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THE

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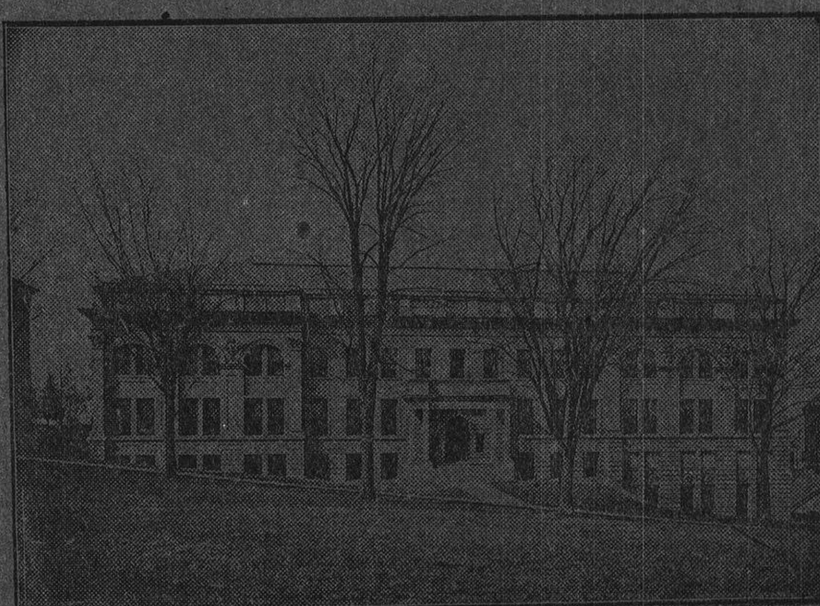


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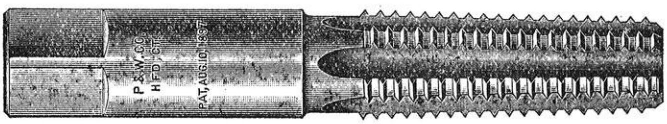


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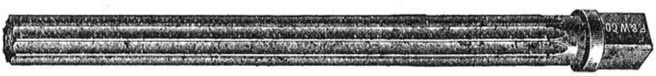


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BOARD OF EDITORS.

# THE WISCONSIN ENGINEER

VOL. 6. FEBRUARY, 1901. NO. 2.


## SIR HENRY BESSEMER.

*An extract of a lecture delivered before the students in the College of Engineering of the University of Wisconsin, January, 24, 1902.*

BY ROBT. W. HUNT, M. AM. SOC. C. E.

A country may be very fertile, and possess the beauties of well cultivated fields, capacious barns and comfortable farm-houses, but if without striking characteristics of landscape, it will not impress itself upon the traveler's attention or memory. So it is with human character. Even-going, constant endeavor, if confined to well accepted lines, may no doubt bring greater happiness to the individual and those associated with him, but it requires rougher, abrupter, and more forcible accomplishment, to make and mark history. No doubt human greatness brings with it a certain amount of happiness, but of all roses it is sure to have the most thorns. Trusting this is true, very many of us can contentedly accept our minor places and render thanks that we have not been called upon to answer for many talents.

Sir Henry Bessemer's character was most emphatically of the picturesque and aggressive type; with his heredity it would have been remarkable if it had been otherwise. He was born in Charlton, Hertfordshire, England, on January 19th, 1813. He was the son of Anthony Bessemer, himself a remarkable man. Firmly believing, as I do, in the theory of a mother's great influence on the character of her sons, I regret that I am unable to tell you of his mother, but I am certain she must have been a worthy helpmate to her husband.

We do know that Henry Bessemer's father was an Englishman, and that he was taken at an early age by his parents to Holland, where they made a permanent home. As he grew up, his natural mechanical bent found opportunity for development by his being apprenticed to a mechanical engineer, in whose employment he took a prominent part in the erection of the first steam pumping engine built in Holland. It was used in draining reclaimed land near Harlem.

Anthony Bessemer was not only equipped with mechanical skill, but must have also possessed a brave and adventurous spirit, for when but twenty-one years old, we find that he emigrated from Holland to Paris in search of a broader field of action. There his career was both romantic and successful. For a Dutch-Englishman to have accomplished what he did in the French capital must have required great ability and a tremendous personality. When but twenty-six, his improvements of the microscope brought him membership in the French Academy of Sciences. Later he occupied a prominent position in the French mint. It was while here that he invented and applied a mechanical device for reproducing carved or engraved work. As James Dredge says in his monograph of Sir Henry Bessemer,* this has been wrongly regarded as an invention of the latter half of the nineteenth century.

Anthony Bessemer acquired riches as well as honors; but the upheaval of the French Revolution caused him to flee for his life, fortunately being able to make his escape even after imprisonment. He returned to his native England, to which country he had, with the business foresight which he afterward transmitted in so large a degree to his son Henry, previously transferred much of his property. He first settled in London where he married and soon thereafter moved to Charlton, where his son Henry was born. At this place he took up the business

*Proceedings American Society of Mechanical Fngineers, Vol. XIX, page 887.

of type-founding, and formed a partnership with one Caslon. The Bessemer-Caslon establishment became the principal type foundry in England, if not the greatest in the world.

I have taken time to thus briefly sketch the career of Henry Bessemer's father that you may appreciate the influences surrounding his early years, which had a bearing on his natural instincts; for it was in that type foundry that he really received his education. It was more than a mere foundry, having attached to it a machine shop and a die-engraving studio. Through these he had facilities for, and incentives to, the inventive and artistic talents which he had inherited.

Like so many other remarkable men, Henry Bessemer's active life began while he was yet a boy in years. While he was in his seventeenth year the whole family moved from Charlton to London, where he at once became busily employed. He had artistic tastes and skill so based on the knowledge which he had acquired of the art of founding and the characteristics of fusible alloys, that his first creative and commercial efforts were devoted to producing art castings in white metal and coating them with copper. His work merited the attention which it attracted for both artistic and mechanical excellence. It also possessed inventive features, as Ure's Dictionary of Arts, Manufactures and Mines gives him the credit of having been the first to so apply copper coatings.

Before Bessemer was twenty, he was an exhibitor at the Annual Exhibition of the Royal Academy. Naturally the notice which his work received made him a name and friends.

His next step was the perfecting of power stamping, not only in metal but also in leather, card and fabrics. He here built up a commercial business which was financially successful. A striking feature of Bessemer's character is that during his whole career, while a bold inventor, he was a money maker and keeper.

It is highly probable that in these early efforts he enjoyed the advantage of consultation with his father, whose advice must have been of great value to him. Anthony Bessemer's experience in the French mint had made him familiar with power press work and he no doubt gave his son the benefit of it. He was already married, that happy event having occurred when he was but twenty-one, and it proved a long and happy union, as his wife died but a short time before his extended and busy life ended. But we must remember that while so young in years when he assumed that domestic responsibility, he was practically older, as he had really been filling a man's place since his sixteenth year, and a person's age is always a relative proposition.

Bessemer's success in embossing led to an event in his life, which while at the time gave him bitter disappointment, and would to a weaker man have brought more serious consequences; singularly was in after years the cause of his Knighthood.

It is almost the universal impression that he was knighted in recognition of the steel process which bears his name, but such was not the case. It came in 1878, when he was sixty-six years old, as a tardy reward for a service rendered the English government about the time of his attaining his majority. The history of this has been so well told by James Dredge, that I quote: "His productions were found worthy of exhibition at the annual show of the Royal Academy. Young Bessemer came into contact with some of the officials of Somerset House, the seat of the Inland Revenue Department. It was notorious at that time that frauds on the government were perpetrated to an alarming extent by the repeated use of stamps affixed to deeds. It was estimated that an annual loss of £100,000 was sustained from this cause, and to devise a means for entirely putting a stop to this occupied Bessemer's attention. It is almost superfluous to say that he arrived at a solution by the simplest means, that of perforating the government stamps with dates. Now that this evident method has found a hundred uses throughout the civilized world, to safeguard stamps or cheques, and to divide postage stamps, being among the most common, it is a little difficult to realize the importance of this invention. To Bessemer it meant, in anticipation, vast things; assured fame, a retaining fee of £600 a year as a government official, and a great advance on the road to fortune. In reality, it meant nothing, for though the invention was at once adopted, the official promises were forgotten, overlooked probably during a political crisis, and change of government. But whatever the cause, he never received any consideration for the large sums he had enabled the British Inland Revenue to save. Some forty-five years later, when he had earned for himself all the fame he could desire, and when bestowed honors were superfluous, he was knighted for this invention which had been appropriated without the possibility of redress, because he had not protected himself by any patent."

The next of Bessemer's commercial ventures seems to have been in connection with the manufacture of plumbago, or black-lead-drawing pencils. Great Britain depended until sometime after 1831 for its supply of plumbago suitable for such pencils upon a single mine located in Cumberland. This was of immense value to its fortunate owners, and was closely guarded and its production limited. It was operated for but a short time each year, when some 40,000 pounds was taken out. Then again tightly sealed. This plumbago was bought principally by a Jewish syndicate for about ten dollars a pound, and by them manufactured into pencils. We are told that this ring was dependent upon an inner one, or the actual cutter of the plumbago, who with great skill, and with a waste of 60 per cent. and for some $5 a pound, sawed the brittle material into thick sticks. The waste realized only 50 or 60 cents a pound, and the prepared sticks when ready for the cedar wood cases, were sold at over $20 a pound. No lead pencils with rubber tipped ends for a cent apiece in those days!

Young Bessemer seized upon the opportunity. He built a powerful hydraulic press; bought up all the refuse and waste plumbago he could find, at about 60 cents a pound. In fact he made a corner on all the available supply in England. This he ground, lixiviated, mixed with proper binding material, and by his powerful hydraulic press, formed into compact slabs which were subsequently cut with fine saws into proper sized sticks, equally as good if not better than those made direct from the ore. He could undersell, and so controlled the market.

Probably this was the first instance of artificial lead-pencil making. It certainly was the first in England. Bessemer made money out of it, but more than that it brought him increased acquaintance and fame. He subsequently sold his secret and devoted himself to other matters.

On March 8, 1838, Bessemer was granted his first patent, No. 7,585, for "machinery for casting type." The invention itself proved fairly successful, and a plant was established at Edinburgh, his brother-in-law, young W. D. Allen, being sent to superintend its installation.

This is probably the first British patent for casting under pressure.

The manufacture of "bronze" powder had been a German secret-monoply. The process of making was carefully guarded, and the material found a world wide market. It was made from a cheap material, but the process of making was known to be long and tedious. To attack such a problem was well suited to Bessemer's active mind and energetic body. He had acquired, more by industry, than through royalties from inventions, quite an independence for a man under thirty; but this bronze powder making taxed his patience and finances to the utmost before he achieved success. But he stuck to it and finally succeeded both technically and commercially. He took out a patent in 1843, but in it he gave but an indication of the way, and nothing of the method of manufacture.

As illustrating the analytical character of his mind, and also his quickness of perception this episode in his career is interesting. He had spent much money, time and labor—built expensive machinery to crush to an impalpable powder the alloys which he employed; and obtained a basis for a pigment which was satisfactory, but it was a failure as a paint, because it had no brilliancy—in fact not even a suggestion of metallic lustre. He was almost hopeless, when he happened to call on a Mr. De

La Rue, the head of a famous stationery house in London, and a scientific man, whose acquaintance Bessemer had previously made in a business way. On this occasion he found him examining samples of flour and potato starch under a microscope, and he explained that they could be distinguished one from the other by the form of their respective crystals. That was enough for Bessemer! Why could not the same thing be used to distinguish between his lack lustre powder and the brilliant German? The microscope did not fail him, as it showed that his grains were round and uniform, while the German powder consisted of very thin flakes of irregular shape.

Therefore the metal must be rolled into the thinnest sheets and then broken into minute particles, and not ground at all. So he had the courage to throw away all he had done and attack the problem afresh. This he did successfully, and was enabled, of course after more patient labor, to produce an article costing one twentieth the selling price of the German.

The Germans hammered out their sheets of metal by hand, as gold foil was produced. Bessemer rolled his by machinery, and subsequently treated it in an equally rapid and economical manner.

But as I have said Bessemer was a money maker, and hence far too shrewd to "spoil" the market, and so simply cut it enough to enable him to ultimately control it. He was too smart to expose his method by taking a patent, and was enabled to successfully conduct the business as a secret process for nearly forty years; and for quite half of that time the business brought him enough money to make him independent if not absolutely rich.

Bessemer entrusted the entire management of the bronze-powder factory as soon as the business was in successful operation to another brother-in-law, Richard Allen.

Of course the German makers were much disturbed by this attack on their heretofore profitable industry, neither were they aware for some time from whence it came. As the machinery of Bessemer's plant was mostly automatic, he was enabled to confine his secret to but a small number of loyal employees. After the Germans learned the source of the trouble, they were for a number of years unceasing in their efforts to learn the secret of the process, but without success, and Bessemer refused to entertain any commercial negotiations. They watched his little factory day and night, and resorted to all sorts of strategy to get inside or to bribe some of the men. Dredge relates that in after years Sir Henry was fond of telling the result of one such incident.

A German agent sought to get the information from the old Scotch engineer of the factory, who promptly reported the matter to Bessemer. He told him to tell the German that he had sounded the man who had designed all the machinery for the factory, and he had consented, for a proper consideration, to see him and give him information. The appointment was made and the interview held, the faithless designer being Bessemer himself. After much assumed fear on his, and many promises of large reward on the part of the interviewer, complete drawings of the machinery were exhibited, and finally copies of them was permitted to be made. This was joyfully and hurriedly done. The emissary departed with promises of secrecy and large rewards.

Unfortunately for the Germans, the plans which had been copied were those representing the abandoned machinery used in Bessemer's early and unsuccessful experiments. Some years afterwards, Bessemer was in the very town in Germany in which was located the factory from which the deceived agent had come. He was desirous of learning the outcome of his practical joke, and so called on the manufacturers. His reception answered all of his queries, or if it did not, the fact of his being arrested at his hotel a few hours later, on some trumped up charge brought by these same manufacturers, certainly did. And the British consul had no little difficulty in obtaining his release. But Bessemer had his life-long chuckle.

In addition to the several interests already described, Bessemer's ever active mind became busy with other problems, among which prominently figure the invention of a type setting machine, the making of an imitation Utrech velvet, the manufacture of glass, and later sugar. He obtained a number of patents on these lines, particularly the latter. I believe he did not accomplish much in glass making, but some of his sugar inventions and devices, while now abandoned, were at the time successful. This lasted up to 1853, and brings us to the time of the Crimean War. You will recall that was between Russia on the one side and Turkey, France and England as allies on the other. There were many failures and bitter disappointments during its prosecution, and probably in no one direction greater than the utter inefficiency of the heavy artillery of the time. This of course led to many inventions, and prominent among them we find those of Bessemer. It is interesting to note that the same era first brought the historic names of Krupp, Armstrong, Pallister, and Whitworth into prominence.

Probably Bessemer's most striking artillery invention was a fully worked out plan of a breechloading automatic gun, using the force of the recoil to operate automatic apparatus to perform the functions of opening the breech, loading and firing. The gun was never built and was intended as a smooth bore, but seems to have been the first one designed on automatic lines, utilizing the power of the recoil. This patent was dated August, 1853. While seeking to perfect the designs of heavy cannon and projectiles for them, he realized the inadequate strength of the metals available for the guns. Cast iron and bronze had well known strength limits, but too low, and another and stronger material was necessary.

Now how to obtain a stronger material. Fairbairn had experimented with melting wrought scrap iron and pig iron together, but with only partially successful results, and with evidently a principal trouble resulting from performing the smelting process in direct contact with the fuel, and thus having the metal absorb the sulphur from it. So Bessemer sought to devise a furnace in which only the products of combustion would come in contact with his charge. He built an air furnace with a hearth, or fire grate proportionately much larger than its crucible or bath; he also introduced air jets back of the bridge wall, which separated the burning fuel from the bath of metal. This with the view of increasing and controlling the combustion. He employed a bath of metal pig into which he added pieces of blistered steel made from pure Swedish charcoal iron.

He obtained a patent which may be called the foundation of a subsequent long series of patents on iron and steel. It was issued January 10, 1855, and entitled "the manufacture of iron and steel."

This furnace was built in England, and from it he obtained some good results, but I expect, also some disappointing ones, because he said, "*some* of the samples of metal I produced by this process were, when annealed, of an extremely fine grain and great strength."

He made a small model of a gun from some of the material which turned up so well, and the turning chips from which were so ductile, he decided to take it to Paris and show to the Emperor, who was so favorably impressed that he gave Bessemer permission to erect a furnace at the government fountry at Ruelle.

Bessemer ordered proper brick from England and arranged the necessary details. But before its erection an accidental observation during the making of a heat in Bessemer's English furnace caused his mind to follow a different channel, and ultimately led to his invention of pneumatic or as it is called, Bessemer steel. Bessemer described this accidental observation as follows: "Some pieces of pig iron on one side of the bath attracted my attention by remaining unmelted in spite of the great heat of the furnace, and I turned a little more air through the fire bridge, with the intention of increasing the combustion; on again opening the furnace door, after an interval of half an hour, these two pieces of pig iron remained unfused. I then took an iron bar with the intention of pushing them into the bath, when I discovered they were mere thin shells of decarbonized iron, thus showing that atmospheric air alone was capable of wholly decarbonizing pig iron and converting it into malleable iron without puddling, or any other manipulation. It was this that gave a new direction to my thoughts, and after due consideration, I became convinced that if air could be brought in contact with a sufficiently extensive surface of molten crude iron, the latter would rapidly be converted into malleable iron."

Bessemer's idea was that by blowing air through molten pig iron, he could decarbonize it down to the desired point and there stop. So he could sometimes, but not every time. There were also mechanical difficulties whose importance he did not then appreciate.

Following the excitement which his process produced, he sold a number of licenses to manufacture under his patents, realizing from them in one month thereafter some $135,000.

His premature action was one of the few business mistakes of Bessemer's career. As already stated, his process was yet undeveloped and bitter disappointments came to his licenses. He was most soundly condemned as a Charleton and a swindler, and no doubt had an unhappy time. But he was equal to the occasion, and was spurred on to greater efforts and spent not only the money first received, but that which he had previously accumulated, in overcoming the difficulties, and perfecting his invention.

But others were also at work on the same lines. In Sweden Goron Frederick Goransson, one of that country's brightest and most energetic iron masters, took the matter up, and discovered that the regulation of the blast pressure and volume of the same had much to do with the success of the process. Akerman says in his exhaustive report on the "State of the Iron Manufacture in Sweden, Stockholm, 1876:" "The Bessemer method of refining has been used in Sweden from its first origin, and it is even doubtful if this process, now of so extraordinary importance, would ever have been developed, if Herr F. Goransson had not immediately after the publication of the patent, applied himself with such determination to carry out exhaustive experiments with it. For, thanks to the raw material employed, which was poor in phosphorus and in other respects of specially good value, a completely satisfactory Bessemer product was obtained at an earlier period in Sweden than in England, and the condition of success so important for this process, that only materials poor in phosphorus are suitable for it, was ascertained."

I have said that Bessemer's original idea was to decarbonize the bath of molten pig iron down to the desired point and there stop, but he found it to be impossible to always regulate the stopping, at any particular point. Mr. Robert Mushet, of the Forest Steel Works in England, investigated the matter and solved this great chemical trouble by carrying on the process until practically all the carbon had been burned out of the charge, and then adding enough carbon to give the desired result, and at the same time adding manganese in a metallic form, which from its affinity for oxygen would unite with the oxygen of the burnt iron present in the bath, thus restoring such iron to a metallic state, and so taking away the red-shortness which had been so fatal to the sound working of the metal. By this invention the Bessemer process became practical.

Mr. Mushet was granted an English patent on September 22, 1856, but so little did he realize its value, that being financially depressed, he allowed it to lapse in the third year. Fortunately for him, he had taken out an American patent, dated May 26, 1857, from which, owing to our laws being better calculated to protect inventors, he received some pecuniary reward. And honor is due to Bessemer for having, after his own enrichment, settled on Mushet an annuity of £300. The British Iron and Steel Institute awarded Mushet in 1876, their Bessemer gold medal.

The first steel rail made, was by Mushet early in 1857, at the Ebbwvale Iron Works. He obtained some metal which had been desiliconized and decarbonized by the Bessemer process, and remelted it in the ordinary crucibles used for melting cast steel, putting forty-four pounds in each; to which, when melted, he added two pounds of melted spiegeleisen. He cast some ingots of about 500 pounds each in weight, and from one of them had a double headed rail rolled. This was put in the track of the Midland Railroad, at a point where iron rails had lasted but a few months. This steel rail successfully withstood the passage of over one and a quarter million of trains, during some eighteen years of service.

By the way, the first American Bessemer rails were rolled at the North mills of the North Chicago Rolling Mill Co. on May 24 and 25, 1865; the steel having been made at the experimental Bessemer Works at Wyandotte, Mich. There were but a half dozen of them, but the rolling was perfectly successful.

The real commercial manufacture of steel rails in America began at the Cambria Works, Johnstown, Pa., from steel made in the Pennsylvania Steel Company's Works, Harrisburgh, Pa., in August, 1867.

Percy relates that, had it not been for an accident, most likely Bessemer would have lost the honor of his discovery. In October or November, 1855, two or three months before the issuing of Bessemer's first patent, George Parry, of the Ebbwvale Iron Works, fitted up the hearth of a reverberatory furnace with a series of pipes in which many holes had been drilled. Plugs were inserted in these holes, and the pipes carefully covered with refractory material, which was dried, the resulting cracks filled up and then the plugs withdrawn. This system of pipes was connected with the blast from a blowing engine, the furnace brought up to a high heat and a charge of melted iron run into it, the blast having been first turned on. By some accident a leak occurred in the furnace, before the process had continued very long, and the metal ran out on the ground. Mr. Perry wanted to make another trial, but the proprietors of the works objected, and so Bessemer's glory was saved to him.

Owing to the bad reputation of Bessemer and his process, it became necessary for him, if to succeed at all, to start works of his own. This he could not do in a large way, owing to limited means, so he succeeded in raising about $60,000, subscribed as follows: Himself and the Longsdon, who married his sister-in-law, $30,000, W. & G. Galloway, $25,000, and his other brother-in-law, W. D. Allen, $2,500.

During all this period of struggle and doubt, the latter was Bessemer's trusted assistant and ally. These works were started in Sheffield in 1858. But they did not at first attempt the manufacture of Bessemer steel, as it is now known. The metal was blown in a small turning converter, and of course the charges of metal were small. After the decarbonization of the metal, it was poured into a tank of water, which had the effect of granulating it. This was afterwards melted in crucibles with an addition of the proper percentage of manganese. The product was used for tool steel purposes. It was probably on June 18, 1859, that the first heat of direct steel was made at these works. They made money very fast from the very first, and their success had given the steel a place in the commercial world.

We will not follow the details of the perfection and introduction of the Bessemer process in England, further than to say that no doubt the Swedish success played an important part in making it easier for Bessemer, and stating that up to the time of the lapsing of his English patents, he received during a part of the time, not less than $1,000,000 per year in royalties. Not all of this was his absolute property, as he had to divide with those who had assisted him during his troubles, but much the largest portion went to him.

In America, William Kelly, of Eddyville, Ky., where he was operating a blast furnace, experimented somewhat on the same lines Bessemer had been following. These he conducted not only at his own plant, but also that of the Cambria Iron Co., Johnstown, Pa. He had many failures, some partial successes, and also undoubtedly part of the time followed the published reports of what Bessemer was doing in England. In fact he erected at Johnstown, a small rotating converter very similar to Bessemer's early one, and I think copied from their print in his patent papers, which derived its blast from the engine furnishing the blast for the iron works foundry cupola. Its workings were not successful, principally because of insufficient blast pressure. But it was the first Bessemer converter built in America, and is today a cherished relic at the Cambria works.

Bessemer received American patents in February and August, 1856. Kelly received United States patents in January, June, November and December, 1857. Kelly claimed priority over Bessemer and the patent office allowed this claim by granting his patents; thus leaving an interesting case for the lawyers and courts.

We will not go further into the history of the Bessemer process and industry in this country, than to state briefly that ultimately the American interests which had secured his American patents both on process and machinery, and the parties who had acquired the Kelly patents, which were all on the process, and Mushet's American patent, united their interests by the formation of a joint company. We did not have "Community of Interests" in those days.

Bessemer could not be idle, so the later years of his life were spent in leisure industry. He built a fine observatory at his country residence, and constructed a telescope on original lines; also experimented on the utilization of solar heat to produce high temperatures and had recourse to many other intellectual ways. He died in his 86th year. He was a man of fine physique, and up to the very end of his life was blessed with magnificent health.

The history of the Bessemer process cannot be given without reference to Alexander Lyman Holley, our American engineer, who did more than any other one man toward making the manufacture a world-wide success, or at least toward making it the great economic success it is today. Holley was convinced of its commercial possibilities while the question was yet an open one. During a visit to England in the Autumn of 1862, he was so greatly impressed with the importance of Bessemer's invention, and was so certain of its successful future, that, upon his return to the United States, he induced Messrs. John A. Griswold and John F. Windslow, of Troy, New York, to join him in purchasing his American patents. But it was not until the spring of 1864 that the negotiations were brought to a satisfactory conclusion. He at once again returned home and began the erection of a 2½ ton experimental plant at Troy, N. Y., for the firm of Windslow, Griswold & Holley. In it the first heat of steel was made February 15, 1865.

I have mentioned the Kelly American patents, and that they as well as Mushet's American ones, had been acquired by other parties. They had erected an experimental plant at Wyandotte, Mich., and in it a heat of steel had been made in the fall of 1864, under the direction of Wm. F. Durfee. Hence the honor of the first heat of Bessemer steel in America belongs to the Wyandotte works.

As I have told you, the rival interests were finally consolidated, this after several years of litigation; and from that day the progress of the manufacture in America was very rapid. Holley became the representative engineer, and was in one way or another connected with nearly all the works built. He made numerous mechanical improvements, in fact Americanized the whole thing.

In addition to Bessemer, I have named Mushet, Goransson and Holley, as men who gave to the Bessemer process its great success. That such was a fact is true history.

Bessemer's character was a rugged one. His mind clear, powerful and conquering. He was of the material from which conquerors have ever been formed. The attainment of his end the one object. Quick to see and appreciate the smallest thing bearing on his quest, and equally rapid to assimulate and use it as his own. I do not mean that he was absolutely dishonest or dishonorable, but to him his own individuality was the greatest thing on God's footstool, and to it all things belonged. Still he must have been loyal to his friends, because the Allens, Longsdons and Galloways and he were firm friends and allies from first to last. But, and here is the point in Bessemer's character, the weakness in it, for which I feel sorrow and regret, almost amounting to contempt. During the years of his life after his great triumphs, he was a frequent writer, but never a line or word did he give one iota of praisė or acknowledgement to either of the three men named by me. It is true he settled on Mushet an annuity of $1,500 a year, but Mushet's invention had saved him from absolute defeat and disgrace. And I believe Mushet would rather have had an admission of his part in the great invention than the money.

Goransson has passed away since Bessemer, a successful, honored man. He did not require Bessemer's praise, but how graceful it would have been if one laurel leaf from the conqueror's wreath had been placed upon his brow. It would not have marred the beauty of the wreath, and would have ennobled the giver.

Bessemer contributed several papers to American technical societies. On the walls of the house of one, of which both were members and Holley had been President, both of their portraits hang, Bessemer's presented to the society by himself; Holley's given by his friends. But even Holley's name was never given in any of Bessemer's ego contributions. Holley did not need his praise. His, as well as Bessemer's achievements will ever speak for themselves, but more than that Holley died as the loved friend of every human being with whom he had ever been associated. Bessemer died leaving a great name, a great fortune, but mourned by few. Which the most to be admired? Which was the greater?

# RIVER GAUGING WITH ROD FLOATS.

By Geo. W. Brown, B. S. '86, C. E. '90.

The young engineer, just out of school, particularly if that school was so located as to afford him no practical experience in hydrography, is apt to feel very lonely upon receiving a wire from his chief directing him to gauge the flow of a certain river. To supply him by next passing steamer, with a current-meter and its accompanying paraphernalia, does not add materially to his composure. Besides, the meter may not have been used for several months and is not accompanied by a table of rating. Then, to make matters worse, there may not be within a day's journey of his camp a larger expanse of still water than is contained in the converted pork barrel serving as camp cistern.

Given the time, our young adapter of nature's laws would rate his meter in a running stream, and then with it would determine the velocity of the stream itself; all with a considerable degree of accuracy. But in these days, except in the public classified civil service, no delay can be allowed for these approximations. Not only must the stream be gauged at once but the results must be reported without delay. Our young friend soon collects himself and, after spending about as much time in preparing other appliances with which to do the work as he would in repacking the meter outfit for return shipment, he proceeds to gauge the stream with rod floats. The chances are that he will find the work, as well as the reductions, so simple that for river gaugings, under ordinary conditions, he will use rod floats in preference to a meter, even if it be supplied with a most satisfactory certificate of character. The accuracy of his results will not be materially less than of those obtained by the use of a modern current-meter.

It is not to be doubted that within the years since '86 was turned loose upon a long-suffering public, the engineering department of the University of Wisconsin has added to its appliances and facilities for hydrographic investigations. That class did its stream gauging upon the bosom of the raging Yahara, at one of the railroad bridges in East Madison. A meter of the Ellis type was used. We rated it in the lake just west of the university grounds. Its constants were both so large that, while it rotated feebly in the strength of Yahara's flood, a large percentage of the flow passed by unchallenged in other portions of its section. So we guessed at the discharge, and the work was done. The experience we acquired, except in the matter of guessing, was of a negative character.

It is often desirable to determine, on short notice, the flow of a stream. One cannot be expected always to have a current-meter at hand. To accomplish the result with a considerable degree of accuracy, and with such appliances as almost any locality affords, is the problem. At the risk of saying much with which the reader is already familiar I give in detail a method of stream gauging by use of rod floats, with an outline of the reductions.

The example given is that of gauging the French Broad River, near Asheville, N. C., in November, 1896. The place chosen was a fairly straight section of the river, and reasonably free from the influence of obstructions. This being a mountain stream of small depth and steep slope, a place was chosen where the water was deep and the local slope light. At that stage, which was considerably above low water, the river had a surface width of about 350 feet. A base-line 200 feet in length was laid off on the right bank as near to the water and as nearly parallel to the main thread of the stream as practicable. Three sections or ranges were laid off at right angles to the base-line at either end and from middle point, and were marked by range flags on either shore. The sections were sounded with a 12 foot pole shod at lower end and graduated to feet and tenths from a boat rowed slowly across the stream and against the current, upon the marked range. The soundings were taken as nearly as possible at equal intervals, and were located in the following manner. With transit set at intersection of base-line and range, and with stadia rod held in boat abreast of sounder, the stadia distance was read off direct. In lieu of a stadia, a level rod might have been used for this distance; but either should be inverted in order that one wire of the instrument might be kept at the zero point of the rod. Not much practice is required to catch distances at a glance with a considerable degree of accuracy. With a recorder at the instrument, every sounding may be located; but with a reasonably regular bottom the location of every alternate sounding will suffice.

One foot to five foot rod floats had previously been prepared and adjusted to differ in submerged length by six inches, having each a freeboard of about two inches. The rods were of white pine, 1½ inches in diameter, and were weighted by lead pipe of some external diameter fitted at the lower end. Final adjustment for submersion of rod was made with shot held in the lower end of the pipe by a plug. The rods were fitted with a staff of No. 10 wire, some of 8 inches long, carrying a flag some 6 inches square, by means of which the rod could be kept in view. Any light material, or a section of tin pipe, might be used for a float, and it might be ballasted with an iron bolt. Whether its length is an even unit or if it projects a considerable distance above the water, is immaterial, so long as it is not affected by the wind. It is not necessary to have so many rods, or that they float so near the bottom of the stream, so long as we have the data for reducing from rod velocity to mean velocity, through wide variations. The writer has gauged a stream of 800 feet in width and from 3 to 15 feet in depth with only four lengths of floats.

In the French Broad gauging, in question, the rods were run across the ranges about every 30 feet, or as near that spacing as it was convenient to place them without undue delay. From inspection of sections the longest rod was started, in each case, which it was presumed would float without touching bottom. If a particular rod struck bottom the flag announced that fact, the observation was cancelled, and a shorter rod started. With transit on base-line at upper section, and with stadia rod held in boat as for sounding, the boat was placed in the approximate thread of the stream some 15 or 20 feet above the range. The float was dropped from stern of boat and started on its trip. The second of crossing the upper range line was noted, and recorded. The stadia distance to the boat, which was made to follow the rod only as far as this range, was then noted. An assistant preceeded the rod to the lower range, 200 feet away. As it approached that range he called out "stand by" and at the instant of crossing he called "mark;" the time being noted and recorded. The rod being followed by the transit, its angular position with reference to the base line, at the instant of crossing the lower range, was determined. At the signal from shore the rod was picked up by the boat and returned to its starting line. To facilitate the recovering of the rod a light linen or silk line was made fast to its upper end and paid out freely from the boat, which was kept well above and to one side of the rod during its run.

All of the notes of this survey, not given in the first six columns of Table I, below, are shown graphically upon the accompanying diagram. The basis of the diagram is a plan of the base-line and the ranges, with the water lines of the river. With the range lines as water surface lines, cross sections of the river were constructed from the sounding notes. Sections of the river at upper, middle and lower ranges are shown by the polygons U u u U′, M m m M′ and L l l L′, respectively in light full lines. The paths of the 12 floats were platted from notes in columns 3 and 4 of Table I. It will be noticed that all of the floats, in this particular case, inclined more or less toward the base-line; showing that line not to have been located parallel to the average thread of the current. This, or any reasonable inclination of float paths, does not effect the accuracy of the results obtained; since the increased distance run is inversely proportioned to decreased perpendicular distance between their paths. The depths of the stream, perpendicularly below the intersec-

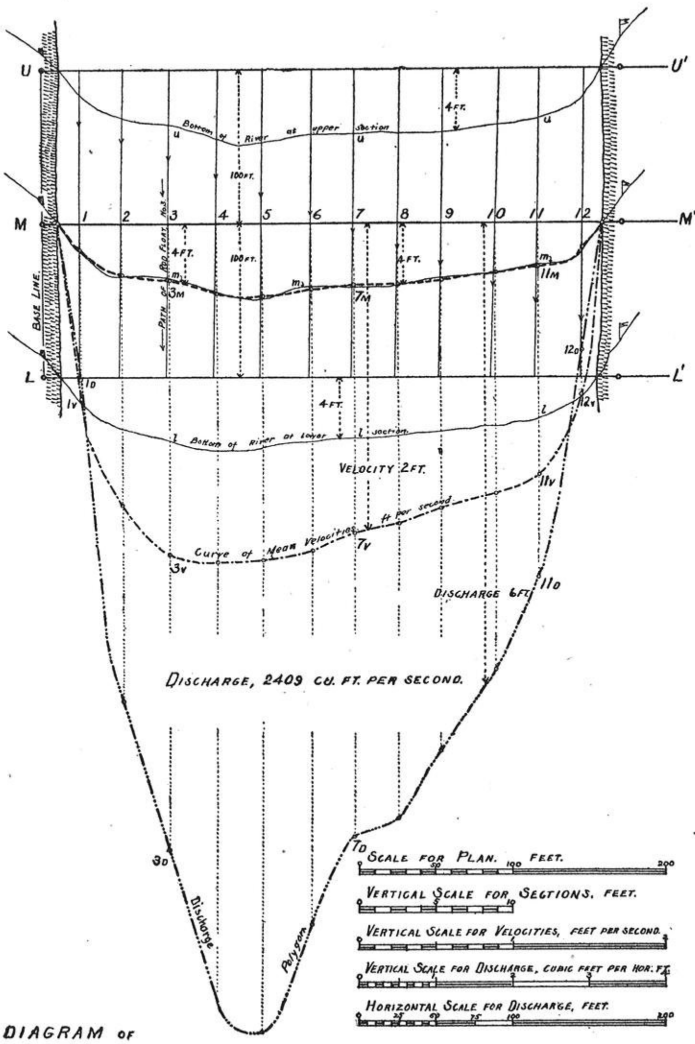


DIAGRAM OF
RIVER GAUGING WITH ROD FLOATS.
FRENCH BROAD RIVER, NEAR ASHEVILLE, N. C.
November, 1896.

Brown, 1902.

tion of each path with the range lines are then scaled, and a fourth cross section is constructed on the middle range, from depths which are the weighted means of the depths at the three intersections. This mean depth is taken as $\frac{1}{4}$ the sum of the upper depth, the lower depth and twice the middle depth. This mean section is shown by the polygon M 3M 7M 11M M′; in a dashed line, thus: ------, and these depths are entered in column 9 of table. The time of passage of floats over this 200 feet stretch of river is then deducted from the difference between columns 5 and 6 of table, and entered in column 7. The velocity of float in feet per second is then computed and entered in column 8.

This brings us to a consideration of the reduction from the velocity of the rod as run, to the mean velociey of that thread of the stream from the surface to the bottom. The accompanying formula for such reduction is that given by Mr. Francis, in his Lowell Hydraulic Experiments:

$V_m = V_r\,[1-0.116\,(\sqrt{D}-0.10)]$., in which

$V_m$=mean velocity for full depth;

$V_r$=observed velocity of rod float, and

$D = \dfrac{\text{depth of stream below bottom of rod,}}{\text{depth of stream}}$ or

D=the percentage of the depth of the stream which is below the bottom of the rod.

The above formula is strictly true when the bottom of the rod is approximately 5 per cent. above the bottom of the stream, and should not be used without modification when it is more than 10 per cent. above the bottom. The writer has made experiments to determine what modification could be used in such cases. In a stream some 12 feet in depth, 5 rod floats ranging from 7 to 11 feet in length were dropped into the same thread of water, from a boat anchored in the stream at a point above the upper range, and some 2 or 3 seconds apart. The passage of these rods across the ranges was noted and recorded. The rods were picked up by a second boat, returned to the starting point, and were run over and over again, in order to eliminate local effects, as far as possible, and to secure a mean velocity for the thread of the stream. The mean of the several observed velocities for each float was taken as the mean velocity of the stream for the depth to which the float extended. Such a modification of the Francis formula was required that the mean velocity for the full depth might be determined from the mean velocity of the shorter floats. It was found that within the range in question, that is when the distance below the bottom of the rod was no more than a third of the depth of the stream, the value of $V_m$ would be given, with a great degree of accuracy, by substituting a variable for the quantity "0.10" in the last term of the formula. This term was found to increase algebraically about one per cent. for every one per cent. increase in the value of D. With the term "—0.10" correct when D equals 5 per cent, the terms within the parenthesis will vary as follows: $\sqrt{.05}-0.10$; $\sqrt{.10}-0.05$; $\sqrt{15}-0.00$. $\sqrt{.20}+0.05$: $\sqrt{.25}+0.10$; $\sqrt{.30}+0.15$; $\sqrt{.35}+0.20$. In the 0.20. In the French broad gauging the values of D varied from 7 to 33 per cent. and the consequent corrections to $\sqrt{D}$ varied from +0.18 to —0.08. These corrections are given in column 10 of table. The corrections to $V_r$ is given in column 11, and the value of $V_m$ in column 12. In column 13 is shown the discharge for one foot in width of stream, in cubic feet per second; the product of the mean depth (col. 9) by the mean velocity (col. 12).

With the middle range line of diagram as a base the various mean velocities are platted in vertical ordinates immediately under the intersection of that line by the corresponding floats. These points being connected with each other and with middle range at shore lines (as shown in dash and dot line), gives the curve of mean velocities. Upon the same base line, and with a convenient scale, volumes of discharge (col. 13) are laid off in vertical ordinates, and being connected with each other and with base line gives a discharge polygon, the area of which, interpreted by proper scales, gives the discharge of the stream in cubic feet per second. It will be observed that, in a general way, the mean velocity and discharge polygons are parallel to the

TABLE I.

| Number of float. | Submersion of float—feet. | Distance from base line at intersection of upper range—feet. | Angle at U between base line and float at its crossing of lower range. | Time of crossing upper range. | Time of crossing lower range. | Time of float in drifting with current 200 feet—seconds. | Velocity of float in feet per second, equals Vr. | Mean depth of water in path taken by float—feet. | Correction "—X" to be applied to "$\sqrt{D}$" in formula. | Correction from rod velocity (Vr), to mean velocity (Vm). | Mean velocity (Vm) of vertical film,—feet per second. | Volume of discharge for one foot in width of stream,—cubic feet per second. | Number of float. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | 1.5 | 25 | 6 35 | 10 11 03 | 10 13 49 | 166 | 1.20 | 1.8 | +.02 | .95 | 1.140 | 2.052 | 1 |
| 2 | 3.0 | 53 | 13 53 | 18 06 | 19 50 | 104 | 1.92 | 3.4 | —.03 | .96 | 1.843 | 6.266 | 2 |
| 3 | 3.5 | 84 | 21 36 | 24 09 | 25 40 | 91 | 2.20 | 3.8 | —.07 | .98 | 2.156 | 8.193 | 3 |
| 4 | 4.0 | 115 | 28 57 | 30 05 | 31 32 | 87 | 2.30 | 4.6 | —.02 | .96 | 2.208 | 10.157 | 4 |
| 5 | 4.0 | 144 | 35 16 | 36 52 | 38 13 | 86 | 2.32 | 4.8 | +.02 | .95 | 2.204 | 10.579 | 5 |
| 6 | 4.0 | 175 | 40 50 | 44 50 | 46 22 | 92 | 2.17 | 4.3 | —.08 | .98 | 2.127 | 9.146 | 6 |
| 7 | 3.5 | 203 | 44 58 | 50 47 | 52 23 | 96 | 2.08 | 4.0 | —.02 | .96 | 2.000 | 8.000 | 7 |
| 8 | 3.5 | 233 | 49 02 | 56 46 | 58 25 | 99 | 2.02 | 4.0 | —.02 | .96 | 1.939 | 7.756 | 8 |
| 9 | 3.0 | 264 | 52 14 | 11 03 41 | 11 05 23 | 102 | 1.96 | 3.7 | +.04 | .95 | 1.862 | 6.889 | 9 |
| 10 | 3.0 | 295 | 55 31 | 11 18 | 13 08 | 110 | 1.82 | 3.3 | —.06 | .97 | 1.765 | 5.824 | 10 |
| 11 | 2.5 | 326 | 58 04 | 17 54 | 19 52 | 118 | 1.70 | 2.8 | —.04 | .97 | 1.649 | 4.617 | 11 |
| 12 | 1.0 | 352 | 60 13 | 25 22 | 28 06 | 164 | 1.22 | 1.5 | +.18 | .91 | 1.110 | 1.665 | 12 |

curve of mean depth. The area of the discharge polygon can be determined with planimeter, or from cross section paper, or it can be computed directly.

The field work of the gauging in question began after 8 o'clock in the morning, and was finished at 11:30 A. M., by a party consisting of a chief, a recorder, one boatman and two helpers. The work was reduced and platted and the results obtained by the chief of party and his recorder in less than an equal length of time.

Three or four gaugings of a stream at low, mean and high stages, will afford a diagram by which its discharge may be determined for any reading of the river staff. For stream gauging, this method affords sufficient accuracy, since the uncertainties of the volume thus obtained are very much less than the uncertainty of the particular stage of the stream, with reference to its high, low or medium stage.

The method of stream gauging with rod floats is better adapted to deeper than to shallower streams, to a limit of 18 or 20 feet in depth; and is applicable to widths up to 800 or 1,000 feet. Rod floats are also adaptable to tidal streams of reasonable depths, but the methods of use and of the reductions are not so simple as in the case given.

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## THE MANUFACTURE OF FARM TOOLS.

H. J. Thorkelson, B. S., 98; ME., '01.

*Ass't Sup't, J. I. Case Plow Works, Racine.*

The experience, particularly of the last century, has taught us that the work of the world is more expeditiously accomplished by dividing and subdividing it so that each part is done by men, trained to do that particular part.

It is the purpose of this brief article to call attention to that part of the world's work which consists simply in making the tools necessary for the economical and expeditious production of our farm crops.

We do not know what tools Cain devised to assist him in tilling the soil, but there is no doubt that the first farm tools made were for the purpose of assisting man's unaided efforts to cultivate the ground. Such tools as the spade and the hoe were doubtless among these early implements, but as soon as man succeeded in subjugating some of the wild animals and training them to do his bidding, they were used to assist in preparing the soil for the seed.

The plow is one of the earliest farm tools that we have any knowledge of and has a most interesting history. It is recorded that Elisha was plowing in a field when he was called to be Elijah's successor and as early as the seventh century B. C. iron shares were in use. We are indebted to the Romans for the invention of the moldboard, but even to this day, in Armenia and other eastern countries, crude iron pointed sticks without a moldboard are used for plowing.

During the early history of our nation, it was customary for the pioneer farmer to construct his own tools, such as drags, rollers, etc., and to seed, cultivate and harvest by hand. The construction of the plow, however, was usually intrusted to the village blacksmith, and many a moldboard has been shaped over the log of a tree.

Some of these blacksmiths speedily developed a reputation for the plows they made, and as the demand for their plows increased, they commenced to increase their facilities for manufacture and in this way many of the large implement factories of today were started.

Different localities and soils require different plows and some manufacturers make over 300 kinds of walking plows alone to suit this varied demand.

As these factories have increased in size they have also increased the line of implements made to meet the ever increasing requirements of the farming industry until now, almost all so called "plow" factories manufacture riding and walking plows, tooth, disc and spading harrows, seeders, cotton and corn planters, stalk cutters, listers, cultivators of all kinds, etc.

But our plow factories form only a single branch of this great industry and manufacture but a few of the many farm tools now considered necesssary on every modern farm.

Besides "plow factories" there are "harvester works," "threshing machine works" and a countless number of different factories, each having its own line of farm tools.

The harvester is a comparatively modern invention and yet so large has been the demand for this tool that although several factories are engaged in its manufacture, one of them employs 9,000 men to supply the ever increasing demand for its goods.

It is customary for harvester companies to manufacture grain and corn harvesters, binders, reapers and mowers and some harvester companies have a still larger line of tools.

The manufacture of threshing machinery, including boilers, traction engines, separators, stackers, weighers, self-feeders, tanks, horse powers and all the necessary appurtenances for threshing, not only wheat but rice, peas and beans, constitutes a very important branch of the farm implement business, but it is unnecessary to further enumerate the different factories or the branches of this important industry.

The output of these implement factories is enormous, in fact, if all the tools made at a certain plow factory last year were placed in a line with a team hitched to each implement and they were driven close together the parade would reach from Chicago to the City of Mexico, a distance of 1,500 miles.

It is difficult to realize the need of the enormous amount of farm tools made until we look at the size of our immense crops.

The average annual crop in the United States is 600,000,000 bushels of wheat, 800,000,000 bushels of oats and 2,000,000,000 bushels of corn. A crop the size of which is difficult to realize.

A more graphic discription of one of these crops will probably enable us to better realize the significance of these figures.

In 1900 we had 83,000,000 acres of corn under cultivation. This would make a cornfield five miles wide around the world and 5,000 miles lap. The product of this great cornfield was

2,105,000,000 bushels. If this crop was all put together it would fill a bin 50 feet high, 400 feet wide and 250 miles long, Allowing 600 bushels to a car it would require 3,508,333 cars to move it, which with the engines required to haul them would make a train that would encircle the earth.

One of the large farms in this country located in Iowa produced in the year of 1898, 215,000 bushels of corn, 20,000 bushels of wheat and 28,000 bushels of oats. This farm contains 6,000 acres of land and the property alone is valued at $180,000. The value of the farm machinery necessary to operate this farm is $17,773.98. From this it is not difficult to imagine that a great number of plows, listers, harrows, planters, cultivators and harvesters, representing an enormous investment, are necessary to produce the great crops of this country.

We are accustomed to think of farm implements as comparatively crude in design and inefficient in operation, but this is not the case. A properly constructed walking plow, when correctly adjusted would seek a certain depth and turn over a furrow of uniform width, if it had no handles but was simply pulled across a field.

A riding plow will pull one-third lighter than a walking plow, doing the same amount of work and carry the plow man besides.

A check row corn planter when properly operated will plant a field of corn depositing the seed every 3′ 4″, 3′ 6″ or 3′ 8″ as the case may be, as accurately as if equally spaced parallel lines were drawn across the field, and another series of similar lines drawn at right angles to the first series, and the seed planted at the intersections of these lines.

These check row planters generally deposit three kernels of seed for each "hill" as it is called. Indeed one of the largest corn growers in Iowa has figured that if but one kernel is deposited, the hill is partially lost, three kernels will bring a profit, while five kernels will bring a loss; and to secure this necessary accuracy requires machinery of superior design.

The three wheeled "listers" used in Kansas and its neighboring states, will plow the ground, loosen the subsoil, plant and cover the seed, and press the ground firmly on both sides of the kernels at one operation.

The modern traction engine has a "differential gear" which communicates power from a pinion on the engine shaft to both driving wheels, but at the same time permits either wheel to turn faster than the other, as is necessary when turning a corner.

The knotter on a harvester is a device very simple in construction, but almost human in operation.

Naturally considerable study is given to the improving and perfecting of the different farm tools made and indeed most factories keep a corps of experts constantly engaged in experimenting on new improvements and simplifying old constructions. The results of this constant improving of farm implements was clearly shown in the patent office exhibition at the World's Fair in 1893. Here were shown models of the first harvester made and of the latest, the former being heavy and cumbersome in appearance and having many times the machinery that the latter had.

The work of this department of an implement factory is most interesting, for whenever a new branch of agriculture, as the beet-sugar industry, has attained any prominence, it is necessary to design a new line of tools to meet the requirements of the new industry, and such designing necessitates a knowledge of the culture of the article raised, the requirements of the trade, the present "state of the art" as far as inventions are concerned and the facilities of the factory for manufacturing.

In these implement factories considerable attention must be given to reducing the cost of manufacture to a minimum and to do this, a large part of the different castings must go from the foundry direct to the assembling room with no machine work whatever. This requires considerable skill in pattern making and a thorough knowledge of molding. This need has brought the moulding machine up to its present state of perfection.

All wrought iron and steel parts must duplicate to a nicety and the expense of making patterns, dies, jigs and templates is enormous.

Many ingenious methods are devised to combine quality with economy in manufacture. The requirements of the more difficult soils of Iowa and the northern states have produced the "soft center" steel used on plows for these sections. This steel is about one-fourth inch thick and consists of three distinct layers of steel; the outer layers being capable of hardening so as to impart the necessary scouring qualities to the plow, while the inner layer cannot take a high temper and hence imparts the necessary strength to the metal without which the steel would be as glass.

To still further reduce the cost of manufacture, special machines must be built, and it is surprising to see the automatic machinery in use in our large implement factories.

In the painting department of a modern agricultural factory, pneumatic hoists are used for dipping the implements into large vats of paint. They are then hung up on trolleys, striped, dipped in varnish and put on trolleys again. In fact in some implement factories the implements do not leave the trolley from the time they enter the paint shop until they are deposited in the cars or warehouse.

In order to secure the confidence of the trade and to maintain a uniform standard of excellence, our large implement factories have thoroughly equipped testing laboratories for making exhaustive tests of all raw materials purchased and chemical and physical tests are made each day of the iron cast to see that it is up to the required standard.

With proper facilities for manufacturing and an economic system of handling the material, it is not unusual for our plow factories to manufacture every day an implement for each man employed. An impossibility without an elaborate subdivision of the work done.

The manufacture of farm tools is indeed a large and important industry, but it seems destined to attain a still larger growth.

During the first eleven months of the last year, the value of our farm implements exported was $16,094,598, and if this trade is not hindered by adverse legislation it should certainly grow still larger, as the opportunities for trade with Russia, Africa and South America increase. Senator Beveridge, speaking of the possibilities of trade with China, says that: "The producers of America, who are 5,000 miles nearer these markets than any of their competitors will ultimately have a Chinese commerce of $100,000,000 a year."

If this prophecy should become true, a portion of this immense export trade will certainly fall to the producers of farm implements, increasing this already large industry enormously.

It may encourage some of our engineering students who are interested in that branch of the world's work which is alloted to our manufacturing industries, to repeat the words of Dean Johnson in his address to the students last fall. He says: "We are about to become the world's workshop and a competition grows sharper and as greater economies become necessary, the technically trained man will become an absolute necessity in the leading positions in all our industrial works."

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## THE DRAFTING ROOM.

EMERY H. POWELL, '91.

The drafting room should be and generally is a well lighted room, each draftsman having his own drawing table near a window. The tables are plain pine drawing boards of good size, perhaps 3x6 feet by 1.5 inches, placed on two wooden horses of a convenient height. Stools accompany each drawing table. There is a large filing case whose top forms a large table on one side or in the middle of the room, for storing drawings, blue prints and tracings. Many a drawing office has a fire proof vault with suitable drawers in which tracings are filed.

Blue printing may be done in the drawing room or in a separate room. The blue print room will have one or more blue print frames which can usually be moved on a track to a good sunlight spot. A tank or bath large enough for the largest print, running water, a drying rack, suitable place to keep blue print papers and tracings, and a table on which to cut paper and trim blue prints will also be provided in this room.

The supplies that go with a drafting room are blue print paper, detail paper, tracing cloth and paper, pencils, pens, ink, erasers, tablets, and generally T-squares are furnished. The draftsman must bring scales, triangles, compasses, etc.

A draftsman usually works from eight hours a day to fifty hours a week, and is allowed two weeks vacation with full pay during the dull season, usually the summer or early fall. He is paid by the day, week or month and no matter which method is used to estimate the price, he will receive his pay once every week or else once every two weeks. Some draftsmen are kept on when times are dull and others are laid off, and more taken on when times are good and shops are full of work. It is not considered a good plan to change draftsmen, because one's efficiency depends upon his familiarity with the work in that particular office. There is more or less routine work in any calling in life, and the draftsman's is no exception.

The technical graduate looking for a place to start and having no previous practical experience is fortunate to get a start in a drawing office at $10 a week; it will probably be less. He will probably be started at tracing, which may be humiliating unless he remembers he is there to learn and while doing his work to the best of his ability must keep his eyes open to what is going on about him. Some system of standard size drawings and methods of filing them will be the first thing to learn. He will learn how blue prints are made in this office from the blue print boy, as each office has some special regulations. It may be that they allow no one in the blue print room besides the blue print boy and those who have the confidence of the head of the department. There may be certain records kept of tracings to show where they are and to make the blue print boy or draftsman responsible for them while in his possession. This same rule may apply to any one using a tracing even when not taking it from the room. The blue print boy may also be required to keep some record of prints to furnish the cost department.

There may be a book-keeper for the drafting room to look after the card catalogue and other records of the office. Every draftsman who hopes to become a head draftsman should have definite ideas of the card catalogue. He should know how it is used in libraries, and how to adapt it to drafting room needs. In connection with the card catalogue, a book is kept in which the tracings are numbered consecutively and a full record of every drawing, date, draftsman making it, and other data are kept. The card catalogue has much the same record or at least enough to tell where to find any tracing and enough about it to be sure that it is the one wanted.

In many small drafting offices the tracing is done by the draftsman who does the designing and makes the drawing. In such cases he can save a great deal of time on the pencil drawing by omitting dimensions, notes, etc., things that he can put in on the tracing without having them on the drawing. If it goes to a tracer it would be necessary to make the drawing sufficiently complete to be understood by the tracer and to put in dimensions on the pencil drawing when he wants them on the tracing. It will also be necessary for him to indicate the cross-sections and kind of metal, and make notes of other data on the drawing, placing them so that the tracer shall get them in the right relation. While it is to be remembered that this takes more of the draftsman's time on the drawing yet there may be and in well regulated drafting rooms will be some saving, because the tracer's time is not worth so much as the draftsman's.

A good draftsman should command $25 a week and a first-class tracer can be had in large cities like Chicago or New York for $15. These are not top prices, yet they are above the average at times. The pay of draftsmen in general fluctuates as the demand and supply of the market. At the present time these may be said to be average prices in Chicago. The man, however, who considers the pay the principal part of his job will be apt to advance less than he who forgets salary and works for experience, doing his best all the time. He will soon learn how much he should receive and will, if his judgment is good, find no trouble in getting full value.

Perhaps something should be said here about methods of making drawings and tracings. There is considerable of a trade to good tracing. Probably most offices use the imperial tracing cloth with one dull and one smooth side, tracing on the smooth side. Many, however, trace on the dull side and, to my mind, it has some advantages. Tracings are generally kept in large flat drawers and if the tracing is made on the glazed side and laid in the flat drawers right side up for easy reference they soon begin to curl up at the corners and edges which soon causes them to get creased and ultimately spoiled. When the tracing is on the dull side and the tracings are put in the same drawers right side up this curling is prevented, the tracing always lying flat and smooth and in good condition for the printing frame.

Another and important reason is that the dull side takes the ink better and erasures are made just as well and show less when done. It undoubtedly wears out the pen faster but it will admit of a finer line. There is more lint on the smooth side than the dull side and greater care must be exercised to prevent the ink from blotting. A grade of imperial tracing cloth is made with two glazed sides and it would seem that by the use of this at least the first objection raised might be overcome, but you will seldom find it in use even in offices where they do not use the dull side for drawing work.

It is now becoming popular in some offices at least to black in the cross sectioned parts with a pencil and smearing or rubbing the lead around with a soft rubber. This takes off the black that would come off easily when the tracings rub together and gives the part a smooth, even color. The best results are accomplished by the use of a soft pencil rubbed carefully all over the parts to be cross sectioned and then rubbed in by an elastic rubber band about one-eighth inch wide stretched over a stick sharpened to a wedge and slightly rounded.

While speaking of cross-sectioning the old method of using parallel lines may be made very rapidly by the use of a suitable section liner. The most simple instrument of the kind is shown in Fig. 1, which may be made by any one from a piece of hard wood about the thickness of the triangle. Cut out a space so that the triangle used shall just have enough motion from end to end, to make lines the right distance apart. The fit of the triangle and liner need not be the whole length but may be cut away as shown. By having a different length space on the opposite side

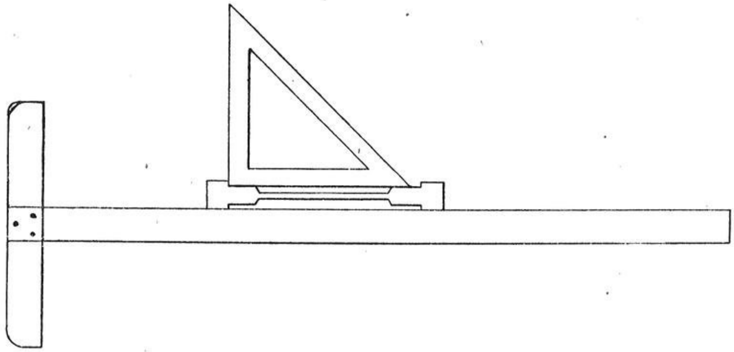

Fig. 1.

of the liner, one may have a fine and a coarse section which will be sufficient for most drafting work. If more variety is desired the instrument can be made with adjustment. By placing the liner on a T-square, then moving first the liner, then the triangle, and drawing a line, you get the result. A little practice enables one to work faster and do better work than with any other instrument or than without using this liner. There are many patent contrivances offered by the firms selling drafting instruments, but none of them are so easily operated or give such satisfactory results.

One objection raised to the blackening process is that it is impossible to show different parts when next to each other. This is less of an objection in actual practice than it at first appears, because it is becoming more common to detail each part by itself, even to showing bolts and screws separate from the other parts. Wherever bolts and screws can be specified by a note, as "$3\frac{1}{2}$," rough bolts A "long with hex nuts" it is better than trying to draw them out. It must always be remembered that clearness is the prime factor in a drawing. In machine shops where the work is of a high class, I mean where there is a large percentage of skilled mechanics and there is considerable fitting and finishing, there the drawings will be scale drawings and usually the scale will be 3″ to 1 ft., $1\frac{1}{2}$″ to 1 ft., $\frac{3}{4}$″ to 1 ft., 8″ to 1 ft.; and where it is necessary to lay out plans of machinery showing their relation to one another and to the building, e. g., in laying out power connections or pipe work, the scale will probably be $\frac{1}{4}$″ or $\frac{1}{8}$″ to 1 ft. Special drawings are sometimes made for the pattern maker and they are always full size. Enough detail will be shown to give a clear and accurate idea of what is expected. If every operation is indicated and all parts show on the drawing it will save a good deal of time somewhere else.

Dimensioning tracings should be done with considerable care and there is no reason why all the figures should not read from one direction, although the dimension lines may have various directions. Fractions should always be made with the bar horizontal as $\frac{1}{2}$, $\frac{3}{4}$, $\frac{13}{16}$ and not inclined as $^1/_2$, $^3/_4$, $^{13}/_{16}$, etc. The figures that look best on a drawing are the vertical as given in Rhenhart's "Lettering for Draftsmen, Engineers and Students." Probably the best letters for shop drawings are the inclined shown in the book above referred to, but for map work and civil engineering drawing the vertical is preferred by many. Dimension and witness lines are made with a dot and a dash and the center lines with two dots and a dash. This is an arbitrary standard but seems to have the preference. Dots are made about $^1/_{16}$″, spaces $^1/_{16}$″ with dashes $^1/_2$″ long. A poor drawing that is well dimensioned and neatly lettered will look better than a good drawing poorly dimensioned and carelessly lettered; therefore a draftsman must practice freehand lettering.

Many offices will have a standard form of title which can readily be applied to any tracing. Sometimes it is put on freehand; sometimes with a stamp. One of the best applications of the stamp is made by using heavy black ink and a metal stamp, but good results are obtained by using a rubber stamp with thin ink. This is best done by rubbing soapstone dust on the tracing cloth first, then stamping with ink, applying lamp black lightly with a brush, and when thoroughly dry clean carefully by striking it quickly with a small clean rag as one might in whisking off dust.

In getting out the original drawings the draftsman may have a sketch to work from or he may have only a few notes giving him the idea of what he has to work up. It is a very convenient thing to retain these notes and sketches for future reference as the draftsman is apt to be blamed if the results are not what was expected, even if he did not design the device in question. He must be able to calculate accurately the weight of metal in a casting or forging, must know the strength required and be able to calculate strengths of materials so as to get the parts proportioned correctly. He must know whether the pattern is one that will draw from the sand and should know what cores are necessary. He should also know what machine work is to be done on the part and should design it so that it can be done most expeditiously. He should be familiar with all the tools in the shop and have an idea of what can be done on each. He should know all the standards in the shops, standard parts, fittings, jigs, bolts, screws, etc. It would be rather bad for a draftsman to design a piece 84″ in diameter when the largest that could be handled was 80″ o rto lay out bolts on a circle with 49 bolts when there was a standard jig of the same size circle for 48 bolts. There are many things he must know and he is therefore generally allowed to go to any part of the shop seeking the information he will need in his work.

The drafting room is where the most of the engineering work is done, except in large shops where there is sometimes a separate engineering department. There is more of a demand for technical training in the drafting room than there used to be. One evidence of this can be seen by looking over the want columns of "The Engineering News," American Machinist" and other engineering papers. There are very few old draftsmen; it is rare that you will see a draftsman over forty years of age. Perhaps as the country grows older this may change, but there must be some other reason why there are not more now. There is probably no work as confining as drafting, and so men are inclined to look for other engineering work than drafting, yet there is no place in a shop where a man can get such a complete idea of an engineering business in so short a time as in the drafting room. Some drafting experience is necessary to all engineers, but a large amount of drafting experience may be detrimental. A broad experience covering as many lines as possible is what is wanted rather than too much time spent on one trade. The best engineering education is the one that makes a man the closest observer and develops the power of describing the most interestingly and accurately. The draftsman who has these qualities well developed and can manage men will not remain a draftsman very long. There are a great many lines of work that a draftsman may be called on to do, besides making drawings. He may be sent to measure up a building, to arrange machinery and power connections, or he may be called on to look over an apparatus, to make suggestions for improvements and afterwards be called to get up the design and drawings of the new machine. He may be sent out to estimate on a certain plant, or to look after the erection and tests of machinery. In fact he may be called upon for any engineering work that the firm employing him needs.

In some drafting rooms one man spends his whole time looking over new drawings and checking the figures on them. The checker is preferably a man familiar with all the lines of work done in that office, and after a drawing is traced the tracing goes to the checker who goes carefully over all the work and indicates all the mistakes to be corrected or changes necessary. The drawing then goes to the original draftsman who looks over the corrections and if they should be made has them made by the tracer; if not he fights it out with the checker.

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## OIL BURNING.

H. B. Gregg, '92.

The essential equipment for the successful burning of crude oil in locomotives consists of

1st—A tank fitted with necessary valves and piping for storing, regulating and conducting the oil;

2d—A burner that will properly atomize it;

3d—A jet of steam or air for atomizer;

4th—A firebox containing proper brick work, and having ashpan with suitable openings to admit air for combustion.

To convert an engine from coal to oil burner, remove grates and grate frames and apply ashpan with suitable plates or castings that will form support for brick work, and having properly arranged air openings, with dampers to regulate the supply of air.

### THE BRICK WORK.

This usually consists of a lining of brick on the bottom of the box, a wall at the front of the box built against the flue sheet, but occasionally from six to twenty inches back, thereby forming a combustion chamber in front of arch; and an arch, shown in illustration, supported on side walls. These walls extend around the box and form protection for mud ring rivets. In some engines, however, the arch brick are supported on studs, in which case the side walls extend up only to sufficient height to protect mud ring rivets, the front wall in both instances being carried up to arch. The brick arch should be built as low as possible in order to protect crown sheet, crown bolts and rivets from overheating.

In arrangement shown special attention is called to the comparatively low arch; to the bottom of the box sloping away from burner, so that broken pieces of brick falling down will not lodge in front of the burner and divert the flame; and to the location of air openings, these being so arranged that the air for combustion is admitted into the lower pan through dampers, passes up through air inlets and into the firebox directly underneath the arch, thus being heated before coming into contact with the firebox sheets and flues.

The burner is bolted or clamped to the mud ring or bottom plate in center of box, and set at an angle so that the oil spray will be directed just below or under the arch. Burners in general may be classified as inside and outside atomizers. In the first class the oil and atomizer are mixed inside the burner, while in the second the oil and the atomizer do not mix until after leaving burner. With some burners it is necessary to have a heater box, while others are made with heater and burner combined. In illustration is shown a separate heater box fastened to frame with necessary piping. In this arrangement the piping and valves are so connected up that live steam can be used to blow out the oil pipes, either out through the burner or back through the oil tank.

It has been found by experience that a rigid pipe connection between heater box and burner causes the burner to get out of adjustment, due to the expansion and vibration of the pipe. To overcome this difficulty a piece of hose is put in the oil pipe line near the burner as shown. The steam for the atomizer and also for the heater is taken from a tee connection in the blower pipe. This pipe branches, one line going directly to the burner for atomizer and the other through heater box to heater coil in oil tank on tender. The valves for atomizer and heater, also handle for the oil regulating valve, are located on left side of engine convenient for fireman.

The fire door is fitted with clamp to hold same tightly closed. It has a hole in center with escutcheon plate and wing nut. This aperture is for *sanding* the flues, which is done occasionally on hard pulls should engine have tendency to lag for steam.

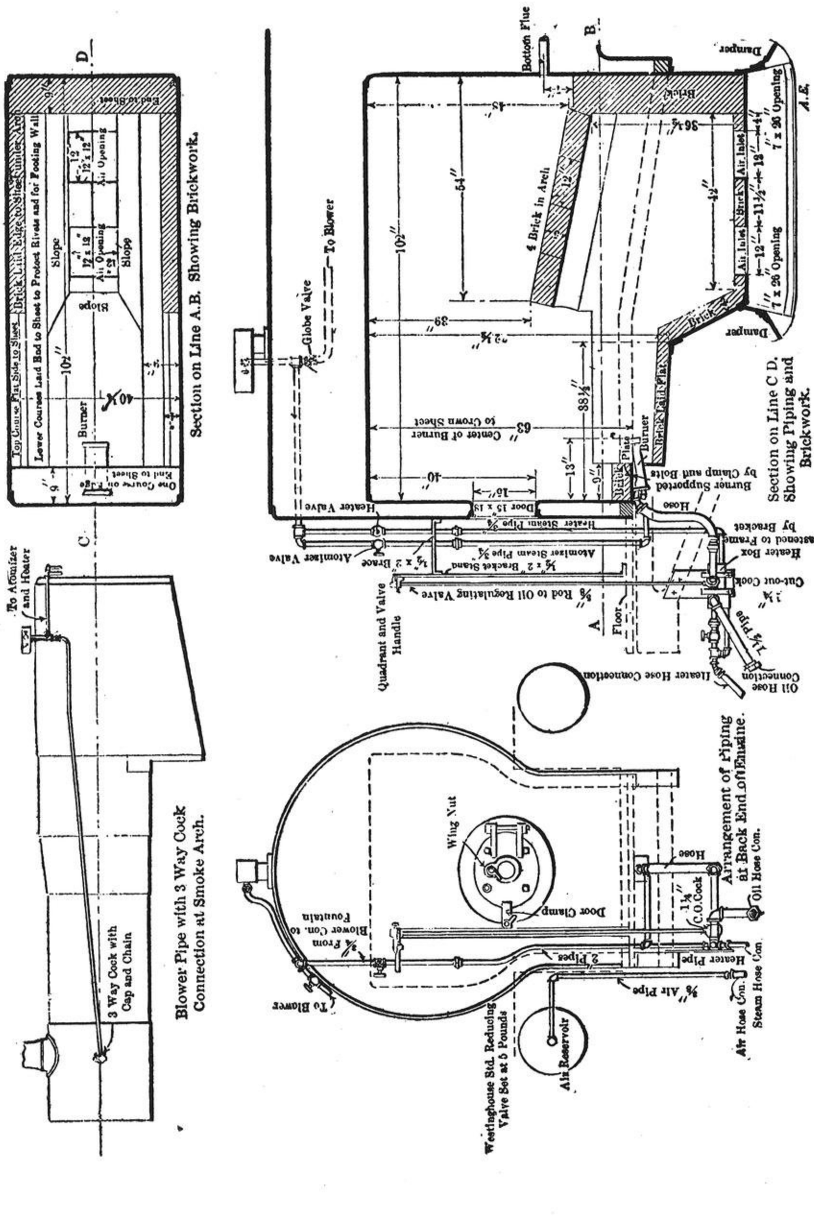


**Fig. 1.—Firebox, Brick Work and Piping.**

This method is very effective in cleaning the gum off the flues, and is only used three or four times going over a division. The sand is applied through an elbow-shaped funnel made for the purpose. When sand is being applied by fireman the dampers are closed and engineers drops reverse lever down a few notches, in order to make the sand more effective. The sand supply is carried in a box located on tender. Another method for sanding flues is to have sand box located up in cab or on boiler with pipe leading to aperture in fire door, the sand being fed into firebox by means of an air jet.

An important change in the usual front end arrangement of a coal burner when engine is equipped for oil is the removal of all netting and plates. The danger from sparks with oil fuel being practically ,eliminated, the front end arrangement consists of only the exhaust nozzle, petticoat pipe and straightor choke stack.

A special three-way cock, forming blower pipe connection to smoke arch, is used in firing up engines in round house or where steam or air can be obtained. The three-way cock can be turned so that a part of the steam or air goes up the stack for draft and a part back to the burner to atomize the oil.

### TENDER EQUIPMENT.

The oil storage tank—illustrated—consists of two tanks connected, built to apply to a standard coal burner engine tank. The lower occupies the coal space, while the upper extends over water tank. The two tanks combined have a capacity of between eight and nine tons of fuel oil. The lower tank is equipped with heater coil—illlustrated—for heating oil to proper temperature. Some, however, do not consider this coil necessary, but recommend heating the oil by blowing steam directly into it. The latter method is much quicker, but as water in oil is very objectionable the heater seems preferable, as with it the condensed steam cannot mix with the oil.

The safety appliances consist of a pop valve set at five pounds, an air gauge, an air vent valve and two automatic safety valves.

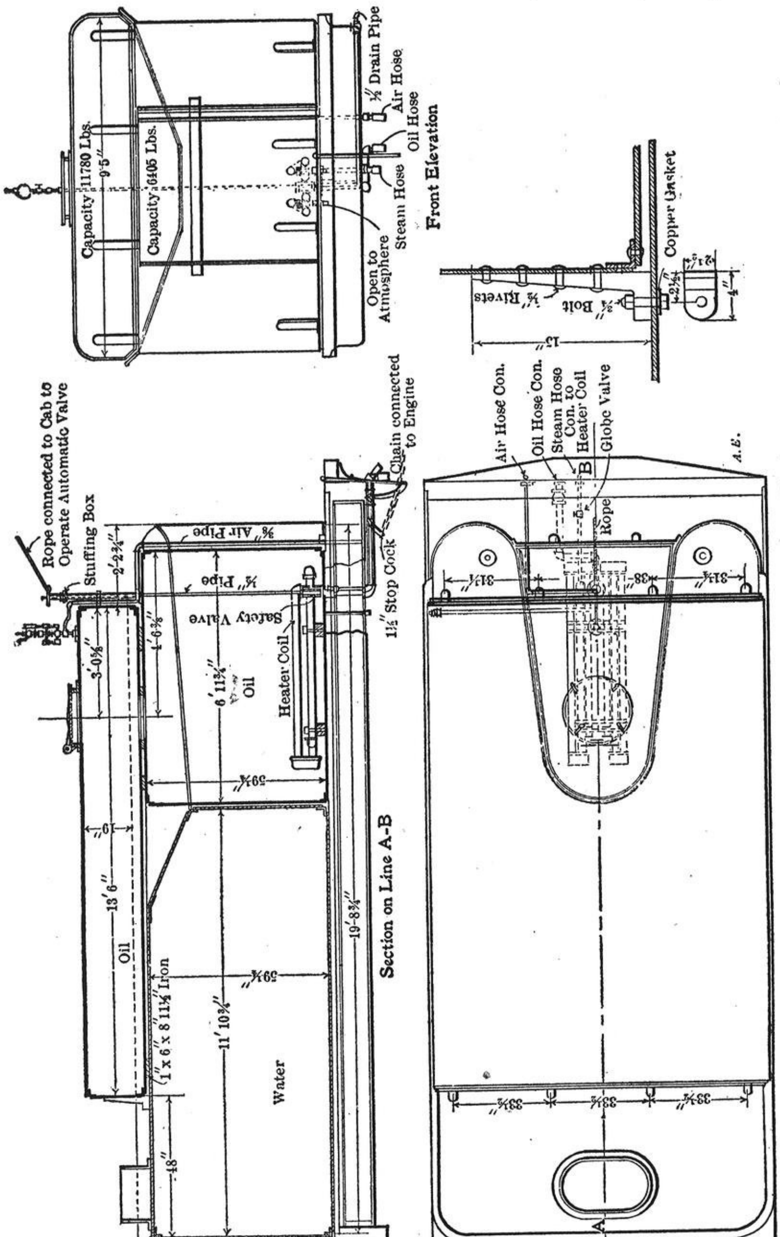


**Fig. 2.—Tender, Oil Tank and Piping.**

One of these (see detail) located in the bottom of tank in the oil outlet has stem extending up through top of tank and stuffing box, and is held in open position by an eye pin passing through stem. This pin is connected to back of cab by a small wire or rope, which in case of break-in-two between engine and tender pulls out the pin, when valve closes automatically and stops the flow of oil. The other safety valve is in outlet oil pipe between tank and burner and is also connected to engine by chain, which in case of break-in-two automatically closes it. This valve is also used to shut off oil while engine is standing in round house with fire out, it being operated by rod extending up through deck.

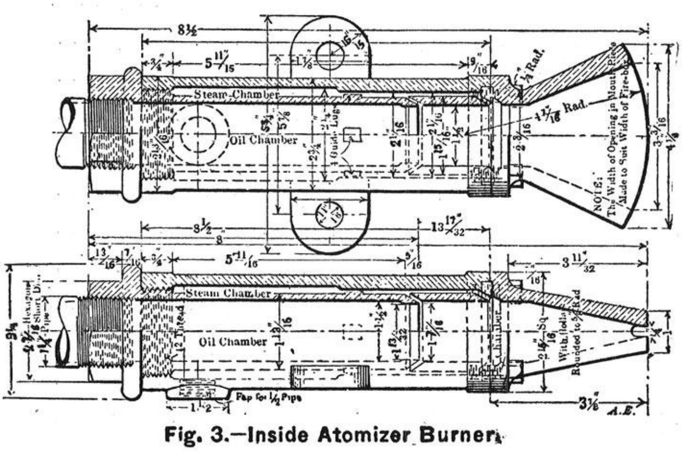


**Fig. 3.—Inside Atomizer Burner.**

A Westinghouse reducing valve adjusted to five pounds is used in the air line between air reservoir on engine and oil tank. It is sometimes necessary with heavy oil to carry about five pounds air pressure in oil tank to maintain a uniform flow of oil to burner.

With new equipment it might be preferable to use a combination oil and water tank in which the oil tank is wholly surrounded by water except on the bottom. This style is safer, but in it the oil is subjected to the cooling effect of the water surrounding it, there being only a single sheet of metal between the two.

Following is detailed statement of cost of labor and material in changing 20"x26" ten wheel engine from coal to oil burner.

| | |
|---|---|
| Oil reservoir, drilling, tapping, putting in place and securing same | $21.60 |
| Automatic valve | 3.90 |
| Heater in oil tank | 5.20 |
| Heater pipes | 1.20 |
| Reducing valve | 4.54 |
| Air pipes | 6.30 |
| Burner | 3.10 |
| Heater box | 3.00 |
| Heater hose | 1.40 |
| Oil hose | 2.15 |
| Stop cocks | 1.53 |
| Regulators | 2.16 |
| Atomizers and pipes | .95 |
| Brick walls and brick arch | 42.25 |
| Oil pipes | .55 |
| Erecting,—blacksmith, machinist and laborers | 32.50 |
| Removing coal burning device | 3.00 |
| Building and placing ash pan, and material | 14.75 |
| Sand box and funnel | 2.50 |
| Pop and air gauge | 5.06 |
| One set of oil tanks, consisting of two tanks | 174.83 |
| | $332.46 |

In the safe handling of oil caution must be used in oiling and firing up engines and in examining and repairing empty tanks. In oiling up engines at night do not approach manhole of tank with lantern or torch for ascertaining amount of oil in tank. In firing up engines never open oil valve before throwing lighted greasy waste into firebox, being sure same is burning when oil valve is opened. Do not enter tank for the purpose of examining and repairing same until oil has been drained and the tank washed or steamed out.

In firing up an oil burner, where steam can be had for blower and atomizer through connection to three-way cock on smoke arch the fire is started by throwing a lighted piece of greasy waste into firebox, then opening atomizer valve and starting oil lightly. After steam forms in the boiler it can be used for atomizer and blower in the usual way. Where no steam or air is available for atomizer the fire must be kindled with wood until enough steam has been formed to work atomizer.

To a fireman used to shoveling ten or fifteen tons of coal into a firebox in going over a division the work of firing an oil burner seems comparatively light, but to keep a uniform steam pressure and a clear stack necessitates close attention, for a

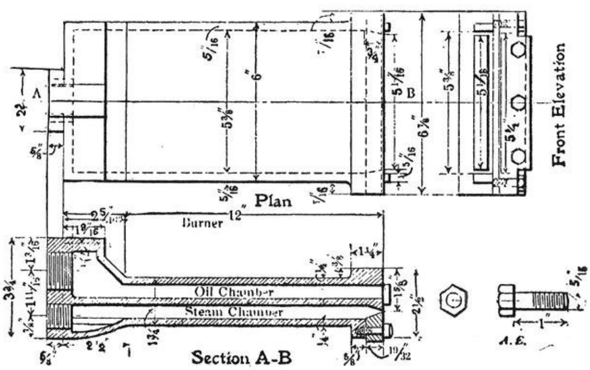


**Fig. 4.—Outside Atomizer Burner.**

change in position of the throttle or reverse lever, or difference of speed, usually requires a readjustment of valves regulating the supply of oil and atomizer to burner. In stopping at stations or when drifting the fire is cut down by moving the regulating valve handle up against the adjustable stop on the quadrant (see illustration). This stop is adjusted so that when the valve handle is up against it the oil will be just sufficient to maintain a light flame in order to prevent waste of oil, black smoke and engine popping off. The fire should not be allowed to go out while engine is running, as cold air will be admitted into firebox and injure the sheets and flues. The fire going out can be detected by the milky white color of the smoke coming from the stack. Can also be detected by the odor.

Too much care cannot be exercised in keeping a uniform steam pressure, for with an oil burner the steam pressure can be raised almost instantly, and it is this irregular and over-firing that causes sudden contraction and expansion of the sheets, leaky flues, and in some instances melting the rivets off inside of firebox.

As to the road service given by oil burners compared with that of coal burners, the oil burners will usually handle their tonnage better and get over the road with less delay on account of having more steam and requiring no cleaning of fires or front ends. It also requires less time to turn engines at terminals, there being no cinders to care for.

Engines are oiled by means of a crane and spout. Elevated tanks used at small intermediate points. These tanks are also used at terminal stations where the main supply of oil is kept in a large additional tank. The oil is transported from the oil fields in ordinary cylinder tank cars, which are equipped with heater pipes to facilitate unloading. From the unloading pit into which three cars can be unloaded at one time the oil runs by gravity into an underground tank. From here it is forced by air pressure to the elevated tanks or into the main storage tank as desired. At places where no air pressure is available the oil is pumped, except in some special cases where the tracks and tanks are so situated that the oil can run by gravity into the storage tanks.

In issuing oil to engines, tanks are all calibrated and a schedule of capacity calculated for each inch in depth; and depth of oil in tank is measured before and after taking oil and entered on a ticket provided for the purpose. Each fuel station is provided with a copy of schedule of capacity of each individual tank, from which reports of oil issued to engines are made.

In general the comparative cost of handling oil fuel is estimated at 75 per cent. less than coal. It is free from starting fires along the right-of-way or setting fire to equipment, and because of its freedom from cinders and black smoke is preferable for passenger service. The additional cost of repairs to brick work, flues and fireboxes, and consequently their shorter lives, is estimated at 25 per cent. more in oil burning engines than the cost of repairs to flues, fireboxes, grates, stacks and front ends in engines burning coal.

TESTS MADE WITH OIL FUEL.

Below are given extracts of reports of tests made with engines in regular working service:

"Report of tests showing the comparison of coal from Gallup, New Mexico, with oil from the Bakersfield district, as used in locomotives in freight service on the fifth division of the S. F. P. R. R. between Needles and Bagdad, California.

"The engines selected were of the consolidation type with 21"x28" cylinders, 57" driving wheel, 68" boiler. Weight on drivers 144,500 pounds, on truck 17,000 pounds, total engine 161,500 pounds. Steam pressure carried, 180 pounds. In one instance engine 465, a 20"x28" cylinder ten-wheeler, was coupled with a consolidation engine for one trip. On all runs engines were run in pairs (double headers).

"The following method was used to find the amount of coal consumed. Before leaving Needles the engine tanks were coaled up and filled full of water and then weighed. At Bagdad, there being no scales, the coal left on the tank was estimated, the tanks then coaled up from chutes and the coal chute weights taken. Upon return to Needles the tanks were first filled with water and then weighed. The difference between the two scales weights, plus the coal chute weights, gives the total amount used on the round trip. Usually the amount of coal left on tanks both at Bagdad and at Needles was so small that it could be estimated fairly close; in some instances the coal being entirely gone.

"The amount of coal charged to the engines each trip includes that used to fire up or to keep them hot while at terminals. Usually at Needles the engines had to be rekindled, while at Bagdad engines were kept fired up.

"The above is also true of oil burners. The amount of oil charged to engines includes that used to fire up and to keep engines hot while at terminals. The amount of oil used was found from the known capacity of the tanks on the engines.

"In estimating the 'Tonnage Hauled' and 'Car Mileage' the water car carrying water for the engines is counted one load and its tonnage included. The way car is figured at 16 tons, but is not counted in the number of cars or the car mileage.

"Three empty cars are figured as equivalent to two loads. Under column 'Time on the Road' is included time between leaving and arriving at terminals. 'Running Time' includes only the actual time train was in motion. 'Delayed Time' includes all time taken up for stops of any kind.

"From the tests in road service it was found that between Needles and Bagdad the amount of coal burned in hauling 1,000 tons one mile is 356 pounds and of oil is 159 pounds, and to haul 1,000 loaded freight cars one mile is 11,946 pounds of coal and 5,334 pounds of oil."

"Report of road tests to determine the amount of fuel oil used, ped ton mile and per car mile in freight and passenger service."

Statement "A" is of tests made over mountain division.

From these two statements it is found that the amount of oil consumed per 1,000 ton miles and per 1,000 car miles is as follows:

MOUNTAIN DIVISION.

Oil per 1,000 ton miles, through passenger service, westbound, is 189 pounds; eastbound, 321 pounds.

Oil per 1,000 ton miles, freight service, westbound, is 142 pounds; eastbound, 246 pounds.

Oil per 1,000 car miles, passenger service, westbound, is 7,039 pounds; eastbound, 11,865 pounds.

Oil per 1,000 car miles, freight service, westbound, is 4,349 pounds; eastbound, 7,376 pounds.

No. 2. COAL CONSUMPTION PER TON AND CAR MILE, S. F. P. R. R.—NEEDLES TO BAGDAD.

FREIGHT — WEST BOUND.

| DATE. | Eng. No. | Time on the Road. | Delayed Time. | Running Time. | No. Stops. | Average Speed M. P. Hr. | Ton Miles. | Car Miles. | POUNDS COAL USED. Total used. | Pounds Ton Mile. | Pounds Car Mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-11-01 | 653-685 | 11 hr. 18 min.... | 4 hr. 22 min..... | 6 hr. 56 min... | 7 | 13.21 | 109920 | 3389 | 43100 | .39210 | 12.7176 |
| 4-13-01 | 653-685 | 9 hr. 32 min.... | 3 hr. 2 min..... | 6 hr. 30 min... | 6 | 14.09 | 102684 | 3298 | 42240 | .41136 | 12.8077 |
| 4-17-01 | 643-675 | 13 hr. 12 min.... | 7 hr. 34 min..... | 5 hr. 38 min... | 7 | 16.26 | 110470 | 2840 | 33590 | .30406 | 11.8274 |
| 4-30-01 | 650-677 | 12 hr. 20 min.... | 6 hr. 17 min..... | 6 hr. 3 min... | 7 | 15.14 | 111844 | 3664 | 38970 | .34843 | 10.6359 |
| 5- 2-01 | 650-677 | 8 hr. 45 min.... | 2 hr. 27 min..... | 6 hr. 18 min... | 6 | 14.54 | 109920 | 3298 | 41250 | .37527 | 12.5076 |

FREIGHT — EAST BOUND.

| DATE. | Eng. No. | Time on the Road. | Delayed Time. | Running Time. | No. Stops. | Average Speed M. P. Hr. | Ton Miles. | Car Miles. | Total used. | Pounds Ton Mile. | Pounds Car Mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-12-01 | 653-685 | 7 hr. 17 min.... | 2 hr. 20 min..... | 4 hr. 57 min... | 6 | 18.50 | 107447 | 3023 | 31760 | .29559 | 9.7449 |
| 4-14-01 | 653-685 | 10 hr. 39 min.... | 2 hr. 36 min..... | 8 hr. 3 min... | 5 | 11.37 | 118164 | 3298 | 44250 | .37448 | 13.4172 |
| 5- 1-01 | 650-677 | 10 hr. 48 min.... | 4 hr. 3 min..... | 6 hr. 45 min... | 8 | 13.57 | 141064 | 3939 | 42200 | .29915 | 10.7133 |
| 5- 3-01 | 650-677 | 9 hr. 42 min.... | 2 hr. 25 min..... | 7 hr. 17 min... | 5 | 15.30 | 108322 | 3617 | 45400 | .41912 | 12.5518 |

| | West Bound. | East Bound. | West and East. |
|---|---|---|---|
| Total number ton miles made .................... | 544838 | 474997 | 1019835 |
| Total number car miles made.................... | 16489 | 13877 | 30366 |
| Total pounds coal consumed.................... | 199150 | 163610 | 362760 |
| Average consumption of coal per ton mile.......... | .36552 | .34444 | .35574 |
| Average consumption of coal per car mile.......... | 12.07774 | 11.79001 | 11.9462 |

No. 1. FUEL OIL CONSUMPTION PER TON AND CAR MILE, S. F. P. R. R.—NEEDLES TO BAGDAD.

FREIGHT — WEST BOUND.

| DATE. | Eng. No. | Time on the Road. | Delayed Time. | Running Time | No. Stops. | Average Speed M. P. Hr. | Ton Miles. | Car Miles. | POUNDS FUEL OIL USED. Pounds each Engine. | Total Used. | Pounds Ton Mile. | Pounds Car Mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-16-01 | 713<br>465 | 10 hr. 21 min.. | 4 hr. 45 min.. | 5 hr. 36 min.. | 8 | 16.36 | 93982 | 2840 | 6670<br>7138 | 13808 | .14692 | 4.862 |
| 4-20-01 | 713<br>723 | 10 hr. 50 min.. | 4 hr. 23 min.. | 6 hr. 27 min.. | 8 | 14.20 | 101676 | 3115 | 9093<br>9093 | 18186 | .17886 | 5.838 |
| 4-22-01 | 713<br>723 | 9 hr. 28 min.. | 3 hr. 44 min.. | 5 hr. 44 min.. | 7 | 15.97 | 109920 | 3298 | 10003<br>9942 | 19945 | .18145 | 6.048 |
| 4-24-01 | 713<br>723 | 7 hr. 15 min.. | 2 hr. 29 min.. | 4 hr. 46 min.. | 7 | 19.21 | 107722 | 2840 | 6820<br>8032 | 14852 | .13787 | 5.229 |
| 4-25-01 | 713<br>723 | 13 hr. 25 min.. | 8 hr. 6 min.. | 5 hr. 19 min.. | 13 | 17.23 | 97096 | 3298 | 10533<br>11745 | 22278 | .22944 | 6.755 |
| FREIGHT — EAST BOUND. | | | | | | | | | | | | |
| 4-21-01 | 713<br>723 | 7 hr. 20 min.. | ........ | ........ | ...... | ........ | 110836 | 3298 | 6971<br>7274 | 14245 | .12852 | 4.319 |
| 4-23-01 | 713<br>723 | 5 hr. 43 min.. | 1 hr. 16 min.. | 4 hr. 27 min.. | 5 | 20.58 | 106989 | 3115 | 7959<br>7274 | 15233 | .14238 | 4.890 |
| 4-24-01 | 713<br>723 | 5 hr. 10 min.. | 1 hr. 8 min.. | 4 hr. 2 min.. | 2 | 22.71 | 113126 | 3206 | 6820<br>7730 | 14550 | .12862 | 4.538 |
| 4-26-01 | 713<br>723 | 8 hr. 10 min.. | ........ | ........ | ...... | ........ | 99844 | 2931 | 10608<br>6668 | 17276 | .17203 | 5.894 |

| | West Bound. | East Bound. | West and East. |
|---|---|---|---|
| Total number ton miles made | 510396 | 430795 | 941191 |
| Total number car miles made | 15391 | 12550 | 27941 |
| Total pounds oil consumed | 89069 | 61304 | 150373 |
| Average consumption of oil per ton mile | .17491 | .1423 | .1586 |
| Average consumption of oil per car mile | 5.787 | 4.880 | 5.3335 |

## No. 3. TONNAGE HAULED—FREIGHT SERVICE, S. F. P. R. R., BETWEEN NEEDLES AND BAGDAD.

| Date. | Engine Numbers. | Train. No. Loads. | Train. No. Emptys | Equiv. No. Load 3 Emptys = 2 Loads. | Tonnage. | Stations. | Distance Between Stations. | Ton Miles. | Car Miles. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | COAL BURNERS—WEST BOUND. | | | | | |
| 4-11-01 | 653-685 | 35 | 4 | 37 | 1200 | Needles-Bagdad | 91.7 | 109920 | 3389 |
| 4-13-01 | 653-685 | 21 | 22 | 36 | 1121 | Needles-Bagdad | 91.7 | 102684 | 3298 |
| 4-17-01 | 643-675 | 31 | | | 1206 | Need es-Bagdad | 91.7 | 110470 | 2840 |
| 4-30-01 | 650-677 | 20 | 30 | 40 | 1221 | Needles-Bagdad | 91.7 | 111844 | 3664 |
| 5- 2-01 | 650-677 | 36 | | | 1200 | Needles-Bagdad | 91.7 | 109920 | 3298 |
| | | | | COAL BURNERS—EAST BOUND. | | | | | |
| 4-12-01 | 653-685 | 33 | | | 1173 | Bagdad-Needles | 91.7 | 107447 | 3023 |
| 4-14-01 | 653-685 | 36 | | | 1290 | Bagdad-Needles | 91.7 | 118164 | 3298 |
| 5- 1-01 | 650-677 | 43 | | | 1540 | Bagdad-Needles | 91.7 | 141064 | 3939 |
| 5- 3-01 | 650-677 | 22 | 7 | 27 | 844 | Newberry-Bagdad | 56.4 | 47602 | 1523 |
| 5- 3-01 | 650-677 | 23 | 22 | 38 | 1102 | Bagdad-Piute | 55.1 | 60720 | 2094 |
| Total | | | | | | Newberry-Piute | 111.5 | 108322 | 3617 |
| | | | | OIL BURNERS—WEST BOUND. | | | | | |
| 4-16-01 | 713-465 | 3 | 42 | 31 | 1026 | Needles-Bagdad | 91.7 | 93982 | 2840 |
| 4-20-01 | 713-723 | 28 | 9 | 34 | 1110 | Needles-Bagdad | 91.7 | 101676 | 3115 |
| 4-22-01 | 713-723 | 32 | 6 | 36 | 1200 | Needles-Bagdad | 81.7 | 109920 | 3298 |
| 4-24-01 | 713-723 | 26 | 7 | 31 | 1176 | Needles-Bagdad | 91.7 | 107722 | 2840 |
| 4-25-01 | 713-723 | 32 | 7 | 36 | 1060 | Needles-Bagdad | 91.7 | 97096 | 3298 |
| | | | | OIL BURNERS—EAST BOUND. | | | | | |
| 4-21-01 | 713-723 | 36 | | | 1210 | Bagdad-Needles | 91.7 | 110836 | 3298 |
| 4-23-01 | 713-723 | 33 | 2 | 34 | 1168 | Bagdad-Needles | 91.7 | 106989 | 3115 |
| 4-24-01 | 713-723 | 35 | | | 1235 | Bagdad-Needles | 91.7 | 113126 | 3206 |
| 4-26-01 | 713-723 | 32 | | | 1090 | Bagdad-Needles | 91.7 | 9985 | 2931 |

FUEL OIL CONSUMPTION PER TON AND CAR MILE ON S. C. RY., BETWEEN SAN BERNARDINO AND BARSTOW. "A."

| DATE. | Engine No. | Train No. | Time on Road | Delayed Time. | Running Time. | No of Stops. | Average M. P. Hr. | Ton Miles. | Car Miles. | Total pounds oil used. | Total oil per ton mile. | Total oil per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PASSENGER — WEST BOUND. | | | | | | | | | | | | |
| 10– 2 | 55........... | 1 | 3.06 | 0.13 | 2.53 | 6 | 28.1 | 24898 | 640 | 5141 | .20648 | 7.924 |
| 10– 3 | 55........... | 1 | 2.54 | 0.18 | 2.36 | 7 | 31.1 | 20437 | 568 | 4189 | .20497 | 7.378 |
| 10– 4 | 58........... | 1 | 2.49 | 0.16 | 2.33 | 6 | 31.8 | 20437 | 568 | 3743 | .18309 | 6.591 |
| 10– 6 | 58........... | 1 | 3.02 | 0.11 | 2.51 | 5 | 28.4 | 28236 | 730 | 4574 | .16199 | 6.265 |
| PASSENGER — EAST BOUND. | | | | | | | | | | | | |
| 10– 1 | 55–51........ | 2 | 2.51 | 0.16 | 2.35 | 6 | 31.3 | 23276 | 649 | 8224 | .35332 | 12.671 |
| 10– 2 | 55 S. F. P. 58. | 2 | 2.52 | 0.15 | 2.37 | 6 | 31.0 | 21735 | 608 | 7341 | .33774 | 12.074 |
| 10– 3 | 58–63........ | 2 | 2.46 | 0.16 | 2.30 | 8 | 32.4 | 24898 | 649 | 7911 | .31773 | 12.189 |
| 10– 5 | 58–62........ | 2 | 2.48 | 0.15 | 2.33 | 7 | 31.8 | 24898 | 649 | 6832 | .27439 | 12.527 |
| FREIGHT — WEST BOUND. | | | | | | | | | | | | |
| 9–28 | 246–51....... | 33 | 9.18 | 4.43 | 4.35 | 8 | 17.7 | 84425 | 2595 | 11313 | .13400 | 4.360 |
| 9–29 | 246.......... | 33 | 8.19 | 2.51 | 5.28 | 7 | 14.8 | 72415 | 2510 | 9348 | .12909 | 3.724 |
| 10– 8 | 62........... | 33 | 6.25 | 1.57 | 4.28 | 5 | 18.1 | 37549 | 1180 | 5624 | .14977 | 4.766 |
| 10–10 | 57........... | 33 | 7.03 | 2.05 | 4.58 | 8 | 16.3 | 39354 | 1407 | 5795 | .14725 | 4.115 |
| 10–12 | S. F. P. 138–92 | 33 | 7.20 | 1.41 | 5.39 | 7 | 14.3 | 77311 | 2427 | 11607 | .15013 | 4.782 |
| FREIGHT — EAST BOUND. | | | | | | | | | | | | |
| 9–27 | 246, 62, 93 ... | 34 | 6.34 | 2.06 | 4.28 | 6 | 18.2 | 70881 | 2271 | 15847 | .22357 | 8.978 |
| 9–29 | 246, S. F. P. 92, S. F. P. 58 | 34 | 6.48 | 2.16 | 4.32 | 6 | 17.9 | 55975 | 1935 | 15117 | .27007 | 7.812 |
| 10– 8 | 62–246....... | 34 | 6.23 | 2.20 | 4.03 | 6 | 20.0 | 36657 | 1217 | 8080 | .22042 | 6.639 |
| 10–10 | 90, 62, 59 .... | 34 | 8.14 | 3.20 | 4.54 | 11 | 16.5 | 62447 | 2109 | 15320 | .24532 | 7.264 |
| 10–12 | S. F. P. 138, 53–62....... | 34 | 6.30 | 2.30 | 4.00 | 8 | 20.2 | 43875 | 1460 | 11958 | .27254 | 9.190 |
| | Average for passenger service, west bound | | | | | | | | | | .18913 | 7.039 |
| | Average for passenger service, east bound | | | | | | | | | | .32079 | 11.865 |
| | Average for passenger service, west and east | | | | | | | | | | .25496 | 9.452 |
| | Average for freight service, west bound | | | | | | | | | | .14205 | 4.349 |
| | Average for freight service, east bound | | | | | | | | | | .24638 | 7.376 |
| | Average for freight service, west and east | | | | | | | | | | .19421 | 5.862 |

FUEL OIL CONSUMPTION PER TON AND CAR MILE ON S. F. & S. J. V., BETWEEN STOCKTON AND BAKERSFIELD.

"B."

| DATE. | Engine No. | Train No. | Time on Road. | Delayed Time. | Running Time. | No. of Stops. | Average M. P. Hr. | Ton Miles. | Car Miles. | Total pounds oil used. | Total oil per ton mile. | Total oil per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PASSENGER — WEST BOUND. | | | | | | | | | | | | |
| 10–22 | S. J. V. 201.. | 1 | 7.41 | 1.16 | 6.25 | 28 | 40.2 | 71438 | 1806 | 10031 | .1404 | 5.554 |
| 10–25 | S. J. V. 205.. | 5 | 7.26 | 1.20 | 6.06 | 21 | 42.3 | 39008 | 897 | 7064 | .1811 | 7.875 |
| PASSENGER — EAST BOUND. | | | | | | | | | | | | |
| 10–23 | S. J. V. 201.. | 2 | 7.58 | 1.08 | 6.50 | 29 | 37.7 | 71438 | 1806 | 10611 | .1485 | 5.875 |
| 10–26 | S. J. V. 208.. | 6 | 8.15 | 1.08 | 7.07 | 21 | 36.2 | 39008 | 897 | 7368 | .1889 | 8.214 |
| FREIGHT — WEST BOUND. BAKERSFIELD TO FRESNO VIA HANFORD. | | | | | | | | | | | | |
| 10–29 | S. F. P. 90... | 33 | 6.24 | 1.59 | 4.25 | 10 | 25.1 | 94256 | 2864 | 6485 | .06880 | 2.264 |
| 10–31 | S. J. V. 204.. | 33 | 4.44 | 0.40 | 4.04 | 5 | 27.3 | 131835 | 4203 | 8064 | .09116 | 1.917 |
| 11– 7 | S. F. P. 93... | Ex. w. | 7.05 | 1.40 | 5.28 | 10 | 20.5 | 130871 | 4439 | 7950 | .06074 | 1.791 |
| FREIGHT — WEST BOUND. FRESNO TO STOCKTON. | | | | | | | | | | | | |
| 10–31 | S. J. V. 204.. | 33 | 5.17 | 0.56 | 4.21 | 4 | 28.2 | 143411 | 4432 | 8073 | .05629 | 1.822 |
| 11–16 | S. F. P. 93 .. | 33 | 6.25 | 1.09 | 5.16 | 5 | 23.3 | 141319 | 4555 | 7450 | .05272 | 1.635 |
| FREIGHT — EAST BOUND. STOCKTON TO FRESNO. | | | | | | | | | | | | |
| 11– 1 | S. J. V. 208.. | 34 | 8.40 | 3.02 | 5.38 | 8 | 21.8 | 107922 | 3795 | 10836 | .10040 | 2.855 |
| 11–16 | S. F. P. 93... | 34 | 6.00 | 0.54 | 5.06 | 5 | 24.1 | 60100 | 2263 | 6625 | .11023 | 2.927 |
| FREIGHT — EAST BOUND. FRESNO TO BAKERSFIELD VIA HANFORD. | | | | | | | | | | | | |
| 10–30 | S. J. V. 103.. | 34 | 5.38 | 1.10 | 4.28 | 11 | 24.8 | 87374 | 2654 | 7130 | .08160 | 2.686 |
| 11– 8 | S. F. P. 91... | 34 | 6.58 | 1.55 | 5.03 | 10 | 22.0 | 67954 | 2355 | 8283 | .12189 | 3.517 |
| Average for passenger service | | | | | | | | | | | .1647 | 6.879 |
| Average for freight service | | | | | | | | | | | .07931 | 2.379 |

LEVEL DIVISION.

Oil per 1,000 ton miles, passenger service, east and westbound, 165 pounds.

Oil per 1,000 ton miles, freight service, east and westbound, 79 pounds.

Oil per 1,000 car miles, passenger service, east and westbound, 6,879 pounds.

Oil per 1,000 car miles, freight service, east and westbound, 2,379 pounds.

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## NOTES ON EUROPEAN ELECTRICAL PRACTICE.

H. A. Lardner, 95.

The following notes are taken from letters received from Mr. W. C. Burton, of the class of '93, who is now electrical engineer of J. G. White & Company Limited, in London, England. One of these letters was written after a return from a visit to the factory of the Allgemeine Electricitats Gesellschaft at Berlin, Germany.

ALLGEMEINE ELECTRICITATS GESELLESCHAFT MACHINERY.

The general design of the alternating current generators manufactured by the Allgemenine Company follows very closely the rotary field type of the alternators made by the General Electric and Westinghouse Companies. They are, however, beginning to turn out rotary field machines of large size, with only skeleton frame work to hold the laminations of the armature, instead of the usual cast ring. The laminated core is fastened at points 7 to 8 feet apart and the necessary strength is obtained by a system of truss rods outside the machine. This looks like a very light construction, but a 2000 KW machine was observed running with apparent success. The railway motors manufactured are almost exact duplicates of those made by the Westinghouse Company in this country. Commutator work, insulation and metal work of all kinds are very carefully done.

The armature windings of most of the Allgemeine's electrical machinery are made up almost entirely of wire instead of formed coils. On the armatures of rotary field machines the teeth are practically closed at the top, the opening being not over a millimeter wide and insufficient for the admission of wire. A tube of micanite is put through the tooth opening and the wire windings are threaded in place, a continuous wire being used all the way around the coil. This character of construction gives materially better regulation and efficiency than does the American type of coil winding, but is of course extremely difficulty to repair, as the entire winding must be taken off and rewound if there is a serious burn-out. The wire wound armatures must be materially more expensive to build than the American type, but as machinists in Berlin receive about 80 cents pe day the matter of labor cost is of much less importance than in the United States.

The same results of low wages are shown throughout the shop practice generally. Even in the apparatus works where the meters, arc lamps and similar small material are made there is apparently not a single automatic tool. In the main factory there are some excellent large machine tools, such as boring mills, laths, etc., all of which were made in the United States. Jig work is generally noticeable by its absence. Every railway motor frame is bolted together and set up on a face plate complete, and all of the drillings are laid out separately by dividers. Any one who has seen this class of work being done in the large factories of the United States will appreciate the difference.

In the manufacture of induction motors the rotors are wire wound, as well as the stationary parts, and on account of the coils being completely embedded in the iron with closed teeth the motors are run with extremely small air gaps and a consequently high power factor and efficiency. The electrical characteristics of the Allgemeine's induction motors are excellent, but the cost of repairs and the necessary time for effecting them will necessarily be greater than with the types made in the United States.

The transformer practice of the Allgemeine Company differs materially from American methods. All transformers for polyphase work are polyphase transformers. Transformers were seen as large as 1,100 KW, transforming from 6,000 volts to 280 volts, and 3 to 6 phase, all in a single piece of apparatus. This arrangement of transforming all phases in one transformer is extremely compact and about half of the space is required for the same capacity that would be used with three transformers. Naturally, the difficulty of repair and replacement is materially greater. Practically all transformers are oil cooled.

The switchboards are materially different in design from those used in America, the quality of work being very good but not well standardized. Panel construction seems never to be used, each board being designed independently. An angle iron frame is built up of the required size of the board and marble put on in large slabs, instruments being arranged similarly to the panel construction in sections along the board. Even for direct current low tension work it is customary to allow no live contacts on the front of the board. A table is arranged behind the panels about two feet wide and three feet above the floor level. On this table the switches are placed horizontally both for alternating and direct current work, and are actuated by levers which pass to the front of the board. The switches for high tension work are of a long air break design, oil switches being somewhat uncommon. Very few quick break switches are used. The magnetic blow out circuit breaker is used for direct current work, but fuses only are used for protecting alternating current circuits. Hot wire instruments of the Hartmann and Braun type are used principally for alternating current work and electro-magnetic instruments for measuring direct currents. Instruments are ordinarily sunk through the marble, only the face showing flush with the face of the board. The marble of the switchboard is polished on both sides, and the wiring work is excellently done, all small wires, etc., being clipped tight to the marble.

There are in Berlin six large central stations controlled by the

Allgemeine Company and three of these contain units of 3,500 kilowatts. One of these stations was visited which contained five 3,500 KW—6,000 volt—50 cycle, rotary field machines. Each was driven by a four cylinder triple expansion horizontal engine operating with highly superheated steam. The engines are very compact and the workmanship on them is fine. There were only two men in this large engine room; oiling and everything else which could be, was done automatically. Elaborate coal handling machinery was installed just outside of this station taking coal from canal boats and delivering it in the front of the boilers, but the firing was done by hand.

The cables connecting these six generating stations with the various substations in Berlin are three conductor paper insulated, laid directly in the ground. The secondary distributing system for lighting is 440 volt, 3 wire direct current, and for the tramways 550 volts direct current. Both of these systems are fed from the 6,600 volt alternating current by means of step down transformers and rotary converters. There are also a few motor generator sets feeding the system. Each rotary has mounted upon its shaft, in a manner similar to the starting motors used in America, an alternating current booster by which the pressure can be varied, thus permitting a wide variation of pressure on the direct current side. By this means it is possible to use the same rotary converter for feeding the 440 volt mains for lighting and the 550 volt mains for the tramways. It is possible to use this booster as a hand regulator, and it is therefore particularly satisfactory when the machine is used for lighting service. The rotaries which were of 1,100 KW capacity were apparently running most excellently on 50 cycles, but the manufacturers are not entirely satisfied with them, as they consider this frequency too high for large machines on tramway service.

The storage batteries are of the Tudor type and are used in all of the substations to regulate the neutral for the lighting system, and for regulating. They are seldom used for heavy discharges or peak loads.

## STREET RAILWAY REGULATIONS IN ENGLAND.

The English board of trade testing requirements for street railways are quite unusual and some comments from Mr. Burton on them will be found interesting.

Four records and sets of tests are required and must be regularly made and reported on by all power stations operated with a grounded return.

A continous record must be kept with recording instruments of the drop in potential between the extreme points of all track, and the ground plate in the station. This drop must never exceed 7 volts, and the measurement requires one or more recording voltmeters with a range from 0 to 10 volts arranged with plug over connections, so that they may be connected in series with any one of the test wires running to different points on the track.

A continuous record of the current returned to the negative bus bar by way of the ground plate connection, instead of through the rails, must be kept. It is provided by the board of trade that this current must not exceed, under ordinary conditions, either two amperes per mile of single track, or five per cent. of the total current output of he station. This test requires a recording ammeter continuously connected in the ground connection with a range of zero to at least 5 per cent. of the maximum station output. The amount of current returned through the ground connection is obviously dependent upon a good contact between the ground plate and the earth. In order to insure this low resistance contact it is provided that there shall be in each station two separate earth connections placed no less than 20 yards apart. These connections to be so maintained that an electromotive force of four volts shall suffice to produce current of at least two amperes from one connection to the other through the earth.

The insulation of the overhead lines and of all feeders shall be so maintained that the leakage of current does not exceed 1-100 of an ampere per mile of line, and if this current exceeds ½ an ampere the running of cars must be stopped unless the leak is removed with 24 hours.

In order that the maximum track drop of 7 volts shall not be exceeded, it becomes necessary on tramways with a moderately heavy traffic to locate stations every mile or so unless enormously heavy return feeders are put in. Of course neither of these methods is practicable and boosters in the return track feeders are resorted to. These boosters are ordinarily motor driven series wound generators but are connected between the negative bus bars and feeders running to various points on the track. A sufficient amount of current is drawn back through these feeders by means of the boosters to keep the current flowing through the rails down to an amount which will not produce a drop of over 7 volts. The ordinary method of calculation of pressure to be given by a booster is to determine the total maximum current which will be used in a section of track to be taken care of by the track feeder in question, to then assume a size for this track feeder, limited by its carrying capacity, and put in series with it a booster which will give a pressure equal to the total drop in this feeder when carrying the maximum current. It is obvious that by this means the potential at the outer end of a track feeder will at all times be the same as on the negative bus bar. A large station will sometimes have a dozen or more of these negative boosters connected into the different track feeders all boosting different amounts.

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## MANUAL TRAINING IN HIGH SCHOOLS.

W. A. Richards, '99.

In 1877 Prof. Woodward introduced a system of exercises, copied in part from the Russian exhibit at the Centennial Exposition in Philadelphia. These exercises consisted mainly of the more common joints used in ordinary carpentry and cabinet work and a few exercises in iron to bring out the principles of forging.

Next came the Sloyd or Swedish system, which starts in with a drawing; from this drawing a pattern is made. The wood is marked from this pattern, and then finished. The exercise when completed, is some useful article. The Sloyd is used in this country, mostly in the lower grades.

The third and now most generally used system is a combination and modification of the above, and is the one we use in Milwaukee. The work is spread over four years. One year of joinery and turning, one of cabinet and pattern making, one of forging and foundry, and the last year is spent in the machine shop.

In the wood work we start with a very simple exercise, planing a board to a certain dimension, then marking it off into two nearly parallel curves, so as to form a coat hanger, when the material is cut away to the lines. This exercise brings in the use of the plane, saw and chisel. The next exercise is an elliptical bread board, which brings in the cope saw. At this stage the pupils are competent to join different pieces, and exercises which bring in some of the more simple joints, such as a box or a picture frame, are here introduced, and some joints (mortise and tenor-dove tails, etc.) alone are made.

The joinery covers one semester, then the pupils go to the turning shop. Here the exercises are the same as would be found in any turning shop or school. The first five or six bring in the uses of all the turning tools, while several more are added for practice with a few pieces of face plate and chuck work. All the exercises in wood are either finished in plain shellac or are stained and finished.

At the beginning of the second year the pupils are in shape to start cabinet work. The first exercise is usually a tabouret or some other simple piece, which, after being set up, is filled, stained, shellaced, varnished and rubbed, giving a very good training in the polishing and finishing of furniture before the next and more elaborate exercise is taken up. This second exercise is a book case, table or some other piece, which will occupy the remainder of the semester. Lastly the pattern work is taken up with such exercises as will bring in all the principles of pattern making. As a last exercise a pattern is made, which is to be used later on for a casting, to be finished by these same boys in the machine shop.

The first two years the work is taken up in one hour periods, as it has been found that the pupils at this age get tired at the end of an hour, and that fully as much work is accomplished on the average, in one as in two hour periods. Beginning with the forging, the pupils work two hour periods, and spend the entire year at the work, with the exception of one month devoted to the foundry work.

The forging course is practically the same as at the university, and includes most of the exercises. We start with the simple exercises in drawing out, bending and upsetting, and lead up to welding and work in steel. Each pupil at the end of the year, has a complete set of tools to start with in the machine shop. The writer makes a great deal of ornamental iron work, and has each pupil draw a design for a jardinere, lamp or some other article, and insists that the exercises be made out of iron, heavy enough to need the forge in shaping it.

In the foundry only a few patterns are placed in the sand but with these are taught all the principles of moulding. Plaster of Paris is used to fill the mould, as it acts very similar to iron. A few fancy pieces are made and pounded in lead, which the pupils can keep as souvenirs of their school days in the foundry.

The last year is devoted to machine shop practice. Here the pupils are first given a few exercises to familiarize them with the workings of the different machines. After these exercises have been completed, the construction of a lathe or other exercise where the fitting together of parts makes accuracy a necessity, is taken up and pushed to final completion. As far as possible the pupils are given exercises, which when completed are machinists' tools. These and the tools made in the forge shop, placed in a chest, which can be made as one of the cabinet exercises, forms a nucleus for their future outfit, if they decide to become machinists or engineers.

I have here covered briefly the course followed in our classes. I wish to add that there is room for a great many improvements, and that in my estimation, some of the work is not manual training but trade work. I would have the drawing department and the shop more in harmony. The exercises should be worked out in the drawing room by the pupils, and then taken up in the shop. The pupil can in this way, by making his own design, not only improve in drawing, but also retain all the manual training benefits of a regular standard exercise, and make the work more interesting. I have insisted as far as possible, that the ornamental iron designs be original. This has met favor with the teachers of drawing, and with a few suggestions from her, some very pretty work has been turned out, as the result. When it is not to the pupils' disadvantage in the machine shop, they are allowed to make something for their own use, but an accurate drawing must be made first.

While most of my work is in iron, it is my opinion that the real value of manual training stops with the wood work, certainly with the forge work, and then the technical or trade work begins. Especially is this so in the machine shop. Manual training was introduced and developed to train the eye and the hand at the same time as the mind. This aim is reached in the wood, but when it comes to the machine shop, outside of a very little training of the eye to fine measurements, there is no great amount of manual training in its true sense.

There is another thing of great importance, which should be taught in manual training and is much neglected, perhaps because it is the hardest task we have—neatness. I find it the hardest of my duties, and unless I am continually giving penalties and am ever watchful, some one is sure to leave tools scattered around, and shavings here and there.

I am sometimes asked: "Is manual training here to stay, or is it a fad?" My answer has invariably been, that it is here to stay; providing the school boards will appropriate enough money for its existence. It is an expensive branch to keep up, and it requires teachers, who can ony be found in the engineering courses at our universities. These engineers will not take up the work on account of the small salary, and the fact that there is no chance for advancement. The only other sources of teachers are the trades, and manual training graduates. As tradesmen have not the requirements and qualifications of a teacher, they are barred, and to take a boy just after he has graduated from the manual training course, and ask him to teach the same course, is not good pedagogy. So until the school boards find out that they are in competition with the manufacturers, and look to obtaining and holding engineers, there is danger of the work degenerating into little more than kindergarten work, by introducing into the grades a few exercises in wood.

In closing let me add just a word to the engineering students of Wisconsin, who may be thinking of taking up the manual training work. I could not advise any one to go into the work, unless he felt it his duty to the community and to mankind to sacrifice his prospects of becoming a noted engineer for the fate of a pedagogue, sure to be turned down in old age. It is true that one can make more the first year or two in teaching, but at the end of this time, the engineer in practice goes ahead, while the teacher, if he wishes to change to engineering, will have to start at the bottom, where his brother did.

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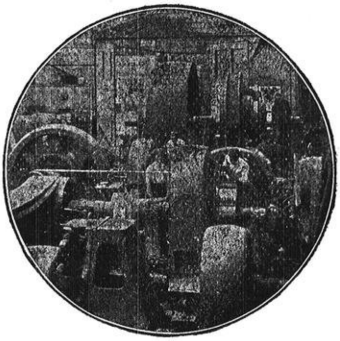
## THE TRAINING COURSE FOR ENGINEERS OF THE GENERAL ELECTRIC COMPANY.*

THOMAS HOWE.



It is my intention in this article to give some idea of the system or course of training employed by the General Electric Company in developing its engineers. A system of this kind has been maintained by the company for many years. While the course is intended mainly to fit men as engineers, it is recognized that those who have had this training possess a superior

*Sibley Journal.

equipment for entering commercial work, and there is consequently a demand for such men in that branch of the business.

Technical graduates and those who have otherwise equipped themselves for the work are admitted to the course and are rated as special employees. There is evidently a preference for the former class of men as the latter constitute a small percentage of those employed.

Until recently the course was limited to the testing department, and heads of departments in need of assistance applied to the head of the testing department for men; but in January of this year a letter was issued by the chief engineer and third vice-president of the company in which he said, substantially, that men to be preferred for advancement to positions in the engineering departments must spend at least one year in the testing department and six months in the drafting room.

In choosing between two men equally qualified, the one of longest training is given the preference.

In all cases of transfer from one department to another, the consent of the heads of departments concerned is to be obtained, and the transfer then submitted to the chief engineer of the company for approval.

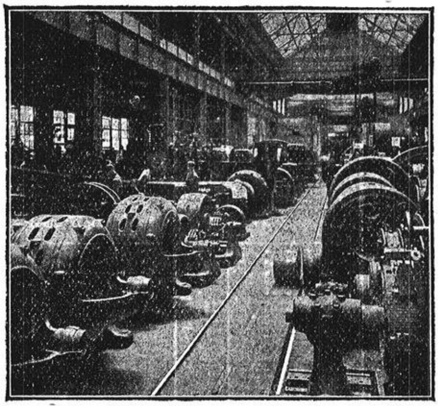
This letter gives a general outline of the policy of the company with regard to its special employees, but it may be departed from as circumstances warrant.

Under some circumstances, where a man is undoubtedly qualified for a position, he may be recommended to it from either the testing or drafting department without having had experience in the other, but other things being equal, men having had experience in both are given the preference.

The special employees in the drafting room are comparatively few in number at present, which is undoubtedly due to the fact that the present system of training has been in force for such a short time. All the testing, with almost no exception, is done by special employees.

While the training described is intended to fit men for more advanced positions, it should be borne in mind that any department in which a man may find himself, in the pursuit of such training, is a part of the system for forwarding the business of the company, and that he is employed in the position which he holds because of the service he can render in that capacity. He should not be surprised, therefore, if he is required for a time to do work which does not yield him as much information as he might acquire if transferred to some other work in the department. It is, nevertheless, true that every opportunity consistent with the progress of the work is given to acquire as much experience as possible.

It should also be understood that the company does not guarantee positions to its special employees at the end of their training. In fact, the end of the training is indefinite. It is believed



TESTING DEPARTMENT.

that, generally speaking, it is necessary for a man to spend at least one year in the testing department and six months in the drafting room in order to acquire the necessary training and demonstrate his capabilities. It may, however, be longer, depending upon the progress the man has made, the demand for men of his qualification, and the number of men of the same fitness in the line of promotion who have had longer experience in the company than himself. Some men may never be recommended to any position.

A concern of the size and interests of the General Electric

Company requires the services of men of such varied abilities and attainments, that any man who has ability and is industrious can feel assured of advancement.

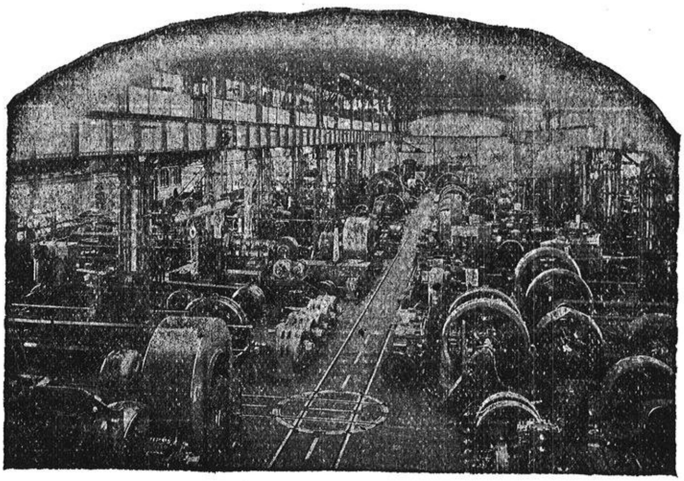
The business of the company is growing at an unprecedented rate and there is a corresponding demand for qualified men at the present time.

All testing of every description is done in the testing department. Every piece of apparatus sent out by the company is tested and inspected electrically and mechanically to determine if it meets the requirements of the customer, and, in case of a specially built machine or new type, special tests are made with a view to learning its qualities as fully as possible. The tests having been performed, the observations are sent to the calculating room where results are worked up and reports made to parties interested.

The calculating room is a section of the testing department. The rest of the department is divided into eleven sections or tests according to the apparatus tested, as transformer, induction motor, railway motor, and other tests. Each section is in charge of a head who is responsible for the work in his section. There are also in each section several men of more or less experience who are recognized as testers.

When a machine is to be tested, one of the testers is put in charge of the work by the head of the section and is held responsible for the test and the machine while under test. Other men in the section, not so recognized, are assigned to assist the tester; the least desirable work being given to the newest man, the new man being given better work if he proves capable, as he becomes more experienced and the men preceding him are transferred to other sections or promoted.

After a man has been in one section twelve weeks, he may make an application, approved by the head of his section, for a transfer to another section, stating which section he wishes to go into. If possible, he will then be transferred to the desired section, or if circumstances will not permit that this be done at



TESTING DEPARTMENT.

once, his application will be kept on file and the transfer effected as soon as an opportunity presents itself. It is not necessary that a man should go into every section, as in some instances the work in two different sections is carried on along similar lines. A man is liable at any time to be transferred from one section to another when, in the judgment of the head of the testing department, the work demands it. The system of transfer applies to the calculating room as well as to the other sections of the testing room.

A tester and his assistants, having been assigned to a machine, they are required to do all the wiring and connections necessary for the performance of the test, see that the machine is in proper condition for the test to be run, both mechanically and electrically, run the test, making an inspection for any defects, and hand in a record of all observations to the calculating room. All large apparatus is assembled, lined, belted, etc., by a gang of mill-wrights employed for the purpose, but in the case of some small machines, the testing men are required to do this work.

The testing department runs day and night, about two-thirds of the entire force working in the day time and one-third at night. In order that each man may do his share of night work, every one who enters the department is expected to work at night for about one-third of the time; that is, if he stays in the department for one year, he is required to work at night for about four months of that time.

The testing department at night is in charge of a foreman who is selected from the heads of sections, who in turn are chosen from the testers. A report of the progress, ability, etc., of each man in the testing department is made by the head of that department from time to time.

The drafting room is what its name implies, and the draftsmen are divided into sections according to the nature of the work being done by them.

On entering the drafting room a man is assigned to work in a section where his services are most needed. If he stays in the drafting room for the prescribed six months only, it is quite probable that he may remain in that section during the entire time. There is no system of transfers here, as in the testing department, but I am informed by the engineer in charge that transfers from one section to another will be effected whenever circumstances warrant it. The hours in the drafting room are from 8 a. m. to 5:30 p. m., with a recess from 12 m. to 1 p. m. on all week days except Saturday, when the day closes at 12:30 p. m. Those in the testing department are from 7 a. m. (except the calculating room, where work begins at 8 a. m.) to 5:30 p. m., with a recess from 12 m. to 12:30 p. m. on all week days except Saturday, when the day closes at 1 p. m. This applies to day men. Those working at night report at 7 p. m. and leave at 7 a. m. and are required to work five nights per week, no work being done on Saturday or Sunday night. All men are expected to work overtime when necessary.

Men just graduated from technical schools, and with no practical experience on entering the drafting room, receive about $10 per week and are raised in salary according as they prove valuable. A man is paid twelve and a half cents per hour in the testing room at the start and is normally raised two and a half cents per hour every six months. On taking charge of a section, a man is given a substantial raise according to the importance of the section and the responsibility assumed. Men working regularly at night receive one and one-eighth hours' pay for each hour worked. Overtime in both testing department and drafting room is paid for at the rate of one and one-quarter hours for each hour worked, except on Sunday, when one hour counts as one and one-half.

The salary received by a man on being promoted to a posittion from the testing department or drafting room, as well as the nature of the position, varies between such wide limits, and depends so entirely on the individual, that it is impossible to give any idea of what may be expected in this respect.

In conclusion I would say that probably no other concern in the world manufactures from beginning to end such a wide variety of electrical apparatus as does the General Electric Company, and consequently in the employ of no other company can such a wide experience be obtained. I think a man who has received a technical education and desires to advance himself in the electrical engineering field, will make no mistake in entering the testing department or the drafting room of the General Electric Company. He can then judge, and no one else can judge so well as he, of his chances of advancement with the company, and, if he is not satisfied with them, he can leave the company, feeling that his time has not been wasted, for he has gained an experience which must be obtained before he can hope to be a successful engineer.

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## THE U. W. ENGINEERS' CLUB.

The work of the Engineers' Club has been very interesting and instructive. Below is given a list of the programs since November 22, 1901:

November 22:

Paper: "Siberian Expansion," G. W. Garvens.

Debate: "Resolved, that it would be more beneficial for an engineering student to take two years' practical work before entering his college course."

*Affirmative*—S. J. Lisberger, H. B. Kirkland, B. F. Lyons.

*Negative*—F. C. Stieler, P. S. Biegler, J. N. Cadby.

Paper: "Nickel Steel," R. V. Holt.

Paper: "Rapid Transit in New York," W. E. Brown.

December 6:

Debate: "Is co-operation better than employment of labor by capital."

*Affirmative*—H. J. Geerlings, E. A. Ekern, D. McArthur.

*Negative*—F. H. Petura, C. S. Peters, B. F. Lyons.

Paper: "Battleships of Different Counties," J. C. Potter.

Paper: "Telephone Exchanges," L. H. Lathrop.

December 13:

At this meeting the following officers were elected for the second club term:

President: F. C. Stieler.

Vice-president: J. G. Hammerschlag.

Secretary and Treasurer: W. E. Crandell.

Censor: W. L. Thorkelson.

Assistant Censor: S. J. Lisberger.

January 10:

At this meeting C. F. Graff presented a very interesting paper on "The White Pass and Yukon Railroad." A short business session followed, at which the following committees were appointed:

*Executive:* J. G. Hammerschlag, F. W. Huels.

*Program:* A. J. Quigley, L. H. Lathrop, C. C. Douglass, H. B. Kirkland, P. J. Kelly, S. J. Lisberger.

January 17:

Music: Quartette.

Debate: "Resolved, that the combination of great railroad systems is detrimental to the best interests of the public."

*Affirmative:* A. J. Quigley, S. W. Cheney, L. E. Rice.

*Negative:* P. J. Kelly, V. McMullen.

Paper: "Smead System of Central Station Heating," E. S. Burnett.

Current Events: H. H. Hunner.

Parliamentary Practice.

January 24:

Music by club.

Review of Prof. B. V. Swenson's Article in Cassier's Magazine on "The Manufacture of Incandescent Lamps," F. W. Huels.

Parliamentary Practice.

Discussion: The complete equipment, including power, of a shops for the manufacture of gas engines, total cost, $12,000.

Current Events: E. A. Olin.

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## THE N. O. WHITNEY ENGINEER'S ASSOCIATION.

The N. O. Whitney Engineer's Association has increased its membership up to the limit with all classes now represented. The papers, periodicals, reviews and debates are improving in quality at each successive meeting. The best papers thus far presented were by W. H. Hauser on Compound Locomotives, by R. Owen on Automatic Telephone Systems, and one by D. J.

Evans giving his personal experiences and observations upon the battleship Oregon, when she was upon the rocks off the coast of China. This latter paper deserves more than passing notice. It was clearly and most interestingly presented, being interspersed with numerous incidents of American pluck, skill and wit; all of which brought forth well deserved applause. Photographs of the damaged vessel as well as many sketches of the details of repairs left a permanent impression upon the minds of the listeners.

A very good talk by Prof. W. D. Taylor was highly appreciated by all present. He emphazied these words: "Make good use of your opportunities" and "Become in earnest." These expressions were made after he had vividly compared the opportunities of technical training twenty years ago with those of to-day.

The following officers were elected for the second term of the societv:

President: E. A. Balsley, C. E., '02.

Vice-president: A. F. Krippner, E. E., '04.

Secretary and Treasurer: R. L. Hankinson, Sp., '05.

Censor: M. A. Whiting, E. E., '04.

Music and parliamentary practice are about to become a regular feature of the program. A committee to work jointly with the two other engineering societies for mutual interest ought to aid much in the effectiveness of this class of college work.

The constitution will appear shortly with a fronticepiece of the late Prof. Whitney.

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## NOTES.

On November 23d the annual course of lectures to the students of the College of Engineering was opened with a lecture by Mr. W. R. Warner, of the Warner and Swasey Company, of Cleveland. The subject of his address was: "Some Observations by a Mechanical Engineer." In this Mr. Warner cautioned the college graduates and college students who enter the engineering field about the wrong impressions which they are apt to entertain as regards their worth to the engineering profession. He dwelt on the careers of some of our great modern engineers, emphasizing those characteristics which made them great engineers, and in conclusion spoke on the opportunities and advantages of the engineering student of to-day.

The second lecture of this series was given by Prof. G. C. Comstock, on January 10th. His subject was "Modern Study of the Stars." He gave an instructive and comprehensive talk, treating the subject more from a historical and explanatory standpoint, dwelling largely upon the problems which modern astronomers have to solve and the methods employed in solving them. The lecture was very interesting, and was illustrated by lantern slides.

The remaining lectures of the series are as follows:

January 17th: Mr. H. T. J. Porter, of the Bethlehem Steel Co., "Modern Forging."

January 24th—Mr. R. W. Hunt, Chicago, "Sir Henry Bessemer."

February 14—Mr. A. J. Wurtz, Pittsburg, "The Development of the Nernst Lamp."

February 21st—Mr. Bertrand S. Somers, of the McCormick Harvester Co., Chicago.

March 7th—Prof. T. S. Adams, University of Wisconsin, "Porto Rico."

March 14th—Prof. J. C. Monaghan, University of Wisconsin, "The Engineer in Empire Building."

March 21st—Mr. Samual Insell, President Chicago Edison Company.

April 4th—Prof. J. G. Mack, University of Wisconsin, "The Engineer and Artisan of Antiquity."

April 11th—Mr. Samuel Rodman, New York, "Burglar-proof Safes and Manganese Steel."

April 18—Prof. P. S. Reinsch, University of Wisconsin, "Industrial Advance in Eastern Asia."

April 25th—Mr. Magnus Swenson, '80, of the Washburn-Swenson Co., Chicago, "The Development of a Problem in Industrial Engineering."

The apparatus of all the engineering departments has been largely increased during the past year. Old machinery and instruments have been repaired and new ones purchased. The civil engineering department has placed an order with a Berlin firm for eleven surveying instruments, to cost in the aggregate $1,700. Several new ammeters and voltmeters, a new wattmeter and a 5 H. P. Gibbs electric motor have been added to the electrical engineering department. A number of special machines and instruments have been donated by different firms to students for thesis work. In the shop there have been added four new lathes, a planer, a twist drill grinder and a milling machine. The laboratories are becoming very crowded, both on account of the apparatus in them and on account of the number of students taking the work. This necessitates the division of the class and interferes considerably with the semester's work. Other improvements and extensions are being contemplated for the second semester.

Dean Johnson has received a copy of Vol. 3 of the "Engineering Index," published by the Engineering Magazine. The work of indexing the engineering articles published in 250 different engineering periodicals was commenced by Dean Johnson, he being at that time professor of civil engineering at Washington University. The first two volumes were indexed by him, but the exacting work and time required in their completion caused him to give the work in charge of the Engineering Magazine. In the last volume the fly leaf contains a half tone of Dean Johnson, and they have referred to him as the founder of the Engineering Index.

The first of the four socials to be given by the engineering students during the year was held in the engineering building on December 9th. It was a decided success in every respect. The building was crowded and everybody reported having a splendid time. The first part of the evening was spent in inspecting the building, etc., then came the program in the auditorium, consisting of music and recitations, after which dancing was indulged in until 11:30. The musical program consisted of a solo or two and the singing of college songs. The words were thrown upon a screen by means of a lantern, so that everyone could become familiar with them. That everyone had an enjoyable time was very evident from the increased attendance at the second social, which took place on December 11. The program of the evening was similar to that of the first. These socials are becoming very popular and a larger attendance is anticipated at the next one, which will occur shortly after the opening of the second semester.

In the physics department several changes have been made. A dark room for photometer work has just been completed, and the small lecture room has been painted and thoroughly renovated. This department now has a fine reading room of its own just next to Prof. Snow's office, in which all the standard journals and many of the engineering papers are kept on file. The room is always open and affords an excellent opportunity for research in the line of physics. There is now a separate shop devoted entirely to the physics department, and fitted out with the best of tools for both wood and iron work. Along the line of apparatus, mention should be made of the large grating spectroscope. This has been set up in the laboratory back of the lecture room, and occupies the whole room. Its base consists of two I beams, 21 feet and 18 feet in length, set at right angles to each other, upon three pins. A 21 foot focus is attained. A Rowland concave 6 inch grating, the largest made, is used, with 14,400 lines per inch.

In the steam laboratory the following improvements and additions have been made:

One 50 H. P. superheater, to be installed just outside the steam laboratory, next to the Nordburg compound engine, for which this superheater is to furnish steam, superheated 200° F. above the temperature of the saturated steam.

One, two stage air compressor, cylinders 12 and 18 inches in diameter, with 12 inch stroke, with compound steam cylinders.

One 55 H. P. high speed engine.

The 5 ton refrigerator plant has been completely installed and some improvements introduced.

The gasoline and gas engines have both been changed and greatly improved.

Four new indicators and a large amount of smaller apparatus, both for steam and for coal and gas analysis.

The annual boiler house test was made by the senior electrical engineers, on Saturday, January 11th, and the annual 24 hour test of the Four Lakes Electric Light and Power Co. occurred on Saturday the 24th. The latter test was made by the senior mechanical and electric engineers. These tests take the place of laboratory experiments and are intended to give the class an insight into the practical methods of station testing.

Mr .C. M. Conradson, M. E., '85, is at present the president and general manager of the American Turret Lathe Manufacturing Co., at Warren, Pa. Their works are in the process of erection and both the buildings themselves and their equipment will be strictly up to date, and entirely complete in every particular. The machines are to be driven by electric power; and electric cranes will be used for the moving and handling of materials. Several of the machines and appliances were designed by Mr. Conradson himself.

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## PERSONALS.

Milan R. Bump, '02, represented the local chapter of Tau Beta Pi in the national convention which was held at Cleveland on November 30th.

Mr. H. P. Boardman, C. E., '94, has resigned his position as assistant engineer of the C. & A. Ry. and has accepted one as assistant engineer of the B. & B. Department C., M. & St. P. Ry. Co.

Mr. H. J. Thorkelson, M. E., '98, is assistant superintendent of the J. I. Case Plow Works at Racine, Wis.

Mr. W. A. Richards, M. E., '99, has resigned his position as instructor in the Machine and Forge shops of East Div. High School, Milwaukee, and accepted an engineering position with the Pressed Steel Car Co. of Alleghaney, Pa.

Mr. Emery H. Powell, M. E., '91, is assistant professor of mechanical drawing in the University of Kansas.

Mr. Henry Fox, M. E., '92, is the locating engineer in the Indian Territory for the Chostaw, Oklahoma and Gulf Ry. Co.

Mr. Louis Barkhausen, '01, is superintendent of the branch shop of the J. I. Case Plow Works at Lynn, Mass.

Prof. Taylor was called to Chicago during the holidays by the C. & A. Ry. Co. in regard to some engineering problem.

Prof. Jackson and Prof. Swenson attended the convention of the Northern Electrical Association, held at Milwaukee, January 15, 16 and 17.

Prof. Swenson is the proud possessor of a daughter, born December 11, 1901. The "Engineer" extends congratulations.

Mr. M. C. Olson, '99, has gone into the designing office of the General Electric Co. His work is under Mr. Riest, and consists in the designing of alternating current machinery.

The engagement of Mr. Victor Bergenthal, E. E., '97, and Miss Alice B. Dacy, '98, has been announced.

The Electric World of July, '01, contains a full description of a patent on a "Two Party Line Ringing System," gotten out by two Wisconsin alumni, Mr. Oscar Leich, 98, and Mr. Max Zabel, '98. Their patent is quite an important one and is attracting considerable attention.

Mr. M. R. Fowler, '01, has entered the engineering department of the Western Electric Co. It is an important position, and as a rule before getting into this department one must have had several years' of experience. Obtaining the position which Mr. Fowler has in such a short time after graduation is a very creditable showing indeed.

Mr. L. M. Hancock, '88, is general superintendent of the Bay County Power Co., with headquarters at San Jose, Cal.

Mr. W. A. Rogers, '88, is vice-president of the Bates and Rogers Construction Co., 1203 Manhattan Building, Chicago.

Edward D. Swinborne, '88, is chief electrician for the Whitman and Barnes Manufacturing Co., Chicago.

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## PUBLICATIONS REVIEWED.

STANDARD STEEL CONSTRUCTION.—A manual for Architects, Engineers and Contractors, by Jones and Laughlins, Limited, Pittsburgh, Pa. Compiled by F. L. Garlinghouse, C. E., Alexander Nurick, C. E. Price $1.00.

This is a beautifully gotten up book, being in the form of a hand-book. The price is merely nominal, but the book is meant to serve the double purpose of a catalogue of Beams, Channels and structural shapes as well as a hand-book containing "useful tables, formulas and other information." Such tables as weights of steel, areas and circumferences of circles, logarithms of numbers, lines, tangents and secants, squares, cubes, etc., are compiled in best shape for ready reference. Although the book is well worth the price asked, a liberal discount on this and the following book received from the same company is given to students.

USEFUL INFORMATION by Jones and Laughlins, Limited, Pittsburgh, Pa. Compiled by C. C. Briggs, M. E. Price 50 cents.

This book is designed for business men, mechanics and engineers. Within its covers, which are only $\frac{1}{2}''$ apart and $3\frac{1}{2}$x2" in size, is compiled and arranged an astonishing amount of information. That the book is useful and fills a want of certain people is shown by the fact that it is in its fourteenth edition. A glance at the few lines taken from the index will show the scope of the book and give an idea of what is contained on its 500 pages.



THE CONSTRUCTION OF A GASOLINE MOTOR VEHICLE, by C. C. Bramwell. Published by Emil Grossman and Bros., New York.

This book is intended to supply the want of a hand-book on the gasoline motor. The material contained in the book was first presented as a series in the "Motor Vehicle Review," and these articles are now put in book form by Mr. E. W. Graff.

At this time, when horseless carriages are so common, this work should find a considerable demand. The subject is well treated and in such a manner that the ordinary person ought have no difficulty in understanding the principles etc. which are explained. To any desiring to gain a thorough understanding of the horseless carriage this book is cheerfully recommended.

NATURE'S MIRACLES; FAMILIAR TALKS ON SCIENCE. Vol. III. Electricity and Magnetism. By Elisha Gaay, LL. D. Fords, Howard and Hulbert, Pub. (cloth 60 cents net).

In this volume the author begins at the beginning, and gives a succinct history of the science of these two interrelated forces. Such a simple exposition of the phenomena of these forces is given that the general reader may get a clear understanding of the subject as far as it is known. Electrical currents, generators, atmospheric conditions, measurements of electricity; the telegraph, telephone, telautograph; submarine and wireless telegraphy; and a series of chapters on the use of the electric current for manufacturing purposes, as at Niagara Falls, are among the topics treated.

*Catalogues:*

We have received from the Allis Chalmers Co., through the Fraser and Chalmers works of Chicago, Ill., a catalogue of "Hoisting Engines and Appliances. Catalogue No. 2."

Besides the complete catalogue along the line indicated the book contains considerable information of value to those interested in the work which the hoisting engine covers.

The Backus Water Motor Co. of Newark, N. J., 172 Pennsylvania avenue, have sent us their latest catalogue, "The Backus Gas and Gasoline Engines."

Those interested in power should know that the Backus company make this statement: "The Backus Gas Engine is guaranteed to have fewer working parts and to be less complicated than any engine built to-day."

"Shafting" is the title of a catalogue sent us by the Jones and Laughlins Limited of Pittsburgh, Pa. It is a price list of patent cold-rolled steel shafting, couplings, pulleys, hangers, mule pulley stands, binder frames, guild pulleys, jib cranes, etc. Besides the regular catalogue, considerable information is furnished in the lines covered.

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## A FEW WORDS FROM THE BUSINESS MANAGER.

*To our subscribers:* Your attention is called to our new terms of subscription given in the front of this issue. Those terms will not hold strictly for this year, however, since through a mistake in printing, the terms failed to appear at all in our first issue. Those who have not paid will please notice that for this year only, the $1 rate is good up to March 1st. After that date all unpaid subscriptions will be billed at $1.50.

*To our alumni:* Please note the above paragraph and do not render it necessary for us to bill your account at $1.50. We wish also to call your attention to our ad. in this issue, calling for certain numbers of the Engineer. We will be very glad to hear from these numbers.

*To our readers:* Please note and heed the little note at the bottom of each ad. page. A little care in regard to this will do more than you think in helping us along.

*To our Madison subscribers:* Wherever possible we ask you to patronize those who show their good-will toward U. W. by advertising with us. The town merchants have so many calls made upon them for support along the line of advertising that it becomes a serious problem to know where to stop. It is a fact, however, that a publication of this kind would be impossible without the income derived from ads. We ask you therefore to show your appreciation of the support thus accorded us, by in turn giving your good-will to those whose names appear on our ad. pages.

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## 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 is 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. Student of Civil Engr. U. W.

Adamson, Wm. H., B. S. C. E., '86. 725 24th Ave., South Seattle, Wash.

*Ahara, Edwin H., B. S. C. E., '92; M. E., '96. 2854 N. Lincoln St., Chicago, Ill.

Ahara, Geo. V., B. S. M. E., '95. With Fairbanks, Morse & Co., Beloit, Wis.

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