The Wisconsin engineer. Vol. 5, No. 2 May 1901

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

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

Vol. 5. May, 1901. No. 2.

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Published Semi-Annually by The University of Wisconsin Engineering Journal Association
Madison, Wisconsin.

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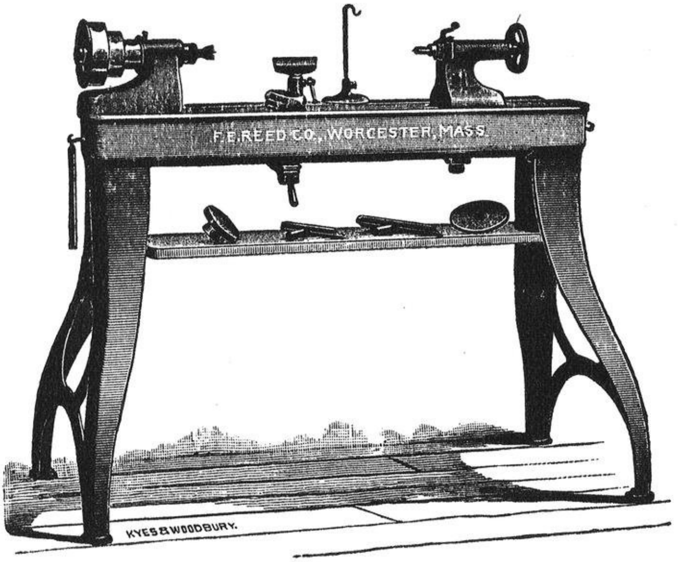

F. E. REED CO., WORCESTER, MASS.
KYES & WOODBURY.

NELSON OLIVER WHITNEY.

The Wisconsin Engineer.

PUBLISHED SEMI-ANNUALLY BY THE STUDENTS OF
THE COLLEGE OF ENGINEERING, UNIVERSITY OF WISCONSIN.

Vol. 5. Madison, Wis., May, 1901 No. 2.

PRICE PER YEAR, $1.00. SINGLE COPIES 50 CTS.

NELSON OLIVER WHITNEY.

The announcement of the sudden death of Professor Whitney on March 17th came as a great shock to his friends in the University and elsewhere. Although Professor Whitney's health had been poor for over a year, he had been gaining strength and was believed to be on the way to complete recovery. Any fair estimate of the character and work of Professor Whitney can be given only by those men who were in intimate touch with him, and the articles following this will give something of an idea of the respect in which he was held by the men who knew him in the different relations of his life. The first three articles were given at a memorial convocation service which was held at the University on April 12th. A short sketch of his life only will be appended here.

Nelson Oliver Whitney was born May 3, 1858, at Aiken, South Carolina, where his parents were temporarily located. He graduated at the Mantua Academy of Philadelphia in 1874 and from the civil engineering course of the University of Pennsylvania in

1878. During the summer following his graduation he was on the geodetic survey of Pennsylvania, and the next winter he was instructor in civil engineering in the University of Pennsylvania and in the Pennsylvania School of Industrial Art. From 1878 to 1880 he was in the office of the chief engineer of the Pennsylvania Railroad, where he was engaged in construction work. The next two years he spent in Mexico as locating engineer, under the late A. M. Wellington, on the Mexican National Railroad. In 1882 he returned to Pennsylvania and became locating engineer on the South Pennsylvania Railroad, and from 1884 to 1886 he was resident engineer on the Tuscarora tunnel.

In 1886 he was appointed assistant to the chief engineer of the Pennsylvania Railroad in charge of construction and maintenance at Chicago, which position he held until called to the chair of railway engineering at the University of Wisconsin in 1891.

The illness of Professor Whitney dates from November, 1899, when he contracted a severe cold while returning with his class from an inspection trip to Pittsburg. The cold soon developed into a severe attack of pneumonia which was complicated by weakness of the heart, and it was only through the most careful nursing and watchfulness that the crisis was successfully passed. By February he had so far recovered as to be anxious to resume in a measure his University work, which he did by riding to and from his office in a carriage. But the exertion was too great, and in four or five weeks he suffered a severe relapse. In the course of the summer he gained gradually and seemed on the way to complete recovery. At the opening of the college year, he again insisted upon doing a share of his work by meeting the students at his home. During the winter he has continued to gain in strength, and it was hoped soon to see him back at his usual place in the University.

Professor Whitney was a member of the American Society of Civil Engineers, of the Western Society of Engineers, and of several railroad clubs and other societies. He was married in 1883 to Miss Mary Ella Taintor of Philadelphia, who, with five children, survives him.

MEMORIES OF PROF. WHITNEY.

GENTLEMEN: I stand before you today in a dual capacity; first, delegated to speak for a strong organization, and second, from my own heart to utter its expression of love for one who was my friend in life and of sorrow that so gracious a friendship should have been taken away from me.

You of the faculty of this great seat of learning have found Nelson Oliver Whitney "a true yoke-fellow" through the years in which together you have been imparting learning garnered from the ages to young men who, from your own and sister states, have sat as disciples at your feet, not to be fed with crumbs from your abundant knowledge but to have their earnest hungering after the truths of science satisfied to the full. You have given generously from your store, each of that in which his gifts have been greatest, and he whose name trembles on our lips was generous of his time and talents in this high service to the young men who shall tread after you in beaten paths; unless perchance some brilliant thinker among them discovers a new way, untrod before, which shall lead to loftier heights of knowledge than those from which you look so calmly down today.

You of the alumni will not soon forget the patient, earnest teacher whose expositions made clear to you facts, processes and deductions, which the cold, soulless type of your text books presented as if through a darkened glass to your mental vision. He was not alone your instructor, satisfied when he had delivered himself of those instructions which it was his duty to impart, but he was your friend and your future was to him a source of earnest solicitude. His wish was to aid by helpful word and deed, to further your material good by bringing you to the notice of those agencies by which your intelligent service could be enlisted for their advancement and your reward. As a father watches the course of his child when he leaves the parental roof, ready to interpose ever by counsel, by material aid, by moral influence for the furtherance of that child's best interest, so your loved mentor watched your course, sorrowing for your failures, and rejoicing when you honored yourself and your alma mater, first by sterling character and mental worth, and second, by high attainment,—the world's only standard of success. This I know because he has talked with me many times about his boys. Would God that I had had such a teacher!

But I must be mindful of my commission. The Western Society of Engineers dates back in its origin to 1869. A little group of engineers effected an organization then under the title of the Engineers Club of the Northwest, for purposes of social intercourse and interchange of professional ideas. "They builded wiser than they knew," and today its roster carries more than four hundred names in active affiliation; proud names, some of them standing for personalities of national and international reputation. But I am among friends of that great society and I have no need to tell them what it is, or what it stands for, or how much of the world's work in the lines of our profession has been done by its members, the scope of whose labors embraces almost all lands. Their monumental works are scattered broadcast all over the wide domain which doffs its hat to "Old Glory." Our neighbors on the north who float the "royal George" know them well and our sister republics invoke and profit by their aid; while the islands of the sea cry to them, "Come over and help us." Of this organization Nelson Oliver Whitney was a distinguished and an honored member and had been for nearly eleven years when he was called to join that great company on yonder shore of the river which is only crossed by the disembodied soul and the hopes which pass beyond the veil and rob death of its sting and the grave of its victory. Ah, my friends, a goodly number of our members stand upon that yonder shore, Cheesbrough, Mason, Latimer, Pope, Poe, Creiger, Booth, and a host of others, good and true, whose names are as household words among us; and now we mourn for Whitney, who in all the years of his membership stood shoulder to shoulder with us in building up the usefulness, character and reputation of our beloved organization. None had its interests more truly at heart than he, and we knew it and delighted to do him honor. There is among us an unwritten law which calls for the selection of our chief executive from among the members resident in the great city which is the center of our activities, based upon the presumption that he will attend all of the meetings of the society,—as he ought in recognition of so high an honor and in fulfillment of so grave a responsibility conferred upon him by his associates,—and be ready at all times to respond to the multiform claims which such an organization has upon the man whom it has chosen as its representative head. And so, although our membership had long recognized the worth and ability of N. O. Whitney, they called him only to the second place of responsibility and honor when on January 4th, 1898, they elected him first vice president, to serve as lieutenant to that other distinguished member, Alfred Noble. This office placed him on the Board of Directors and I have heard from his associates how faithfully and fruitfully he labored with them. You who knew him so well realize that it was inevitable that his Western Society affiliations should give birth to warm friendships and in the days which have gone by since that fateful 17th of March, I have heard some sincere tributes to the memory of this good man from those who learned to know him through those affiliations.

He was ready to do his part toward our entertainment and our instruction, and we all remember with keen appreciation the way in which he made us sharers in the pleasure and the profit of his European journey by giving us in pictured story the garnered memories of what he had seen and learned in those happy months abroad. It does not seem amiss to me, who knew and enjoyed the quiet vein of humor which was his to recall an amusing incident in connection with that lecture over which we have both laughed heartily and others with us, for I have told it on him in public assembly and he has had his joyous revenge at my expense in happy jest. He was my guest on the occasion of this lecture, and as we with our wives were passing across the city in one of those cavernous and noisy vehicles known to Chicago as carettes, a fellow member, now also of the silent majority, pulled the strap which called a halt for the vehicle, and started to get out with ladies who accompanied him. I recognized him and said: "Shall we see you over at the Hall?" His reply was, "No; better show at the Grand." The absurdity of the situation was too great for it not to have a climax, and I capped it by saying: "Stop a minute. Let me introduce you to Professor Whitney." But confusion fell upon him like a mantle, and he escaped in the visible darkness of the street, leaving us laughing heartily at his discomfiture.

The Society which he honored bids me bear its message of condolence and sympathy to you. When our next roster is published, there will be a star opposite the name of N. O. Whitney, as there is opposite the names of our many past officers who have entered into their well earned rest, and some of us when we see it will think a thought borrowed of scripture, "another star in glory."

I have spoken for my society and his; words unworthy to perpetuate our feeling for him,—but how shall I speak for myself? "I would that my tongue could utter the thoughts that arise in me" as "I long for the touch of a vanished hand and the sound of a voice that is still." True friendship is among the priceless things of life; wealth cannot buy it, influence cannot make it; it is born of subtle affinities of mind and heart which are sometimes mutually discovered in the very alpha of acquaintance; in other cases the full recognition comes only as the result of long intercourse; but in either case, unless there comes a loss of those elements which create the affinities, the friendship goes on until the omega of life is reached. And who shall say that it will not endure in unending joy in the life which is beyond the grave? My friendship for him dates back to the days when he was engineer of the Pennsylvania company in charge of its engineering works of projection, construction and maintenance in the vicinity of Chicago. Our meeting came about through one of those occasional interruptions to the continuity of home life growing out of changes of residence or some domestic upheaval which sunders the relations of mistress and maid. Both of us were driven to seek the scanty comfort, to those of home affections, of a boarding house, and it so chanced that a happy circumstance sent us to the same dispensary of daily sustenance. There we met and I saw a man whose gentle demeanor and modest air attracted me. We became acquainted and I found that the surface outcroppings were a true index of the worth and kindliness of the man. The years have made no halt for him or me since then; "the valley of Ajalon" has gazed up at no standing moon, and science has marched on with rapid stride, laying nature's storehouse under contribution, but no shadow has fallen upon the path of our friendship until at last, "the one is taken and the other left." But why go on making declaration of that friendship? You knew him and you know how easy it was to give friendship to such a man and how securely it was held when once given. It was a benediction to all who shared it, and I thank God I felt that benediction. With thanksgiving for what we have had and sorrow for what we have lost let us leave him to the sure mercies of the God and Father of us all, in whom he trusted.

ISHAM RANDOLPH.

As we meet today to pay a public tribute to our departed colleague and friend, it becomes my privilege and duty as the one most closely associated with him in the College of Engineering to offer a few words in behalf of his co-workers in the University.

It is doubtless true that his students, coming as they did into close personal contact with him in the relation of student and teacher, could appreciate even better than his colleagues the influence of such a character as that of Professor Whitney. Few of those present have, however, come to know him in such a relation; but while it is not permitted you to listen to his daily counsel, yet we may all draw inspiration from those noble traits which have for so many years more directly manifested themselves to others.

Professor Nelson O. Whitney was born on May 3rd, 1858, at Aiken, S. C., where his parents were temporarily located. He came of a worthy ancestry,—a genuine, vigorous and conservative stock. His father died when he was only a few months old and his mother moved to Madison, Ind., where they resided until 1864. They then removed to Philadelphia, and here it was that the boy received his education. He graduated from the Academy in 1874, and in the spring of 1875 entered the civil engineering course of the University of Pennsylvania. This he completed in the spring of 1878, at the age of twenty, having finished the work of a four years course in a little over three years.

Like most engineering graduates the line of his future work was not yet definitely decided upon. Immediately after graduation, and indeed before receiving his diploma, he accepted a position on the U. S. Geodetic survey, where he spent the following summer. The next winter and spring he taught at the Pennsylvania School of Industrial Art, and was also an assistant to Professor Haupt at the University. His railway experience began in the office of the Chief Engineer of the Pennsylvania Railroad, but in about a year he, in company with a score of engineers from all parts of the United States, left for Mexico to assist in the location and construction of the Mexican National Railway. In this work he gained much professional knowledge and formed many valuable friendships. Many are the interesting incidents related by Professor Whitney of his life in Mexico, both of the country and its people and of the personal traits of those with whom he was thrown into such intimate relation. These experiences and the mementoes brought home were always a great source of pleasure to him.

After returning to the United States he spent four years as locating and resident engineer on the South Pennsylvania Railroad, one of the boldest and most skillfully located roads in the country. With but three years of practical experience, he was placed in charge of some of the most difficult parts of the work. While on this work he was married in 1883 to Miss Mary E. Tainter of Philadelphia.

When this railroad project was abandoned Professor Whitney came to Chicago as assistant to the Chief Engineer of the Pennsylvania Railroad company, where during the next few years he had charge of the construction of several short lines of railroad in the city and suburbs. In his Chicago practice he did a large amount of work in assisting in the adjustment of conflicting interests, and it was in this connection that his patience, firmness, and tact in dealing with business men and other engineers won for him the greatest respect and esteem. It was in work of this nature that he exemplified in the highest degree, the fact that it is the ability to meet and deal with his fellow man, rather than ability to deal with material things, that marks the highest merit in a man.

While ever insisting on what he believed to be right, he was eminently fair and just, and matters of professional differences were never allowed to infringe upon personal relations. Naturally he met many engineers, and at this time he made perhaps his closest friendships with men of his profession. His sense of professional integrity was of the very highest, and in his work in the character of expert witness, in which capacity he was frequently called upon to serve, he always acted on a distinctly high plane. With great aptitude for quickly collecting the most significant facts, with keen observation and quiet, persistent manner, his statements always carried great weight. He was eminently fitted for such work, for instead of its being displeasing to him and causing personal friction with professional people, it was rather a source of pleasure, and it was his special gratification to acknowledge character and ability in the engineers who might appear in behalf of the opposite side. Rarely can one be found who placed this branch of professional practice on so high a plane.

In 1891 the authorities of the University determined upon enlarging the work of the College of Engineering, and President Chamberlin was called upon to select the heads of three new departments,—a task at once difficult and of vital importance to the welfare of the University. Men for this work should be of wide practical experience in their respective branches, and should combine the ability to conduct engineering enterprises with the ability and willingness to devote their energies thereafter to the training of youth.

One of the chairs, and perhaps the most difficult to fill, was that of Railway Engineering, for active railway men can seldom be induced to abandon the busy life to which they have become accustomed for the more quiet and less varied work of a teacher. Upon making inquiry among railway officials, Mr. Whitney of Chicago was suggested as a man eminently suited for such a position. After an interview with him, President Chamberlin, with his accurate judgment of men, offered him the chair. The change at first seemed out of the question, but the consideration of the advantages here offered for his family, induced him to accept, though with some misgivings as to the wisdom of the course. With many years of practical work since his graduation, and almost no experience in teaching, the transition to the classroom was a radical change, and one which is seldom wholly satisfactory to those who undertake it. That it was accomplished with so high a degree of success is a proof of the breadth of character of the man.

Many practical men fail wholly to realize the essential nature of the art of teaching, and make the mistake, especially at first, of merely imparting the largest possible amount of useful information in the time allotted. Professor Whitney saw further than this, and appreciated to the fullest extent those things which would tend to the best development of character, and to give that training necessary as a foundation for the wider school of practice.

Sharing, as I have, the same office with Professor Whitney for many years, his methods of work have been a matter of considerable interest to me. Apparently never in a hurry, he possessed the ability of moving directly from one task to another that enabled him to accomplish his work with ease and efficiency. If his work worried him it was never apparent, and so far as I could judge, no task that he did seemed of less importance or as requiring less thoroughness in its performance than another. His notes and memoranda were always exceedingly brief and expressive. Complicated methods or apparatus were of little use to him. A man of highly trained judgment in the field, he made use there of the simplest methods and instruments, a trait which characterized all his instruction and which was of the greatest value to the students. Where others might load up the student with large numbers of special and unusual problems, he would discard to a large extent the text book and rely on the application of the simplest methods to solve the problem. By suggestion and example the students would be led easily over difficult points until they obtained a mastery of the subject.

Professor Whitney had the practical man's aversion for rushing into print, and although he had a great amount of valuable material derived from his own experience which he gave his classes, he could never be persuaded to publish it. He could not appreciate the standpoint of those who measured the merit of a man largely by what he had written. With him a difficult piece of construction successfully executed, a railroad emergency quickly and skillfully met, or an army of workmen efficiently directed, were the things to test the real merits of a man.

Professor Whitney would undoubtedly have disliked to teach the more elementary subjects. His methods were adapted rather to mature minds. He believed thoroughly in placing a student on his own responsibility, and while devoting a large amount of time outside of classes in assisting the students, he always encouraged independent action. He insisted on all work being faithfully and honestly executed; the man who shirked his duty had little of his sympathy. The growth of his students in their capacity for accepting responsibilities and for the faithful discharge of duties was to him the criterion by which the value of his work was measured. The interest he took in the development of "his boys" while under his instruction continued as strong after their graduation, and it was one of his greatest pleasures to watch the career of those whom he had assisted in securing positions.

Too often the teacher fails to fully realize the possibilities of his calling and is so completely devoted to his special subject that he touches the student only through this means; but the genuine personal interest which Professor Whitney had in "his boys" made it possible for him to exert to an unusual degree a beneficent influence on the lives of those who came into daily contact with him.

As a member of society Professor Whitney performed his full duty. He resisted the tendency which many specialists have to leave to others their obligations to their fellow-man. Even during his long and critical illness he maintained his interest in all that was going on about him. He was an active member of several engineering and scientific societies, and was a frequent attendant at their meetings, where the social features were of especial attraction to him. He was also an influential member of the church, and a man of wide interests in all the activities of the community. Possessed of an unselfish personality he unconsciously invited the acquaintance and confidence of others. In his family he was the ideal husband and father, and in his devotion to their interests lay his greatest ambition. To his children he has bequeathed as an inspiration the memory of a noble, unselfish life.

The world gains its recompense for the loss of such a man through the impulses for good which he has inspired in others and which he leaves as a perpetual legacy.

To the engineer an exemplification of the highest honor and integrity, to the teacher an example of efficiency founded on sympathy, and to the student an inspiration for the faithful performance of duty, it may be said in the fullness of its meaning: He has lived well, and the world is better for his living.

FREDERICK E. TURNEAURE.

It is with a feeling of deep sorrow and loss that I accept the task and at the same time great privilege of testifying to the sterling worth of Professor Whitney.

I first met him in Chicago during the summer previous to his change from the practice to the teaching of Railway Engineering. At that time he spoke with some diffidence of the change he was about to make, expressing doubts as to his fitness for the new work before him. I was absent from the University during Professor Whitney's first year, but after my return had him for professor and class officer the next two, my junior and senior years, and any doubts I could possibly have held as to his qualifications for his position were dispelled at the start never to return. His wide experience eminently fitted him for instructing in the subjects assigned to his chair.

Since being asked to pay tribute to our beloved professor I hunted up my book of notes taken in one of his classes, and in looking it over was astonished at the ground covered and the number of important points discussed. I realize now more than when in his classes, with what good judgment he selected the fundamentals, not spending too much time on details which could better be learned in practical work.

I wish to give one illustration from his instruction for which I am not indebted to classroom notes. A long stone arch bridge was completed and had been in use for some time, apparently a fine structure, when it suddenly failed without warning, several arches being completely wrecked. The cause was found to have been a stratum of soft clay underlying the rock upon which the arch piers had been founded.

The engineer who built the structure was on record as urgently requesting that he be permitted to spend more money in exploring the material upon which the bridge was founded, but his protest was overruled by those higher in authority, they being fully satisfied as soon as the borings reached rock, thinking it a useless expense to bore into the rock to any depth. As it turned out, the rock was but a thin, weak stratum, practically floating on the soft underlying mud and wholly unsuited to bear a heavy weight.

By the aid of this illustration Professor Whitney impressed very forcibly upon our minds the great importance of spending sufficient time and money in preliminary examination of all the conditions affecting a proposed important piece of work.

Professor Whitney was not limited by his own experience, as many men are; he was progressive, not bigoted; he did not assume that his experience and knowledge covered the whole field in his specialty, and therefore he continued to broaden and to exert a broadening influence on the students.

But Professor Whitney was not only a good professor; he was a good man in every way and a sincere friend of the students. Always ready to help them, he took an interest in each one individually, and was ever willing and glad to advise or answer questions. Students were welcome at his house where they were well entertained and made to feel entirely at home.

Probably all of the '94 engineers well remember the parting lecture he gave us shortly before commencement. This was in the nature of a friendly talk about the prospects ahead of us and contained much sound advice concerning the mode of conducting ourselves in practical work, the proper relations, discipline, etc., governing the intercourse between employees of different rank working for a common employer and many other useful hints.

He did not lose interest in the boys after their graduation, but was always glad to see or hear from them and learn of their progress after leaving U. W.

In brief, Professor Whitney was at once a teacher, a guide, and a true friend to his students, deserving and receiving the love and esteem of all who were worthy a like return from him.

H. P. Boardman.

Nelson Oliver Whitney and the writer were friends and comrades ever since we were small boys in West Philadelphia. I cannot recall when we first met, but it must have been before either of us was ten years of age. We went to school together at Hasting's Mantua Academy, were in the same class (1878) at the University of Pennsylvania, and began work together on the U. S. Coast Survey, Triangulation of Pennsylvania. Later we were both employed at Pittsburg serving the Pennsylvania Railroad interests there; some years later with the South Pennsylvania Railroad in Southern Pennsylvania, and as late as the summer of 1899 we were associated during the summer building a Portland cement plant in Pennsylvania.

As a boy Whitney was a bold, courageous lad, quick tempered, inclined to audacity and headstrongness; but he was warm hearted, had a keen sense of humor and a fund of commonsense, which usually kept him out of mischief. The play of these differing qualities made him a lively and attractive fellow, though often a very provoking one. I am sure his friends of later years will recognize these qualities matured and softened by years in the earnest, cordial manner which often became enthusiastic when interested, but which nevertheless always had a quiet restraint and sense of measure in it.

There can be no doubt that he had a natural aptitude for his profession, which was always a great advantage to him. Though a thoroughly educated man, his methods were always practical. And when a young man the theoretical side of engineering never fretted him as it sometimes does young engineers who have a good deal of trouble to align practical work with their book knowledge. The rationale of his methods once clear to his own mind, the theoretical side of it did not appeal to him. In the field on location or construction, he was quick and extremely matter-of-fact in all of his methods. Doing his work on these lines, he was seldom hurried, always seemed to have plenty of time for observation and took a great interest in the actual conduct of the work by contractors. He had a large fund of information on all such matters, and was an extremely interesting talker about them.

I can readily imagine that as a teacher he would at once command the loyalty and interest of his students to an unusual degree. He was never fussy nor exacting, but possessed that genuine interest and earnestness in his work, which must have been not only attractive, but a great advantage to young men in that most important particular of character building.

With regard to the organic weakness which broke down his health in latter years, and from which he finally died, I am not familiar. But I remember that as a boy his heart was always peculiar in this respect of having a very slow pulse, beating normally at somewhere between 55 and 60 pulsations per minute. As a young man he used to laugh at it, and say that his heart was slow and steady, and would outlast two of the quick sort; but I suppose there must have been some weakness from childhood.

I have lost my oldest and my dearest friend, whose place no later friendship can ever take. Never! Forever!

FREDERICK H. LEWIS.

I am very glad to have an opportunity to express in some measure my regard for Prof. Whitney, both as a teacher and as a man. Few professors are so uniformly well liked by their students as he was. I think I can truly say that I have never heard a word of real dislike for "Whit." To those who know how freely students express to each other their opinions of instructors, this fact speaks volumes for the fairness of the man toward all with whom he had to do. With many of us, however, the feeling was more than passive friendliness and respect. We felt that he took an interest in each one of us, not as a student merely, but as a personal friend and we would have been ungrateful if we had not repaid in kind.

That which attracted us first and which we always admired in him was his quiet, unassuming character. There was nothing of the pedant about him. With him we never felt that indefinable something which seems to surround the conventional professor; that overpowering sense of contact with superior knowledge. He was always approachable and came to be regarded by many students toward the close of their course rather as an experienced fellow engineer giving friendly pointers to a novice in the profession than as a man whose work was to turn out an annual consignment of young men who would measure up to a certain standard of technical knowledge.

Essentially a man of work rather than of theories, a man who believed in accomplishing everything in the simplest, most direct manner possible without any show, he never took occasion to air his technical knowledge unnecessarily. This trait led some perhaps to underestimate his ability. He saw everything from the view point of a man actively engaged in his profession rather than as a man absorbed in the theoretical side only. We as students were not long in finding this out and thereby had increased respect for his opinions and teaching.

As for myself, I did not appreciate him fully until I knew him outside the class room. While a very capable instructor, he did not have the rare gift of imparting abstract knowledge in an entertaining way and did not appear to advantage in the lecture room. Let, however, the actual conditions, the actual problems be met in field work, in the drafting room or elsewhere and it was a different matter. Then it was that the reserve ability became apparent and the student profited by it. His contempt for the "fair weather engineer" was hardly greater than for the man who allowed formulae to entangle his common sense and dwarf his native resource.

He was constantly exhorting us to grapple with any responsibility which presented itself, no matter how difficult it appeared. "Ability to meet emergencies proves the real engineer." "Assume responsibility until you feel things crack in your head. It will do you no harm, and you don't know what your ability is until you *have* to use it." Such were the working mottoes with which he sent us forth. To us he seemed the type of man, well balanced, of good judgment and sound heart, which the world needs; the kind of man to tie to.

It is no detraction from Prof. Whitney's work as a professor to say that in the memories of most of us the tutor will be overshadowed by the kindly friend and adviser.

E. C. BEBB, '96.

Nothing could be written that would give an idea of the love and respect that the civil engineering students had for Professor Whitney. When he was ill after his return from the trip to

Pittsburg, the desire exhibited by all the students in his senior class to find some manner of showing their sympathy for him speaks in a more forcible manner than could any words at this time of the high position he held in their esteem.

His way of always teaching a thing as it was done in practice made the boys respect him as a teacher, but I am sure that while we all felt that he was an able engineer and teacher, it was not these qualities so much as others that made him dear to us. We respected him as an engineer, and we loved him as a man.

His great interest in us was one of his most prominent characteristics, and it was ever prominent. He was always willing to devote any amount of time to help the boys secure positions upon graduation, and he wrote hundreds of letters every spring to assist them in getting work.

One afternoon shortly before his death I was at his home and spoke of a circulating letter that I had recently received and had forwarded to another member of the class. The scheme was that each man write something and send the whole to the next one, and so on. He expressed his regret that he had not seen this letter, and asked me to be sure to bring it to him the next time it came around. He asked what each man was doing and what his chances were for promotion, and a father could not have shown more interest in a son than he showed in each member of the class. We knew that he was a man who would do what he felt was his duty at any cost. At the completion of the work in railway economics, he felt that he could not properly give us a standing without an examination, and, while too ill to walk, he came up in a carriage and gave the examination, though he was taking the greatest risk in so doing.

He had a very frank way, and yet was very kind. If a man in one of the lower classes asked for help in getting a position for the summer, Professor Whitney would plainly tell him that he must help the upper classmen first; that he was always glad to write letters of recommendation, but the man must apply for himself.

As a class officer he was always ready to help the boys out of any difficulty. When we complained of the work required in chemistry, he at once did all he could for us and succeeded in getting it reduced. When any of the boys would get into trouble on account of student pranks or anything of that nature, he always took an active interest in the case, and we knew that it was not for the purpose of getting convicting evidence, but rather to find a suitable excuse or proof of innocence, and that he would do all in his power to help the unlucky fellow out of his difficulty.

Every student that has taken work under him is able to relate many incidents which show these sterling qualities; but all who knew him will feel that words are not only unnecessary but wholly unable to express our esteem for a man so noble, for a friend so dear.

E. E. SANDS, '00.

Among the students who had the pleasure of studying under Professor Whitney, I think the members of the class of '94 had the best opportunity of knowing him.

He was, at that time, in good health and always accompanied the boys on their out-door trips when surveying or doing other engineering work. I may safely say there was no other member of the faculty more beloved by his class than Professor Whitney. We all thought highly of him and listened to his suggestions with interest, for we felt that his was a practical nature and the experiences he told were always full of valuable hints for the students.

As a rule, Professor Whitney was quiet and earnest in all of his work, but there were times when he lost the seriousness of certain situations and indulged in quiet jokes, generally at the expense of some unsuspecting member of his class. The following little story will probably illustrate this as well as any:

Just before the class of '94 graduated, Prof. Whitney called the members of the civil engineering course together and gave them a short talk before they should leave the University and enter into business life. After commenting on the seriousness of the proposed step, he gave us all kinds of good advice and finally touched upon the subject of marriage. He said something as follows: "Among other things I wish to impress upon you, boys, not to marry too early. Marriage is all very well and good in its place but it seems to me that a young engineer should get a foothold in his profession before taking such a step." Then with a smile lurking about the corners of his mouth, "Of course these remarks apply more particularly to Baehr and Tibbits," whereupon the other members of the class gave me a good laugh. I arose and asked Professor Whitney when he was married, whereupon he hesitated a little and then acknowledged that he was married before leaving college. I then asked him if he regretted it and he replied that he did not, but at the same time I know that he appreciated the situation.

We shall all remember Professor Whiney as a close friend of the student body and especially those who were in his particular charge. I presume there is not one among the graduates of the civil engineering course who has not received aid and valuable suggestions from him since graduation, and I am sure we all love to think of Prof. Whitney.

W. A. BAEHR.

I first met Whitney in Chicago in 1886. We were both at that time with the Pennsylvania Lines,—I on maintenance work, and he in charge of construction of some branch lines building in that vicinity.

I had heard a good deal about him from some relatives and had looked forward with pleasure to meeting him. We both had considerable field work in mountain country and with this mutually congenial topic as a basis and the interest we had in our work as a stimulus, we got on well together.

Recently, in putting some of these properties together in a new organization, I have had occasion to look over some of the work he then did. The examination confirmed my impression of his careful, painstaking and intelligent discharge of his duties,—elements of character which I think the men at the University, who came in contact with him, must all have recognized and been benefited by.

L. F. LOREE.

It was with great sorrow that I learned of Prof. Whitney's death. From letters I had received from him and from reports that came from Madison I had hoped he might be able to recover.

He will be greatly missed by the University but his place will be harder to fill in the hearts and minds of the alumni. Always taking a keen interest in the work of his graduates, he was ever ready to advise and assist them in securing positions. He kept in touch with most of his former students and I can say for all of us that his letters were always gladly received for their words of advice and encouragement.

Always pleasant and gentlemanly he won the respect of his students and no work was ever more enjoyed than that under Prof. Whitney. R. C. CORNISH, C. E., '97.

In speaking of Professor Whitney's death, Acting President Birge expressed himself as follows:

"Professor Whitney was one of our ablest and most useful professors and one of the best and most lovable of men. He was amply qualified for his profession, both by the study of its theory and by practical experience. He gave himself with great devotion to his University work—not only to his teaching, but also to his students. He was perhaps exceptional among professors in the degree to which the last quality was present. He was thorough and exacting in his demands as a teacher but in his teaching never lost sight of the personal qualities of those under his instruction. He had rather such a sympathy with them as made his instruction doubly effective. He inspired them not only by his knowledge but also by his kindliness and by the example of a high and noble life. The University suffers a very great loss by the death of such a teacher and such a man."

Dean J. B. Johnson, who has been closely connected with Professor Whitney for years, speaks as follows:

"Professor Whitney was one of the very few railroad engineers who were well fitted for college work. He was at once a successful engineer with a large experience in responsible positions on the leading railroads of the world, and also a very successful teacher. He was as zealous in his college work as he had been in his engineering practice. He was always solicitous for the individual interests of his students and he followed the subsequent careers of 'his boys' with almost a father's attachment. His manner was always mild but earnest and his students held him in the highest respect and esteem. They cheerfully consented to go to his house to hear his lectures on the more important subjects, rather than to have another give these at the college building. His work had been greatly lightened, however, partly by division among other members of the faculty of the college of engineering and partly by an additional assistant. It will be a difficult matter to fill his place in this college."

Professor Storm Bull, who has known him for ten years, says:

"He was the perfect type of a gentleman, always fair-minded and always saw things in the best light. He always respected the opinions of others and never claimed knowledge of anything in which he was not thoroughly prepared. Professor Whitney was very thorough in whatever he did. He expected to be back again at his University work but I noticed the last time I saw him that he was not as cheerful as usual. His loss will be most keenly felt by all of his co-workers in the University.

Professor Jackson, who has been formerly located at Chicago, in speaking of Professor Whitney's work in Chicago, said:

"He was universally liked by all who knew him and his Chicago friends always spoke of him in the highest terms of praise. Last year Professor Whitney was vice president of the Western Society of Engineers and was also a member of the finance committee of that organization during the past year. He ranked very high in the engineering profession and especially along all lines of railway engineering."

TECHNICAL EDUCATION IN EUROPE.

JOHN M. BARR, '99 Pittsburg, Pa.

It was only after considerable hesitation that the writer of this paper entered upon a discussion of the subject. So many valuable articles have been written upon the general plan of technical education abroad, its scope and method, that there remains little to be added along these lines. Moreover, an adequate study of this subject would involve rather more than a year's stay abroad, and the writer scarcely feels in position to do the subject justice. A student's views, however, may be of interest to the readers of the Wisconsin Engineer, and with this in mind the present article was written.

The education of the European engineer begins much earlier than is the custom with us and the primary schools are in many respects superior to ours. The primary teachers are for the most part men of a high degree of intelligence, and consecrate their lives to their profession. From the start the children are led to take an active interest in their work, not that this implies any lack of discipline, for if anything, the discipline in the European primary schools is more rigid than in our own. The studies are made real, however, and any one who has read the little monologues in the German reader on plant life or rocks, or on similar subjects, cannot but be impressed by the beautifully clear and simple manner in which the matter is treated. Thus we see that the best teachers and the best writers devote themselves to the children and arouse in them the spirit of investigation which will be so useful to them in after life. The Europeans seem to be of the opinion that nothing is too good for the scholars in the way of solid early preparation, an opinion with which the writer heartily agrees.

As a consequence of this training the students enter the "Gymnasium," which corresponds to our high school, with an interest in their work and with an accurate conception of the meaning of the simpler physical laws. The training in the high school is quite severe, and the work in mathematics is especially good. In fact, the graduates have a working knowledge of the integral and differential calculus, and what is of greater value, they have a good physical conception of the idea involved. When we consider that this is rather more than can be said of our average college graduate we may at once appreciate that here is one department of our educational system which suffers by comparison. Whether the better grasp be due to a greater amount of time spent upon the subject or to better methods of instruction the writer is unable to say, but the fact remains that to these youngsters the calculus is like a tool ready to be used and used correctly when needed. Each operation means something real, has a physical significance. The writer feels fairly safe in saying that to the average American student the physical significance has to do with the weary hours spent in carving integral signs, or the labor involved in carrying the text book to and from classes. As time permitted the writer attended some lectures upon this subject in Zurich, and they were in the nature of revelations. The application to physical laws was constantly referred to, every point gone over in detail and made perfectly clear. As a result of the Gymnasium training the students entering the German university have the advantage of the best possible training in mathematics, and the first year is devoted largely to review, though some higher work is taken up.

The university course does not differ materially from our own. The same general subjects are taken up, but the mathematical treatment is very complete, and very much more generally employed than in our engineering institutions. The students are well in position to grasp the work when treated in this manner, and the method has in its favor thoroughness and elegance. The work is all given in the form of lectures with written reviews at certain intervals. The lectures are written up at night, and the time required of the student is about the same as under the text book system.

At the end of the sophomore year, in addition to the regular semestral examinations is held a so-called übergang examination, which covers all of the work taken up during the first two years, and students who are successful in this examination are eligible to the work of the last two years. The semestral examinations continue through the last two years, and before a degree is conferred the student is obliged to pass a final examination covering the four years' work. The examination is partly written and partly oral and is generally quite severe.

The lecture rooms are about what one might expect, with the seats rising in tiers from the professor's lecture table, and the front wall being covered with blackboards. About ten minutes before the lecture begins the students begin to file in with their black oil-cloth covered note books and portable ink wells, for the fountain pen has not yet come into very general use among the students. Each man has his regular seat which he reserves at the beginning of each semester. As the professor enters the students all rise and remain standing till he has reached his lecture table. They then resume their seats and pens scratch busily, for the professor has much to say and speaks rapidly. The lectures are very complete and no point is considered too trivial to be fully treated. Often a subject is treated in three or four different ways and no pains are spared to make a subject perfectly clear.

The laboratory work is an important adjunct to the lectures, and here the points brought out in the lectures are taken up in detail. The writer was surprised at the amount of time that the professors spent in the laboratories personally supervising the work. A striking feature in this connection is the small amount of attention given to the rapidity with which the work is turned out. If the work is done well, accurately, and understandingly, the time involved is never thought of. This fact explains in a measure the excellence of the technical data compiled in Europe; for our motto, "Time is money," is fatal to the success of work of this character. The instructors in the laboratories are generally men studying for a higher degree, and as a class were quite efficient.

The doctor's degree seems to be highly valued on the other side, and at all institutions of importance may be found quite a number of students doing their "doctor arbeit." The arbeit is similar to our theses, and for the American student at least, whose time abroad is limited, rarely pays when one considers the amount of time involved.

Engineering societies among the students are very much in vogue in Europe, and are attended regularly by both students and professors. Papers are read and discussed, technical information exchanged and the students and professors brought into close contact. A custom exists in Munich which the writer thought excellent. Every Saturday afternoon the students and professors meet and the students are at liberty to ask questions on any subject connected with their work. Here are brought up all sorts of riddles pertaining to the theory, practice, or to the current technical literature, and in a word, here the student may have discussed any point which has proven especially difficult. Here as in the classroom the discussion is very thorough, every phase of the subject being considered. All of the faculty so far as the discussion comes within their province speak,—

the chemist, the physicist, the mathematical theorist, and the practical man all take part in the discussion, and as may be imagined, some conclusion is generally reached before the discussion closes.

Engineering trips are made during the semester to the factories and plants in the neighborhood of the school, and during the spring vacation a longer trip is made. This trip last year was to the exposition at Paris, and the details were quite like our inspection trips. Each professor took with him a certain number of students, and together they inspected the various exhibits and discussed them in detail.

A word regarding the faculty may not be amiss. The writer had heard so much about their peculiarities that he had grave apprehensions as to his reception. He found, however, that they were a very superior class of men in every way, and well able to command the respect of their students. They certainly treated the writer with the utmost consideration and did all in their power to make his stay abroad a pleasant and profitable one. They are much interested in America, and seem to be anxious to visit our country, and the writer's only hope is that if they do they may receive all the kindly consideration and hospitality that they show the American student abroad.

The student life has not been touched upon in this article, for the reason that to do the subject justice would lead us too far. Suffice it to say that the student life abroad is quite as interesting, though as might be expected, entirely different from our own. The writer is of the opinion that the average American student better appreciates the responsibilities of his position and devotes more time to his work than is customary on the other side.

The writer is often asked: "Are the European technical schools better than our own?" It is hopeless to enter into a discussion upon this point. There are so many conditions which are foreign to us affecting the character of the technical schools in Europe that to discuss this matter intelligently would involve an immense amount of study. Food, climate, social and trade conditions, and above all, the character of the European people, are all prominent factors in the problem. It is by no means certain that the character of training best suited to make a successful European engineer would meet American requirements. There are some differences, however, which the most casual observer cannot but notice, and these the writer gives without comment:

First—A much better preparatory training than we find in America.

Second—The slow, methodical character of the German student, with an entire absence of our impatience in arriving at results, making a longer and perhaps more thorough treatment possible.

Third—A much more mathematical treatment of engineering subjects, and

Fourth—A much closer relation between faculty and the student body than in America.

The European countries are most liberal so far as education goes, and many of their best thinkers have devoted themselves to the solution of the educational problem, and the writer feels that whatever the faults of the European system, when one considers the many celebrated names among the graduates of European schools one cannot but feel that the European system at least needs no apology.

NOTES ON CEMENTS AND CEMENT TESTING.

HENRY FOX, U. S. INSPECTOR, PRINCETON, ILL.

The enormous impulse given to the cement industry during the past few years in every part of the world finds its origin primarily in the fact that concrete masonry has been universally adopted to replace all classes of stone masonry in the construction of engineering works such as sidewalks, pavements, foundations, bridge abutments, piers, retaining walls, fire proof buildings, sewers, arch culverts, tunnels, fortifications and harbor-work. This transformation has taken place gradually, so that it is now generally conceded that concrete masonry can be easily substituted for stone masonry with the ultimate object of securing a material reduction in the cost of the work as well as saving much valuable time expended in erecting the structure, and when proper care is employed in the manufacture and inspection of the cement used in the concrete the durability, permanence and strength of the structure are absolutely assured.

It may be said that portland cement is practically the result of applied science; its component parts must be selected with skill and care; the different steps in the process of manufacture must be observed closely and the final product carefully examined so that no inferior or surplus material may enter or remain in it.

The production of a portland cement differs fundamentally from the natural or Rosendale cements, which are made from limestone (containing a percentage of alumina and magnesia) just as it is found in nature or in the quarry, without any selection being made or its receiving other treatment than calcination and grinding.

Before entering into the discussion of cement testing, a preliminary description of the raw materials entering into the composition of a portland cement and a method of converting the same by means of a chemical and mechanical process into a fine powder of double silicate of calcium and alumina may be mentioned.

The raw materials combined in the manufacture of a portland cement are clay and a white calcareous earth called marl; these materials have the following approximate chemical analysis:

Soft limestone or marl.		*Clay.*	
Carbonate of lime	88	Silica	50
Magnesia	2	Alumina	24
Silica	8	Oxide of iron	10
Alumina	1	Calcium	5
Oxide of iron	1	Magnesia	2
		Alkalies	3
	100	Organic matter	6
			100

Perhaps, following the initial step of incorporating the raw materials in a wash mill or similar process, the most important step taken to advance the uniform production of a portland cement is the burning or calcination of the slurry, composed of clay and chalk chemically combined; this function has been more thoroughly accomplished by the introduction of the rotary kiln, which is essentially a long steel revolving cylinder lined with fire brick and of three or four tons' capacity; at one end of this cylinder, called the burning end, an intensely hot flame (produced by the combustion of gas, petroleum or pulverized coal) is forced into the cylinder by means of a blast. The slurry, or in the case of a natural cement the pulverized limestone from the quarry, is fed in a continuous stream at the opposite end of the kiln; as the revolving cylinder has a slight inclination the cement material moves forward toward the flame and gradually becomes heated, giving off all volatile matter and eliminating carbonic acid gas. In its passage through the cylinder the cement material augments its temperature until it reaches the zone of greatest heat when the particles begin to fuse and adhere to each other, and finally at the expiration of one-half hour it becomes a mass of clinkers. After these clinkers are cooled they are reduced in a crushing roll to a uniform size and then passed through a pulverizing mill, which further reduces them to the required degree of fineness.

It is therefore evident that the conversion or transformation of the raw materials into a cement involves three separate and distinct processes:

First—The careful and exact apportioning of the clay and chalk chemically and then obtaining a thorough mechanical mixture of these ingredients in a wash mill or similar apparatus.

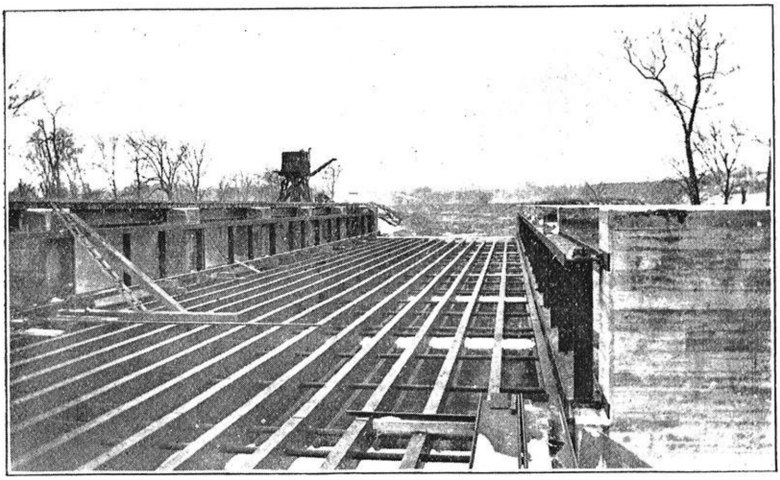
Second—The uniform calcination of the slurry in a rotary or dome kiln.

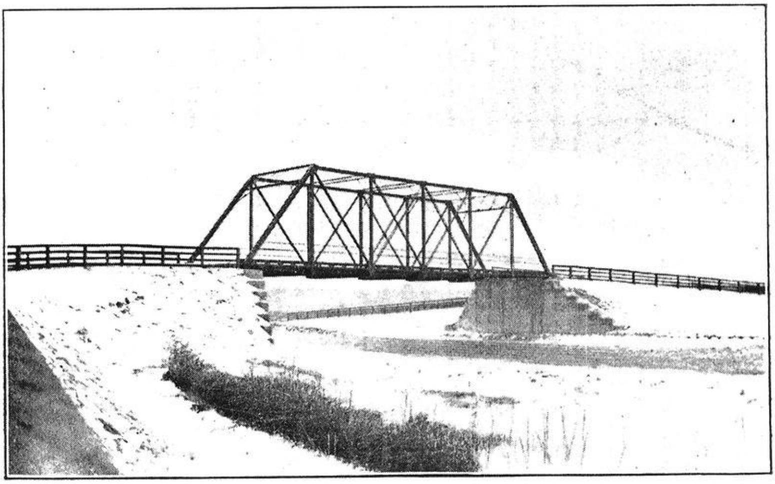
Third—The reduction of the calcined clinker to a powder by fine grinding.

Hence we may assume that any defect in the incorporation of the raw materials in the first process cannot be prevented in the second and that the last one has not the power to relieve the cement from the injurious effects of imperfect manufacture in the other two.

At an early date it became manifest that certain methods of standardizing cements were necessary in order to secure a thorough knowledge of their principal characteristics, such as fineness, rate of settings, color, soundness or permanence of volume, tensile strength, specific gravity, compressive strength, adhesive qualities, porosity and chemical analysis.

It cannot be assumed at the present time that the various methods used to define the salient features of the various brands of cement are permanently fixed so that a uniform practice of cement testing has been adopted by those directly interested in the matter; this statement relates more particularly to the various meth-





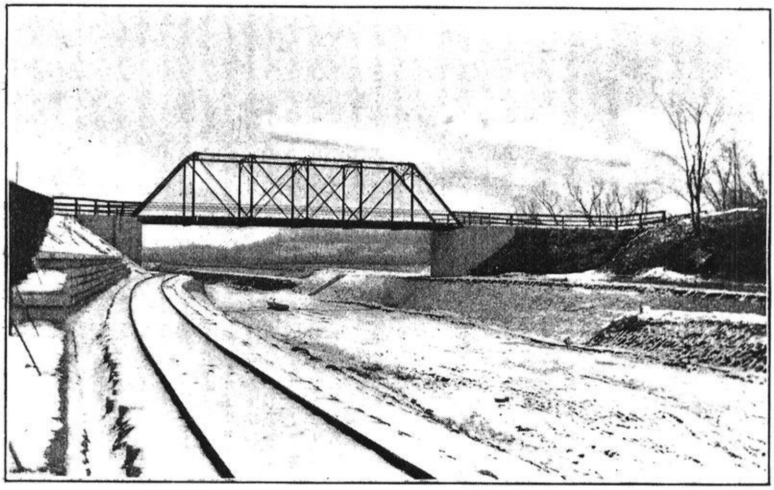
Illustrations of Concrete Construction.

ods of obtaining the tensile-stress per square inch; also to the method and value of using the accelerated tests to determine the permanence of volume. Consequently a comparison of the results obtained of a cement tested by one system with the results obtained under another cannot be correctly understood unless the conditions are known as to how the various tests were made. A report on a uniform system of testing cements was made by the committee appointed for this purpose by the American Society of Civil Engineers at the annual meeting of the society on January 21, 1885. This system, formulated by the combination of ideas furnished by experienced men, was designed to be practical, simple in detail, rapid and easy to manipulate as well as accurate when executed by a careful and experienced cement tester.

As the series of cement tests about to be described conforms in its general outline to the system just alluded to, the writer also assumes that the testing laboratory is equipped with the following apparatus:

One Riehle or Fairbanks, Morse & Co. testing machine; 50 brass briquette moulds, Am. Soc. C. E.; 1 marble mixing slab, size, ⅞" x 18" x 36"; 1 graduate, 0 to 8 oz., and 0 to 250 grammes; 1 scale, graduated ¼ oz. to 16 oz.; 6 immersion trays; testing sieves, Nos. 3, 5, 6, 8, 10, 20, 30, 50, 70, 100; 1 oil stove; 1 wash boiler; 100 glass plates, 4" x 4"; 4 glass plates, ½" x 6" x 10"; 1 ¼ ℔ x 1-12" Gilmore needle; 1 1℔ x 1-24" Gilmore needle; 1 brass rammer; 1 clock; 1 record book; 1 almanac; toweling; tables.

It is also taken for granted that proposals with explicit specifications attached thereto have been issued and bids upon the same received for a certain quantity of cement. The contract for the most economical cement has been awarded upon the following considerations: the general reputation of the cement for a period of not less than 5 years; its commercial net weight and cost price per barrel, fineness (so as to determine its inert matter) and tensile strength per square inch of briquettes made with proportions 1 part cement to 3 parts standard sand, said briquettes being placed 1 day in air under a damp cloth and 27 days in water, thus obtaining the ratio of cost to strength. Further that the delivery of the cement in car load lots is in progress.



Illustrations of Concrete Construction.

PACKING, SAMPLING AND STORAGE.

Samples should be taken from each car load lot so that ten per cent. of the barrels, may, at random, be inspected and a cigar box full of cement be taken from each barrel. The number of the sample should be plainly marked upon the barrel and on the box containing the sample in order to identify it; where the cement is shipped in bags it should be piled in car load lots in the warehouse and the number of the sample may be located by a tag fastened to the bag by means of a wire. In taking the sample it is important to observe that the cement should be free from lumps, perfectly dry, securely packed in well coopered barrels, of standard size and having the brand of cement plainly marked upon it; the barrel should also be lined with water proof paper. Where the cement is of American manufacture and is allowed to remain in the warehouse for a period not exceeding six weeks or until fully tested, it may be shipped in substantial, well sewed canvas bags or sacks, so as to reasonably protect the cement from moisture.

Any cement damaged by water and caked to such an extent that the damage can be ascertained from the outside of the barrel or sack should be rejected.

It is also a good practice to occasionally weigh a barrel of cement as it is unloaded from the car into the warehouse.

Each barrel of portland cement should weigh at least 370 pounds net cement; sacks, if used should contain a fixed amount of cement or usually four sacks to the barrel.

Each barrel of natural cement should weigh at least 265 pounds net cement per barrel, bags, if used, to be of uniform size, usually two sacks to the barrel. All cement should be stored in a rain tight building, which is free from draughts of air, with the floor of the warehouse at least six inches above the surface of the ground in the clear. Cement which has deteriorated from moisture or other cause during storage should be rejected.

FINENESS.

It is an established practice to grind a portland cement to such a degree of fineness so that 99 per cent. will pass through a standard sieve with 2,500 meshes per square inch and 87 per cent. through a standard sieve with 10,000 meshes per square inch.

A natural cement is ground to such fineness that at least 90 per cent. will pass through a standard sieve with 2,500 meshes per square inch, and 75 per cent. through a standard sieve with 10,000 meshes per square inch.

The value of fine grinding has been amply proven; a laboratory test briquette made of the residue left upon a No. 100 sieve will demonstrate the fact that this material has little or no cementing qualities and therefore justly merits the term "inert matter."

The testing sieves are circular in shape with a strong wooden frame about 12 inches in diameter and 3 inches deep. In a No. 50 sieve the wire is made of No. 35 wire and that of No. 100 of No. 40 wire.

It is customary when testing cement by car load lot to weigh out 100 ounces of the cement from the various samples taken from the car; place 1-6 part of this in the No. 50 sieve and strike the sieve vigorously against something fixed or solid as the side of the room, allowing that portion which passes through the sieve to fall upon a thick white paper placed upon the floor; this operation to say the least requires considerable patience and should be continued until, upon shifting the sieve so that it is directly over a clear space on the paper nothing is observed to fall upon it, after a good shaking. Placing the residue in the scale pan, repeat the operation until the whole 100 ounces of cement has been treated. The residue is then weighed and the percentage through the No. 50 sieve calculated.

Then pass the part which has fallen upon the paper through the No. 100 sieve in the same manner as previously described; the result obtained by adding the residue secured upon the No. 50 sieve to that upon the No. 100 sieve will give the total residue upon this last named sieve from which the percentage passing through the No. 100 sieve can be calculated.

It does not always prove to be the case that the coarser ground cement is inferior to its finer ground competitor; in fact in certain cases, the laboratory tests may demonstrate that in regard to the question of tensile stress per square inch for briquettes made with the proportions one part cement to three parts standard sand,

Brand of Cement.	Percentage Through—	
	No. 50 sieve.	No. 100 sieve.
GERMAN PORTLAND—	100.0	96.4
Heyn Bros	99.6	93.3
Lägerdorfer	100 0	91.0
Star Stettin	98.7	87.9
Josson & Co		
AMERICAN PORTLAND—	100.0	94.8
Atlas	100.0	91.8
Alpha	100.0	95.0
Giant	100 0	96.2
Taylor	98.5	91.6
Empire		
AMERICAN NATURAL—	90.6	77.9
Utica	95.0	80.0
Milwaukee	99.5	92.5
Louisville		

the finer ground cement does not make the better showing thus indicating that there are other inert constituents in the cement.

CHEMICAL ANALYSIS.

The chemical analysis of a cement is an important factor in its manufacture but little importance is attached to it as a practical cement test.

The following table compiled from different sources is submitted in order to give a little information under this heading as something additional will be taken up in this line under "setting of cements:"

Name of cement.	CaO calcium oxide.	SiO_2 silicon dioxide.	Al_2O_3 aluminium oxide.	MgO magnesium oxide.	K_2O Potassium.	CO_2 carbon dioxide.	Na_2O sodium.	SO_3 sulphur Trioxide.	H_2O moisture.	Fe_2O_3 iron ferric-oxide.	$CaSO_4$ sulphate lime.
Empire Portland	61.96	20.55	6.19	1.82	1.11	1.46	0.72	2.04	0.17	.....	....
Giant Portland	61.37	23.36	9.24	1.00	0.25	......	0.25	0.50	.....	4.03	....
Condor Portland	64.38	24 00	5.86	0.9	......	......	......	0.83	.....	3.50	....
Star Stettin Portland	64.41	22.85	5.51	1.23	0.46	......	0.46	......	.....	2.76	2.86
Stettin Gristower	61.75	21.30	9.30	1·00	.. ..	......	......	1.97	.....	3.50	....
Lägerdorfer	61.99	23.55	7.47	1.42	0.35	......	0.54	1.07	....	2.40	....
Alsen Portland	59.98	24.90	8.22	0.38	0.25	......	0.25	0.86	2.16	3.00	....
Champion Silica Sand Cement	34.21	58.60	3.84	0.75	......	......	......	0.60	.....	2.00	....
Dyckerhoff	58.03	20.25	12.39	0.74	......	......	......	......	.....	4.03	....
Germania	64.38	22.36	2.83	1.87	......	......	......	......	.....	4.15	....
South Bend	60.25	19.26	14.54	......	......	......	......	......	... .	3 39	....
Buckeye	57.82	20.80	12.31	4.84	......	......	......	......	.....	4.64	....
Brooks & Shoobridge	57.68	22.74	11.44	0.51	0.31	3.50	0.32	0.60	1.90	.....	....
Knight, Beavan & Sturge	61.38	19.75	7.48	1.28	0.37	......	0.38	0.97	.....	5.01	....
Atlas	60.95	21.3	7.65	2.95	0.52	1.14	0.63	1.81	0.27	2.85	....
Slag Cement	51.57	27.15	10.80	2.70	......	......	.....	1.38	5.50	0.90	....
Utica, Natural, Clark Brand	22.27	20.84	20.39	15.24	......	......	......	......	15.07	2.19	. ..
Natural Cements: Louisville(Banner Bd)	46.90	18.92	11.02	0.97	......	......	......	......	.....	1.91	....
Milwaukee (Keystone Bd.)	36.08	23.16	6.33	20.38	3.00	......	2.27	......	7.07	1.71	....

SETTING.

When a neat cement is combined with water to such a consistency that the mixture will not show any excess of water on the surface when moulded upon a glass plate into a pat (about 3 inches in diameter; ½ inch thick at its center and having thin edges) and then allowed to remain in air under a damp cloth; it will be found to gradually change to a solid mass. This process is called "setting" and the rapidity with which a cement "sets" or loses its plasticity determines whether a cement is quick or slow setting.

Quick setting cement becomes set in less than ½ hour, and a slow setting cement requires a longer time than ½ hour, but not longer than twelve hours to reach its final set. The theories in regard to the setting of cements, that have been advanced by Le Châtlier as published in "Annales des mines, Paris, 1899, are now generally accepted."

He stated that the setting which is a rather sudden change, is due to the formation of the calcium aluminate and that the ultimate hardening or increase in strength is due to the calcium silicate.

It was also shown that upon mixing a neat cement with water the following chemical transformation takes place:

$$3\,\mathrm{Ca_2\,Si\,O_4} + \mathrm{Ca_3\,Al_2\,O_8} + 6\,\mathrm{H_2\,O} =$$

$$= \left\{\begin{array}{l} 2\,(\mathrm{H\,O\,Ca\,O})_3\,\mathrm{Al} \\ \text{Hydrated calcium aluminate} \end{array}\right. + \left\{\begin{array}{l} 3\,\mathrm{H_2\,Ca\,Si\,O_4} \\ \text{Hydrated calcium silicate.} \end{array}\right.$$

The hydrated calcium aluminate at once begins to crystallize out in the form of needles which extend in every direction and are the first cause of the setting of a cement; at the same time a much slower process begins in the gradual crystallizing of the hydrated calcium silicate which gives the final hardness or strength to the cement.

The character of the crystalline structure of the cement is greatly influenced by the temperature; at 60° Fahrenheit the crystals receive their normal development and also an increase in the temperature above 60° Fahr. accelerates the production and decreases the size of the crystals; this has the effect of decreasing the ultimate strength of the cement; likewise a drop in the temperature causes the crystals to form slowly with a corresponding increase in the size of the crystals and a diminution in their number; this too has the effect of lowering the strength of the cement. To illustrate, the retarding influence of the temperature on the setting qualities of a cement a laboratory experimental test with briquettes made at a constant temperature of 60° to 80° Fahr., and having the proportion of one part cement to three parts standard sand can be successfully taken from the moulds in 15 hours, while if the temperature is reduced to 35° Fahr. it will require at least 50 hours to remove the briquettes from the moulds, although the same sample of cement is used in both cases. The initial and final points of setting of a cement have been arbitrarily fixed. There are a number of methods by which these points are established, the one used in the United States was first recommended by Gen. Gilmore, who took a pat of neat cement and found the time at which a wire 1-12" diameter and sustaining a load of ¼ pound would cease to penetrate the pat, calling this point the initial set and the time at which the pat would sustain a wire 1-24" diameter and loaded with one pound was called the final set of the cement.

This method applied to the same brand of cement does not always give an identical result when used by different experimenters for the following reasons:

I. Variation in percentage of water used in making the pats.

II. Temperature of surrounding air.

III. Condition of the damp cloth used to cover the pat so as to prevent the rapid drying out of the surface of the pat.

The time is reckoned from the moment of adding the water to the neat cement; these two ingredients should be thoroughly and evenly mixed upon the marble mixing slab for an interval of 5 minutes before forming the pat. Immediately after making the pat its number should be traced upon its surface with a sharp point. In making the pat just enough water should be added to the neat cement to secure a mixture of such plasticity that it will retain its form readily upon a glass plate and show no excess of water upon the surface of the pat when smoothed down by a trowel.

The temperature of the surrounding air should be from 60° to 70° Fahr.

The towel used to cover up the pat should be immersed in water of about 65° Fahr. and then wrung out by hand so as to leave it slightly moist and as fast as the atmosphere takes up the moisture in the towel, the operation of dampening the towel should be repeated.

	Initial $\frac{1}{12}'' \times \frac{1}{4}$ lb.	Final $\frac{1}{24}'' \times 1$ lb.
GERMAN PORTLAND—		
Heyn Bros	0° 23′	6° 42′
Lägerdorfer	1° 29′	2° 55′
Star Stettin	2° 50′	6° 15′
Josson & Co	1° 15′	2° 19′
AMERICAN PORTLAND—		
Atlas	2° 01′	6° 12′
Alpha	1° 56′	6° 29′
Giant	2° 15′	6° 35′
Saylor	1° 25′	7° 05′
Empire	2° 08′	6° 34′
AMERICAN NATURAL—		
Utica	0° 46′	1° 55′
Milwaukee	0° 30′	1° 00′
Louisville	0° 45′	1° 25′

For all practical purposes it is only necessary to know whether the cement to be used in the concrete work is quick or slow setting without any particular notice of the initial or incipient set. In the ordinary cases of concrete construction work the concrete can be mixed, deposited in the form, and tamped before the initial set of a slow setting cement has taken place. It is indeed a mooted question whether retempering a cement does anything more than delay the time of final setting as we have already observed that the ultimate strength due to the final crystallization of the hydrated calcium silicate is a slow process.

The Germans, therefore, have adopted as a standard test for the final test, the practice of taking a pat of neat mortar and then testing the pat from time to time until it will resist the penetration of the finger nail when under a slight pressure.

CONSTANCY OF VOLUME.

The volume of a cement should not change; to determine this attribute the American Society of Civil Engineers recommended that cold air and water pats of neat cement be used; this test requires from 3 to 28 days for development.

Mr. Faija elaborated upon this plan by adding the experiment of subjecting a pat to the effects of a warm water bath for a period of 24 hours, at a temperature of 110° to 115° Fahrenheit.

Dr. Michealis first proposed to use a higher temperature, asserting that the increased temperature would advance the hardening of the cement to such an extent that by this accelerated test one could form a better opinion of the durability of the cement. Dr. Michealis and Prof. Tetmajer adopted the 24 hour boiling water test, that is, a pat of neat cement upon reaching the final set of the cement was then immersed in cold water, then the water was gradually raised to the boiling point and maintained at a temperature of 212° for the remainder of the 24 hours.

Mr. Maclay first used the plan of subjecting the pat, after reaching the final set of the cement, to the action of a steam bath for the remaining portion of the 24 hour test.

Of recent date the method of placing a pat in a current of hot air has been investigated as a laboratory test.

A cement must be free from all substances that may produce deleterious expansive action in a mortar made therefrom. The cement must not warp, check, crack or show other indications of unsoundness, when neat cement and water are taken so as to form a mortar of such consistency that it will retain its form when moulded upon a glass plate into a pat about three inches in diameter, ½ inch thick at the center and becoming thinner at the edges.

The pat should be left to set and harden under a damp cloth for 24 hours, as cement pats while setting should be protected from exposure to currents of air and the sun by means of a damp cloth, if not so protected the rapid evaporation of the water will cause air cracks to appear and the entire surface of the pat will scale up before setting begins. After the pats have been left for 24 hours under the damp cloth they may be exposed to air and water at ordinary temperatures.

If the pats while hardening in air or under water show signs of warping or cracks along the edges it indicates expansion of the cement; these indications of expansion generally appear in about 3 days, but in any event an observation of 28 days is sufficient.

The various methods of steaming and boiling pats or briquettes are not of recent origin but have been employed for a number of years by the manufacturers of portland cement, more particularly in Germany, as a means of determining the quality of their cement.

It is a well known fact that the presence of an excess of free lime (due to careless method of manufacture) in a portland cement will eventually cause a decrease in the cohesion of the molecules and an increase in its volume; it may therefore lead not only to permanent loss of strength but to a total disintegration of the mortar. These tests were however abandoned by the German cement manufacturers in 1892, for after careful study and examination these tests were thought to be unreliable, even though taken in conjunction with the other cement tests.

The following reasons were advanced for such action:

I. That the excess of free lime was not in all cases promptly detected by steaming and boiling tests.

II. Certain unreliable cements successfully passed these violent tests.

III. Magnesia could be placed in cements to the extent of 15% without any serious results while undergoing these tests and yet over 2% of magnesia in a cement is ruinous in its effect.

Notwithstanding the position taken by the German manufacturers, these tests will generally reveal a cement of imperfect manufacture. In making the tests an oil stove and a wash boiler with its cover are the important utensils, however the apparatus is not complete without a wire netting made to fit the interior of the boiler and fixed in position so that the pats when placed upon it are completely immersed in the hot water. A second wire netting is suspended within the boiler about one inch above the water level as in this position the pats when placed upon it are enveloped in the steam or vapor rising from the hot water.

If there be an excess of free lime in the cement these hot tests will cause the pat to expand and disintegrate. In expanding the pat will flatten out, increase in diameter, and numerous radial cracks will pass through it from its center to the circumference, besides all this the adhesive properties of the cement are annihilated and the cement is reduced to a worthless powder. Should the experimenter meet with anything of this character it is well to repeat this test after having treated the sample of cement to air slacking for say 7 days, by placing the cement in a pan and stirring it about daily; then, instead of making a pat, mould a briquette and after it has been 24 hours under a damp cloth observe how nicely it fits into the clips of the testing machine. After treating this briquette to the hot water or steam bath for about 3 hours again observe how well the briquette fits the testing machine clips, of course, if the briquette has expanded it will no longer fit the clips even though the expansion cracks which appear in the pat test are not usually manifest when the briquette is employed. If after exposing the cement to air slacking it blows or shows unsoundness or expansion at the second test the propriety of using it in concrete work is extremely doubtful.

TENSILE STRESS.

The form of briquette adopted is that recommended by the American Society of Civil Engineers and having a cross-section at its middle of one square inch in area. The standard tests are for 7 and 28 day intervals using neat briquettes and briquettes with the proportions of one part cement to one part standard sand for all natural cements; neat briquettes and briquettes one part cement to three parts sand for all tests of portland cements.

A comparison of the actual results obtained in different laboratories will demonstrate the necessity of having all tests made in a thoroughly reliable and exact manner; even then there is a marked variation owing to the following considerations:

I. Difference of temperature in laboratory.

II. Percentage of water used in mortar.

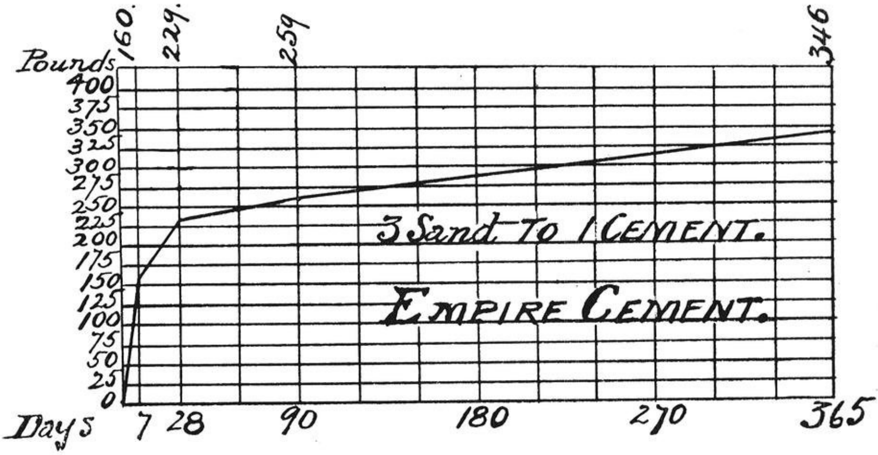
III. The manner and energy with which the mortar is prepared.

IV. The way in which the mortar is placed in the moulds.

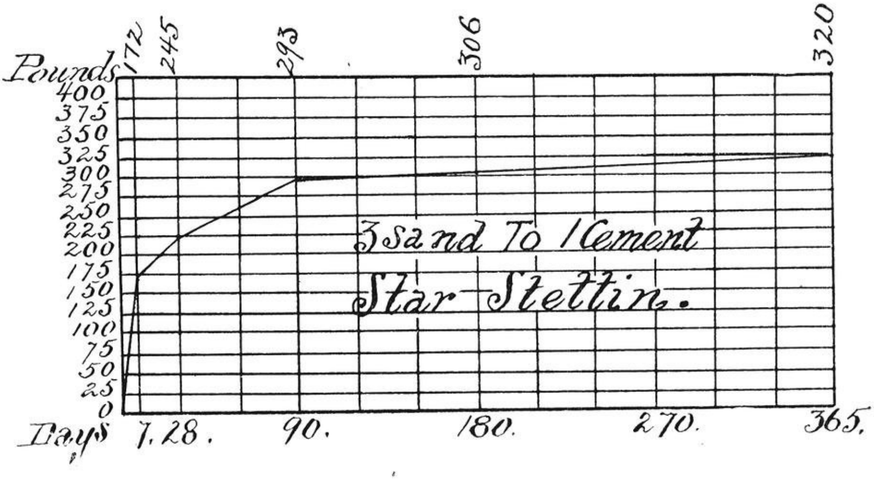
V. Temperature of water in immersion trays.

The test of neat cement although employed, is not to be considered of as much importance as the sand test or the capacity of the cement to carry sand, because oftentimes an inferior brand of cement will give a very high short time neat cement test,—indeed, the German portland cements do not show as high neat cement tests for the 7 and 28 day periods as their American competitors, yet the sand tests develop satisfactorily the superiority of the German cements.

It is desired to describe a way of making cement briquettes by hand similar to that introduced by the Germans.



American Portland



German Portland.

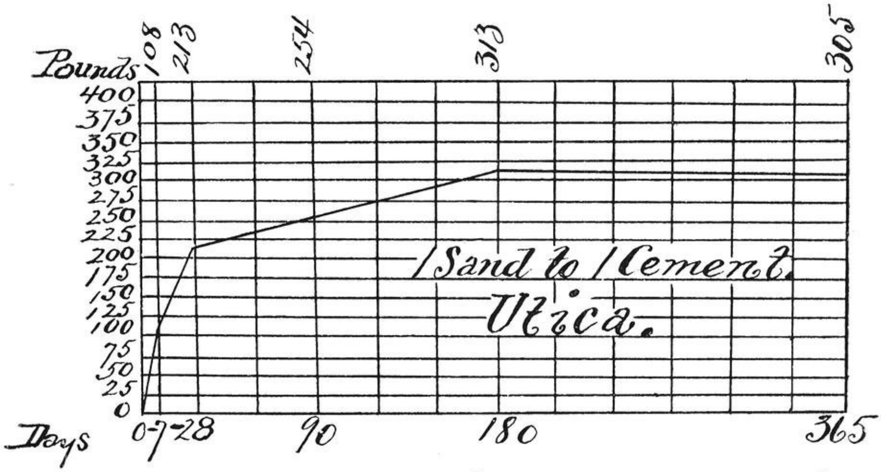
The quantities used in the mixture or mortar are determined by weight.

By sand referred to in these tests for tensile strength is meant standard sand or clean crushed quartz screened through No. 20 sieve and caught on No. 30 standard sieve.

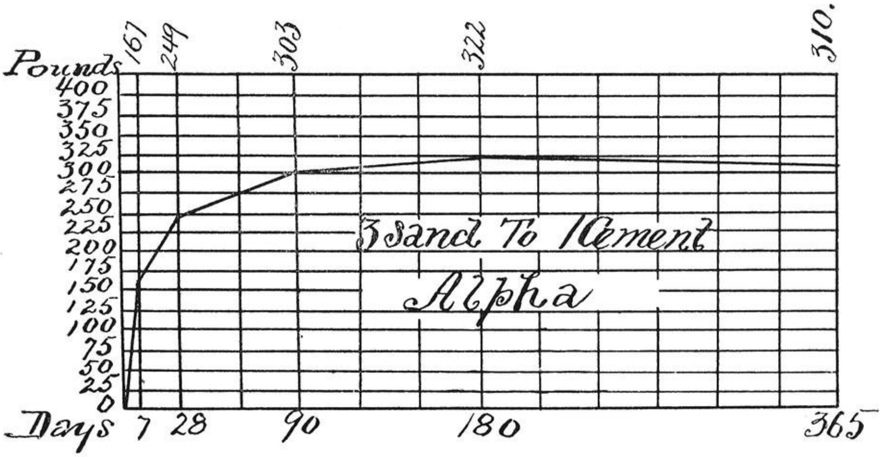
By this method four briquettes are made at one time and constitute one number in the record book, two of the briquettes being made for the 7 day tests and two for the 28 day tests.

Place four clean moulds directly on the glass plates upon the mixing slab and then proceed to weigh out 15 ounces of standard sand and five ounces of cement; then thoroughly incorporate the dry sand and cement with a small trowel upon the marble mixing slab for at least five minutes or until the resulting mixture is entirely homogeneous; add at one time from 8 to 10 per cent. of water and mix again with the trowel as rapidly as possible for another five minutes. The percentage of water added should make the mortar at the end of the five minute mixing about the consistency of freshly dug moist earth; then fill each mould about one half full of the mortar and proceed to thoroughly ram it with a brass rammer (having a diameter of ⅝ inches at one end and upset to ⅞ inches diameter at the other; it being 8 inches long and weighing 16 ounces) by letting the rammer fall freely about one-half inch in striking the mortar; this process is continued until moisture flushes the surface so as to remove all air bubbles and to have the mortar thoroughly and evenly packed in the mould. Repeat this process twice more in filling the moulds and with the trowel strike off the mortar level with the top of the mould. Place the briquettes upon the glass plates on another table and cover them with a damp cloth for the remainder of the 24 hours taking care to preserve the number of each briquette by means of a marked slip of paper placed under each mould.

Remove the briquettes from the moulds before the end of the first 24 hours and the number of each one can be marked upon its surface with a soft lead pencil; with the exception of the 24 hour test briquettes, all are immersed in water; the briquettes being placed on edge in order to expose a greater surface to the water. The water in the trays should be changed three times per week.



American Natural.



American Portland

With this system of making cement briquettes the following specifications for the tensile stress per square inch for both natural and portland cements have been carefully established.

Natural cement.	24 hrs. lbs. per sq. inch.	7 days lbs. per sq. inch.	28 days lbs. per sq. inch.
Neat briquettes	60	100	180
1 part cement to 1 part sand	....	90	180

Portland cement.	7 days lbs. per sq. inch.	28 days lbs. per sq. inch.
e at briquettes	450	550
1 part cement 3 parts sand	135	240

Care should be exercised in keeping clear records as to when the briquettes should be broken; about the best way is to secure a large almanac with considerable space about the figures and mark upon it, at the time of making the briquettes, the advance dates upon which it is desired to break them, so that the written numbers in the space about the printed figures of the calendar will at once give the desired breaking list without reference to the daily record books; this method will act as a check upon the system of notes kept.

A good way to clean the brass moulds is to rub them over with a piece of cotton waste saturated with coal oil and then allow the oil to remain upon the moulds a short time; then scrape the cement off with the trowel or case knife and rub dry with a clean piece of waste. Everything about the testing laboratory should be kept scrupulously clean and all surplus waste materials should not be permitted to accumulate.

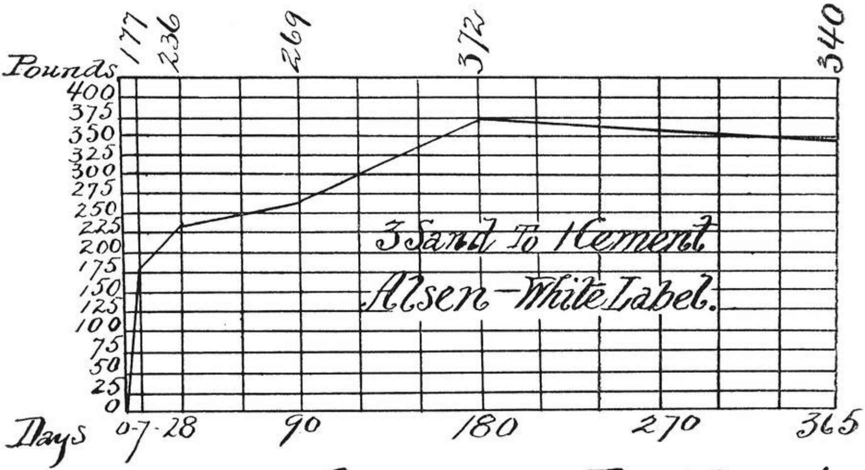
SAND AND PEBBLES OR GRAVEL.

In conjunction with all concrete work there are a number of interesting and necessary experiments to be made; these are the determination of the voids, size of the aggregates and the percentage of clay or earthy matter in the different samples.

Sand may be said to be clean, sharp or angular, reasonably coarse grained, silicious and not containing over 2 per cent. by weight of clay or other earthy impurities.

That part of the gravel which passes a No. 4 sieve will constitute sand.

Ordinarily for the facing work of concrete masonry torpedo sand is employed or that portion of the gravel which passes through a No. 5 sieve. The percentage of clay can be obtained by washing the sample (about ten pounds), collecting the wash water with its impurities in a jar; then after allowing the water to settle draw off the clear water on top with a siphon and then evaporate the remainder to secure the clay residue.



German Portland

Pebbles constitute that portion of the gravel which does not pass through the No. 4 sieve and should be clean, of tough, hard material, and from ¼ inch to 2 inches in dimensions. Pebbles are often used as a substitute for crushed stone in concrete masonry construction. Gravel may be said to be a natural mixture of sand and pebbles, grains varying from fine sand (passing through No. 50 sieve and caught upon No. 70 sieve) to large pebbles of 2 inches in dimensions.

Gravel containing vegetable matter or more than 2 per cent. of earthy impurities should not be used for concrete purposes.

The sand in the gravel should not materially exceed the voids in the pebbles; before using the gravel for concrete masonry the exact percentage by volume of sand and pebbles contained in the gravel should be ascertained and the mixture proportioned accordingly by the addition of sand or pebbles as the case may demand.

AN EXPERIMENTAL LABORATORY TEST WITH PORTLAND CEMENT CONCRETE.

Take 8 ounces by volume (apparent), as determined in the glass graduate, of pebbles, size of pebbles screened through a No. 3 sieve and caught on No. 5 sieve; pour water into the graduate until the water exactly reaches the top of the pebbles; this was found to require 4 ounces of water indicating 50 per cent. voids for the pebbles taken in this experiment.

Then take 4 ounces by volume (apparent) of standard sand and place it in the graduate and again add water until it reaches the top level of the sand; the water added in this case was found to be 2 1-16 ounces, or in other words, the standard sand contained 51½ per cent. voids.

Then add 2.06 ounces of portland cement by volume and 1.04 ounces cement as the cement shrinks to 2-3 its original volume upon adding water, making a total of 3 1-10 ounces of cement added by volume of dry cement.

We then have for our aggregates:

8 oz. by volume pebbles.

4 oz. by volume standard sand.

3 1-10 oz. by volume dry portland cement.

Four briquettes were made of the above mixture and after being allowed to remain in air under a damp cloth for 24 hours, two briquettes were left 6 days in water and the other two 27 days in water before they were broken.

7 day briquettes gave 171 lbs. tensile stress per square inch.

28 day briquettes gave 303 lbs. tensile stress per square inch.

In the foregoing experiment the clay or earthy impurities were removed from the samples of pebbles and sand by washing them.

FIRE PROOF BUILDING CONSTRUCTION.

BY J. T. RICHARDS.

The different uses of fire-proofing material in a building are as follows:

(1) *Floors*—The filling in of the spans between iron beams.

(2) *Partitions*—The 2" to 6" walls dividing the interior of a building into rooms.

(3) *Furring*—The covering of the inside of exterior exposed walls, leaving an air space.

(4) *Column Covering*—All interior columns and those left exposed by brick work.

(5) *Girder Covering*—All girders projecting below the floor arches.

(6) *Ceilings*—The placing of false or hanging ceilings.

(7) *Roofs*—Flat or sloping base for slate, etc.

MATERIALS USED.

The different materials used are few in number and the peculiar application or use in certain places sometimes makes one more desirable than another. The following constitute the principal materials now in use, singly or in combination:

(1) Clay, or terra cotta (dense and porous).

(2) Concrete (solid), as a lintel in floor construction.

(3) Concrete (cinder), supported by light iron work.

(4) Plaster-blocks, of plaster-of-paris as foundation material.

(5) Expanded metal or wire lath supported on light iron work leaving an air space.

FLOORS.

There are many systems of floors on the market, some few of which are standard and much used, and others practically of little value. A floor sytem to be practical must meet the following requirements:

(a) It must be absolutely fire-proof, and be able to withstand sudden changes of temperature without failing or cracking, as is often the case when water is applied while the material is heated.

(b) It must be readily adaptable to any width of span up to 8 feet, as in every building there is a variety of widths of spans, due to the odd shape of the building plot, spaces left for light areas, courts, stair and elevator wells, etc.

(c) It must come within the limit of the weight specified per square foot and be of the strength required in the specifications.

(d) It must be easily applied in the building.

(e) The point that governs most is the cost. It must be able to compete with other systems.

Of the systems now in use, the terra cotta, cinder concrete and brick are of the arch system. The solid concrete, plaster blocks, etc., are of the lintel system. Perhaps the most used material is terra cotta. It has been the standard and given the best results, with but one drawback, its weight. It is made in two grades, known as "dense" and "porous" terra cotta.

Dense material is made from the clay tempered to a stiff, plastic condition, usually adding sand or ground brick to lessen the shrinkage in burning and thus to prevent cracking. Porous material is made the same way but with the addition of combustible materials, as sawdust, cinder or coke, which, burning out, leave the burned material full of cells or pores, rendering it less refractory and soft enough to receive and retain a nail. The porosity of material also increases its value as a non-conductor of heat.

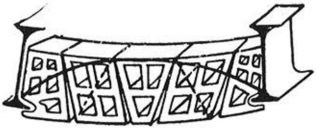


Fig. 1.

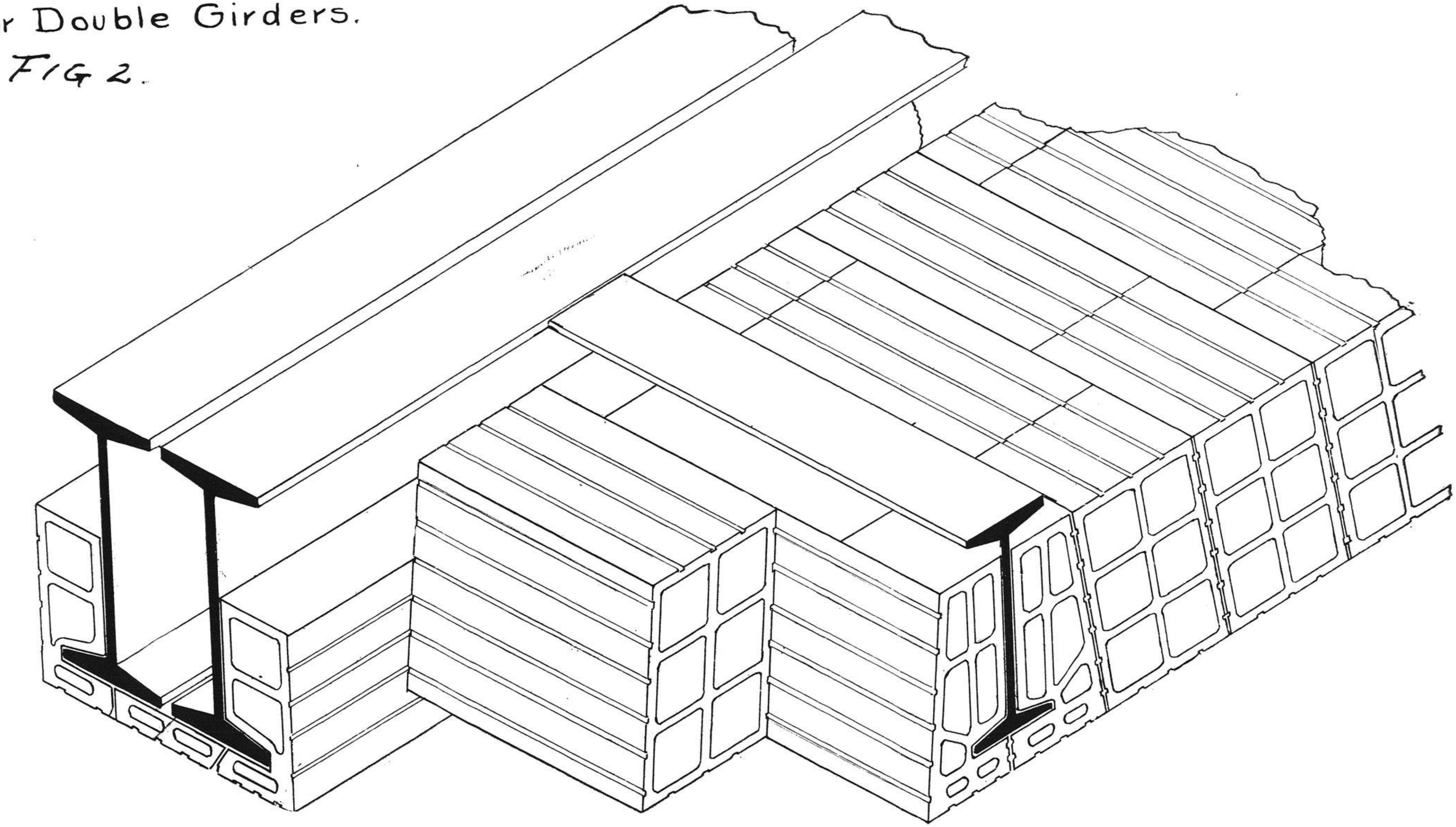
Terra cotta arches are made in both "side" (Fig. 4) and "end" (Fig. 5) construction. In the former the hollows run parallel to the beams and in the latter at right angles to them. The former has been used mostly but the latter is becoming the favorite for several reasons, viz.:

(1) Less cost of manufacture.

(2) It requires but one die.

(3) The different shapes are made on the cutting-off table.

2" SIDE CONSTRUCTION ARCH
AND
Method of covering
Single or Double Girders.
FIG 2.



The "side" construction requires a die for each shape and means a loss of time in setting the dies.

The "end" construction is the stronger, as the clay is moving in a line with the cells, which is also the line of thrust in the arch, as shown in Fig. (3). Figures (1) and (3) show the line of compression which is an arc drawn through the seat of the arch on the lower flange of the beams and the highest part of the arch. Now, to consider one block, the strain will follow the dotted line diagonally across, so in the "end" construction it is in the webs while in the "side" it must cross the core.

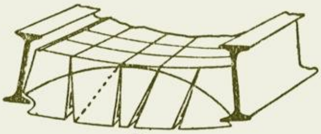


Fig. 3.

In Figs. (5) and (4) is shown the arch made up of two skew-backs, to fit the beams, intermediates and a key. The material is always made 12″ long with two sizes of intermediates and three or more of keys. This material (clay) is the standard to-day, although the entire weight of the fire-proofing for a building slightly exceeds that of the structural iron and is several times more bulky.

The segmental form of arch, Fig. (6), is much used and is very economical where the ceilings are not required to be flat. Where the ceilings are flat metal ceilings are hung underneath.

Concrete (solid) forms, acting as lintels, are not economical, and having to depend on their acting as beams, require metal ceilings usually, so increasing the cost.

Concrete (cinder) forms, as the Roebling system, are meeting with some success and are very good for a certain class of buildings, as warehouses, etc. They are usually made as in Figs. (10), (11), woven wire with a rib every 12 inches sprung between the beams and the cinder concrete filled on that, Fig. (10), while a metal lath ceiling is hung underneath. The main defects in this system are the opportunity to slight the concrete and the length of time required to dry, an item of great importance when a building is being rushed to completion.

Another system that deserves mention is the Rapp system, Fig. (7), which has tees made of sheet iron bent in an arc and the brick laid dry on them and filled up with cinder concrete. The tees are anchored together as shown in the sketch. This system is used quite extensively in the cheaper class of large buildings. The average weight of floors with flat ceilings or segmental forms with suspended ceilings, is given below:

Terra cotta arches.

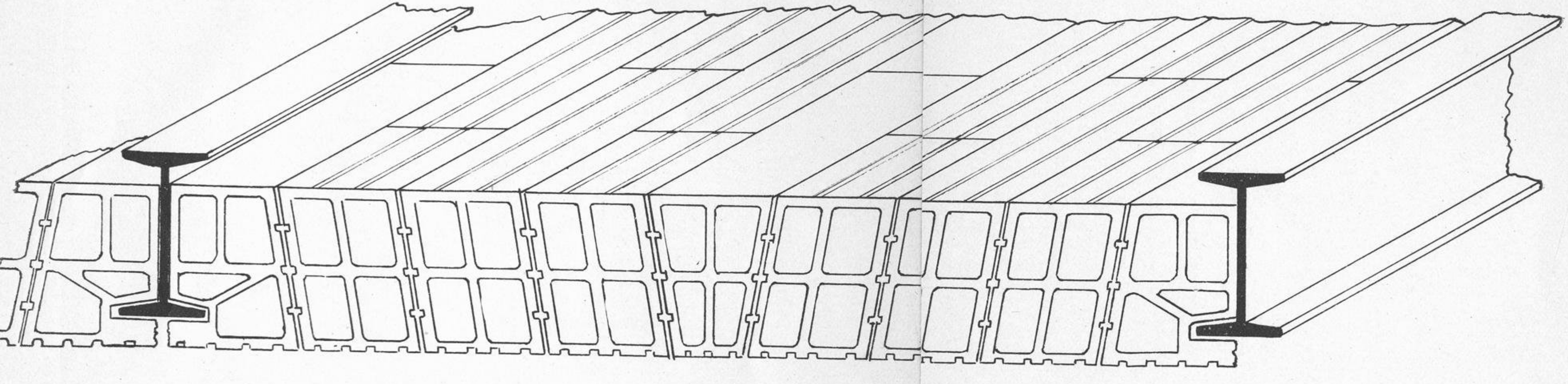
Depth of arch.	Weight per sq. ft. arch.	Weight ceiling.
12 (flat)	44 lbs.	
10 (flat)	38 lbs.	
9 (flat)	36 lbs.	
8 (flat)	32 lbs.	
7 (flat)	30 lbs.	
6 (flat)	27 lbs.	
6 (Segmental)	27 lbs.	10 lbs. flat ceiling.

PARTITIONS.

There are perhaps more forms of partitions than of floor systems, but the same preference is given the terra cotta here as in floor arches. The main essential is not strength, but that they may be sound-proof. Many patent partitions fill all other requirements but fail here. The clay blocks are usually 12″ x 12″, and of the thickness required, 2″, 3″, 4″, or 6″, usually 3″ or 4″.

Perhaps the next best partition made is the plaster block, macite or mackolite, which is porous, cuts readily with a saw and holds a nail well. It is especially adaptable to office buildings, where whole partitions frequently have to be cut loose and moved.

The 2″ wire lath partitions are used where space is to be economized, 1½″ angles or channels are placed vertically with sufficient cross ties and the wire lath or expanded metal stretched on this. It is plastered on one side, then filled up with plaster, and is sometimes called the 2″ solid partition. This is not entirely sound-proof, owing to its solidity. A sound-proof partition must have a dead air space. Hence, we cannot expect a good partition less than 3 or 4 inches thick.



STANDARD 8" ARCH

Wgt 32# per sq. foot.

FIG 4

FURRING.

The covering of inside of exterior walls where exposed is usually done by leaving about 2″ of air space to keep out dampness, cold or heat during extremes in the weather. As a rule, basement walls are furred and all walls less than 16″ thick. Two systems are in use, terra cotta and metal lath.

Terra cotta is 2″ thick, made two pieces together, Fig. (8), so they can be easily split with a trowel at the building. Nails are driven into the brick joints to help hold it in place.

Metal lath furring is made by fastening 1¼″ angles or V-shaped uprights to the brick wall, 12″ centers, and stretching the metal lath on these, fastening it with wire clips. The terra cotta requires two coats of plaster and the metal lath three coats.

Column covering and girder covering are made to fill the sections of beams to be covered when made of terra cotta, or if of metal lath, a light iron frame work supports the lath.

ARCHES.

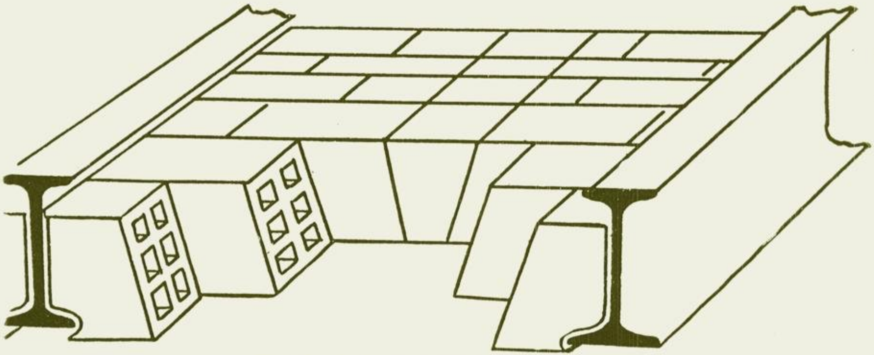


Fig. 5. End construction arch.

CEILINGS.

Ceilings of terra cotta are usually made by spacing tees 18″ to 24″ centers and laying the blocks on these, a rabbit being cut in each and so the course is flush with the bottom of the tees. Blocks are 2″ or 3″ thick.

Metal lath ceilings are more economical, being lighter and so cheaper to put up. Three-inch channels are hung with 5′ centers or under the roof or floor beams (for hanging ceilings), and 1″ channels, tees or angles, 12″ centers fastened to these by clips and metal lath applied as for partitions.

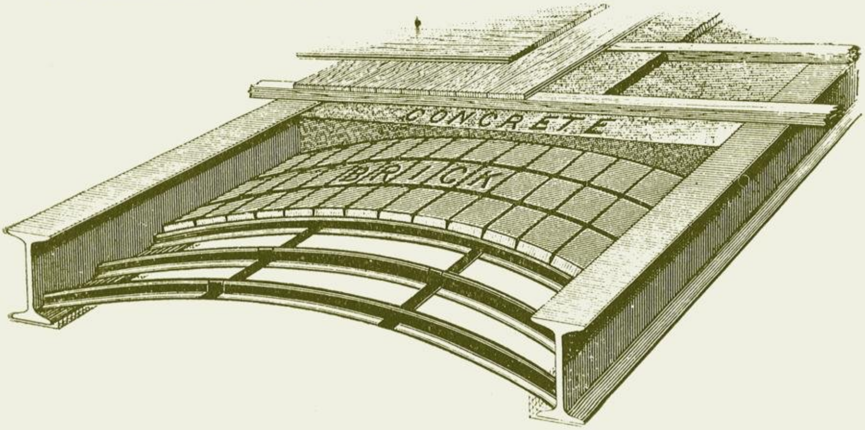


FIG. 7.

Flat roofs with only a slight pitch usually have hanging ceilings for two reasons:

(1) To produce a flat, level ceiling.

(2) To make the top floor cooler.

ROOF BLOCKS.

For a roof where arches are not used, or pitched, mansard or tower roofs, terra cotta blocks are universally employed. They are usually made 3″ x 12″ x 18″ or 24″, Fig. (9), tongued and grooved, and commonly known as book tile. These are laid between tees, spaced 19″ or 25″ centers and are porous, so the slate or other roofing material can be nailed to them.

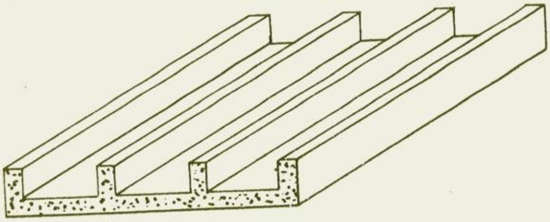
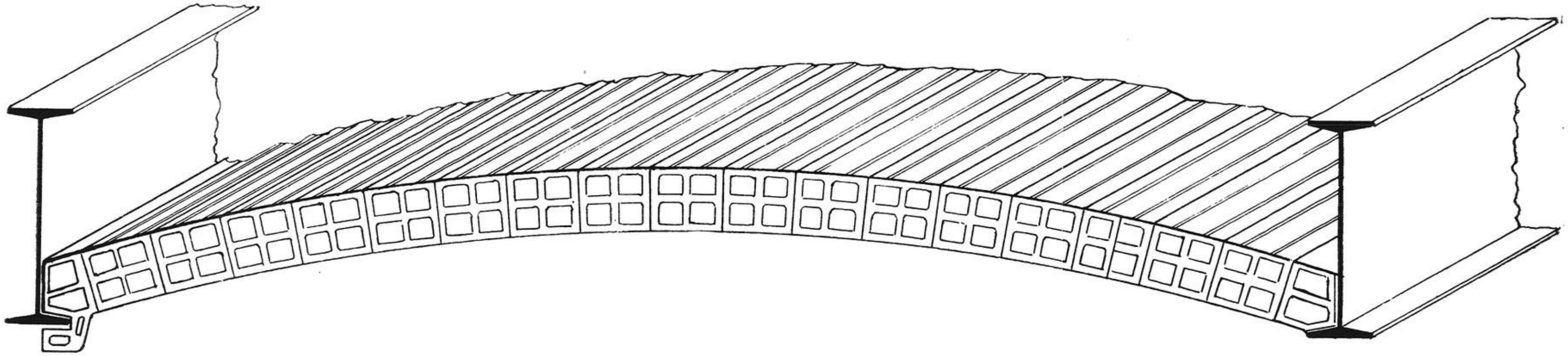


FIG. 8.

2″ x 12″ x 12″ Furring



6" SEGMENTAL ARCH

Showing protected and non-protected flange.

27# per sq. ft.

FIG. 6.

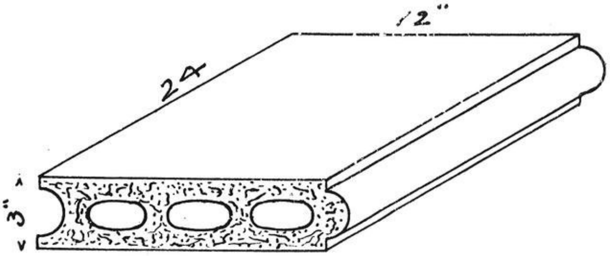
This practically completes the fireproofing of a building, ready for the plastering and finishing. We give below a set of specifications for the fireproofing of a building.

SPECIFICATIONS.

Fireproofing work for an office building.

Materials used must be of the best of the several kinds. Material and workmanship must meet the approval of the architect, or his representative, and all condemned material must be removed from the site at once.

Floors.—Fill in the iron floor beams with 10″ dense or porous terra cotta blocks, side or end construction, 1″ bevel, sound and true, of a cherry color, with a clear ring when struck. The skew-backs shall accurately fit the flanges of the beam with lips 1″ thick, or soffit tile to protect the lower flange. They shall be set in (——) cement mortar and form a smooth, uniform ceiling underneath. Fill in over the arches with cinder or broken terra cotta to the top of the floor strips after the same have been laid by the carpenter.



3"×12" Block

FIG 9.

Partitions.—Build all partitions as shown on plans of sizes marked, of porous terra cotta blocks with web of sufficient thickness to retain a nail; (or, if dense material is used, 20% to be porous as above for nailing purposes). Cover all flues and vents as shown on plans.

Furring.—Fur the entire basement wall, except in coal-room

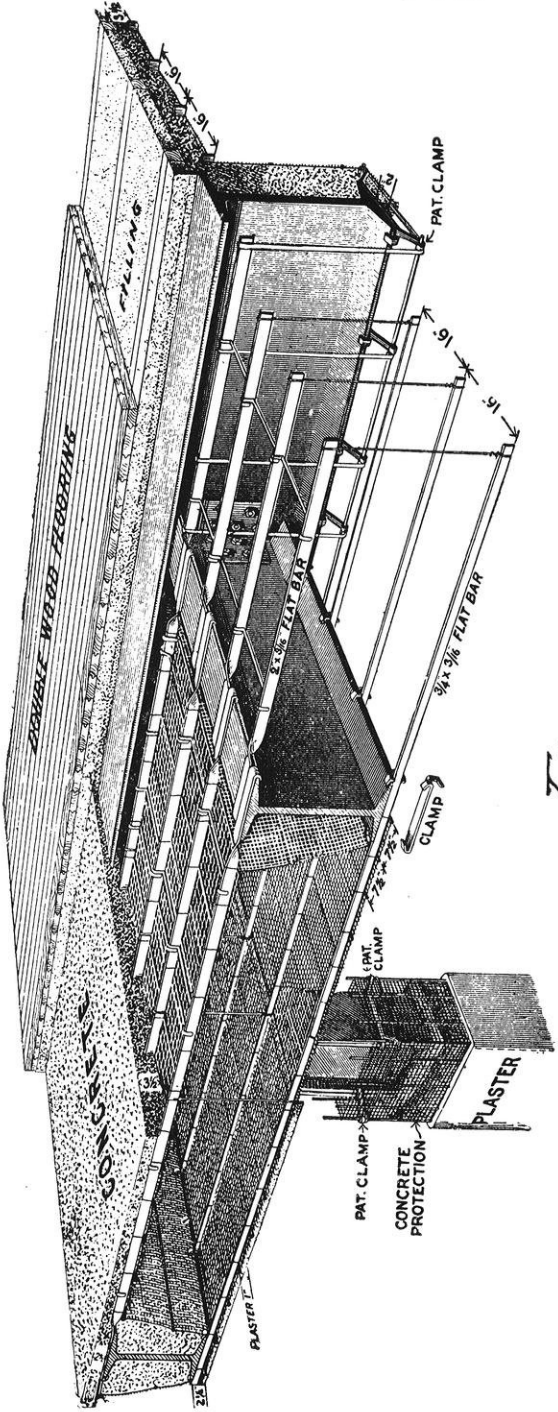
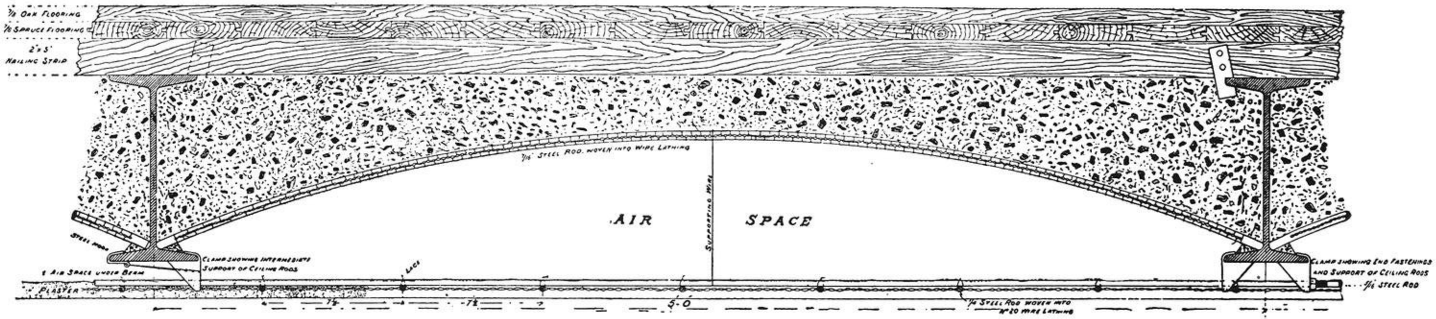
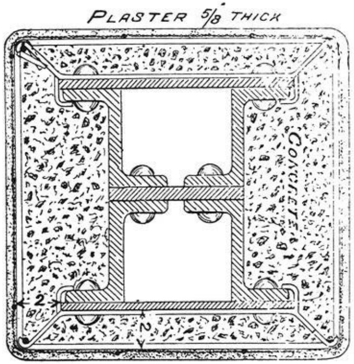

DOUBLE WOOD FLOORING
FILLING
CONCRETE
3½
16
16
2
PAT. CLAMP
16
16
2 x 3/16 FLAT BAR
3/4 x 3/16 FLAT BAR
CLAMP
7½
7½
PAT. CLAMP
PAT. CLAMP
CONCRETE PROTECTION
PLASTER
3½
PLASTER
2½

FIG 10.

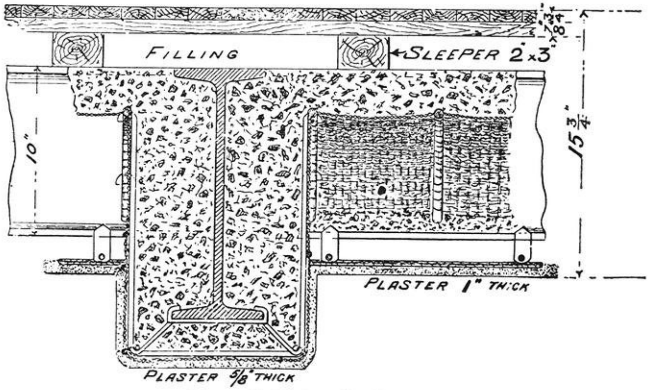


Adapted for Public Buildings, Offices, Theaters, Hotels, Schools, Churches, Banks, Libraries, Hospitals, Residences, etc.



Typical Column Section.

FIG. 11.



Typical Girder Section.

and boiler-room, over and under all windows and doors, and all exterior walls that are exposed (no party walls are to be furred) with 2″ porous terra cotta furring or other material approved by the architect.

Hanging ceiling in the top story, to be suspended from the roof beams, may be of 3″ terra cotta blocks or "B" Expanded Metal lath. Ceilings must be true and level and at the height on plans.

Roof Blocks.—Fill in the iron work of mansard roof with 3″ porous terra cotta blocks, also roof of pent-house.

Girder and Column Covering.—Cover all girders and columns with 2 inches of terra cotta, the same to be set true to line and pointed up.

The contractor is to remove all material and debris from the building, do all patching after the other workmen are through, and turn over his work thoroughly completed.

MONTANA COALS.

W. H. WILLIAMS.

In many ways nature seems to have been more kind to the North American continent than to any other section of the globe. In no way is this better manifested than in the distribution of mineral resources. Not only are they abundant, but coal, that indispensable article in all mining and metallurgical operations, seems to have been very generally and promiscuously distributed, so that it is nearly always to be found in close proximity to great metal producing districts, thus furnishing at moderate cost the fuel necessary for operating mines and reducing the ores.

In no state is this better exemplified than in Montana. The great gold, silver, copper, and lead mines of this state are nearly all situated in the main chain of the Rocky mountains. In an irregular group of mountains forming the outlying eastern chain of the Rocky mountain system are found nearly all the coal mines of any consequence in the state. Thus the haul from the coal mines to the reduction works varies from 50 to 200 miles. This eastern spur of the Rockies extends from the Yellowstone park in a northwesterly direction nearly to Great Falls, the different mountains making up the chain being known as the Gallatin, Bridger, Little Belt, Big Belt, etc. The geological surveys show coal indications scattered through the entire length of the range. Indeed, large coal mines are now in operation at Horr and Cinnabar on the northern line of the Yellowstone Park, and at Sand Coulee and Belt, a few miles southeast of Great Falls, as well as at numerous places between these.

The only coal measures so far discovered, outside of this group of mountains, are on Rocky Fork Creek, and Clarke's Fork of the Yellowstone in Carbon County, about 100 miles east of Cinnabar, and near the Wyoming line. Of these the Rocky Fork Coal Company's mines at Red Lodge have been longest open, having been in operation since 1889. The mines at Gebo and Bridger have been opened since 1898.

All the coal measures so far discovered belong to a comparatively recent geological era, and hence they consist of bituminous or semi-bituminous coals. Some of the semi-bituminous coals are not very far removed from lignite. Some recent discoveries of coal in the Gallatin mountains are claimed to be semi-anthracite, but for this we have only the word of the enthusiastic prospector, as they have not yet been put on the market. A diamond drill prospecting outfit in Fergus county has recently reported the finding of a bed of anthracite near Lewiston. It is to be hoped that this may prove true, as it would be a positive boon to all domestic users. I have seen several coal veins showing on the faces of cliffs in the Bridger mountains. These outcroppings show very thin veins, however, not thick enough to pay for working.

Most of the Montana coal veins are tilted into approximately vertical positions and are mined by what is called the "stoping" process, so that little timber is used and no pillars are left. This is the same method of mining as is practiced in all thin, nearly vertical veins of mineral.

The largest mines at Belt and Stockett, near Great Falls, are worked by the Amalgamated Copper Company, and the greater share of their output shipped to their mines and smelters at Butte and Anaconda. At each of these mines the daily output is about two thousand tons of coal, while from the Belt mine, which produces a coking coal, about 150 tons of coke are shipped daily. Coking coal of a better grade is found at Horr and Cinnabar, near the park line. At each of these places the Montana Coal & Coke Company has large plants of coking ovens, the daily shipments amounting to 150 to 200 tons. The hardest coals found in the state are mined on Trail Creek, in Gallatin County, and Bridger, in Carbon County. Each of these coals are truly bituminous, but high in ash, due to more or less clay mixed with the carbon in a finely divided state. They are the most sought for domestic uses.

Carbon County probably produces more coal than any section of the state, the mines at Red Lodge shipping about three thousand tons daily, while the Bridger and Gebo mines each ship two thousand and one thousand tons respectively. The Bridger mines are the most up-to-date in equipment, and are operated throughout by electricity. In fact, I believe these are the only mines in the state using electrical coal cutting machinery. The majority of stock in these mines is owned by Senator W. A. Clark. Outside of these mines hand mining is the rule, the price paid being 75 cents to one dollar per ton. This, together with high freight rates, makes coal expensive, the average cost of lump coal being probably $4.50 per ton, delivered in bins. The poor quality of Montana coals has encouraged importations from outside mines. Large quantities of coal from Rock Springs, Wyoming, are shipped into Dillon, Butte and Anaconda, over the Oregon Short Line Railway, while the Great Falls & Canada Railway brings considerable quantities of coal from Galt, Canada, which finds a ready market in spite of its high price. Both of these coals are used almost exclusively for domestic purposes, and have the same general appearance and qualities of Indiana block coal. It is quite probable that coal measures will be found ere long in Montana that will equal these, as every new mine opened in the last four years has put upon the market a little better grade of coal than what we had had previously.

The following table of the results of evaporation tests on several kinds of Montana coals will probably give a better idea of their qualities. These tests were made at the Montana State College by the writer, and the showing is the best yet made by any coals so far tested.

Kind of coal.	Evaporation per lb. of coal. from and at 212° F.	Per cent. of ash.
Red Lodge, nut	4.13 lb.	21.95
Bridger, nut	3.95 lb.	20.95
Bridger, lump	4.98 lb.	19.86
Chestnut, washed	5.18 lb.	22.77
Trail Creek, lump	5.38 lb.	13.47
Trail Creek, mine run	4.65 lb.	21.33

LAYING OUT A VALVE GEAR DIAGRAM FOR A CORLISS VALVE AIR COMPRESSOR.

A. L. GODDARD, '96, Camden, N. J.

Corrections to previous article: Fig. 1 shows, not a full Corliss valve air compressor as stated, but a half automatic compressor with Corliss inlet valves. On page 24, fifth line from the bottom, gamma should be Y. In the last line on this page, .542 should read .524.

We have now to lay out the valve gear diagram showing the lines of the eccentrics, levers and rods for operating the valves in such manner that the cards taken from our compressor would resemble our compression diagram, Fig. 5. We will begin with the L. P. compressor cylinder.

The events of the stroke should be, starting with the crank on back dead center: Back end inlet opens at .01 stroke or ½ inch from back end; crank end outlet opens at .524 stroke or 25.15 inches from back end; back end inlet closes at forward end of stroke; crank end outlet closes at forward end of stroke; crank end inlet opens at .01 stroke on return; back end outlet opens at .524 stroke on return; crank end inlet closes at back end of stroke; back end outlet closes at back end of stroke.

To operate the valves, we have two eccentrics, one for the outlet valves and one for the inlet valves. The eccentric rods E connect to carrier arms at B and C, which multiply the motion and transmit through side rods F to the wrist-plate side rod pins

H and J. From the wrist-plates, valve rods K carry the motion to the valve arms.

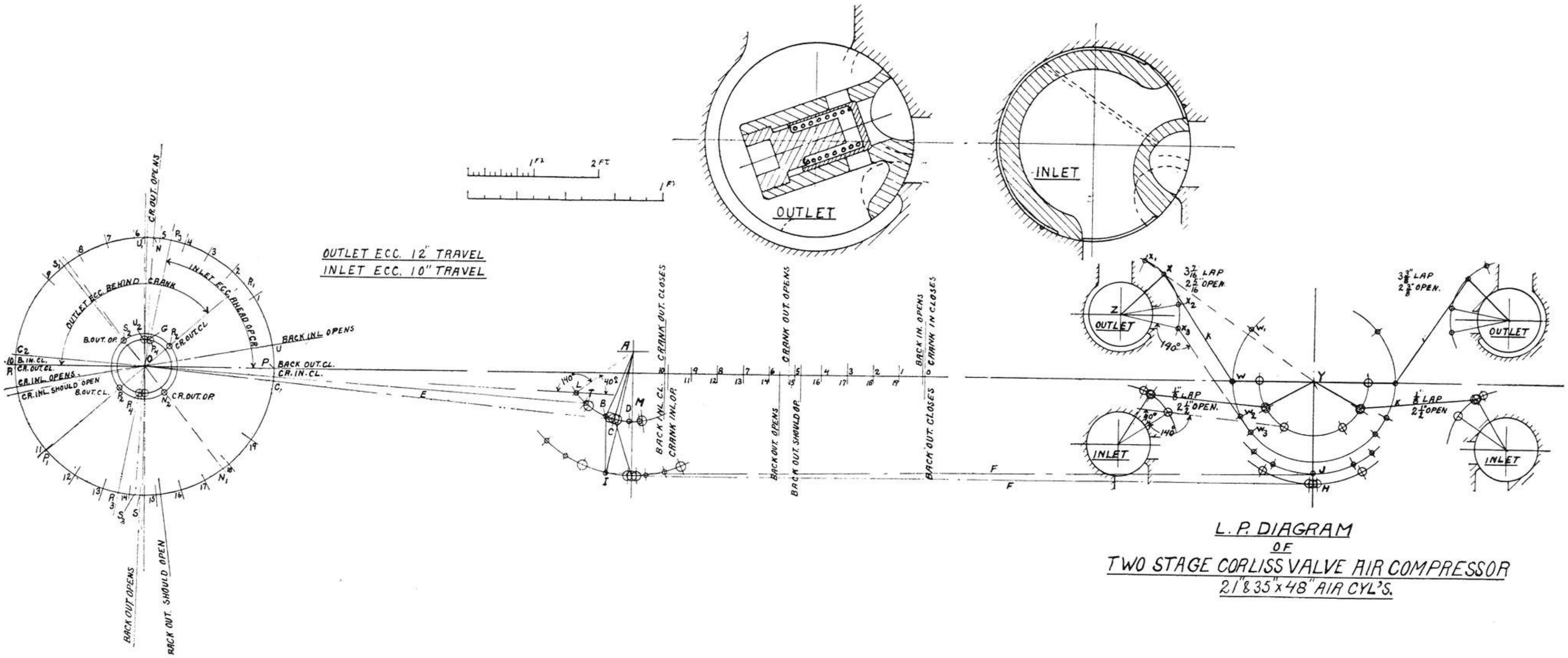
The sections of our valves are shown in the figure. These valves are double ported, thus giving quicker and fuller opening with less travel. The port openings are 4 in. wide by 38 in. long. The valve lips are 3/4 in. wide, giving a net area of 123.5 sq. in. If we make our compressor 21 in. and 35 in. by 48 in., our L. P. piston will have a net area of 954.6 sq. in. Running at 600 ft. piston travel per min., we would have

$$\frac{954.6}{123.5}$$

$\times$ 600 = 4640 ft. per minute for the air speed through valves based on average piston speed. The maximum speed of piston travel with a connecting rod of a length equal to five times the crank radius, occurs at about .45 stroke from back end and its ratio to average piston speed is 1.6. This would make our maximum air speed through valves 7,400 ft. per minute. This is a safe and fair value with quick opening valves. It has been shown in practice that an actual speed of 9,000 ft. per minute through the inlet valves, caused a drop in pressure noticeable on the indicator cards. It might be advisable to use lower speeds through the outlet valves than through the inlet valves, but it is best to keep both as low as convenient.

In a double ported valve of 3¼ in. net opening, 1⅝ in. opening of each lip gives full opening. We should have, however, in outlet valves, to insure quick opening and closing of the valves, 40% to 50% over travel, making the maximum port opening 1.4 to 1.5 times full opening; therefore, we should have about 2 5-16 in. to 2 7-16 in. port opening for the outlet valves. Since the inlet valves open and close when the piston is moving slowly, it is not so essential that they open so quickly, but since they remain closed under pressure during a full stroke, care should be taken that the back travel is reduced to a minimum.

In the diagram the smaller circles are used to indicate the position of the centers of the outlet connections, and the larger circles, the centers of the inlet connections, at the various events of the stroke. An examination of the diagram will show that a valve must have the same position at closing as at opening and that, since the levers and rods all have reciprocating motions they



L. P. DIAGRAM

OF

TWO STAGE CORLISS VALVE AIR COMPRESSOR

21" & 35" x 48" AIR CYL'S.

must have identical positions at the opening and the closing of a valve which they operate. Also, since the outlet valves close at the ends of the strokes, these events are 180° apart and the opening of these valves must be approximately 180° apart measured on the crank circle. This is true also of the inlet valves. But the diagram shows plainly that, owing to the angular action of the connecting rod, the proper points of outlet valves opening are a considerable way from 180° apart. By taking advantage of the angular action of the eccentric rod, this error may be reduced; but unless the eccentric rod be made very short relative to its travel, the error will be considerable with the ordinary connections. A special connection which will be described later will entirely overcome this error. It will be noted that if we set our valve gear so as to open and close the crank end outlet correctly, the back end outlet will open early; and if we set for the back end outlet the crank end outlet will open late. Now, since because of the inertia of the air in the passages, the pressure will continue to rise for a short time after the valve opens, it is best to set the valve gear to open the crank end outlet correctly. This puts a hump on the crank end diagram at the beginning of the outlet, and leaves the back end outlet line nearly straight.

The best proportions of the various parts of the valve gear can be determined only after many trials. The valves for this cylinder have been drawn 12 in. diameter; the valve arms 11 in. radius. The outlet eccentric travel has been taken at 12 in., the carrier arms have pins at 13 in. and 23 in. radius for eccentric rod pins and side rod pins respectively. The limiting angle of action for the valve gear parts is usually 40°. Therefore we select L, so that the angle O L A shall be 140°. Then by setting our dividers from L to the farther side of the eccentric circle, we have the length of our eccentric rod and by moving back to the nearest side of the eccentric circle we get the point M which defines the path of the eccentric rod pin travel. The middle position B is so taken that an arc struck from it as a center and with the eccentric rod as a radius, will bisect the eccentric circle. This is the middle position because the pin oscillates both sides of it in equal periods of time. Sometimes this point is so taken that an arc struck from it as above will pass through the center point O. This is wrong. Now, since the crank end outlet valve opens with the crank at N and closes at R, the arc N R between these points represents the period during which this valve must remain open. This arc must be equally divided either side of the line through O from the eccentric pin at point of opening. This must be located by trial and may require two or three trials. This locates the points N_2 and R_2, which are respectively the positions of the eccentric at opening and closing. Since the back end outlet closes 180° from the closing of the crank end outlet, the line R_1 O extended gives P_2, the position of the eccentric at time of closing of the back end outlet. This determines the point T, whence we locate S_2. The arc S_1 P_1 represents the period of opening of the back end outlet. Laying this arc back from P, we see that by having the point T higher than D we have delayed the opening of the back end outlet and corrected part of the error due to the angularity of the connecting rod. Otherwise the valve would have opened at S_3 instead of at S. Since the weight of the valve gear parts tends to reduce the angle O L A, this angle might perhaps be taken a few degrees larger than 140°. This would carry T still higher, and increase the delay in opening the back end outlet valve. Had the valve arms been so connected with the wrist-plate or the valve been so constructed that the crank end outlet opened with the carrier arm moving in the opposite direction, the limiting angle of 40° would have been laid off at the opposite end of the carrier arm travel.

Now, for the sake of simplicity and symmetry of action, the point I is located relatively to B so that the side rod pin on the plate moves equal distances either side of the center line. Having arranged this, we locate all the events of the outlet valves upon the arc of the wrist-plate side rod pin travel, and then proceed to locate upon the wrist-plate, the pins W for the valve rods. We have chosen 17 in. and 15 in. for the lengths of the arms of the outlet wrist-plate. These lengths are gotten by trial, the end to be attained being to locate the point W_1 a little above the line X_1 Y so that there shall be as much dead motion as possible while the valve is closed. This point, W_1, should not be far enough above the line so as to give more than 1/8 in. oscillation of the pin X, and then to locate the point X_3 so that the angle Z X_3

W_3 shall not be more than 140°. When these results have been attained, the positions of the valve arm pin for the various events of the valve should be determined. The maximum port opening is indicated by the angle X_2 Z X_3 and, measured on the valve circle, gives 2 5-16 in. The lap measured between Z X and Z X_2 is 3 7-16 in. The same relative location of the valve rod pin and valve arm for the back end outlet gives 2 3-8 in. port opening and 3 3-8 in. lap. This is because the back end outlet valve opens ahead of time.

In laying out the inlet diagram, the difference between the periods during which the valves will remain open is inappreciable, but if the eccentric is arranged to open the back inlet valve correctly, the crank end inlet will open a trifle early. This is the best way to arrange it. We will use 10 in. travel for the inlet eccentric. We do not need to get near the limiting angle of action with the inlet side rod, so we select such length of eccentric rod as will give us equal travel both sides of middle position. This is found by trial. We assume some point on the eccentric rod pin arc as the middle position and draw a line from this point to O; then we bisect the eccentric circle by a line through O perpendicular to this line. The distance G C from a point of intersection to the assumed middle position of the pin is the trial length of eccentric rod. If the two parts of the eccentric circle do not give symmetrical travel to the pin C then the length G C is changed until they do. As in the outlet diagram the arc U R representing the period during which the back inlet valve is open, is laid off symmetrically with respect to the line through O from the position of the eccentric rod pin at the point of opening. This gives us U_1 R_3. Then the line R_3 O is continued through O to locate P_4, which is the position of the eccentric when the crank end inlet closes. As before the events of the valves are carried through to the valve arms, making the wrist plate arms of such proportion as to give good opening with minimum back travel. Here we use the limiting angle as indicated on the diagram.

The high pressure diagram is constructed in exactly the same manner.

If we wish to entirely correct the error in the point of opening of the back end outlet, we may use a sliding block in our valve rod connection to this valve, which is so arranged, that the minimum length of the valve rod is the same as the crank end outlet valve rod; thus it will push the valve shut at the proper time as in our present diagram; but when moving in the opposite direction the valve is delayed by the lost motion in the rod end just enough to compensate for the error introduced by the angular action of the connecting rod. It will be noted, however, that this reduces the valve travel, and care must be taken that this does not reduce the port opening too much.

BRIDGE INSPECTION.

GEO. H. BURGESS, Asst. Engineer Penn. R. R.

In giving these few ideas as to methods pursued in the inspection of bridges and the materials used in construction, the writer will not endeavor to go beyond a somewhat brief description of the ordinary practice of the railroad company upon whose inspection staff it has been his privilege to serve at various times, and the inspection of steel bridges only will be considered.

The complete inspection of a bridge from the time of the award of the contract for its construction to the day it is pronounced completed and all "slow orders" for trains are removed, may be divided into three parts, given in the order in which performed: Mill, shop and field inspection.

Mill inspection as its name implies, consists in looking after the manufacture of the raw materials at the rolling mills. Upon the award of the contract for a bridge to one of the bridge companies, the order is immediately sent forward to the drawing room where enough pencil sketches and drawings are made to allow the bills of material to be made out. This material should be ordered as speedily as possible as considerable time must necessarily elapse before the material can all be rolled. The mills have regular schedules governing the rolling of the various sizes of material and the mill order is distributed over the schedule in its proper rotation, and, in these days of large demand, it is almost impossible to obtain any variation from fixed schedules for delivery of material. The inspector is furnished with a copy of all bills of material, or mill orders as they are called, and he must keep himself posted as to the mill schedules and thus know when the various sizes on his order may be expected and must be on hand to properly inspect the same when rolled. His duties are to see that the orders are correctly filled as to size and weight and the material meets the requirements of the specifications of the railroad company.

The material taken from any furnace is identified by a number, the first one or two figures representing the number of the furnace from which the melt or blow was taken and the remaining figures representing the number of the melt which had been last made in that furnace. Thus a "blow number" 17350 means the 350th melt from furnace 17. This number is stamped on each piece which is rolled from the ingots cast from this melt and the material may thus be identified at any stage. Chemical analyses are made at the mill laboratory and copies of the results furnished when desired. If the results of the analysis are satisfactory the material is accepted, so far as chemical properties are concerned, and if not, the entire melt is rejected and no pieces bearing such melt number are to be accepted on the order.

From the finished material test pieces are cut as required by the specifications. Their size depends somewhat upon the material from which the piece is cut but they are generally 18 inches long having a sectional area of not less than one-half square inch. As a rule, one test piece is cut from each different size of material rolled from each melt and these pieces are subjected to tension tests up to the point of rupture in a testing machine. The elastic limit, ultimate strength, reduction of area at point of fracture, and the elongation in a given length, usually eight inches, are observed. The limits within which such quantities must lie are given in the specifications and if conformed to in every respect, the material is accepted subject to surface inspection. Should the test be satisfactory in all respects but one, two pieces for retesting may be cut and if both of these tests are satisfactory the material is accepted. Bending tests are also required, differing for different materials but quite essential to show the quality of the material.

In making the surface inspection, each side of every piece should be examined to locate any burns, flaws, slivers, or imperfectly rolled spots and the inspector should refuse to accept any pieces which have become warped during cooling unless to his knowledge the bridge shop to which the material is to go is equipped with machinery to straighten such material. During the surface inspection, the size of the pieces should be verified to see if they correspond with the sizes required by the orders. Any material varying more than 2½% in weight, either above or below the ordered size, should be rejected. This does not apply, however, to wide plates which may overrun in weight as much as 5%. Each piece so inspected is stamped with the individual stamp of the inspector and the shops are not allowed to use any material not properly stamped.

Recently the matter of surface inspection has become a serious question at the large mills and some of them have absolutely refused to allow any of it to be done. After material is rolled, it is the desire of the mills to load it and ship at once as otherwise it has to be moved to the yard and there turned by hand and later loaded for shipment, at times causing great delay and confusion and frequently a portion of the material for an order becomes hopelessly misplaced and new material must be rolled. If the surface inspection cannot be made at the mill it must be made at the shop before the material is used. This is frequently done during the unloading of the material. The objection to surface inspection at this time is that when a rejection is made a greater delay ensues as the material must be shipped back to the mill for replacement.

Occasionally a piece of material is found to be defective while being worked at the shop and of course should be thrown out. Punching and shearing steel will sometimes develop flaws that are impossible to find by ordinary surface inspection and it is well for an inspector to watch his material carefully during its progress through the shop.

The shop inspection should be carried forward from the time the material is taken from the yard into the shop instead of leaving it until the various pieces are completed. The inspector should make himself familiar with all processes of the manufacture of his work and see that no defective material is used and that the workmanship is first class. A foreman overzealous to turn out work at a low cost may resort to many sly tricks, though, be it to their credit, this state of affairs is not allowed to exist if the matter is properly brought to the attention of the managers of the various shops.

When a piece of work is given to an inspector to attend to he is provided with a complete set of shop drawings and with these he should become perfectly familiar. Some engineers require their inspectors to check over the drawings and verify every dimension given which involves the proper fitting together of the various parts and the checking up of all field connections. This checking of the drawings will make an inspector perfectly familiar with them and he notes the points which require special attention.

In going over a member the inspector should assure himself that the various pieces have been properly assembled to make up the member; that all necessary chipping has been done to provide for the proper clearances; that all punching for rivet holes has been correctly done and all pin holes bored out properly; that the riveting is correct, using flattened or countersunk rivets where needed and leaving open holes where indicated on the drawing; and finally measure up the piece to assure himself that it is correct in every respect to properly enter into the structure.

The above outline gives in general the course of procedure in inspecting the shop work in the proper order without entering into details. At each stage care should be observed in looking into all methods of doing the work. For instance before the various parts are assembled, all surfaces coming in contact should receive a heavy coat of red lead and this is sometimes omitted or carelessly done if not watched. Again, in assembling, the rivet holes may not match perfectly and the metal may be drifted or gouged out to allow insertion of the rivet. This should not be allowed as the metal may be injured by such practice. All badly matched holes should be reamed though a great many specifications require all work to be reamed now which insures a good fit and makes tightly driven rivets almost certain.

It is well to test all the rivets in a member to see that they are perfectly tight and are upset to entirely fill the holes. A light hammer is used for this purpose and a man is soon able to detect a loose rivet by the sound when the head is struck a light, sharp blow on the side. The best practice is to tap each rivet in a member though some inspectors content themselves with testing only the most important ones.

The lengths of members between rivet holes for all connections with other members should be verified with a steel tape and all skewed or difficult connections should be assembled in the shop to make sure of a perfect fit. All pin holes should be carefully measured and the inspector should assure himself that the pin holes through a member are bored at right angles to its axis. The writer once found a chord section that measured ⅝" longer on one side, center to center of pin holes, than on the other. It was fortunate that the mistake was discovered at the proper time as it is apparent that it would have been impossible to put such a member in place. At this particular bridge the falsework was in momentary danger of being carried out by heavy ice during the erection and the discovery of such an error at that time might have caused serious interruption to the traffic had the falsework given away while awaiting a new member to replace the defective one, as well as great delay to passengers and loss of thousands of dollars to the railroad company.

In inspecting eye bars for pin connected structures, the workmanship is looked after carefully as the upsetting the bars to form the heads may not be well done. The lengths of the bars are verified to 1-32", center to center of pin holes, and where a number of bars are made alike, all the bars in a set are required to be piled up and a pin of the required size must pass through the pin holes in all the bars without driving. This requires very exact work. It is generally the practice to order two or three extra bars in filling out a bill of eye bars and these are put in a hydraulic testing machine and pulled to destruction. The same general results are required as in the specimen test of the same material though not quite as high results can be expected. Should the full sized tests prove unsatisfactory, the entire lot of bars may be rejected.

The field inspection consists in seeing that the structure is erected in accordance with the plans, that all field connections are properly riveted, and that the structure is put in perfect condition for use before the erection force is allowed to leave. All adjustable parts should be tightened properly and when adjustable laterals are used, it should be seen that the chords are brought to a true line. Occasionally, members of a structure are injured in transit or in handling and the inspector should see to it that such parts are put in perfect condition before being allowed in the bridge.

While it has been the aim to give in a general manner the course of procedure in inspecting a new structure from the time the material is ordered until the bridge is completed it might not be amiss to give a brief description of the inspection of a structure that has been in the track for some years and which requires investigation as the engine loads are constantly increasing and structures of ten years ago are becoming too light for the traffic.

In making an inspection of an existing structure, each part should be carefully examined to ascertain its condition, all connections should be gone over to discover loose rivets and, in an open web bridge, the various parts of each member should be tested to see if they are all performing their proper share of the work.

Action under trains should be noted by remaining upon the structure during their passage and it is advisable to ride over the bridge on the engine of a fast passenger train as well. Deflections under various engine loads may be taken by reading a level rod fixed upon the bridge though the writer has found a fence board quite convenient for this purpose used in the following manner: The board is set upright, generally just inside the truss or girder and set firmly on the ground or in the bed of the stream. The position of some fixed point on the bridge is marked on the board, and the observer remaining upon the bridge may mark the lowest point of the deflection on the board during the passage of the train and measure same. While this method is rather primitive it has been found quite satisfactory. After observing the action of the structure under load and its physical condition, together with the actual stresses calculated from the same loading, and comparing the actual to the calculated deflection, a decision may be reached as to the advisability of removing the structure and replacing with a structure more suitable for the requirements.

SOME RESULTS OF A TEST OF HEATING AND VENTILATING APPARATUS.*

O. B. ZIMMERMAN.

The application of forced draft to aid in the heating and ventilating of large public buildings, has come very recently into general practice. In applying new methods the maximum efficiency results from a careful study of the theoretical and practical conditions, and since tests of the kind herein described are not as a rule, very completely carried out, on account of the number of observers necessary for sufficient data, the results of this test may, therefore, be of interest. They are however given only in part, here.

The test was made under regular service conditions, with the regular employees in charge, in order to find defects and also means of correcting them. Ninety-six observers were used after having had special drill in their respective parts. These observers aided in two runs, one on February 28, and one on March 1, 1900, during the hours indicated in Plates 1 and 2. All results were carefully recorded, in the most important data by two independent observers, and in the less important by single observers.

In general we had these conditions: The heating by hot air of a building containing approximately 800,000 cubic feet the air being taken from out of doors, except at night, heated by steam coils in the central plant, and then distributed about the building by a plenum fan system. The temperature of the circulating air to each room, was under thermostat control. This circulating hot air system was supplemented by a direct system through radiators, in the more exposed portions of the basement, halls and third floor.

The central heating plant contained the following: two 96 H. P. boilers each having a direct radiation capacity of 8000 sq. ft.; one 15″ x 12″ low pressure engine; two 140″ x 4′ steel plate fans, belted to the engine; tempering coils 3212 sq. ft., heating coils 12000 sq. ft., overhead coils 400 sq. ft., radiators 1510 sq. ft., or a total

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* The West Division High School of Milwaukee, Wis.

of 17,222 sq. ft of direct radiation. The ducts leading to the various rooms were under damper control in order to regulate the speed of air, as well as its quality. These dampers had been readjusted many times, sometimes by irresponsible parties, with the result that the air was, in few cases entering the rooms at anywhere near a reasonable speed. One case in particular the air was entering the room at about 30 feet a second when a speed of 6 to 8 would have been sufficient.

The methods of heating were three: A. By direct steam to all the coils through a reducing valve, a system seldom used. B. By exhaust steam from the engine and pumps. C. By a combination of A and B this system was almost constantly in use.

In a trial run of system B, we found it to fail signally, under the weather conditions then prevailing, although the outside air averaged 29° F. At the end of a run of twenty-six minutes, the temperature fell very decidedly throughout the building. The curve of room 21, near the 12 o'clock period, Plate 2, illustrates the typical room curve during this period. Note the effect also, at this time during this same trial, upon the temperatures in the hot air room (Plate I).

With these conditions in mind, then, let us look at some of the results.

The heating value of the coal, 11,153 B. T. U., was determined from the percentages of moisture, volatile hydrocarbons, carbon and ash, and gave us a basis from which to work out our efficiencies.

The absolute boiler pressure was 67.11 ℔s., the amount of dry coal burned per square foot of grate 15.43 ℔s., quality of steam 97.31 per cent., boiler efficiency 66 per cent.

The average indicated horsepower required was 30.56, steam used per stroke from actual test using the coils as a condenser .1085 ℔s., water per indicated horsepower hour 34.95 ℔s. The indicated horsepower dropped quite uniformly from about 32 to about 28 from the early morning hours to closing time, owing to the gradual heating up of the building. This result would seem at first sight, paradoxical, since the total quantity of air delivered per hour was about the same throughout the day, but is explained by the fact that the air in passing through the deep banks of heating coils to the hot room went through far more resistance than the tempered air, in order to get to the ducts leading to the rooms, and as more hot air was used in the earlier part of the day we readily see the reason for the decrease in horsepower required.

The fans each showed an average blast of 45,916 cu. ft. per minute at 50° F. temperature and under the pressure in the plant enclosure. This corresponds to an issuing velocity from the fan of 1766 ft. per minute while the fan periphery speed was 4400 ft. per minute.

The peculiar circulation of the air between the fan and the air ducts is worthy of special study alone, and I would suggest this as a study or investigation.

In order to work out the efficiencies, all losses were carefully sifted out, the actual loss of water was found to be 2.2 per cent. of the whole. This was easily accounted for in the leaky valves, especially the exhaust valve to the air.

For the combined system of heating we have the following as representing the total heat delivered to the plant during the test:

A = Total quantity of heat delivered in the form of direct steam $= x\,r + q \times$ weight of direct steam.

B = Total quantity of heat delivered in the form of exhaust steam $= x'\,r' + q' \times$ weight of exhaust steam.

C = Total quantity of heat in the drip from the coils $= q'' \times$ weight of drip.

Then for the efficiency up to and including all coils, radiators, etc., we have substituting totals:

D = Total heat in coal $= B\;T\;U \times$ weight of coal.

$$\frac{\mathrm{A+B-C}}{\mathrm{D}} = \frac{\mathrm{w\,(xr+q) + w'\,(x'r'+q') - w''q''}}{\mathrm{B.\,T.\,U.} \times \mathrm{w^{iv}}} = 42.56 \text{ pr ct.}$$

Since the q is returned to the boiler and is consequently, not wasted, we would have:

$$\frac{\mathrm{A+B}}{\mathrm{D}} = \frac{\mathrm{w\,(xr+q) + w'\,(x'r'+q')}}{\mathrm{B.\,T.\,U.} \times \mathrm{w^{iv}}} = 50.1 \text{ per ct.}$$

For the coils themselves we get:

$$\frac{\mathrm{A+B-C}}{\mathrm{A+B}} = 83.9 \text{ per cent.}$$

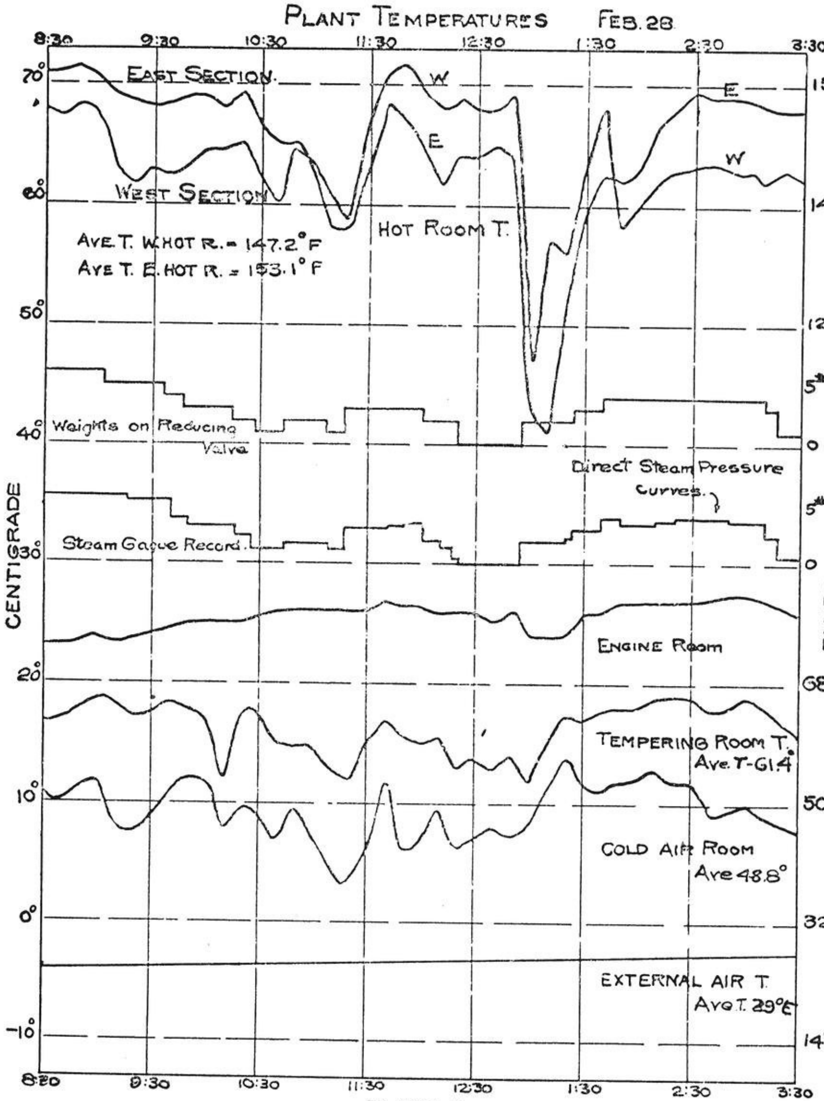
PLANT TEMPERATURES FEB. 28
8:30
9:30
10:30
11:30
12:30
1:30
2:30
3:30
EAST SECTION.
WEST SECTION
W
E
E
W
HOT ROOM T.
AVE. T. W. HOT R. = 147.2° F
AVE T. E. HOT R. = 153.1° F
Weights on Reducing Valve
Direct Steam Pressure Curves.
Steam Gauge Record.
ENGINE ROOM
TEMPERING ROOM T.
Ave. T - 61.4°
COLD AIR ROOM
Ave 48.8°
EXTERNAL AIR T.
Avg T. 29°F
CENTIGRADE
70°
60°
50°
40°
30°
20°
10°
0°
-10°
FAHRENHEIT
158°
140°
122°
5#
0
5#
0
68°
50°
32°
14°

PLATE I.

If again, here, we consider the drip returned to the boilers our percentage goes up to 100%.

Following the heat to the rooms we deal with the enormous losses in this type of plant as a heating system. Part of the heat losses are radiation through the room walls and through the windows, others are by escaping air through cracks about the windows and lastly by heat losses up through the ventilators.

We can reduce this then to a formula of the total efficiency as far as heating goes,

$$\frac{\text{Heat delivered to the rooms — heat going out of ventilators}}{\text{Total heat in coal.}}$$

= E = Total volume of air in cubic feet delivered to the rooms in any definite time as per minute.

F = Weight of air per cubic foot.

G = Specific heat of air.

T = Temperature of the entering air.

T′ = Temperature of the escaping air.

$$\frac{E \times F \times G\,(T - T')}{\text{B. T. U. used per min in coal}}$$

= approximately 4.1% in this building and under these conditions. The average complete change of air from readings taken at the fan openings and at 61.4° F. was once in every 6.56 minutes. This same volume corrected for a decrease in pressure and rise in temperature to 73.6° would give a complete change of air every 6.31 minutes. Careful readings in all the rooms with anemometers gave an average change of air every 7.1 minutes. This difference of 11% may easily be accounted for by leakages through cracks and also inaccuracies in the reading of instruments.

Referring to Plate I we have a comparative scale of temperatures in the heating plant. On the right are given the temperatures in the Fahrenheit scale, on the left, in the Centigrade. This shows the gradual rise in temperature of the air from the external air curve to that of the hot air rooms.

The coils in the plant were so arranged as to be practically two complete sets, one-half feeding the east section and the other half the western. A continuous series of readings during the winter gave the average of the west hot room about ten

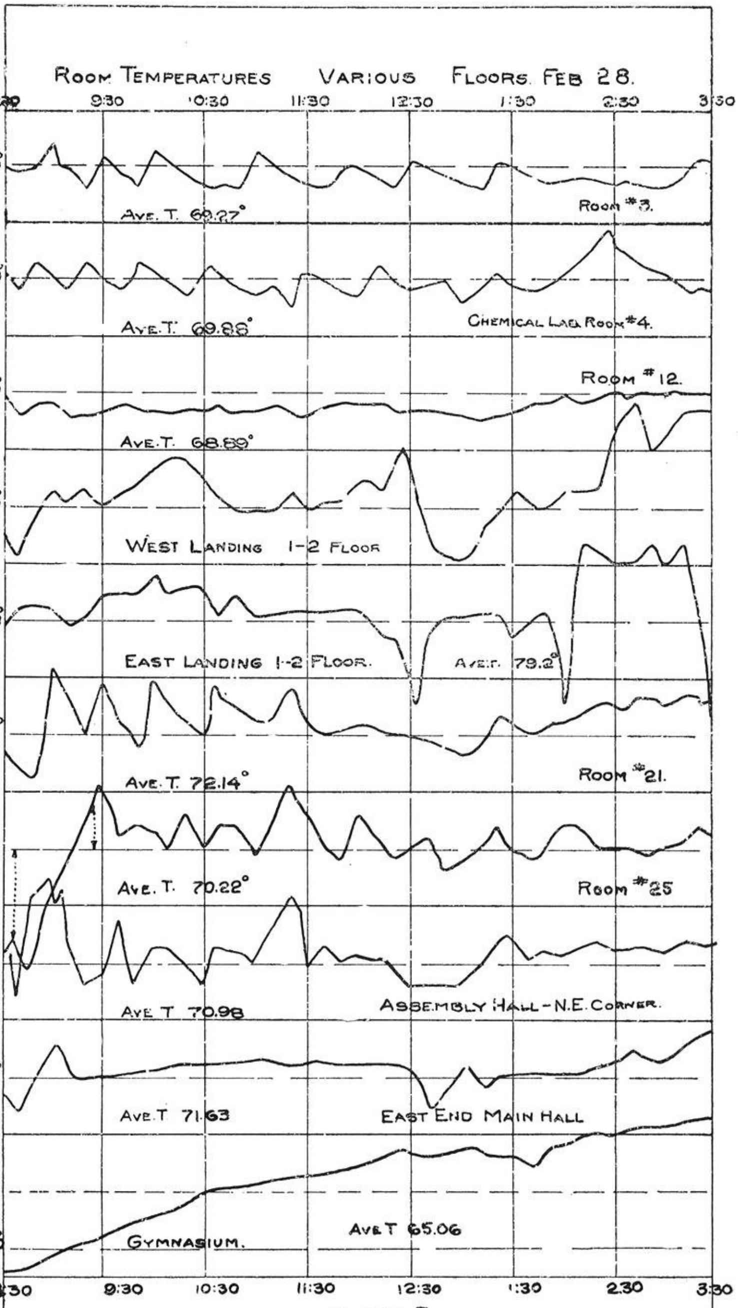
Room Temperatures Various Floors. Feb 28.
8:30
9:30
10:30
11:30
12:30
1:30
2:30
3:30
70°
Ave. T. 69.27°
Room #3.
70°
Ave. T. 69.88°
Chemical Lab. Room #4.
70°
Room #12.
Ave. T. 68.89°
80°
West Landing 1-2 Floor
78°
East Landing 1-2 Floor.
Ave. T. 79.2°
71°
Ave. T. 72.14°
Room #21.
70°
Ave. T. 70.22°
Room #25
70°
Ave. T 70.98
Assembly Hall - N.E. Corner.
70°
Ave. T 71.63
East End Main Hall
60°
Gymnasium.
Ave. T 65.06
8:30
9:30
10:30
11:30
12:30
1:30
2:30
3:30

PLATE II.

degrees lower than that of the eastern. This is largely accounted for in the fact that the west hot room delivers hot air to 57% of the room volumes of the building while the eastern section fed 43%. It was a notable fact also that the west half of the building was more easily cooled down and also harder to heat than the east section of the building.

Our curves for the hot air room show a difference of 6° on February 28. The average temperature of the rooms on February 28, taking separately those fed by the east section and those fed by the west section, showed averages for east section, 69.3° and west section 70.6°. This, however, is accounted for by the fact that the wind was 20 miles N. E. on that day and as the building is in a very open location we can easily recognize why this should be true. On March 1st these averages were reversed when the wind had died down. Only a few of the room temperatures are here given in Plate II in order to show types, note particularly the regulation of the thermostats, the waves of heated and cooling air. By the tangent to these curves we are enabled to see the speed of rise of temperature and also its fall. In the chemical laboratory, room 4, note the effect at 1:45 of a class entering and using bunsen burners up to 2:30. Curve of room 12 shows a very active thermostat. Room 21 shows the furious blast of 30′ per sec., also note the high speed of air and irregular action of thermostat in room 25 and Assembly Hall. The latter curve is one which was almost duplicated in the six other temperature curves of this room.

The gymnasium curve with the curves of the east and west landings, show, by comparison with the more uniform room curves, the great advantage of thermostatic control when the controlling instruments are in normal working condition. Note on the curve of the east landing the effect of opening the outside doors at noon time, these dips do not appear in the west landing because these doors were closed and locked.

Humidity tests showed the building to average far too low. On the days of the test the external air was practically saturated while in the building readings showed an average of 55%. A record kept during the winter months gave an average less than 50%, where it should be 70% for the most healthful conditions.

With these figures as a basis it is readily seen that by simply changing the speed of the engine from 175 r. p. m. to 135, we would still secure sufficient frequency in the change of air, and the many draughts of air which tended to produce colds and general discomfort, would be reduced to a more comfortable speed. The humidity could be increased by a steam jet or by placing tanks of water with a large evaporating surface in the hot air rooms.

There is one other point brought out here, that is, that adjustable systems of heating and ventilating need the closest of care if the best results are desired. It is not alone necessary for the apparatus to be set up, and left to run itself. The result of such methods generally is, that the system is soon found more or less unsatisfactory and as this dissatisfaction grows the condemnation of the system and installer results. It seems to me it would be most excellent policy for firms setting up such apparatus to keep in their employ a competent engineer to do nothing except to watch such plants as his firm have installed; this to be done at no expense to the owner of the plant. Such a man would certainly pick up useful information enough to pay his salary many times over. By this means then we certainly would be able to arrive at comfort in our homes and public buildings far in excess of that experienced today.

THE SUMMER SCHOOL FOR APPRENTICES AND ARTISANS IN THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF WISCONSIN.

The announcement that the summer session of 1901 will have a school for artisans and mechanics, has called forth wide comment and extreme interest. Letters have been received which indicate that in attendance the school will be one of the most successful departments of the summer session, new as it is.

The "Iron Age," probably the most widely read of all industrial journals, devoted an entire page to extracts from the announcement, and Dean Johnson of the Engineering school, through whose efforts the plan was realized, has been the recipient of many compliments from neighboring state universities and from prominent educators for his enthusiasm and progressiveness in actually doing what other schools have only dared to think about. The school will be devoted to the instruction of that immense body of young men who have gone into industrial occupations direct from the high school or even from the grades. At present almost the only way they have of obtaining the practical training needed is by means of the correspondence schools. That there is a great demand for this education is shown by the fact that one of these correspondence schools has on its lists 250,000 names, and of this number thousands are Wisconsin men. If there are so many who have this desire for training, the remarkable advantages of the Wisconsin engineering department can scarcely fail to be appreciated and enjoyed.

Dean Johnson has for an ideal, toward which he will endeavor to conform his plan as the school progresses, a system of schools by which a boy of ability, though he have only a rudimentary education, may work upward from one to the other to the most perfect training in his profession.

This school has been established for the benefit of machinists, carpenters, or sheet-metal workers; stationary, marine, or locomotive engineers; shop foremen and superintendents of water works, electric light plants, power stations, factories, large office and store buildings in cities; and for the young men who wish to qualify themselves for such positions. For these employments the full four years' professional courses in engineering are not required, and yet to satisfy the present demand upon this class of men it is necessary for them to obtain considerable theoretical and practical knowledge not commonly taught in any of our schools.

In the case of apprentices the purpose of the school is to give them a certain amount of theoretical and practical instruction in the line of their trade, which they would not get in the shops, but it is not the purpose of the school to give the shop practice which they are expected to receive in serving their apprenticeship.

The machine trades lie at the basis of all manufacturing, and superiority in these very largely sustains our modern national prosperity. The practical abandonment of the apprenticeship system, also, as a result of the very general adoption of labor-saving machinery, and the common practice of confining a workman to the operation of a single type of machine, leaves our young men with no means of acquiring that wide and thorough knowledge of the machinist's trade which formerly they could obtain in the workshops by a long apprenticeship. For these reasons some new kind of industrial education becomes imperative. Many young men in the industrial employments are now receiving instruction through one of our many correspondence schools and some of them are being greatly helped in this way. These schools do not give any personal instruction, however, and they can offer no shop or laboratory facilities. Their students, therefore, work at very great disadvantages, in comparison with such opportunities as will be offered in the summer school for artisans at the University of Wisconsin.

At the present time instruction of this kind can only be given during the summer term of six weeks. During the regular college year the shops and laboratories are filled with the regular students, taking the four years' professional courses in the College of Engineering. It is possible, that, if the demand is sufficient, this instruction to artisans may be organized into a separate school, under the auspices of the University, either in Madison or elsewhere, and the work given throughout the entire year in short terms of six to twelve weeks.

At present no detailed educational requirements will be specified for entrance upon this work. Each candidate will be questioned to ascertain his fitness for taking the work, and if it seems likely that he will be benefitted by it and that he will not be a hindrance to the others he will be admitted. A speaking and writing knowledge of the English language, and a fair knowledge of elementary arithmetic will be found necessary to a profitable pursuance of the course.

No diplomas or formal certificates will be granted to persons taking this work in the University of Wisconsin, but letters will be given by the Dean of the College of Engineering stating what work has been taken and the proficiency attained.

Students in this school must present themselves on or before the opening day of the term, and they will be expected to remain for the full six weeks.

Each student will be expected to elect such work from that which is offered in the following schedule, as he desires to take, and for which he is found to be fitted, and in such quantity as to keep him profitably employed. In general it would be well to elect two or three lectures a day and to devote the rest of the working day in the shops or laboratories. The lecture periods are one hour each, and the shop and laboratory periods are four hours each. The school hours are from 8 to 12 A. M. and from 1 to 5 P. M.

There is a uniform entrance fee of fifteen dollars charged for all students taking this course. This applies to both residents and non-residents of the state of Wisconsin, and also to all regular engineering students who take their shopwork or other work in the regular summer session of the University.

In addition to the entrance fee there will be shop and laboratory fees charged at the rate of five cents per hour of actual total time spent in any shop or laboratory. These fees are payable in advance at entrance. The entrance fee cannot be refunded. In case of sickness, or of other unavoidable withdrawal, before the middle of the term, one-half of the shop and laboratory fees paid in will be refunded.

Room and board can be obtained from four dollars per week and upward.

The College of Letters and Science of the University holds a summer session at the same time as this Summer School for Artisans and all the classes in this department will be open to those students in the School for Artisans who can show a suitable preparation for such courses. There are, also, many entertaining and instructive lectures given in this department to which the general public is admitted and which can be attended by the students in the School for Artisans without any special arrangement or permission.

It is anticipated that many of the students in attendance upon this School for Artisans will be of those who are regularly employed in responsible positions, and who cannot attend these summer sessions without obtaining leaves of absence from their employers. These employers may be individuals or private or public corporations, but in any case they might find it to their advantage to encourage their more studious and intelligent apprentices, workmen, foremen and superintendents to come to these summer sessions and get a better grounding in fundamental principles, as well as in the latest and most scientific practice, in their several branches of work. Most of the accidents which occur in factories and power plants are the results either of ignorance or carelessness; so far as they result from a want of scientific knowledge (which covers much the larger portion of such accidents), they could be avoided by a more thorough education on the part of the persons in charge. But aside from accidents, there are scores of ways about any large plant in which losses occur, from the inefficiency of the appliances used, or from bad handling of them, which would be greatly reduced or entirely eliminated, by a better scientific training on the part of those charged with the purchase or operation of such machines. Indeed, it would be to the interest of many owners to send one or more of their employees to such a school every summer in order to increase their efficiency in managing their share of the business.

One of the leading purposes of this School for Artisans is to supplement the work of the Correspondence Schools. Persons coming with a fair knowledge of the theory of a certain line of practice could spend their entire time in the shops or laboratories if they chose, and so put into practice, or prove experimentally the scientific principles learned from books, or in the correspondence courses. There are no correspondence courses given in this University, but persons applying to the University for correspondence instruction will be referred to the regular correspondence schools, some of which are giving very good and thoroughly sound instruction along many lines of engineering and mechanical practice.

Students in high schools and in academies of high school grade will be admitted to the shopwork courses, and by putting in eight hours a day for five days in the week, and four hours on Saturday forenoon, they can obtain some two hundred and sixty hours of shopwork. In this way one could receive in six weeks as much shop instruction as he could get in a manual training school in a whole year. In three such summer courses, therefore, he would receive the full complement of shopwork given in the usual manual training school course, and so obtain the full benefits of such a school.

Furthermore, students in the preparatory schools could then clear off a large portion of the required shopwork in the College of Engineering, so that when they come up to take their engineering courses they could be excused from so much of this work as they had taken in advance of their freshman year. In this way they could relieve themselves of a large part of this practical shop instruction, which now greatly burdens the students of the engineering courses. They would thus have more time for general reading or for taking other studies either in the College of Engineering, or in the College of Letters and Science. This method of taking the shop instruction during the vacations of the high school course is, therefore, *urgently recommended* by the faculty of the College of Engineering whenever it is found to be practicable.

The instruction given in the summer school will be divided into the following five special departments:

I. Courses in Steam Engineering.
  1. Lectures on the Elementary Theory of Heat.
  2. Lectures on Steam Engines and Boilers.
  3. Experimental Work in Steam Laboratory.
  4. Operation and Management of Engines and Boilers.
  5. Gas and Gasoline Engines.
  6. Traction Engines.

II. Courses in Applied Electricity.
  1. Dynamos and Motors.
  2. Electric Wiring.
  3. Meters, Transformers and Lighting.
  4. Telephone Service.
  5. Electric Batteries.
  6. Electric Station Records.
  7. Elementary Theory of Alternating Currents and Their Applications.
  8. Electroplating and Electrotyping.

III. Machine Design.
  1. Use of Elementary Formulae.
  2. Mechanical Drawing for Artisans.
  3. Mechanical Drawing for Manual Training Teachers.

IV. The Materials of Construction and Transmission of Power.
  1. Lectures on the Properties of Materials.

2. Tests of the Strength of Materials.
3. Tests of Lubricants.
4. Transmission of Power.

V. Shop Work.

1. Bench and Machine Work in Wood.
2. Foundry Work.
3. Bench Work in Iron.
4. Production of Flat Surfaces and Straight Edges.
5. Machine Work in Iron.
6. Practice with the Planing and Milling Machines.
7. Practice with the Lathe and Milling Machines.
8. Forge Work.
9. Tool Making.
10. Machine Construction and Pattern Work.

The teachers in this summer school will be selected from the regular staff of professors and assistants in the College of Engineering. A sufficient number of these will be detailed to this work to provide the necessary instruction for those who attend, provided they make application before June 1, 1901.

Persons desiring to attend this school during the coming summer are asked to make application to the undersigned on or before June 1, 1901. In the letter of application information should be given under the following heads:

1. Age and amount of school training.
2. Amount and kind of experience in practical work.
3. The courses in the above list which the applicant wishes to take.

This information should be given in considerable detail. Some of the courses here listed will be given only on condition that there are a sufficient number of students to warrant forming classes in such subjects. In case there are more applicants than can be accommodated, those applying first will be given the preference. It is necessary to know by the first of June about what work will be demanded in order to arrange for the necessary teaching force.

All correspondence and inquiries relating to the work of this Summer School should be addressed to J. B. Johnson, Dean of the College of Engineering, University of Wisconsin, Madison, Wisconsin.

THE U. W. ENGINEERS' CLUB.

The close of this semester finds the Club in a very prosperous condition. The membership is now the limiting fifty. The meetings have been well attended and the work in the Club has been uniformly good during the year, for although the programmes have of necessity followed the same old lines, the work in debates, papers and discussion has been characterized by a good lively interest from all sides.

As has been customary in past years the Club year closed with two jollification meetings. The first of these was the Freshman blow-out, held May 17th, in which event most of those who came in this year took part, and a very commendable programme was given.

The second of these, and the last meeting of the year, was held at the Avenue Hotel, May 24th, with some thirty members present, besides several guests and honorary members. The occasion was the annual banquet and was a satisfactory finale to a year of hard work. Toasts were given by the guests and several of the students and a general good time was enjoyed by all.

The officers of the Club during the last third of this year were: President, W. P. Hirschberg; Vice President, W. L. Thorkelson; Secretary and Treasurer, L. H. Lathrop; Censor, H. T. Plumb; Assistant Censor, F. C. Stieler.

THE ENGINEER IN ATHLETICS

Although engineers have the greater part of their time taken up by work of different kinds, they have, nevertheless, found time to ably represent the University in the various departments of athletics. Engineers have played on our foot ball and base ball teams and have taken a prominent part in track athletics, but it is with crew work that they have been most closely identified.

It is to be regretted that they can not take a more important part in foot ball than they do. There are men among them who have the necessary weight and brawn, but the afternoon hours devoted to foot ball practice are already taken for work in the shops and the different laboratories. Notwithstanding this discouraging fact, there have been engineers who have done most creditable work in this department of athletics, notably Peele, who has been on the 'Varsity eleven for several years.

In base ball the engineers have always been prominent. This does not require the hard, steady training necessitated by foot ball, and consequently the engineers have more of an opportunity. This year especially the engineers are making a good showing. Pierce, the captain of the team, is an engineer.

There are not many engineers engaged in track athletics, but the few who are engaged are doing good work. Hahn and Keachie in the distance runs, and Hughes, who has done creditable work in the high jump, are perhaps the most prominent.

More engineers are engaged in crew work than in any other branch of athletics. The regularity of the hours of training permit them to enter into crew work as they can enter no other branch of athletics. Engineers have always been the back bone of our crews. The crews of '99 and '00, which rowed such wonderful races in the East, each contained three. The crack '03 class crew had four and the prospects are that fully as many will be on this year's 'Varsity. It may be noted that Armstrong, captain of the '03 crew, and Gibson, captain of this year's 'Varsity are both engineers.

Engineering students are thus taking an active part in athletics and their work in this line compares well with that of the other departments of the University. Considering the hard work and the few spare hours that the engineers have, it may be stated that their showing in athletics is most creditable.

THE YOUNG ENGINEER.

"What have I accomplished and what position am I capable of filling?" are perhaps two of the most common questions a graduate in engineering is apt to ask himself at the end of his college course.

The first question can best be answered by the questioner himself, for no one knows better than he whether he has applied himself earnestly enough to warrant the confidence which is naturally due the successful young man. In the first place he must have a reasonable amount of confidence in himself, for if this is lacking it is useless to expect his employers to place him in a position of trust and responsibility. Secondly, he must never refuse to undertake a piece of work "because he never did that work before." This is an expression frequently heard in machine shops, usually made by some unthinking apprentice who forgets that it is his duty to learn how.

The second question the graduate asks himself is not so readily answered. The answer to this question does not depend so much upon what the young engineer thinks he knows, but rather upon what his future employer thinks he ought to know.

Employers, owners of manufacturing plants, and business men in general may be classified as college bred men and the so-called self-made men. The college bred man has all the benefits derived from daily contact with men of widely differing opinions about matters concerning his own particular line of work, and it is a matter of no great difficulty for him to understand a college man better than a man of the second class named. In obtaining employment under such a man a graduate stands a better show for advancement than would otherwise be the case. On the other hand, an application for a job under a man of the second class is usually met by the question "What practical experience have you had and where did you get it?" In nine cases out of ten the answer is: "At the University of ——————," whereupon the applicant is told that if he wants to begin at the bottom and work up, he can do so by starting in the shop and working as an apprentice until he has gained sufficient practical knowledge to make his advancement profitable to his employer and to himself. This is due, no doubt, to the fact that the above named employer has gained his experience and knowledge by hard work and costly experiments, and it is often very hard to convince such men that any other method of attaining the desired end may be employed with equal success. In the end this is the best way for a graduate to begin his career as an engineer. The greater percentage of students entering the engineering courses come direct from high schools or other preparatory schools, with a very scant knowledge of manual training. It is therefore essential that those who have not had sufficient practical experience before entering an engineering school should obtain the same after the completion of their theoretical training.

This is necessary, not only for the beginner's own good, but also for that of his employer, for, having served a short apprenticeship in the shop he is better fitted to oversee and judge the work of others.

In nearly every case a graduate in the mechanical or electrical courses begins in this way or in the draughting room of the firm he is working for.

A variety of positions are open for the civil engineer, among which may be mentioned railroad, city, bridge and mining work, in all of which there is considerable field work and draughting. Students from either course may begin work in some subordinate position connected with a manufacturing establishment and work up into the business management.

A great number of people have an erroneous idea that a college graduate ought to draw a big salary as soon as he gets his first job; they seem to think that such a young man ought to be paid according to what he knows. The majority of people who think this may be found in the ranks of ambitious parents who judge only from what their sons have learned from books, and who forget that a man's salary depends not upon his knowledge, but upon the practical application of the same.

This is well illustrated in the case of a man taking a position in a shop. First he is asked a number of questions as to what he can do, and if he can give satisfactory replies he is given a trial. At first he will be expected to work for low wages, which will be increased as he becomes more proficient in the use of tools. When that stage of his career has been reached, he will realize the importance of having both theoretical and practical knowledge at his command, for while a theoretical man may be able to design a piece of machinery in all its details, he may not have a very clear idea of how the different parts of his machine are made in the shop; he would only be able to judge of the efficiency of the machine as a whole.

The wages a college graduate may expect vary from a dollar and a quarter to two and a half dollars per day of ten hours.

There is a case in Milwaukee where a graduate from an eastern engineering school, failing to find profitable employment in the East (that is, other than shop work), came West and entered into a four years' apprenticeship in order to complete his education.

The graduate in engineering is well fitted to take up a great variety of positions. Among the more important ones might be mentioned draughting, shop work, field work, teaching, and the operation of steam plants. A graduate who has a thorough knowledge of steam engines and boilers is not required to take an examination for the position of stationary engineer.

Whatever position the graduate may choose, let us hope that by diligent application he may soon rise to a position of responsibility and trust, and thus reflect credit upon his Alma Mater.

THE JUNIOR ENGINEERS' TRIP.

The Junior engineers' annual inspection trip was scheduled to begin at 5:00 a. m., April 1st. To those of us who had never lived on a farm, the matter of "rousing out" at such an early hour was somewhat of a task. Yet about twenty-five junior electricals and mechanicals managed to reach the depot in time to take the early train for Milwaukee.

The party was in charge of Prof. B. V. Swenson, Prof. A. W. Richter, Prof. E. R. Maurer, and Mr. Budd Frankenfield.

On arriving at Milwaukee we went directly to the Hotel Pfister, where we were met by Prof. Johnson of the Johnson Electric Service Co. After breakfast Prof. Johnson took charge of the party.

The first place visited was the Slocum Straw Hat factory, where we saw the entire process of straw-hat manufacture. The straw braid, which is imported, is bleached, dyed, sewed into the desired shapes, pressed, sized or varnished, trimmed and made ready for the wearer's head.

From the hat factory we went to the Pfister & Vogel tannery. The methods of tanning and preparing leather were found very interesting and instructive. Very few of us had any idea that so much work was necessary in order to obtain our shoe leather.

The afternoon was spent at the shops of the E. P. Allis Co.

Here were seen many very interesting things. The large, twelve-thousand horse-power, vertical, engine, then in course of construction, was the center of attraction. This engine was about fifty feet in height and occupied about twenty-five hundred square feet of floor space.

The next morning we visited the Christenson Eng. Co. and the Schlitz brewery. The chief article manufactured by the Christenson Engineering Co. is an electric air-compressor. In their foundry we saw the crucible process of making steel.

At the Schlitz brewery we were shown the entire plant. The bottling department and the keg factory were the most interesting parts.

At noon we went to the city hall in order to see the tower clock. The clock is operated by compressed air. All of the mechanism was made by the Johnson Electric Service Co., and the gong was cast in a Milwaukee foundry.

In the afternoon the party visited The Vilter Mfg. Co., The Nordberg Engine Co., and the Johnson Electric Service company. The Vilter Mfg. Co. have quite a large factory and are engaged, almost exclusively, in the manufacture of ice making and refrigerating machinery.

At the Nordberg Eng. Co. are manufactured the well-known engines of that name, also stamp-mills and other mining machinery.

The Johnson Electric Service Co. are the manufacturers of the Johnson humidistat, Johnson thermostat and tower clocks. The manufacture and testing of the thermostat was quite interesting. Prof. Johnson's shops are certainly model in all respects. The cleanliness of the place and the systematic methods employed were very striking.

We returned to The Pfister for supper and at 7:15 took the train for Chicago.

All of the students had enjoyed the two days' stay in Milwaukee and felt very grateful to Prof. Johnson for the kindness which he had shown us.

Upon our arrival at Chicago we were greeted with the 'Varsity yell given by a dozen or more of our loyal alumni. We went directly to the Briggs House where most of the party registered.

Wednesday forenoon was occupied by our visit to the Western Electric Co. This company manufactures telephones, dynamos, motors and electrical supplies of all kinds. The insulating of copper wire, the manufacture and testing of telephone cables, arc lights, motors and dynamos were a few of many instructive things to be seen at the Western.

The party divided in the afternoon, the mechanicals going to the Northwestern Repair Shop and the electricals going to two of the Chicago Edison power houses.

Thursday morning the entire party took the train for South Chicago. The first place visited was the South Works of the Ill. Steel Co., where the sights seen were the most spectacular of the whole trip. We saw the entire process of steel-rail making from the time the molten metal came from the furnace, until the rails were loaded upon the cars. In the Bessemer converter house, three converters were seen in operation. In the railmill, steel-rails were being rolled from the large ingots. The open-hearth method of making steel was also seen at the South Works.

After dinner the party went to the Scuth Chicago Ship Building Company's yards, where several large steel vessels for ocean travel were seen in the process of construction. The North-western, which has been recently launched, was seen in the nearly finished form.

Friday morning the entire party visited the power house of the Metropolitan Elevated. This is a very large and "up-to-date" power house, all of the dynamos being of the large direct-connected type.

From the power house the mechanicals went to the Crane Pipe Works and the electricals went to the Chicago Telephone Co. exchange. The Crane Pipe Works were not in operation during the visit.

The Telephone exchange of the Chicago Telephone Co. is an excellent example of a large modern telephone exchange. This exchange handles five thousand subscribers. Lamp signals are used on the boards.

In the afternoon we visited the packing house district and went through the plants of Swift and Libby, McNeill & Libby. Both of these places afforded very interesting sights.

This finished our trip. All of the students were well pleased, and came back to work with many new ideas concerning practical engineering.

F. A. DELAY.

TECHNICAL GRADUATES IN POWER PLANTS.

There is no doubt that the modern power plant offers a rare opportunity for the use of technical training such as is received at our College of Engineering, and the following abstract from the "Engineer" Cleveland, O., may be of interest to many of our prospective graduates. "The technical school is the place where the technical training, which every chief engineer of a large power plant should have, may be procured at the least expense of time and money. Such schools are even now numerous and so remarkably well equipped that no one who would set out to obtain a thorough grounding in thermodynamics would hardly think of obtaining it in any other way, were it possible tor him to attend school.

Every year sees a new school established, yet the attendance increases, the capacity of many, both of the oldest and youngest, being taxed to the limit. The technical schools are today graduating about 4,000 men a year, and it will be safe to predict that in twenty years there will be over one hundred thousand technical graduates in this country not beyond the prime of life. These men must find something to do. There is every reason why they should enter the stationary power plant. The problems confronting the users of power are problems that require the application to them of the best trained minds. With the price of coal increasing, competition growing sharper and the tendency to do things, and to compel others to do them, on a large scale, becoming stronger, the power plant will have need of men whose advantages have been the very best.

There is no line of engineering so vast, having a capacity to give employment to so great an army of trained men. There is no branch in which ability has a better opportunity of finding a profitable field, one in which men of brain can make places for themselves without crowding others out.

To the technical student who has any natural love of his chosen profession, employment about a power plant is in many respects ideal. There practice and theory operate together to produce a result. There is science enough to satisfy the most scientific and action enough to attract the most active. The position needs the man and the man the position. One could come to no decision more logical than tnat the chief engineers of power plants in time to come will have earned a sheepskin in an engineering school before taking up their life work.

But the question is, will technical graduates enter this field? The reasons why they should are so strong that the answer is very naturally in the affirmative.

If we may judge what they will do by what they have done, however, we cannot hope for much in that direction. We know of less than a half dozen graduates of engineering schools who have taken up power plant engineering except as consulting engineers. Their opinions being asked as to why this is so, the six or eight technical school graduates consulted on this point agree, with remarkable unanimity, that it is because the technical graduate is not attracted by the situation and prospects offered in the power plant. He must usually begin as an apprentice, wiping, oiling or stoking, ıf he learns how to run a power plant. This is not in the line of the average engineering college man's aspirations. He expects to work hard. He knows he must learn something practically, or at least has been told so if he attended a school that deserves the name. But for some reason he prefers not to start as a fireman or oiler. One college man suggests as a reason for this fact that there is a prejudice against men from the engineering schools in power plants. From the chief engineer down to the last understudy in the fire room there is no sympathy to be found for a college man, he says, but on the contrary, contempt of his lack of practical knowledge, that manifests itself in many unpleasant ways. This, it is urged, is the most discouraging condition a young man from school can meet. Were it not for this unsympathetic atmosphere he thinks they would be much more inclined to go into the power plant, as they now go into the drawing office, the shop, the laboratory and out on practical construction work, where they meet with all the difficulties of beginners. Perhaps this is the principal reason why our college men avoid the power plant. Another man with a sheepskin, and an M. M. E. besides, believes that when the possibilities of the engine and boiler rooms become better known more men of scientific training will enter them. Not until recently have chief engineers of power plants received pay that compared favorably with the pay of the shop and construction department or consulting office. The idea the average undergraduate has of the engine room is that the limit may be put at about twelve hundred a year.

Doubtless both of these men are right, but there is no probability of a speedy change in the attitude of the engineer's force towards the young fellow from school, and in the past few years, during which time the salaries of chiefs in the 500 largest plants in this country have increased over 15 per cent., and in a smaller number over 30 per cent., no beginning has been made. If the payment of salaries of five thousand a year by not a few power plants has not opened the eyes of young college men to the opportunities of the field, such an awakening can hardly be looked for. While we believe that the modern power plant offers a rare opportunity for the use of the training obtained in a technical school, its first requisite is the training to be obtained only in the power plant, by a vast amount of hard work, and the latter will always be the principal qualification. The education now required by the responsible person in a large power plant where economy is studied as carefully as it is in the best regulated workshops, that is, the education obtained from books, is not too difficult for a bright, hard working man to procure by private study during leisure hours. He must know how to get the greatest amount of work out of the fuel bought and the wages paid his men; he must be able to follow the heat unit from the furnace door to the electric light on the street, the planing machine upstairs or the car axle ten miles away. He must, in short, be able to measure everything and test every process about the plant, and must be a good manager of men. Then, most important of all, he must attend to his business strictly. There is no branch of mechanical work where larger salaries can be earned in the future, we believe, than in stationary steam engineering. And there is no branch in which the training of a college may become more valuable if carefully applied. Yet it may also be said that there is no branch the best positions in which are more accessible to the fellow who has never seen a college than power plant engineering. And it is with no little satisfaction that this is admitted. Not that we would estrange the college man from this field, but that it is a good thing for a business or calling when it is not exclusive and is open to recruits from every walk. We will take this occasion to advise young graduates who are willing to work hard and persistently for success and to begin at the bottom to carefully consider the prospects in this field before choosing their work. Because the college is not, in practice, a preparatory school for steam engineering is no reason why mechanical engineers should not enter this field, which is directly in their line of work, and place themselves in training for the many lucrative positions now existing and for the still better ones that will probably be found in the field before many years."

PERSONALS.

Edward P. Meffert, ex-C. E. '01, is with the I. C. R. R. Co. at Peoria, Ill.

C. W. McCollister, ex-C. E. '01, who has been with the American Tin Plate Co., Elwood, Ind., is now in the office of the city engineer of Madison. He will return to the University next year.

Merton A. Countryman, '00, is employed by the I. C. R. R. Co. in Illinois.

Wm. O. Hotchkiss, C. E. '03, has left the University to accept a position on the U. S. Geological Survey in the state of Washington.

F. J. Vea, M. E. '01, has accepted the position of manager of the Stoughton Wagon Works, Stoughton, Wis.

Harry A. Severson, C. E. '01, left for Rockford, Ill., this month, where he has secured a position with an inventor.

John F. Hahn was elected president and Arthur Quigley treasurer of the sophomore class for the second semester.

Patrick J. Kelley was elected vice president of the junior class for the second semester.

Paul F. Chamberlain, ex-C. E. '01, is a mining engineer at Tower, Minn.

Walter P. Hirschberg was chosen president of the U. W. Engineers' Club at the regular spring election of officers.

Rudolph Hartman, C. E. '01, has been in a hospital at Milwaukee for the past month.

Professor Storm Bull was recently elected mayor of the city of Madison.

Charles Arthur Holden of New Hampshire has been secured to take charge of the work in cement testing and stereotomy for the remainder of the semester.

Charles H. Watson of Milwaukee, a senior in the mechanical engineering course, has left the University on account of ill health.

Frank J. Bachelder, ex-C. E. '01, has been with the B. & O. R. R. Co. at Albion, Ind., for the past year.

The work of the Civil Juniors in Railroad Maintenance, formerly taught by Prof. Whitney, has been entirely dropped for the present year, but instead will be given them next year.

J. C. Long, C. E. '03, has accepted a position with the National Sugar Mfg. Co., Chicago, Ill.

H. C. Groute, C. E. '03, has gone to Canada to engage in R. R. surveying.

John Wilson, C. E. '02, has accepted a position on the geological survey. His work will be in the state of Iowa.

ALUMNI NOTES.

E. E. Hunner, '00, of Spokane, Wash., was a visitor at the Delta U. house last month.

Russell W. Hargrave, '98, is taking graduate work in the University during the present semester.

Arthur J. Hoskin, '90, is calculator in the office of the United States surveyor general at Denver, Colo.

John H. Griffiths, '93, is professor of mathematics and civil engineering at the Clarkson School of Technology, Potsdam, N. Y.

John F. Icke, '00, is taking graduate work in the University during the present semester.

Eldridge G. Merrick, '00, is connected with the Stanley Electric Manufacturing Co. at Pittsfield, Mass.

Christian Hinrichs, '90, has recently been promoted to the position of chief draughtsman of the engine department in the Cramps' shipbuilding yard, at a salary of $2,500 per year.

C. C. Lloyd, '96, and Miss Clara E. Jansen, both of Milwaukee, were married in that city December 26th.

Harry B. Sturtevant, '80, is superintendent of mines for the Federal Land Co., at Flat River, Mo.

A. J. Grover, '81, was assistant engineer on the Union Pacific R. R., 1898-99, chief engineer on preliminary and location surveys in the state of Durango, Mexico, until August 1, 1900, and since then has been assistant mining engineer for the Union Pacific Coal Co., Omaha, Neb.

L. B. Weed, C. E. '00, is with the Minnesota Iron Co. at Mesaba, Minn. He was a visitor at Madison during the latter part of March.

The address of J. T. Richards, C. E. '98, is 200 10th St., Jersey City, N. J.

Leo E. Granke, C. E. '00, has been at Madison during the past winter, employed on the U. S. Geol. Survey.

Melvin B. Stone, C. E. '00, who has been with the N. P. Ry. at St. Paul, Minn., since graduation, is now with the American Bridge Co., at Minneapolis, Minn.

W. J. Buckley, '99, is with the Consolidated Gas Co. of New York, 168 Broadway, Longbranch, N. J.

L. E. Moore, '00, is with the American Tin Plate Co., Elwood, Ind.

Interest in class base ball games among the Sophomore engineers:

April 27, 1901.—Exciting game between M. E. '03, and E. E. '03. Score 17 to 16, in favor of M. E.'s.

May 1, 1901.—Game between E. E. and C. E. Score 20 to 13, in favor of C. E.'s.

May 3, 1901.—Game between C. E. and M. E. Score 17 to 18, in favor of C. E. Very exciting.———

Student to Prof. Trowbridge—Is it possible to see through a person's head with X rays?

Prof. Trowbridge—Not always.

NOTES.

Professor Jackson was recently called to Chicago to testify as an electrical expert in a case involving infringement of patents.

Professor F. E. Turneaure and Professor H. L. Russell are the joint authors of a volume recently published by John M. Wiley & Sons, entitled "Public Water Supplies." It will be widely used as a text book. The book contains about seven hundred pages.

The College of Engineering has had a very valuable course of lectures this year, given by the various members of the engineering faculty.

A hydrographic map of Lake Mendota and the adjacent topography has just been published by the State Geological and Natural History Survey. The work of surveying was done mainly by the junior and sophomore civil engineering students of the classes of '97, '98, '99 and '00, under the immediate charge of Professor L. S. Smith.

"Modern Frame Structures," written by Dean J. B. Johnson and Professor F. E. Turneaure, is to be translated into Japanese.

A series of papers by Dean J. B. Johnson on "Sewage Disposal" is being published in the *Municipality*.

Professor C. I. King, of the College of Engineering, has returned from the East, where he has been for the purpose of inspecting the various schools of engineering. His investigations have convinced him that Wisconsin stands in the front rank with the best engineering schools of the country. When due consideration is given the fact that some of the institutions with which this comparison is made are old, established schools of wide reputation, which have turned out some of the best engineers, the judgment of Professor King is an exceedingly complimentary one to the Wisconsin University. The trip included visits to the University of Pennsylvania, Columbia College, Stevens Institute, Brown University, Massachusetts Institute of Technology at Boston, Worcester Polytechnic, and other schools.

Professor J. B. Johnson spoke at the University of Michigan banquet in Milwaukee, March 1st.

At a recent meeting of Tau Beta Pi, the honorary engineering fraternity, six new members were elected to membership, their records for the three years being of a sufficiently high standard to qualify them. The new members are all of the class of 1902. They are as follows:

Herbert L. Whittemore, M. E., of Madison; George A. Scott, E. E., of Oshkosh; Milan R. Bump, E. E., of Spokane, Wash., James W. Watson, E. E., of La Crosse; Chester H. Stevens, C. E., of Mason City, Ia.; Frank M. McCullough, C. E., of Sturgeon Bay.

At the meeting of the clay workers of the state, held at Madison February 16th, Dr. E. R. Buckley was elected secretary. Dean Johnson gave a talk on the use of brick and terra cotta.

The state legislature has appropriated $30,000 for equipping the new engineering building and has increased the annual income of the engineering college by $7,500.

The Wisconsin Alpha chapter of Tau Beta Pi held its third annual banquet April 24th. During the evening Dean J. B. Johnson was initiated into the fraternity.

About thirty members were present. A bountiful menu was served in seven courses, after which the assembled fraters were treated to another feast in the shape of a program of after dinner speeches. Professor A. W. Richter presided as toastmaster in a faultless manner. His ever ready wit employed itself in introducing the speakers so as to keep the banqueters in high spirits.

Professor J. G. D. Mack started the flow of eloquence with a speech on "Raw Material." Budd Frankenfield associated his remarks around the subject, "Grounds." "The Trestle Bent" was the subject of Harry Severson's toast. Professor F. E. Turneaure responded in a very able speech to the sentiment, "The Engineer in Politics." He mentioned the frequent necessity for city engineers to become active in the political field. Frank M. McCullough spoke on "Riding the Goat." The program of toasts was concluded by Dean J. B. Johnson, who presented a graceful and pointed speech on "The Finished Product." He urged his hearers to become broadminded men and not limit their activity to the mere practice of engineering. The festivities were prolonged into the early morning hours.

The Tau Beta Pi fraternity is to the engineering school what the Phi Beta Kappa is to the departments of letters and science of colleges and universities. Membership in Tau Beta Pi is accorded only to those students who stand highest in scholarship and who possess the qualities of good fellowship. To be voted into this fraternity is one of the greatest honors that can come to an engineering student.

The new Engineering Building was thrown open to the general public on Wednesday evening, February 27th. This reception, although in the nature of an experiment on the part of Dean Johnson, proved to be an unqualified success. For the first time the uninitiated were permitted to view the *modus operandi* of the school, and from seven to half-past ten a steady stream of visitors was escorted through the structure from the testing laboratories in the basement to the draughting rooms on the top floor. The upper classmen were detailed to show the different methods, while the freshmen and sophomores acted as ushers. In order not to have too large a crowd in the building at once, students were admitted from seven to eight, and the general public during the rest of the evening.

The committee in charge of plans for the new Carnegie School of Technology which, it is said, is to have an endowment of $25,000,000, has requested Dean J. B. Johnson to act on a committee of educators who are to determine the plan and scope of the new institution. Dean Johnson has also been invited to address the convocation of the regents of the University of New York, which meets at the Statehouse in Albany next summer, on "Technical Education."

Professor Monaghan says in speaking of the selection of Dean Johnson as one of the committee of eminent educators to determine the plan and scope of the proposed Carnegie School of Technology: "Wisconsin has to congratulate itself that Dean J. B. Johnson, as one of the leading authorities on technical and industrial art education, has been recognized as such by the Carnegie, Schwab, McConway committee of Pittsburg, Pa., who are about to construct a new technical institution in the city of Pittsburg.

While a great personal compliment to Dean Johnson and also a great compliment to the University, it will be of inestimable value to the new school, for Dean Johnson not only has studied the technical education in question in this country but has spent considerable time abroad, where he gave the subject the closest study in Germany, France and England."

It is interesting to note that it is the purpose of Mr. Carnegie to make this school, if money and work can do it, the greatest of its kind on earth. It is likely to become the lasting monument to the liberality, if not to the genius, of Andrew Carnegie.

The committee of education will advise the scope and plan upon which such an institution should be based. Dean Johnson will undoubtedly advise that the school have a foundation large enough to meet all needs of our whole industrial and commercial life, leaving it open at the top, so to speak, for the highest attainments in science, art, and even in literature. No doubt his familiarity with the schools in Paris, Berlin and London and other large cities will encourage the establishment of industrial art schools, commercial schools and commercial high schools.

The original committee which has had the matter in charge of establishing such a school consists of C. M. Schwab, President of the U. S. Steel Co., Wm. McConway, President of the McConway, Torley Co., and Jno. A. Broshear, astronomical instrument maker, of Alleghany, Pa. They have been working several months on this scheme and have come to a point where they are ready to submit the whole subject to a special committee of technical educators.

The regular annual trip to Milwaukee and Chicago was not taken by the Civil Juniors. Instead it was proposed to take a few days' trip to Milwaukee. This latter plan was, however, also abandoned, as early next year an extensive trip will be taken to Milwaukee and Chicago, the special object of the visit in the latter place being the Drainage Canal of Northern Illinois.

Possibly during the coming summer a new book will appear edited by the professors in the engineering department. During the past winter there has been a series of lectures by the faculty of the College of Engineering on the different representative engineering men whose names adorn the outside walls of the new building. These lectures were so popular with the engineering students and hill students as well, that it is thought that this series of lectures compiled in book form would make an interesting edition. The lectures are a good review of the engineering progress during the last century and their compilation in book form would place information, not now accessible, into the hands of readers interested in engineering literature.

As announced by invitations, the annual banquet of the U. W. Engineers' Club was held at the Avenue Hotel, Friday evening, May 24th.

At nine o'clock 36 Club members and 8 honorary guests sat down to a merry feast of viands and song. In keeping with the general good taste of the banquet were the neat little menu cards, —fancy little blue prints, made entirely by some of the members.

About 12 o'clock the toast master, H. T. Plumb, with a few remarks about former banquets and peanut lunches of the Club, called for the toasts of the evening.

Dean Johnson responded with "The Ethics of the Engineer," presenting many good thoughts in his usual pleasing manner.

President W. P. Hirschberg spoke for the Seniors in the toast "Looking Backward," reciting many of the changes and incidents to the Club during these four years.

"The Mayor," was the toast given by Prof. Storm Bull.

With the toast, "Fields," W. L. Thorkelson, for the Juniors, worked in many a sharp drive on the various classes and professors.

"Reminiscences," was responded to by Prof. D. C. Jackson.

The Sophomores were represented by J. N. Cadby with the toast, "What We Know."

W. W. Gore toasted "The Ambitions of the Freshmen."

Prof. J. G. D. Mack spoke for the other professors, and presented as a toast, "The U. W. Engineers' Club."

"The Farewell from the Seniors," was given by Alvin Meyers.

The banquet ended with the singing of the "Toast to Wisconsin."

BOOK REVIEWS.

A NEW WORK ON PUBLIC WATER-SUPPLIES.*

This is a book especially designed as a text book in the leading colleges of engineering. It is, however, of equal value to the practical water-works engineer. It marks an epoch in the literature on this subject. It brings to the designing of public water-supplies the same degree of critical analysis and foresight which has long been available to the engineering profession in other lines of practice. The work has been written by specialists in the several departments of purity of water-supplies, of general water-works designing, and of pumping machinery. A most valuable feature of the work, which at once engages the attention of the reviewer, is a list at the bottom of each chapter of all the important literature on the subjects treated of in that chapter. These lists are very complete and carefully selected, there being six hundred and eighty-two in all. These lists are further classified under sub-headings in each case.

It is difficult to give an adequate description of this work in a short review. The general arrangement and sequence of subjects, together with the paragraphing and the bold-faced, topical headings, adapt it especially to its use as a text book.

The analytical treatment, which many of the problems of design have received in this work, gives to it a unique character and will lead to a more scientific construction of public works. Striking instances of this analytical treatment are chapters VII and XIV, on Ground-water and on Works for the Collection of Ground-water. Here is formulated the loss of flow of ground-water, under the varying conditions which the water-works engineer must take into account. In these chapters the exhaustive experimental and analytical studies which have been carried out in the College of Agriculture in the University of Wisconsin have been utilized. These studies are of special importance to all

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* PUBLIC WATER SUPPLIES.— Requirements, Resources, and the Construction of Works, by F. E. Turneaure, C. E., Professor of Bridge and Sanitary Engineering, and H. L. Russell, Ph. D., Professor of Bacteriology, University of Wisconsin; with a Chapter on Pumping Machinery by D. W. Mead, C. E., M. Am. Soc. C. E., etc. Published by John Wiley & Sons, New York. Large octavo, 746 pages, 531 cuts. Price $5.00.

cities located in a glaciated region where water-supplies may be drawn from underground sources, admitting of more or less free flow. They can also be applied to the flow of ground-water in porous rocks. There is no question but that a large proportion of the water-works, which utilizes a ground-water supply, have been poorly designed on account of a lack of knowledge of the principles of ground-water flow.

The one hundred pages or more, which have been prepared by Dr. Russell, on the Quality of Water-supplies, is of the utmost value and significance. Dr. Russell is as high an authority on this subject as there is in America, and these chapters have brought the subject down to date in the fields of bacteriology and chemistry. The citations of instances and authorities also in these chapters are very full. These chapters alone make the book one of distinct and exceptional value.

The chapters on Purification Works also include the latest and most reliable information in this important field, and here, as elsewhere in the book, the best foreign practice, as well as American, has been made tributary to the treatment and to the conclusions.

Professor Turneaure's part of the work, which is much the largest portion, bears the marks of his usual care and ability. It is evident that he has made himself familiar with the best practice the world over and has judiciously selected the safest and most characteristic samples for illustration. Some unique graphical diagrams for rapid computations are furnished, which will prove a great saving of labor in designing. This portion of the work would seem to leave nothing to be desired within the compass of such a book. The size of the book is not indicated, however, by the number of pages, since the page margins are narrow, the actual plate composition being 4½x7 inches, so that each page contains about four hundred and fifty words.

The chapter on Pumping Machinery has been prepared by an engineer of large experience in this field for both large and small cities. It includes, therefore, the results of actual experience as well as of theory, and contains the latest and best practice, especially with centrifugal pumping machinery. In this field Mr. Mead has had very remarkable success and has secured very high efficiency from this class of pumps, when working under a great head.

The design of elevated tanks and towers is treated at length and with considerable mathematical analysis. Detail drawings of two styles of elevated tanks with spherical bottoms are also furnished.

In general it may be said that this work contains all the latest and best scientific knowledge necessary to the scientific designing of public water-supplies, and also gives to the reader references to the entire field of literature on this subject. It will soon become the standard text book in the class room and the standard hand book for the hydraulic engineer and water-works designer. The work is a credit alike to the authors, to the University of Wisconsin, and to the engineering profession. The book is receiving high praise from water-works engineers and from the engineering journals.

J. B. J.

Tunneling—A Practical Treatise. By Charles Prelini, C. E., with additions by Charles S. Hill, C. E., Associate Editor "Engineering News." pp. 311. 150 Diagrams and Illustrations. New York: D. Van Nostrand Company, 1901. Price $3.00.

This work will doubtless be gladly welcomed by engineers, teachers, and students in civil engineering. Drinker's "Tunneling" is all that can be desired for a treatise of reference but there has been a demand for a much briefer but thoroughly up-to-date work which would meet the needs of the average engineer and at the same time would be suitable for use in the class-room. These requirements seem to have been well met in the present work.

The subject matter is well arranged, the general plan being to explain all the operations involved in the particular method under discussion and then to illustrate these by examples from actual practice. The book is entirely descriptive in character, and, as the text is well illustrated, it should be easily understood by the reader. While the author has been but a short time in this country the examples have been selected with due consideration to the latest American as well as foreign practice; and in this connection the assistance rendered by Mr. Hill of the Engineering News has doubtless added much to the value of the work.

F. E. T.

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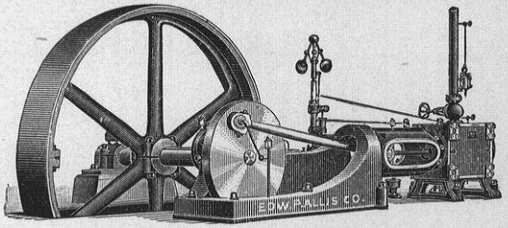
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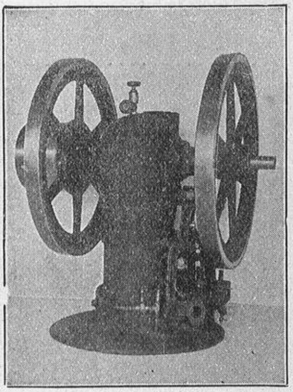

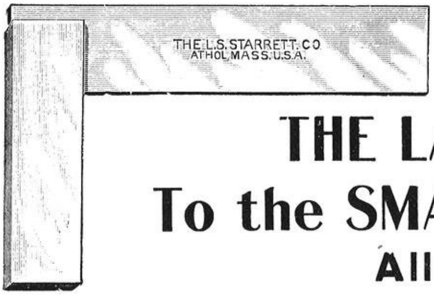
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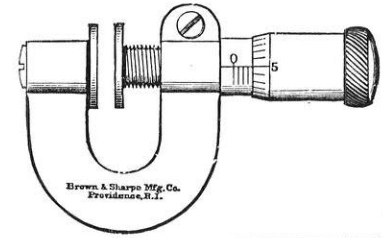
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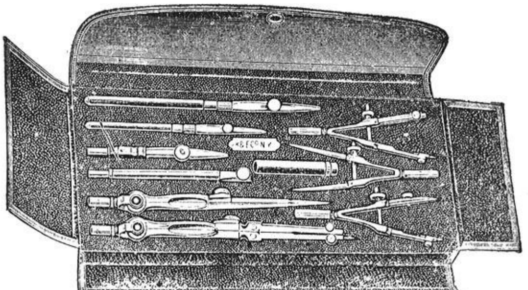

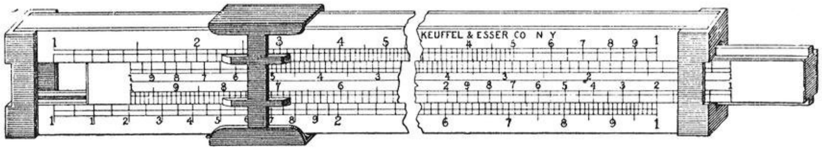
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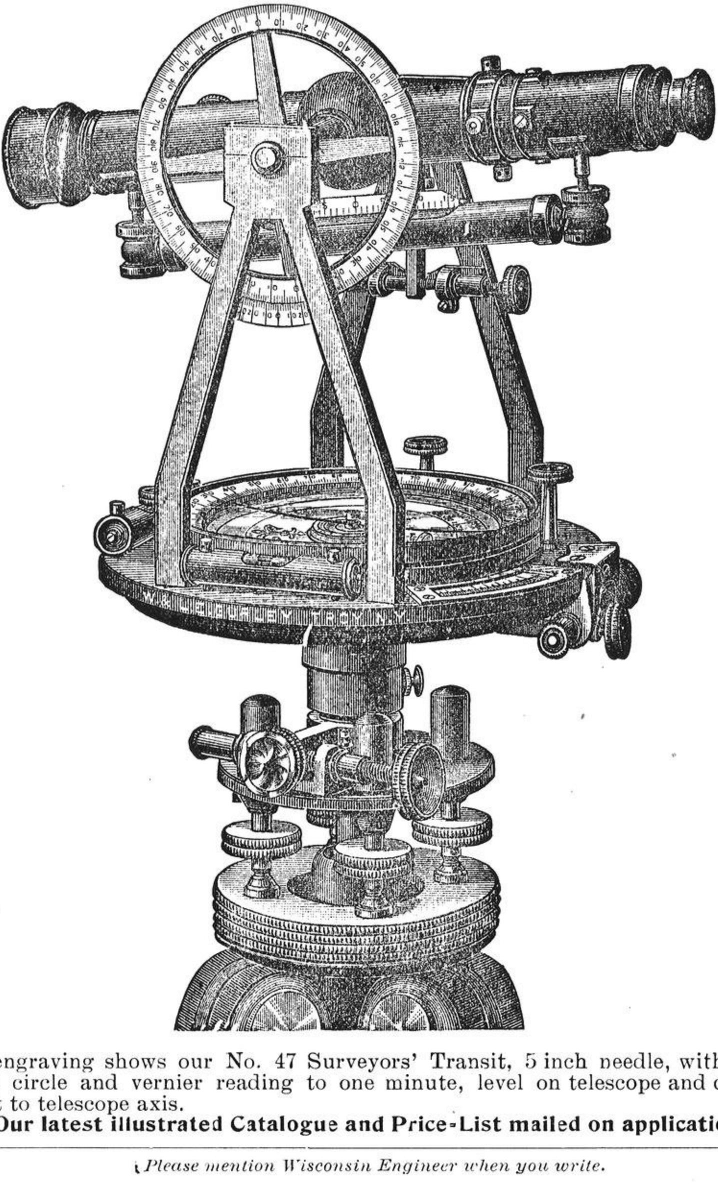

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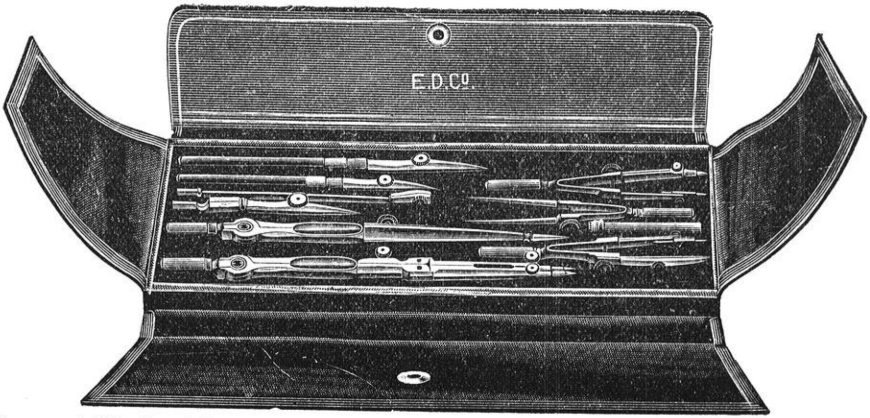
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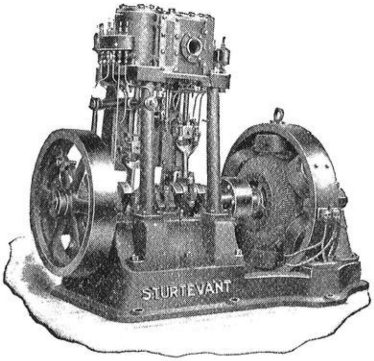
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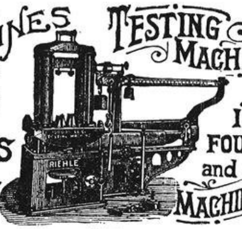
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