouth-piece doors, by radiation and the sensible heat of the waste gases escaping into the atmosphere, plus leakage and carbon lost in the ashes. A good recuperative bench has a heat efficiency of about 70% to 72%.

The present greatest obstacles to increasing the efficiency are the lack of knowledge concerning the specific heat of gases at temperatures varying from 0° to 4000° F., and the difficulty of making accurate high temperature determinations. Le Chatelier's pyrometer is a great help, but to those of us engaged in the gas engineering business, it seems a great pity that some enterprising college professor cannot or will not immortalize himself by determining such coefficients not from purely theoretical considerations alone but also from experiments.

We will now follow the course of the gas as it is made in the retort. The changes taking place in that vessel are many and complex, and leaving that the crude gas passes up the standpipes, across the bridge pipes, and down the dip pipes into the hydraulic main, looking more like nasty yellow smoke than anything else. In the hydraulic main the gas deposits a large percentage of its tar and some ammoniacal liquor, and has attained a temperature of about 150° to 180° F.

From the hydraulic main it is usually conducted through the foul main to the exhauster. These are made in various designs, but the Root's rotary type is probably the best known in this country. They are so governed as to maintain a constant low pressure in the retorts. The exhauster is the heart of the works; it draws the gas from the retorts, pushes it through all the condensing scrubbing and purifying apparatus into the holder, and thus indirectly actuates all the gas meters in the city, which "work while the poor gas man sleeps."

Beyond the exhauster, the first object is to free the gas from the remaining tar. This is done by hot washing, scrubbing, or by mechanical devices such as the Pelouze and Audouin tar extractor, which depends on impact to deposit the tar. After this vessel a condenser is usually placed to cool the gas down to 70° or 90° F.

From here, the most approved way to partially purify the gas is to pass it through one or more scrubbers, where it is thoroughly flushed with crude ammoniacal liquor. Crude gas contains a certain percentage of ammonia, which in the scrubbers unites principally with CO_2, H_2S, CS_2 and C_1, forming ammonium carbonate, sulphide and chloride. The heat developed by these reactions should afterwards be taken from the gas by another condenser.

It is a known but seldom appreciated fact, that were sufficient ammonia present, gas could be entirely purified by scrubbing with ammoniacal liquor, but unfortunately there is only about one-fifth enough ammonia in crude gas to do this.

The gas after leaving the scrubbers, is now colorless and freed from tar and a large part of its ammonia. It then passes into a final scrubber or washer, where the remnants of ammonia are absorbed by fresh water.

The final purification now takes place to rid the gas of all of its H_2S and a portion of the CS_2. In England, where unnecessarily stringent laws prevail, lime is the final purifying agent since this presents the only practical way to remove all the CS_2 in addition to the H_2S. But in the United States iron oxide is almost universally used. The oxide mixture is usually prepared by adding about 25 pounds of rusted cast iron borings to a bushel of shavings of pine wood, and a series of large vessels, called purifiers, filled with such a mixture.

Foul oxide does absorb a certain percentage of CS_2, but most of this compound passes on with the gas. The chemistry of the iron oxide purification process can be represented as follows. The foul gas passing through the oxide forms two sulphides of iron as follows:

$$Fe_2O_3, H_2O+3H_2S=Fe_2S_3+4H_2O \text{ and}$$
$$Fe_2O_3, H_2O+3H_2S=2FeS+S+4H_2O.$$

When the material ceases to absorb H_2S, it is taken out of the purifier and spread in layers about 12 inches deep, and thus exposed to the action of the atmosphere. This operation, known as revivification, reconverts the iron sulphides into Fe_2O_3, depositing the sulphur in the free state.

$$2FeS+3O=Fe_2O_3+2S \text{ and}$$
$$Fe_2S_3+3O=Fe_2O_3+3S.$$

After the material is revivified, it is again placed in the purifier, and is thus used over and over again, until the free S forms 40 to 50 per cent. of the mass, when it is no longer fit for use.

The gas, thus finally purified, passes to the station meter to be measured.

2. *Water Gas Manufacture.*

The system of water gas manufacture mostly used to-day is the Lowe Intermittent system. In this method, a generator filled with incandescent carbon (from either coke or coal) is brought to a high heat by an air blast. The resulting producer gas passes on through a vessel called carburetter and also through a superheater, in both cases being burned in these vessels by an additional blast, thus heating all three vessels, and the waste gases are allowed to escape into the atmosphere. When these vessels have attained the proper temperature the blast is stopped, also the valve allowing the gases to escape to the atmosphere.

Now a steam valve is opened and a large amount of steam is allowed to enter the generator below the fire. Passing up, the H_2O vapor is decomposed, the hydrogen passing on unchanged, while the oxygen first unites with the carbon to form CO_2 and this in turn takes on an atom of carbon and becomes CO.

The "blue" gas, consisting of CO and H, passes on to the carburetter, where it meets with a spray of crude oil or gas naphtha, which is vaporized in the highly heated carburetter. The oil is added to make the "blue" gas burn with a luminous flame, in other words, to give it candle power. The lower part of the carburetter and the whole superheater are filled with a checker work of incandescent fire brick, and the mixed gases passing through this, become permanent or "fixed" gas. When during these actions the set has cooled too low for proper gas making, the steam and oil are turned off, and the blast on, until the machines are again hot enough to make gas.

It will thus be seen that this process is an intermittent one, the "blast" periods and "gas making" periods succeeding each other regularly. The gas after leaving the superheater passes through a seal, which prevents it from coming back during blasting, then into a scrubber, then into a tubular water condenser, and finally into a small relief-holder.

From the relief-holder the gas enters an exhauster, which forces it through one or more washers to take out the oil tar. Since oil always contains some sulphur, the gas, after being freed from tar, passes through purifiers where similar reactions take place as in coal gas purifiers. Thence the gas passes to a station meter.

3. *The Station Meter.*

In order to determine the final efficiency of any gas plant, it is necessary to measure the gas made with considerable accuracy. This is best accomplished by the wet station meter, which consists of an outer cast iron case, and an inner sheet iron drum. This drum is divided into three or four compartments, so arranged that the gas enters each compartment at one end and leaves at the other end only when the inlet is below the water with which the case is more than half filled. These compartments are accurately measured and their contents computed.

When running, the drum revolves somewhat like a squirrel cage, each compartment in turn receiving its quota of gas from the inlet end, and in turn discharging it to the outlet of the meter. The motion of the drum is communicated to a dial, where the number of cubic feet passing is correctly registered.

Of late years the large wet station meters are being displaced to a small extent by proportional meters, in which the main body of the gas passes through unmeasured, but only a certain small percentage is by-passed and measured. These proportional meters, as they are called, possess the advantage of cheapness, and they have recently been so perfected as to become really reliable instruments. When once they are universally known to be accurate at all speeds, the wet station meter will be a thing of the past.

4. Storage.

The tendency today is unmistakably to build steel gas holders with steel tanks. Except in very cold climates these holders need not be housed in, and as builders are getting more experience, the holders are becoming structurally more correct. There is apparently no limit to the size which may be attained by these vessels, a twelve million cubic foot holder having been built in London some years ago. It is rumored that a holder containing twenty million cubic feet is in contemplation in the United States. This will be a veritable monster, the bottom plates of the tank being about 2 1-2 inches thick, and requiring 2 1-2 inch rivets. Such a holder will contain many thousand tons of steel, and will be a tremendous structure.

I will not describe holders in this paper, having written an article for the "The Wisconsin Engineer" in the number of January, 1901, on "Steel Gas Holder," to which anyone interested is referred.

5. Photometry and Calorimetry.

The old photometric standard was the British standard sperm candle, burning 120 grains sperm per hour. The standard never was satisfactory, being so variable and having a shade of color different from a gas light. The various other proposed standards are as follows:

a. The Carcel lamp, burning purified colza oil at the rate of 648 grains per hour.

b. The Hefner-Altenick amyl-acetate lamp, burning with a flame 40 mm. high.

c. Methven's slot standard, in which a certain portion of a gas flame is visible through a certain sized slot.

d. Harcourt's pentane standard.

e. Standardizing against electric incandescent lamps.

The Harcourt pentane lamp, and the electric incandescent lamp are both satisfactory in their way. But photometry is far from being a "solved" problem, inasmuch as we want some instrument that will quickly and correctly give us the *mean spherical* candle power.

Calorimetry is assuming more and more importance in the gas business. With the rapid increase of fuel gas uses, it is "heat" that is wanted, not so much high candle power. It will not be long before the cry will be "More B. T. U.'s," and to that end the gas engineers are directing their attention. It goes without saying that "more B. T. U.'s for less money" is the correct aim, and it is today one of the things toward which we are looking, Whether the gas shall in itself have a higher calorific value per cubic foot, or whether we shall distribute a fuel gas of lower heat but very cheap, remains for the near future to decide.

6. Usual Simple Tests for Purity.

For tar. A piece of clean paper against which a fine stream of gas is allowed to impinge. A brown or dark discoloration will indicate the presence of tar.

For ammonia. A piece of moist reddened litmus or turmeric paper held against a small stream of gas. Turmeric paper turns brown and red litmus paper turns blue in the presence of ammonia.

For H_2S. The gas is allowed to bubble through a solution of lead acetate, which turns brown in the presence of H_2S, owing to the formation of lead sulphide.

For CO_2. A solution of lime or baryta water.

The above are the simple tests usually employed. I am glad to state, however, that gas companies, especially the larger ones, are now employing chemists, especially college men, and we may reasonably expect a large development in the science of gas chemistry within the next few years.

7. *The Governor.*

This instrument is used to regulate the pressure of gas in the distributing system. In its usual form it consists of a valve or a set of valves, controlled by a float, which in turn is controlled by the pressure on the outlet side of the governor. The holder pressure is usually too large to be used constantly, and the governor allows of regulation according to fluctuations in the demand.

There are various forms of automatic governors on the market, which adjust themselves to the demand within certain limits. But there is visibly large space for improvement in this direction.

8. *Residuals.*

The residuals usually disposed of at a gas works are coal and oil tar, ammonia, and coke. In some of the larger works sulphur and cyanides are recovered.

The uses of coal and oil tar, when made into pitch, tar pavements, roofing felt, paints varnishes, dyes, etc., are well known and will not be enumerated.

Ammonia, whether anhydrous or aqua ammonia, or as ammoniun sulphate, is used largely. Refrigerating plants are are now almost wholly dependent upon anhydrous and aqua ammonia. The sulphate is extremely valuable as a fertilizer and chemically also.

Coke and breeze are now recognized as valuable fuels. The constantly increasing demand for clean screened coke of various sizes, either as coarse, nut or pea, to replace anthracite coal, attests to its popularity.

Sulphur is beginning to be recovered from spent purifying material, and in recent years the development of the cyanide process of gold extraction has caused more attention to be paid to the recovery of the cyanogen of gas. These last two residuals are, however, only extracted in very few gas works in the United States, but a large development will undoubtedly take place in that line also.

General Remarks.

In conclusion, I wish to appeal as strongly as I can to the college men who are studying engineering, whether civil, mechanical, mining, electrical, or any other of the numerous special developments of our science. We are living in an age of rapid progress, of constantly widening and broadening views, and of greater and more generous impulses toward each other. The future will see the great body of all engineers laboring in unity, endeavoring to secure the greatest good to the greatest number, and recognized by their fellow men as the real benefactors of mankind. Therefore I appeal to all to strive to encourage each other, to let each field have its utmost possibilities developed, and by thought, word and deed to help your fellow engineer whenever you can.

The gas business, among the rest, is on the verge of a vast revolution, and to those to whom the gift of seeing beyond the pale of ordinary men is given, visions of immense central *energy* distributing plants arise, from which issue forth streams of gas and electricity that shall light, heat and give power to the universe.

PAPER MAKING.

O. B. ZIMMERMAN.

Every engineer finds himself constantly coming in contact with paper and its uses, and since the uses are so varied and each use requires paper of a particular kind to best serve that purpose, it seems reasonable that he should know how to choose the quality from an understanding of the process of its making.

We see paper everywhere, in blue prints, the drafting room, as insulation in the form of red fibre; we see it made into pulleys, car-wheels, pails, tubs, barrels, in fact we meet it everywhere, from the paper collar on the workman to the insurance policy, in the office where the entire business is conducted upon it by contracts, letters and records, which latter are either temporary or permanent. So again I say he should know how to choose the quality with reason.

While I do not intend to go into the finer details of the chemistry of its making, it is my desire to give the basis for one's judgment, should he find himself in a position to select for his superiors that which is economical in every way.

Though the name of paper comes down to us from the Egyptian plant, papyrus, out of which the early paper was made in Egypt, still we find even more ancient records of the use of pulp for the manufacture of paper which take us back into the third century B. C. and to the Chinese nation. We do not know how much further back the real start began.

When the Arabs and the Hindoos invaded Tartary, they carried away with them a knowledge of the process of paper making which they introduced throughout their territory, so, when the Moors invaded Spain, the method came to Europe from that quarter, and in a more peaceful way through Greece, which country had trade relations with both Moors and Hindoos.

The Egyptian process consisted in making use of the inner cutacles of the long rushes from the Nile's banks. These rush cutacles were from eight to ten feet in length and were laid side by side, moistened, then coated with an adhesive paste of flour and later a glue size. Across these were then laid a second layer, treated similarly. The whole, when dried in the sun, was beaten with a mallet and finally polished with a piece of ivory or a tooth tool.

This process developed between the third and fourth century B. C. The Romans took hold of the process some time later and developed the details, though the method remained the same.

The first mill of note was erected in Nuremburg, Germany, in 1390; the first in England in 1490, though it was not until 1770, when Whatman, after a careful study and apprenticeship on the Continent, carried back to England the details of the making of the finer qualities of paper. English paper from the Whatman Mills at Maidstone became well known and today stands preeminent for the quality. Most of us know the hot and cold pressed papers from these famous mills.

Paper after the Chinese or pulp type was first made up from the fibers of rags. We find the earliest examples of cotton rags being used in the tenth century, linen rags appear first in the thirteenth. From then or until the eighteenth century, rags formed very largely the substance from which paper was máde. The increasing use of the same, especially after 1450 the discovery of the printing press, caused the manufactors to look about for a substitute, and as a result we find the following becoming a basis for this product: esparto, a long grass which grows on Southern Spain marshes, and the marshes of the northern coast of Africa, flax, hemp, straws since 1800, and wood. Wood has come into very general use only since 1870.

From these various substances cellulose, $C_6 H_{10} O_5$, is removed, it being the basis of paper. All of the above named materials are made up largely of fibers, these fibers consisting of a casing or sheath of cellulose, containing air in the dead fibers and protoplasm in the living. In the walls of this cellulose is deposited by infiltration during the growth ot the plant, certain mineral salts and resins of very complicated chemical nature, which harden and stiffen the sheath. There is also more or less of a cork-like substance deposited, which gives elasticity to the plant. These fibers form bundles and arrange themselves end to end, to make up the woody part of the tree or the stems of the straw like plants.

From all these materials the impurities such as the mineral salts and resins have to be removed by various chemical and physical means*. The rags such as cotton are made from nearly pure cellulose as it comes from the cotton plant so do not need the severe chemical treatment given the other materials.

Cellulose has the same chemical formula as starch though it possesses very different chemical properties. It is a highly resistant substance to chemical action but it has a strong affinity for certain salts such as those of vanadium iron and aluminum. It is dissolved in concentrated suphuric acid when dry, forming a colorless solution, which when diluted and boiled causes the cellulose to be converted into dextrine and glucose. This latter can be fermented with the production of alcohol. So we see the process of the production of alcohol from rags or wood alike. Acetic acid is also a product of cellulose by chemcial means.

With nitric acid cellulose forms products such as nitroglycerine, gun cotton, collodium, and with nitric and sulphuric acid, together we get celluloid. While many other interesting facts can be stated, the main point to be emphasized here is not so much its wonderful chemistry, but that it makes a highly resistant and permanent substance if properly treated.

In the old process of paper making from rags, the rags

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*So as to leave the cellulose as pure as possible.

were collected, sorted at the mill according to color and material, trimmed of all foreign material, cut up, soaked in water and piled in cellars for from six to twenty days (to rot.) They were frequently turned during this time to avoid heating

The "rotting" consisted of a disintegrating of the stiffening and gluten used in the cloth, while the cellulose was left practically unaffected.

After being carefully mashed and pounded by rude mechanical stamps to separate the fibers, the pulp with a considerable quantity of water, was run into a tank from which the workman with a dexterous clipp of his "deckel" scooped up just the right quantity of material, and with the proper end and side sifting motions of his deckel caused the fibers to intermesh or "felt" while the water escaped through the sieve.

From here he passed the sheet to the "coucher" who piled sheet after sheet alternately with felt and squeezed his "post" to remove moisture, the latter act being repeated a number of times, following which the sheets were loft dried. The sizing and finishing were much like the methods of to-day. It is interesting to note that the names of the actions above are to-day used to designate those particular parts of the present fine machines.

As the present time, rags are treated by boiling at a pressure from sixty to seventy pounds, in rotating cylinders, with a liquor containing from 5 to 15 per cent. milk of lime. Sometimes a little soda is added when colored rags have been used. The material following the boiling is allowed to drain for a few days, when it is thoroughly washed with hot water and sent to the pulping machine.

The methods of producing paper pulp from other materials than rags are mainly of two types: the alkalin and the acid process. Other processes than the ones to be described are known but are in little use commonly. In both of these processes the principle features are similar to the rag process except that we have more impurities to remove and consequently more chemical action necessary. In both processes where wood is used the bark is carefully removed, then it is chipped up into small pieces in order to allow the chemicals to attack the fibers both end and sides.

In the alkaline process, also called the soda process, NaOH is the most often used chemical, it being in solution to the strength of 11° Bé. The chipped wood, mostly of the softer wood, as bass, is boiled in this solution for from six to ten hours and at a pressure of from ninety to a hundred pounds. The liquor reduces the resin and liguin, these latter being mainly organic acids which neutralize the soda and the whole can be washed out with water, leaving the wood pulp for use.

The liquor and wash water containing the soda and impurities is then evaporated by the multiple effect process until of considerable strength, when it is burned in order the reclaim the soda. From 85 to 90 per cent. is then saved. The soda process is more expensive than the alkaline and causes the wood fiber to be weakened considerably, especially when it is carried out at the higher pressures, hence high temperatures are used by preference, as the two temperature pressures are reciprocal. So while we get a good soft pulp from the process we do not preserve the strength of the fiber. This process was first developed by two Americans—Watt and Burgess about 1853 and is used in a number of mills about the country.

The acid process, or better known as the sulphite process, and the one so extensively used here in Wisconsin along the Fox and Wisconsin Rivers, makes use of sulphurous acid. Here, too, a liquor is used which will reduce the miner al salts and resinous substances in the wood and leav e the cellulose fiber free, the process being as follows: The wood, largely spruce, pine and hemlock, is barked, chipped, thoroughly dusted and sifted before being carried to the chip bin. The liquor which reduces them is made by burning sulphur in an oven with just the right quantity of air to form SO_2. This gas is cooled and carried to a series of tanks arranged one above another, each filled with a milk of lime solution, or better a lime and magnesia. The sulphur dioxide passes into the lower of three tanks and then through each of the other two, the gas being weakened as it goes up. The lime solution starts in the upper and passes to the lower so that the liquor is getting stronger as it comes in contact with the stronger gas. In each of these tanks is an agitator to keep the liquor stirred up, thus assisting the chemical action.

The liquor and the chips are next brought together in the digester, where steam is turned on and gradually raised in pressure up to ninety pounds, though this process varies in different mills. Here the cook goes on for about eight hours when the spent liquor is drawn off and the pulp thoroughly washed to remove all traces possible of the acid. The result of this process is known as sulphite pulp.

The digester, which is made of heavy steel and in dimensions frequently forty feet high by twenty in diameter, is the great problem for the engineer to solve. Here they must have a strong metal, with an acid resisting lining to prevent the sulphuric acid from attacking it. Lead one-half inch thick is often used, but since this expands with the heat in the ratio of 123 for iron to 297 for lead, there is a buckling of the lining, frequent breaks result and the digester is in constant danger of being destroyed. Acid resisting materials such as bronze are too expensive, so substitutes are looked for with great eagerness by pulp mill owners. They have tried many linings, such as cement, brick, and chemical coatings, all of which are more or less unsatisfactory. Here then is one of the problems for the future chemical engineer.

Another method of producing wood pulp is by grinding it off from logs by means of grindstones. In this case no impurities excepting the bark are removed. The standstone grindstones are flooded with water, which carries the ground pulp with it into tanks for use direct. The treatment of the straws is similar, simply involving changes in the quantity of chemicals used.

From this point on, all pulp is treated in general the same, whether it come from rags, ground wood, soda or acid process.

The bleaching process is accomplished by the use of hypo-

4-Eng.

chlorite of calcium or soda, the pulp being heated and run into the bleaching solution. Sometimes a little dilute acid is added or an acid base is used to assist the operation. Many methods of bleaching have been used, such as the use of free chlorine or electrolytic bleach, the latter accomplished by electrolyzing a solution of magnesium chloride or a saturated brine. This method has not been much used practically as yet.

Often, too, no bleaching is used, *e. g.* in cases where the colored papers are made. When it is used, the excess of hypochlorite of calcium is thoroughly washed out or is destroyed by an anti-color. Following either operation a most thorough washing is necessary.

The main machines used in the process of finishing for the pulp are known as Hollanders, since they were first devised by that people. We often call it the beating engine, since here the material is thoroughly mixed and beaten into the final form for the sheet paper.

The beating engine is charged with a quantity of stock according to the quality of the paper desired, the rag pulp being used for the finest and the ground wood for the poorest, with varying quantites of rag, sulphite pulp, soda pulp, or ground wood pulp. In Europe in place of the wood pulp esparto pulp is largely used. Here in the beating engine the most thorough separation of the fibers is obtained and upon this factor also depends largely the quality of the paper.

Many papers in the cheaper grades require more weight, body and smoothness than would result for the plain fibers and to meet this want a mineral filler or loading material is used. Certain clays such as kaolin, pearl hardening agolite process the necessary qualities of fineness, freedom from grit, sand or mica. These fine clays fill up the spaces in and absorb the fibers in the finished product if throughly mixed up with the pulp in the Holland.

Along with the filler is added for most papers upon which which writing is to be done, a "size" which prevents absorption of inks or other fluids. These sizes are of two kinds, resinous or animal size. This may be introduced either in the beating engine or the paper may pass through the size, when it is then called tub sizing. The resin is added in the form of a soap; this soap has been made by boiling rosin with sodium carbonate. When well mixed a solution of alum is run in, this preciptitates a resin of aluminum upon the fibers thus producing a resistant, now absorbing coating.

Animal size is a gelatin, obtained in the same way as glue. The gelatin size may be distinguished from the mineral size by the fact that the animal size works its way to the surface while the rosin size is present all through the paper.

Following the above is the coloring matter, which is added also in the beating engine. The colors for the finer grades of paper are produced by the ultramarine pigments red, yellow, green, violet and blue, or by the use of the cocheneal color, red; while the cheaper colors are produced by the analine dies.

While all of these substances, the pulp, the body material, the size and the coloring matter are being added, a most thorough mixing takes place for several hours, when the stuff is carried to the large Fondrinier machines, which in themselves deserve a more extended description than can here be given. Suffice it to say the stuff or pulp with all its necessary additions is run upon a long rolling sheet of wire cloth through which the water is drawn or sucked. The wires transmit it while being shaken sideways and up and down to thoroughly felt the fibers, then onto a long felt cloth and through and over heated rolls until wound up dry, ready to cut.

Paper is made in this way from 96″ to 158″ wide and runs through these machines at the rate of 100 to 500 feet per minute, the finer papers using the slower speeds.

On account of the great variety of paper on the market it is desirable to know what has gone before to know what to look for in the finished product. We need not know all the fine chemical points but we should know what would cause permanence in color, or what would be the cause of disintegration of the paper. A great deal has been said lately of the quality of paper which goes into libraries. Many valuable books are today going to pieces so rapidly that the librarians are much worried. It has been found that gas made from coal and burned in libraries causes a very decided discoloration and disintegration, due to acidity. In wood pulp papers it has been proved that it is due to oxydation pure and simple, so we may expect in the future to see the splendid newspaper files of our present day papers crumbled to dust. Especial attention is directed to the keeping of books and papers of value away from chemical laboratories, or wherever gas from coal tar products are prevalent. A committee of the English Society of Arts, in 1898, made the following recommendations after a very careful study of the subject in order to reduce both discoloration and disintegration:

*That the (1) normal standard of quality for book-papers required for publications of permanent value.

Fiber: Not less than 70 per cent. of fibers of Class A be used; all mechanical wood-pulp excluded.

Sizing: Not more than 2 per cent. rosin, and finished with the normal acidity of pure alum; starch excluded.

Loading: Not more than 10 per cent. total mineral matter (ash).

(2) With regard to written documents, it must be evident that the proper materials are those of Class A, and that the paper should be pure and sized with gelatin and not with rosin. All imitations of high-class writing papers, which are merely disguised printing papers, should be carefully avoided.

*The committee divides paper-making fibers into four classes:

(A) Cotton, flax and hemp.

(B) Wood celluloses, (a) sulphite process and (b) soda and sulphate process.

(C) Esparto and straw celluloses.

(D) Mechanical wood-pulp.

And they recommend:

From the above discussion, then, the recommendations of the Committee should be understandable; and furthermore, an engineer should be able to specify what he desired for permanent papers, or cheaper grades, whether it be for valuable maps, blue prints or office paper.

The care with which the paper has been prepared is understood by an inspection of its surface. The presence of small specks of black or brown indicate pieces of bark. The bark is more resistant than the other impurities and thus escapes with the cellulose into the finished product. Frequently shiny specks are seen. These often are mica or other impurities from the filler used. The polished surface is produced by "calendering," or by an iron roll which runs faster than the surface velocity of the paper as it passes through the roll. The water-marks noticed on holding the paper to the light are produced by a thinning down of the paper while still wet when it goes through the press rolls.

As to the quality, only a careful microscopic examination would reveal the real material, also certain chemical tests. For the engineer, however, these are not always available tests, so he can use a study of its quality by the feel and by tearing it to note the length of fiber exposed. The longer fibers indicating rag and the shorter wood pulp; he should tear in two directions, at right angles, in order to be sure to test across the run, as the fibers are sure to be felt better in this direction. Try various papers—blotters, in which no filler or size is used, strawboard, up to the best bond paper available; note the size, filler, finish, water-marks, impurities, feel, the color. Try all with ink to note the finish for printers' ink or pen and ink, the opacity, and I'm sure paper will be found of more interest than before. With these general remarks I hope our engineers will find it easier to choose what they want in this line, let it be wrapping paper or parchment. There is a good demand in this industry for our engineers. Wisconsin has many paper mills, and it may be your fortune to be with one of them.

THE QUANTITY OF WATER USED FOR FIRE SERVICE IN MADISON.

J. H. NEEF, '03.

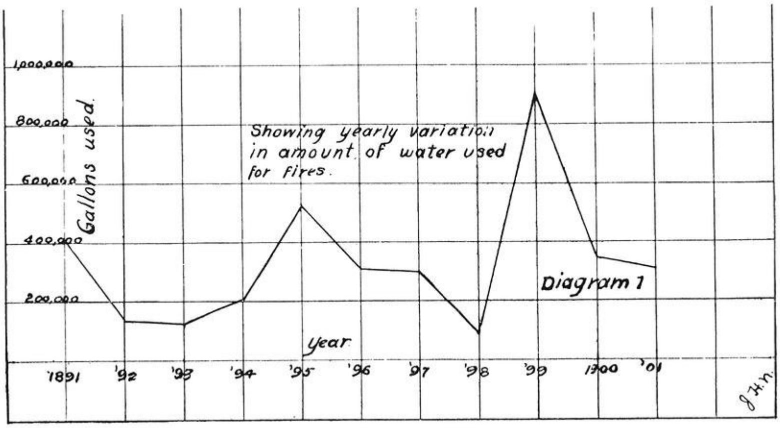
The best and most accurate data at hand for the quantity of water necessary for fire protection, are the results of Prof. Freeman's experiments, which may be found in the publications of the American Society of Civil Engineers in 1889. In discussing this subject I have used these experiments as a basis of calculation and comparison.

In the annual reports of the Madison city water works for the past ten years are given the quantities of water used at each fire. This data must necessarily be somewhat approximate for the principle reason that these amounts must be estimated from the increased strokes of the pumps during the fires. This data is given in table No. 1, together with the total amount of water consumed for domestic and fire use annually, and the duration of fires.

TABLE NO. 1.

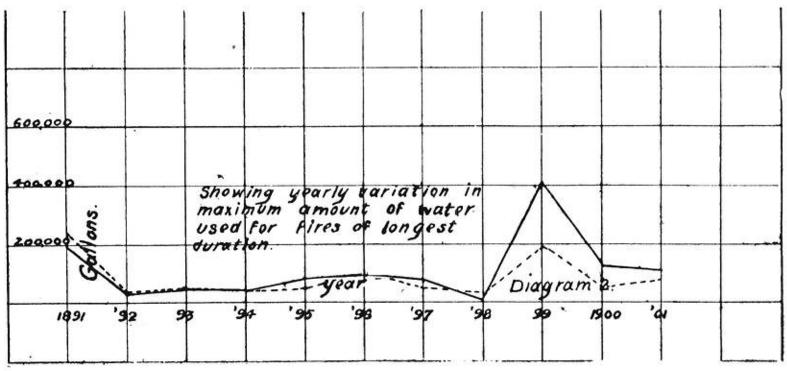
Year.	Water pumped.	Used for fires.	Yearly total time of fires. Hrs.	Min.	Maximum used for longest fire.	Duration. Hrs.	Min.
1891	197,889,450	409,000	17	05	195,000	10	00
1892	226,035,800	135,000	5	30	35,000	1	20
1893	268,246,300	128,700	6	17	45,000	2	10
1894	272,006,950	202,700	8	35	42,000	1	45
1895	313,705,500	528,200	19	00	84,500	2	10
1896	325,408,500	317,400	15	22	98,000	4	25
1897	290,972,750	299,250	12	40	82,500	2	05
1898	273.016,500	92,500	6	45	18,000	1	20
1899	291,934,250	907,100	27	57	408,000	8	00
1900	306,639,450	349,400	19	50	124,000	2	25
1901	358,494,000	314,500	14	09	110,000	3	00
	3,270,349,450	3,683,750	153	10	1,242,700	38	40

From this data diagram No. 1 has been constructed, showing the yearly variation in the amount of water used for fires.



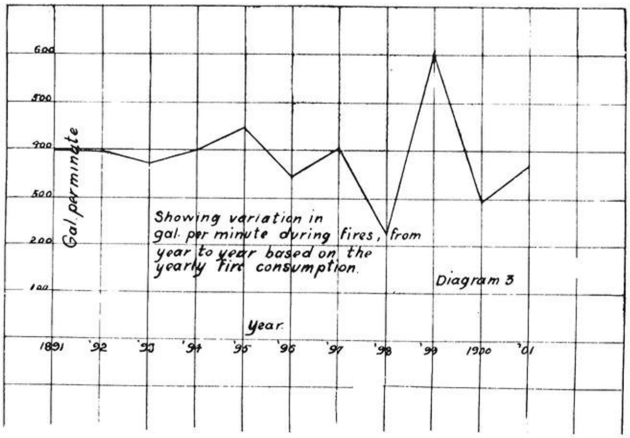
This curve is very irregular, due to the fact that in some years larger fires and of longer duration occurred.

This fact is emphasized in the curves of Diagrams 2 and 3, which show the yearly variation in the maximum amount

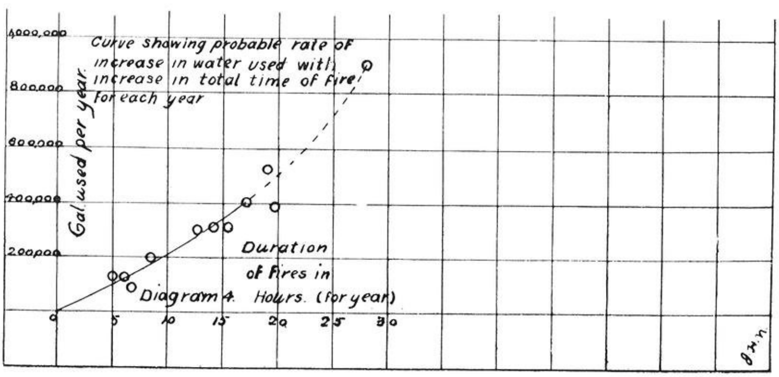


of water used for longest fires and the variation in gallons per minute from year to year, respectively.

In all of these curves, it will be noticed that there is a maximum in the year 1899 and that a smaller maximum is reached in 1895. The striking maximum in 1899 shows clearly the effect of larger fires of long duration. If it were not for the great excess of water used in this year, the curve in Diagram 2 would approximate a straight line, which would go to show that for a city of the size and nature of Madison the maximum amount of water, used at anyone fire is practically constant.

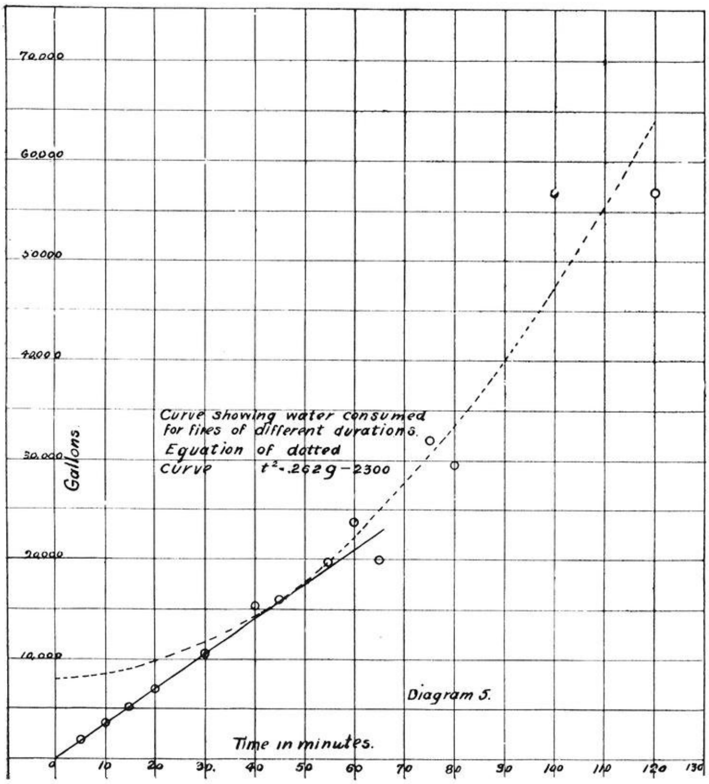


From an inspection of Diagram No. 3 it would appear that in a general way the amount of water used in gallons per minute was decreasing from year to year. The reason of this variation may be due to a number of causes, the principle ones



may be difference in hydrant pressure, length of hose used, size of nozzle, number of fire streams used and the loss through the relief valve which is attached to the hydrant to prevent water hammer.

The experiments of Freeman show that with a hydrant pressure of 85 pounds, which is a fair average of the pressures used in Madison, a one-inch nozzle at the end of 500 feet of hose will discharge approximately 194 gallons per minute and will raise a good fire stream to a height of 65 feet. Comparing these figures with Diagram No. 3, it would appear



that the amount of water used per minute was, on the average, equivalent to that of two good fire streams with a variation of 50% above and below the average. Taking this amount as a basis the computed maximum amount of water, as shown by Diagram 2, would be represented by the dotted line in that Diagram.

Diagram No. 4, shows the probable increase in water used for fires with increase in total time for each year.

In diagram No. 5 are plotted the amounts of water used in different lengths of time. Between values of 0 and 60 for t all of the points, except three, lie very close to the curve, the lower part of the curve approximating a straight line or giving a rate of 20,000 gallons per hour.

According to some authorities 10,000 gallons per hour make a good fire stream. Upon this basis the data would again give us the equivalent of two fire streams for periods up to one hour or thereabout, but from the curve it would appear than for longer periods of time, such as two hours, the consumption is much higher being equivalent to that of three fire streams.

It will be noticed that with the greater increase in the time the greater is the variation in amounts of water used, as plotted from data given in reports of City Water Works. This no doubt is due to the variation in number of streams and to the lengths of hose used; the latter evidently depending upon the number of hydrants tapped.

The approximation also becomes greater, as t increases, owing to the causes of variation, given above, and a mean curve to the plotted points would give an average amount of water used in any given time. Such a curve shown by dotted line, in Diagram No. 5, is similar to the parabola $t^2 = .262g - 2300$, in which t=time in minutes and g=gallons used. This curve has been plotted upon diagram to show the approximate law of variation in gallons used to the time of duration.

When t=45 minutes, or there about, the approximate constant, shown by straight line, ceases and the variable increase of gallons used to the time of duration, begins. For fires of duration greater than two hours, the variation becomes greater, as might be expected, since the conditions are probably never the same, and the fluctuations in amount of water used is a minimum when existing conditions are alike.

As an illustration of a great divergence from this curve, on July 24, 1901, when the Baptist church burned, four leads of about 400 feet each were laid; two leads from the 6 inch main, corner of Wisconsin avenue and Dayton street, one from the 4 inch main, corner of Johnson and Carroll streets and one from the 8 inch main, corner of Dayton, Fairchild and State streets. At this fire 89,000 gallons of water were used in five hours and fifty minutes or 254 gallons per minute, and assuming that out of the four leads, two were in constant use the five hours and fifty minutes, the value of the stream, would be but 127 gallons per minute. With a one inch smooth nozzle, such as is used by Madison Fire Departments, a 127 gallon stream is not considered by Freeman, even of fair quality.

The fire pressures at all of the hydrants tapped were 75 pounds or more; if the pressure at station was increased to fire pressure, and with this hydrant pressure 190 gallons per minute should have been obtained through 400 feet of hose and one inch nozzle. Such a stream would be considered one of good qnality, capable of reaching a height of 83 feet or a horizontal distance of 133 feet and remaining a good effective fire stream to 65 feet vertically and 60 feet horizontally.

Evidently there was either an error made in computing the amount of water used or there was not an equivalent of two streams used all the time.

A factor which would cause a great difference in the amount of water used, is the pressure at the hydrant, but even this could not make such a great difference in Madison as may be seen from the following: The lowest pressure at a hydrant in Madison is found at the corner of Pinckney and Gilman streets. Here the pressure is but 48 lbs. when the pressure at the pumping station is at the uniform pressure (85 lbs) always carried. In case of a fire the pressure is increased to 100 lbs. at the station and this hydrant pressure is increased to 68 lbs. With 100 feet of hose an excellent one inch fire stream could be obtained from this hydrant, discharging about 218 gallons per minute and reaching a vertical height of 76 feet, while if 500 feet of hose were used, with the same pressure at the hydrant, a 170 gallon per min. stream would be the result, having a vertical height of but 56 feet.

The maximum amount of water which a city of 19,000 inhabitants should be able to have upon demand, for fire purposes, is from Kuechlings formula, $q=200\cdot(2.8\sqrt{x})$, where x=population in thousands and 200=the value of each stream in gallons per minute. But this is based on the assumption that twelve fire streams be used at one time, which for a city the size of Madison would be equal to about twelve, but this number is never required at once. The hottest fires having been fought with six streams, and with this number of streams the amount of water for fire purposes would be about 1200 gallons per minute.

The nearest approach to this value in the past ten years, was on Mar. 30, 1895, when the amount of water consumed was 1100 gallons per minute. This high value being accounted for by the fact that two fires broke out at the same time, and it is for this reason, that more than one fire may occur at the same time. that such a high value is given for the number of streams in the above formula. It is indeed necessary in order to provide a sufficient amount of water in time of emergency.

However from this study of the Madison fires it would appear that for the fire of short duration at least, it is not necessary to consider that a quantity of water more than an equivalent of two good fire streams will be used, but that for very large fires a liberal reserve should be made.

AN OLD ENGINEERING CLUB.

In the issue of the *Wisconsin Engineer* of Dec., 1900, we find a history of engineering clubs in the University by Mr. Quigley, which was worked up from old *Cardinals* and such other information as could then be obtained. It seems that in 1892-3 the papers of the University did not take the proper interest in the "few" engineers then in this college, so slipped by the following notes which I find recorded in the Journal which was kept during my four years here as a student. These minutes are of the old Association of Engineers, which came into existence in 1892 and died in 1893, with only the meetings as here given, intervening. Perhaps these notes will remind some of the "old boys" of incidents which they can transmit to the editor to complete our records here. On page 80 of the Journal I find, under Friday, Nov. 4, 1892:

"Meeting of the Engineers in the Engineers' reading room, Science Hall, to discuss the advisability of forming an Engineers' Club. Prof. F. R. Jones advanced many advantages of same. Good remarks also by Profs. Bull, King, Jackson and Whitney. Seniors were not in favor of same on account of its breaking up their discussion classes. Burton and Kurtz most prominent. Much wrangling. Finally, however, Woodward was elected temporary president; O. B. Zimmerman, temporary secretary. Committee on Membership list was named, with power to call next meeting." (As I have no record as to the personnel of this committee, I will rely upon my memory for the chairman, who was either G. Gerdtzen or H. P. Boardman.)

Friday, Nov. 11, no meeting.

Friday, Nov. 18—Meeting in same place. Topic: "The Utilization of the Power of Niagara." Different phases discussed, by the Seniors mainly.

Friday, Nov. 25—Vacation.

Friday, Dec. 2—Fifty members assembled in (old) reading room, Science Hall. Topic: "Discussion and Comparison of the English and American Locomotives." This was divided up into sections as follows:

I. Mr. Hanes spoke on "Roadbeds and Rails."

II. Mr. Worden spoke on "Metal Ties."

III. Mr. Loomis spoke on "The Locomotive."

IV. Mr. Sweeton spoke on "Brakes."

V. Mr. Kummel spoke on "Cars."

VI. Mr. Hackney spoke on "Lighting of Coaches."

Profs. King, Bull, Jackson and Whitney were present.

Friday, Dec. 16—Meeting held. Committee formed to see about having lectures on "Law Relating to Engineers." It was decided to form a permanent society with the name of "The Association of Engineers of the University of Wisconsin"(?) Mr. Burton, '93, was elected president, Mr. Ross, '96, secretary.

The subject for the evening was: "Signals for railroads," also "Switching" and "Transmission of Power, Rope, Wire, and Hemp Shafting;" Friction cones. (Minutes of former meetings turned over to Mr. Ross.)

Friday, January 20, I find the notes—Burton, Ross, Gerdtzen, Goddard, Parr, Bebb, Worden and some others present twenty in all."

Discussion—"Nicaragua Canal."

Goddard and Gerdtzen spoke.

February 3. O. B. Zimmerman on Hydraulic transmission of power—on Compressed Air, and—on Electrical Transmission. The latter discussed by Prof. Jackson.

February 17—Joint Debate.

As I find no further notes on Friday evening in the Journal, I presume the society died about this time. I refer to Mr. Ross for data from his secretary book.

As I recall the meetings, they were very interesting especially to a freshman such as I was, and my reverence for those "Seniors" at that time, I hope is to-day equalled by the corresponding classmen for their elders. I also recall that the Professors came as regularly as we, and one time

Prof. Bull and Prof. King got interested in a discussion over compounding of locomotive or some locomotive valve gear and while some of the students nodded, they spoke for forty minutes. I wondered, "Would I ever be able to talk as scientific as that." I still am of the impression I can never equal the ideal then formed.

O. B. Z.

PERSONAL.

Murray C. Beebe and Miss Agnes Roseburg Kelly were married, January 17, in Pittsburgh. Mr. Beebe is connected with the Nernst Lamp Co., as chemist, having charge of the manufacture of the Nernst details (glowers, heaters and ballasts) which involves considerable experimental work.

Associated with Mr. Beebe in the Nernst Co. are Budd Frankenfield and L. E. Terven, who are also doing experimental work. Mr. D. E. Beebe and Mr. Carpenter, '02 (classical), are exployed in the sales department. It will be seen that the Nernst Co. is well supplied with Wisconsin graduates.

The engagement of Prof. C. F. Burgess to Miss Ida May Jackson, of Milwaukee, is announced. THE ENGINEER extends its congratulations.

A. C. Olson, '02, visited the university several times in the past two months. He was with the C., M. & St. P. R'y before Christmas.

E. E. Terrell, ex '03 is at present engaged in bridge construction in Missouri. He is foreman of a "gang."

James Gilman, ex '03, is back at the university, having spent the last five months in Knoxville, Tenn., as masonry inspector.

Sanford P. Starks, '02, who has been doing post graduate work at Cornell is one of the many who have left that institution on account of the typhoid fever epidemic now raging there.

W. J. Gibson, '02, and Miss Ida P. Schmidt, of Hartland, were married December 18th. Gibson has a position with the Fuller & Johnson Co.

F. A. De Lay, '02, is instructor in electrical engineering in the Michigan school of mines, at Houghton.

Edwin S. Ela, '96, and Miss Alice Marie Cheney were married at Beloit, November 26th. Mr. Ela is a recorder in the United States Government Survey.

H. W. Dow, '02, is instructor in the Iowa State College, at Ames.

F. C. Stieler, 02, is employed on the Chicago, Aurora & Elgin Elect. R'y and is located at Aurora, Ill.

W. P. Herschberg, '01, is with the Cambria Steel Co. His address is 340 Locust St., Johnstown, Pa.

P. W. Pengra, '02, has resigned his position in the Madison Gas & Elect. Co. to accept a position with the Chicago Edison Co., in their designing department

Carl F. Stillman was in the city recently and visited the varsity. He is at present with the U. S. Steel Corporation at Hibbing, Minn.

NOTES.

On February 11th the engineering building was thrown open to the legislators. All the laboratories and the shops were in full operation, and exhibits of drawings were made in the various draughting rooms. A large crowd of visitors wandered about the building from 8:00 to 10:30 o'clock, and great interest was manifested in the various exhibits. The liquid forge, the electric furnace, the talking arc light, the magnetic rings, and the Engineers' ping pong, were centers of attraction to the visitors who gazed on in open-mouthed wonder. Indeed, were the Engineers to give a circus, we are of the opinion that their side shows would outclass anything ever heard of.

A series of five non-resident lectures has been given thus far this year. They are generally well attended, and the lecturers are given enthusiastic receptions. Following is a list of the lecturers and their subjects:

Captain H. D. Rodman—"The Manufacture of Burglar Proof Safes.

Prof. E. W. Orton, Ohio State University—"The Silicate Industries."

Jan. 23. J. N. Faithorn, Vice-President, Chicago & Alton R'y—"Railway Freight Rates."

Feb. 27. J. M. Alvord, Consulting Sanitary Engineer of Chicago—"Sewage Disposal."

March 6. John Ericson, City Engineer of Chicago—"Water Works of Chicago."

The Civil Engineering Society, formed shortly before Christmas, has been fortunate in securing some very excellent talks by professors in the University. Following is a list of the lectures held up to date:

Prof. G. C. Comstock—"My Experience in the United States Engineer Corps."

Prof. Monaghan—"Duelling."

Dr. H. L. Russell—"Biology of Water Supplies from an Engineering Point of View."

Prof. W. D. Taylor was initiated into the local chapter of Tau Beta Pi, on January 28th. At the meeting on February 18th the following members of the junior class were initiated: W. J. Benedict, M. E., Milwaukee; S. W. Cheney, M. E., Fond du Lac; R. F. Ewald, C. E., Fairchild; R. G. Griswold, M. E., West Salem; W. S. Kinne, C. E., Winona, Minn.; L. F. Musil, E. E., Manitowoc; G. G. Post, E. E., Madison; W. A. Rowe, E. E., Eau Claire; E. M. Shealy, E. E., Columbia, S. C.; L. F. Van Hagan, C. E., Chicago.

The Senior Civils held a banquet at the Avenue Hotel, Saturday, February 7th. It was in the nature of a post exam jubilee and was the outcome of a desire to get the "bunch" together for one more good time before graduation. The evening was spent in recalling the many happy incidents of our college career, and making forecasts for the future. An effort will be made by the class to keep a chain letter in circulation among the members after graduation.

MINSTREL SHOW.

Without question the minstrel show given by the senior engineers on March 5th was a "howling success." The show took the place of one of the regular engineering sociables, the financial backing for the production being furnished by the social committee. It was therefore possible to issue invitations to all engineering students and their ladies, so that no difficulty was experienced in filling the house. It must be said in this connection however that there were large numbers of "Hill" students making inquiries as to the price of admission who were evidently very anxious to gain an entrance.

Considering the fact that there was no outside coaching whatsoever, the program ran off very smoothly, credit for which is due to Messrs. Hadfield and Huels. Great credit is also due the stage carpenter and electrician for the clever manner in which they decorated the stage. The end men acquitted themselves nobly, Friend and Huels capturing the audience with a new jig.

The program itself was gotten up somewhat ingeniously and we print it in full:

Park Street Theater,

Season of 1902-3.

MR. STORM BULL

PRESENTS

Wisconsin Senior Engineers World-Famous Minstrel Production

Thursday, March 5th, 1903.

Business Manager	Irving Seaman
Stage Manager	F. W. Huels
Musical Director	R. H. Hadfield
Stage Carpenter	S. J. Lisberger
Electrician	E. A. Ekern

CAST.

END MEN.

"Billy"........Huels
"Jack"........Friend
"Olie"........Johnson
"Johnny"........Cadby

SOLOISTS.

Tootsie........Hotchkiss
Wootsie........Neef

QUARTETTE.

High........Anderson
Low........Dean
Jack........Morrison
Game........Seaman

CHORUS.

Chump........Chamberlain
Bump........Geerlings
Hump........Goudie
Stump........Bailey
Knocker........Lyons
Dump........Lathrop
Slump........Haase
Lump........Wedemeyer

INTERLOCUTOR.

HORSE POWER........H. P. Howland
Hauteboys, Dancing Girls, Peasants, Law Students, Soldiers, etc.
E. A. Birge........Premier Danseuse
E. E. Bryant........Chief of Hot Boys and Peasants
Admiral Curtis........
........Commonrot for bums, LAW STUDENTS, Soldiers, etc.

PROGRAM.

The Terrible Engineers.. Chorus
(Words by Musical Director.)
Don't Forget You're Talking To a Lady........................ Johnson
Songs I heard one Sunday Morn.............................. Hotchkiss
My Castle on the River Nile .... Cadby
(Premier's Entrance.)
Mammy's l'il Boy... Quartette
On Broadway in Dahomey By and By........................... Friend
My Sunday Eve.. Neef
The Furniture Man .... Huels
Medley.................. .... Chorus

OLIO.

1. "More Rope".. M. J. Hill
2. "Somethin Doin'"................................... J. A. Stewart, '04
3. "Stunts"...........John Pugh, E. W. Drake. '04, W. E. Schreiber, '04
4. "University Banjo Trio"......................... Frost, Elmore, Gove
5. "Nothing in particular" .... E. O'Mara
6. Illustrated songs?........................ Sung by F. A. Chamberlain
(Lantern slides by B. F. Lyons, L. F. Van Hagen, '04.)

I guess that will be about all.

Three Cheers, Three Beers,
'Varsity, 'Varsity Engineers.

Next attraction—"I was seeing Nellie home."

PATRONS.

John { Babcock.
Quan.
Mack.
Jones.
Hickey.
Olin.
Conohan.
Parkinson.
Doescher,
Bolzt. }

THE U. W. ENGINEER'S CLUB.

The following is a record of the the meetings that have been held since November 21, this being the last date recorded in the previous number of the Engineer.

December 5, 1902.

Singing, club.

Debate: *Resolved*, That all water power rights in the United States territory be owned by the Government.

Affirmative.	Negative.
H. S. Imbusch.	Anger.
Rice.	Cadby.
C. I. Zimmerman.	Lyons.

Won by negative.

Paper: "Manufacture of fuel from peat"—Cheney.

Paper: "The National Cash Register Works"—Quigley.

December 12.

Paper: "Laying of Water Flumes"—Peotter.

Paper: "Opening of mines"—Ekern.

Debate postponed.

December 19.

Business meeting at which following officers were elected:

President—F. W. Huels.

Vice-president—A. J. Quigley.

Secretary and treasurer—E. Wray.

Censor—S. J. Lisberger.

Assistant censor—F. J. Petura.

January 10, 1903.

Meeting adjourned on account of annual Joint Debate between Hill societies.

January 23.

Talk: Money and Banking—Prof. Scott.

Paper—Jones.

Paper: News Items—W. H. Imbusch.

February 13.

Business meeting.

February 20.

Paper—Kirkland, Wray.

Paper—Biersach.

Debate: *Resolved*, That labor organizations as they now exist are contrary to the best interests of society.

Affirmative.	Negative.
Petura.	McArthur.
Cadby.	Quigley.
Ekern.	Lisberger.

This was an impromptu affair and was won by the affirmative.

Paper: News Items—Sawyer.

February 27.

Paper: Single Phase Current Electric Railway—Lisberger.

Paper: The Century Plant—Walfing.

Paper: Review of Periodicals—Ekern.

Debate on question, Was Germany justified in her action towards Venezuela?

Affirmative.	Negative.
Dean.	Colburn.
Leasman.	Hunner.
Douglas.	Lyons.

Affirmative won.

N. O. WHITNEY ENGINEERS' ASSOCIATION.

December 5, 1902.

Singing by club.

Paper: "The Modern Canning Factory"—C. S. Eustis.

Debate: *Resolved*, That co-education in colleges is desirable.

Affirmative.	Negative.
H. S. Cole.	D. P. Falconer.
Wm. Ungrodt.	I. B. Hosig.

Discussion of the subject by society.

Decision in favor of affirmative.

Critic's report, R. G. Griswold.

December 12.

Singing by club.

Paper: "The Sault St. Marie Power Canal"—P. W. Morrisey.

Debate: *Resolved,* That it is for the best interest of the United States to build and maintain a large navy.

Affirmative.	Negative.
E. W. Galloway.	R. G. Griswold.
F. H. Hanson.	A. T. Stewart.
E. L. Barber.	G. G. Post.

Discussion of question by society.

Discussion in favor of negative.

Critic's report, Edward Zaremba.

December 19.

Singing by society.

Debate: *Resolved,* That the present system of caucus nominations ought to be abandoned.

Affirmative.	Negative.
A. F. Kripner.	A. E. Helzer.
W. S. Locher.	E. Duckett.
A. H. Miller.	W. H. Hauser.

Discussion of question by society.

Decision in favor of affirmative.

Critic's report, M. E. Wharry.

The following were elected as officers for the ensuing term:

President—W. A. Rowe.

Vice-president—R. G. Griswold.

Secretary and treasurer—M. W. King.

Censor—R. L. Hankinson.

Jan. 9, 1903.

Singing by Society.

Installation of Officers.

President's Address.

Reading, "Freaks and Fallacies of Steam Engine Design."—L. B. Morehouse.

Periodicals, "A New Type of Wireless Telephone;" "The Power Plant at Canvery River in India."——S. B. Robertson.

Talk on the rise and development of the new method of charging storage batteries by means of the electrolytic rectifier.—Prof. Burgess.

Critic's Report—F. V. Larkin.

January 16.

Adjourned for the Joint Debate.

January 23.

Singing by the Society.

Periodicals, "Blue Printing by Arc Light."—H. I. Ward.

Paper, "The Nernst Lamp."—M. A. Whiting.

Talk, "How a Ship is Navigated."—Edw. Zaremba.

Critic's Report—E. A. Goetz.

February 6.

Jollification Meeting.

Singing by Club.

Recitation—Harvey.

Recitation—Post.

Recitation—Brenton.

Parliamentary Practice, led by Hankinson and Whiting.

Light Refreshments.

Stories—John Babcock.

February 13.

Singing by Association.

Lecture on Paper Making—Prof. Zimmerman.

February 20.

Singing by Association.

Paper, "A Private Electric Lighting System in Milwaukee."—Zinke.

Periodicals—Conrad.

Paper, "The Experiences of a Wisconsin Graduate in the E. P. Allis Works."—Smith.

Debate—E. E. vs. M. E.—"*Resolved:* That electricity is a more desirable motive power on railroads than steam."

E. E. Affirmative.	M. E. Negative.
Bradford.	Griswold.
Krippner.	Hoefer, C. A.
Stewart.	Wharry.

Discussion of Question.
Decision in favor of Negative.
Critic's Report—Hanson.

NOTICE TO SUBSCRIBERS.

The Northern Electrical Mfg. Co., of Madison, Wis., U. S. A., has just completed and is now operating a power plant for the generation of the power and lighting current required in its works. There are two generating units—a 200 K. W. Northern Dynamo direct connected to a 225 H. P. Vilter Corliss Engine at 100 R. P. M.; and a 50 K. W. Northern Dynamo direct connected to a 75 H. P. Ball Engine at 290 R. P. M. The large generator is used for the day load, while the small machine supplies the current for operating the machinery and furnishes light required by the night shift. Two 250 H. P. boilers constitute the steam plant, using a Cochrane feed water heater. A 120 foot steel stack is used. The current is carried from a six panel marble switchboard through a tunnel into the distributing board in the shop. Exhaust steam is used for heating the works.

The power plant is housed in a new brick wing 87′8′′ x 100′4′′. An additional wing 38′ x 100′4′′ was constructed simultaneously; the additions accommodate—in addition to the generating station—paint shop, pattern shop, brass workers' department and boxing department, which previously occupied crowded quarters in the main works.

The company has just issued its booklet No. 31, describing various kinds of Direct Current Generators manufactured by them. A copy of the booklet will be sent on request.

On another page will be found an advertisement for back numbers of the WISCONSIN ENGINEER. Any of our readers having copies of Vol. 1, No. 2, Vol. 2, Nos. 2 and 4, and Vol. 6, No. 1, which they will dispose of should communicate with us stating what you have and what you want for them. We know of several parties desiring some or all of these numbers and we will be glad to hear from anyone having such numbers for sale.

The attention of our readers is called to the advertisements of the Northern Electric Mfg. Co., of Madison, Wis., and the Harrison Safety Boiler Works, of Philadelphia, Pa. It will be noticed that both of these concerns have stated that they are able to furnish positions to our students. Everybody ought to be interested in these announcements.

The ENGINEER is in receipt of a calendar from the John Roebling's Sons Co., Trenton, N. J. The calendar shows a good view of the New East River Bridge at New York during process of construction.

The Pratt & Whitney Co., Hartford, Conn., have sent us two neat pamphlets illustrating their "New Model Turret Lathes" and their "New Thread Milling Machines." The pamphlet on Lathes present some new ideas. The pamphlet describing the "Thread Milling Machine shows an apparatus which may be considered an advance in machine shop practice. These machines make anything from threads to spiral springs and this is done by means of milling cutters. Our readers are advised to send for a sample copy of this pamphlet.

NEW BOOKS.

PROBLEMS IN ELECTRICITY. By Robert Weber, D.Sc., Professor of Physics in the University of Neuchatel. Translated from the French by Edward A. O'Keeffe, B. E. M. I. E. E. Technical Institute of Cork. Pp. 351 (London: E. & F. N. Spon, Ltd; New York: Spon & Chamberlain, 1902.)

This book contains 746 problems carefully arranged and all worked out in neat style. They form a graduated collection which will enable the student to familiarize himself with the technical terms and formulae employed in this branch of physics. An unusual amount of space has been devoted to the subject of units and a great many of the problems are arranged with the view of bringing out the definitions of the units employed. The first section of the book deals with units of force, work, power, temperature and heat and their relations to each other, a sort of review of Mechanics and Heat in which a student must be well grounded in order to do anything with Electricity.

Under the subject of static electricity the relations between the practical and the electrostatic units are given and problems which give a physical conception of their magnitude are plenty. The majority of text-books omit these very important relations and give only the relations between the practical and the electromagnetic systems, leaving the student to find the other comparison by the reading of the story about the velocity of light. Very few text-books, for instance, will state that three hundred volts are equivalent to one electrostatic unit of potential, or that one microfarad is equal to 9×10^5 electrostatic units, and yet, are these relations not experimental ones? It is only by a familiar knowledge of these numerical relations that one is able to obtain a physical conception of practical problems.

The subject of condensers is treated very thoroughly; a great variety is given, ranging from he old time Leyden-jar to Atlantic cables. Unfortunately the author has failed to make use of any of our modern commercial condensers with which the student becomes so familiar in the American laboratories, but we have only to remember that the telephone service in Switzerland does not require the use of condensers in order to account for the omission.

Dynamic electricity forms the major portion of the book, each subject being treated at great length. The usual problems dealing with resistances and the electromotive forces of cells are improved upon, in that, very practical ones are given. The work upon dynamos, lighting, telegraphy and telephony is good and ought to be of great assistance to any student who has had the usual elementary course in physics.

A great many tables in the appendix add to the value of the book. Among them is a very complete table showing all the relations between the units, their symbols, dimensions, etc. The book is nicely bound, adequately furnished with references, and has a good index. G. W. W.

ALUMNI DIRECTORY.

The Alumni directory given below is as near perfect as we can make it with the information at hand. A complete and authentic directory is indispensible in a college like ours, and to keep it correct, we need the support and encouragement of both undergraduates and alumni. The names of alumni, whose addresses we are not certain of, are indicated by asterisks (*). Anybody possessing information, as to any change of address, or correction in the directory, will do the ENGINEER a favor by imparting such information to our alumni editor.

Abbott, Clarence E., B. S. M. E., '01. 433 Murray St., Madison, Wis.

Adams, Bertram F., B. S. M. E., '02. Grad. Student, U. W. Sigma Chi House, Madison, Wis.

*Adamson, Wm. H., B. S. C. E., '86. Address not known.

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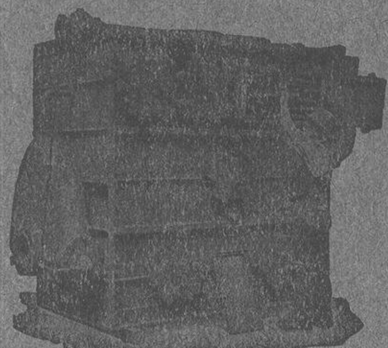

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