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CONTENTS

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THE WISCONSIN ENGINEER

VOL. 10 DECEMBER, 1905 NO. 1

SPECIFICATIONS FOR AN ENGINEER'S TRANSIT AND LEVEL.

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Repeated inquiries from students and practicing engineers regarding the best type of transit for topographic work, would seem to indicate that a brief discussion of this topic would be of interest. A careful review of the available literature* on the subject, discovers comparatively little of direct value. As a penalty for this seeming indifference, instrument makers, with few exceptions, have been slow to devise improvement which would keep pace with the constantly increasing needs of the practitioner. Mr. Edward Moliter, Mem. Am. Soc. C. E., in his paper on precise leveling, above referred to, says: "Another difficulty in the way of progress is that the makers are peculiarly obstinate, and show a marked indisposition to alter their designs of instruments to better suit the requirements of the engineer. A battle of words is generally necessary to convince the maker of a desirable improvement, and when convinced, he will adopt the improvement only when specially ordered. This applies more especially to American makers, probably because American engineers, generally, are more easily satisfied and seem to entertain a high degree of

*The most important exceptions to this statement are the discussions by officers of the U. S. Coast Survey on merits and defects of topographic instruments, mostly plane-tables, see U. S. C. & G. S. Report, 1891 and 1892; the discussion brought out by Edward Moliter's paper, on precise leveling, in Transactions of the Am. Soc. C. E., Vol. 45, and a recent article, by W. L. Webb, entitled, "Some devices for increasing the accuracy or rapidity of surveying operations." Proceedings Am. Soc. C. E. for December, 1901. "Desirable features in a Transit for Topographical Surveys" by George J. Davis, Eng. News, March 31, 1905.

confidence in the ability of the maker to produce the best possible instrument."

The writer believes another reason why American engineers have not more generally demanded and secured desired improvements, is that almost invariably the instrument makers require an extra price for any change, even if the alteration is less expensive in design than the regular detail. In this way the buyer's pocket book is made to pay the penalty of its owner's progressiveness.

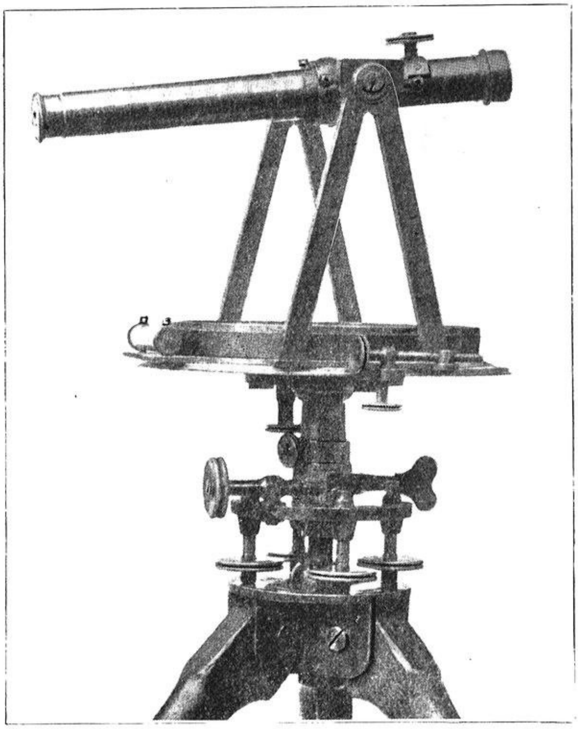

Fig. 1. First American Transit made in 1825.

Aside from the natural conservatism to be expected, this non-progressiveness is largely due to the fact that very few instrument makers have ever used their instruments in the field. This precludes them from discovering the short-comings of their instruments, the first step in the direction of an improved design. Under such circumstances it is unfortunate that experienced observers have not been more *insistent* upon improvements in design suggested by their experience.

It has seemed to the writer that some of the oldest American instrument firms have shown the least enterprise in this matter. On the other hand, much younger firms, while still holding firmly to the many good points of the established types of instruments, seem more ready to adopt improvements suggested by experience.

It is encouraging to note, that during the past few years American instrument makers have shown much more interest and enterprise in meeting the demands for improvements.

The knowledge of what constitutes an excellent transit for stadia topography and the methods of testing to discover the actual facts in a particular case, have seemed so important to the writer that for several years he has made the study of the sources of error in instrumental design, and the necessary laboratory work for their detection, an integral part of the required work of his surveying classes. In fact, part of the data upon which his criticisms are based, (including tests of sixty field instruments belonging to this college), was secured by his students in their regular work above referred to.

Let us first inquire what are the features of the usual complete engineer's transit or tachymeter which are most open to criticism, and what are the proper remedies. It is the writer's observation that the performances of the vertical circle and telescope level fall far short of what reasonably should be expected, and thereby greatly limit its usefulness as a topographic instrument. The causes of this deficiency may be stated as follows:

(a) Too small a vertical circle.

(b) The omission of a sensitive level from the vertical circle for the control of its zero.

(c) The use of irregular and non-sensitive telescope level vials.

It is a well known fact that an error of several feet in the horizontal location of a topographic point would scarcely be discernable on a contour map of ordinary scale, while an equally large error in its vertical location might entirely vitiate the map for its designed purpose. In view of this fact, the time honored custom of using transits with large horizontal circles, frequently reading to fractions of a minute, results in simply strengthening the work at a point already the strongest, while the custom which sanctions the use of small vertical circles weakens the work at a point where the greatest accuracy is needed. With a transit provided with horizontal and vertical circles of *equal* size, the elevations will still constitute the weakest part of the work.

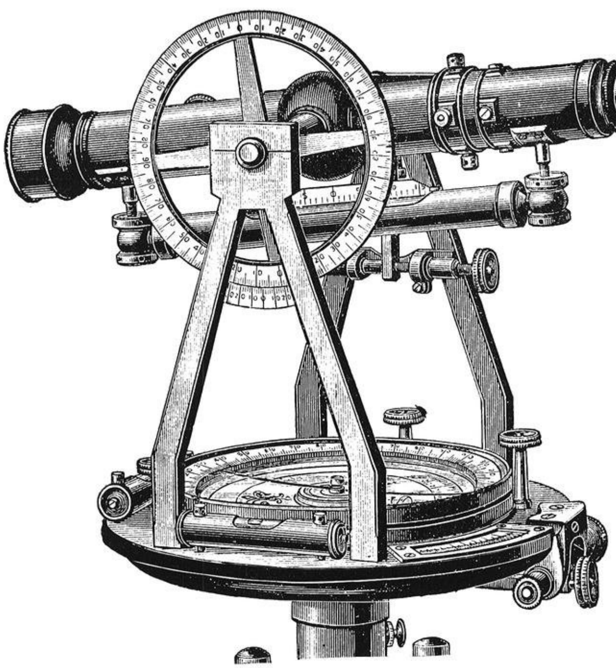

Fig. 2. This Transit has too small a vertical circle.

The usual excuse for the common practice of furnishing transits with smaller vertical than horizontal circles is found in the supposed danger of injuring the larger sized circle. The writer's experience under the most trying circumstances, incidental to rugged mountain climbing, would indicate that this danger is greatly overestimated. In fact, if the circle is protected with a cast metal guard, (and it always should be so protected,) there can be little danger. Another very good solution for this problem, provided the engineer is willing to forego a complete vertical circle, is found in a device described by Walter L. Webb,* consisting of a short arc of very large radius provided with two verniers whose zeros are exactly 60° apart. The graduated arc attached firmly to the telescope axis, is numbered in two rows from 0° to 60° each way. For elevated reading (plus) the right hand vernier is used, while for depression (minus) angles the left-hand vernier is read. Such a device

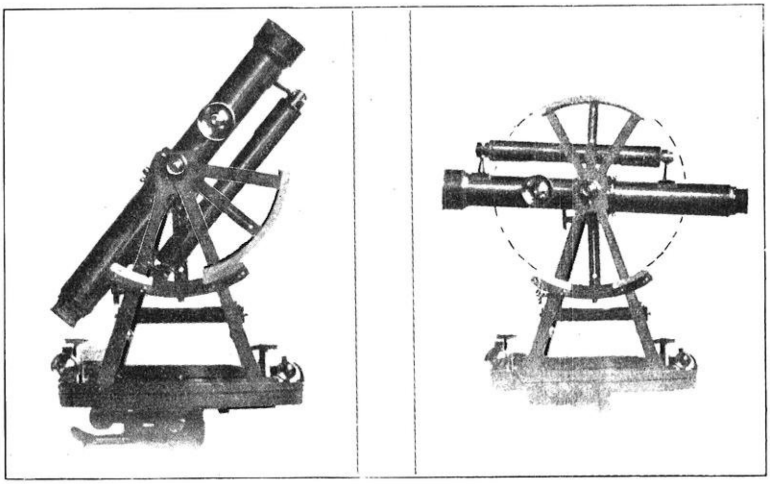

Fig. 3. Webb's Vertical Arc.

readily allows of an arc of seven inches in diameter which would insure ease and certainty of its readings to half minutes.

This device is more clearly shown by Fig. 3, taken from Webb's paper above referred to.

Whether an arc or a circle be furnished, its vernier should be provided with an accurate and easy method of adjusting the zero.

Few American transits are so provided.

One objection to the substitution of the vertical arc for the complete circle is, that it precludes the *reversion* of the circle for the elimination of errors of adjustment in such problems as, for example, the determination of azimuth by the direct solar observation, now so commonly used in the west.

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*"Some devices for increasing the accuracy or rapidity of surveying operation." Transactions Am. Soc. C. E. Vol. XLVIII, 1902.

Although the small vertical circles generally furnished by makers ostensibly read to single minutes, experienced observers are well aware that this accuracy is seldom realized, because of the uncertainty of the reading. Such circles should be graduated to half minutes and provided with permanently mounted magnifying glasses.

A second element which introduces error into the vertical work of a transit is the common practice of depending upon cheap non-sensitive plate levels for the control of the vertical circle zero. If not specified, makers send out plate levels with a sensitiveness between 100 and 360 seconds per one-tenth inch of level. Now every topographer knows that after the orienting backsight has been taken and before the foresight can be taken, the instrument will get out of level, a condition indicated by the plate bubbles getting off center. This introduces errors in the vertical circle readings, it may be of equal angular amounts. Nor can the plate levels be releveled without introducing an error in the orientation which will effect all subsequent azimuths. But even if this displacement does not always take place, a sensibility of 100 to 360 seconds is quite inadequate to control the vertical circle. The proper remedy for this evil is found by placing an extra level on the standard or upon the vertical circle guard, made adjustible so as to read zero when the telescope level is horizontal. The American makers usually charge $10 for this extra level. A view of such a device is shown in Figure (4).

The writer would advocate two double verniers on the vertical circle even if the second vernier is used only to check eccentricity. The entire vertical circle should be protected by the guard, the verniers being covered by glass windows, the same as the verniers on the horizontal limb.

A third suggested change in the construction of the telescope has for its object suitable provision for making the optical center of the object glass describe a straight line coincident with the geometrical axis of the telescope. This requirement is often lacking and yet without it the other specifications will fail to insure accurate work. The most frequent causes of the failure of the above requirements are due to either too short an object glass slide or imperfect or inadequate fitting of the movement. This point is discussed more fully under the head of the wye level.

A fourth needed change in the design of the transit and one certain to improve the accuracy of its vertical work is found in a rational increase in the sensibility of its telescope level.

Except in very mountainous regions a properly run topographic traverse by the "transit and stadia method" allows a considerable proportion of the vertical angle readings on turn-

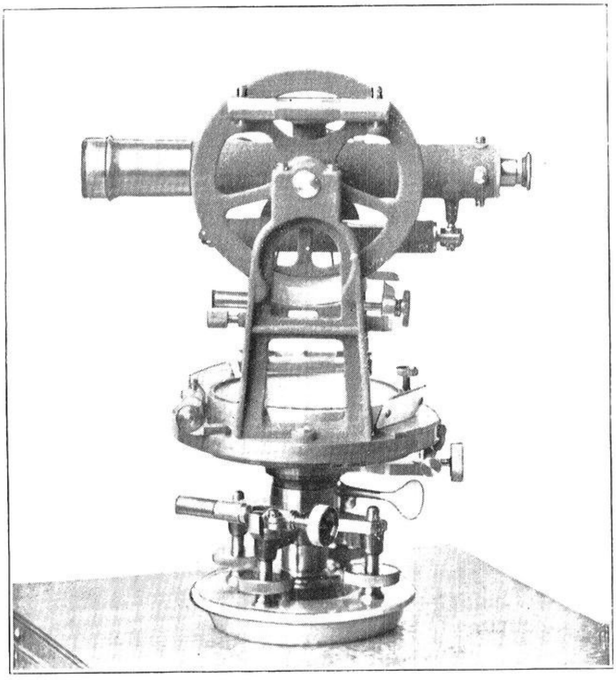

*Fig. 4. Showing extra Level for the Control of the Vertical Circle.**

ing points to be replaced by level readings, thereby correspondingly reducing the amount of required office work, while at the same time insuring a higher degree of accuracy in the resulting levels. This would be notably the case of a combined hydrographic and topographic survey of a river and its adjacent valley. This point was first brought to the writer's attention while making a survey of the Colorado River for a distance of about 25 miles near Yuma, Arizona. At this point the river flows in a wide sandy valley of light gradient so that practically all ele-

* Made by A. Kuhlo, St. Paul, Minn.

vations were taken by level readings.* Although this survey was executed under the most trying conditions of weather, and with an average length of sight of about 300 meters, its levels checked on bench marks determined by accurate spirit leveling within about one-half a foot.

Equally close results have since been observed on topographic lines which lead the writer to the conclusion that a properly devised level on the transit telescope is quite sufficient to secure results under favorable circumstances comparable to that of common Wye levels, and expressed by the formula, error = 0.05 ft. x the square root of distance in miles as the highest limit, and perhaps twice this for lowest limit, the latter being expected only under very unfavorable circumstances of length of sight and weather conditions.

If the above statement of the accuracy of transit levels be accepted as true, and a fast increasing number of topographers are accepting it, the field for the engineers' wye level is small indeed.

However, such high grade work cannot be expected with transits furnished with the non-sensitve and irregularly ground level so frequently furnished the unsuspecting purchaser. After considerable experimental work to determine this point, the writer would suggest a sensibility corresponding to one-tenth inch, equal to from 15 to 20 seconds of arc. Of course the sensibility of the levels and the magnifying power of the telescope are inter-related.

Other important requisites of a rationally designed engineers' transit,not always complied with, may be considered under the following heads: (a) Magnifying power, (b) Chromatic and spherical aberration, (c) Definition, (d) Flatness of field, (e) Illumination, (f) Centering of lenses. The limits of this paper will allow only a very general treatment of the above points. Preliminary to testing a transit, the owner would do well to

*A. Brandis Son & Co , light transit with sensitive level was used. See also for a discussion of such survey, Journal of the Asso. of Engineering Societies. Vol. 14, page 219, by J. L. Van Ornum, Prof. of Civil Engineering, Washington University, St. Louis, Mo.

See also Engineering News Aug. 31, 1905 for valuable report on "River Profile Work of the U. S. Geological Survey, Kennebec River, Maine, by Prof. A. D. Butterfield and G. M. Brett.

look carefully into the telescope barrel through the objective in order to discover the presence of an interposed diaphragm, sometimes inserted by the maker to prevent the discovery of the many evils resulting from poor lenses and poor workmanship.

Such a diaphragm should never be tolerated, because it must reduce the effective diameter of the objective correspondingly, and thereby seriously interfere with its function as a light gatherer. The presence of such a diaphragm may always be taken as *prima facie* evidence of poor workmanship, *unless inserted near the reticule.*

The magnifying power of a transit should depend in part upon the least count of its vernier and the size of the objective. An ideal magnification would be one such that a movement of the alidade corresponding to the least count of its vernier, should cause an easily perceptible movement of the line of sight on the object sighted. As the diameter of the objective largely determines the illumination of the image, it should be as large as possible and be consistent with other details. It should also be transparent and highly polished. If d be the diameter of the objective in millimeters, and m the magnifying power of the telescope in diameters, then the illuminating power of the telescope $i = \frac{d^2}{5m^2}$; the natural illumination being taken as unity.

The flatness of the field depends largely on the sphericity of the eyepiece. This may be tested as follows: Draw a heavy lined square eight inches on a side, and place it at such a distance from the instruments that it shall nearly fill the entire field. When the telescope is focused its side should appear perfectly straight, though a slight curve at the *extreme* limits of the field should cause no appreciable error in stadia work.

The definition of a telescope depends upon three conditions, the accuracy of the curvature of the various lenses, upon their centering and upon their movement in focusing. If the eccentricity of the eye piece is large or if the optical axis of the lens be not parallel to the line of sight, the definition may be so poor as to seriously effect the focusing of the extreme stadia wires. Displacements of the objective are even more serious in producing poor definition of the image.

Lateral displacements of either eye pieces or objective may be discovered by taking the telescope of the transit out of the standards, and, after focusing the threads and objective on some distant point, turn the telescope in improvised wooden wyes. The image and the threads will appear to move in the arc of a circle above the telescope axis even when the wire or reticule adjustment has been perfectly made. Not infrequently makers send out even wye levels whose lenses, when tested as above, show very large eccentricities. Such an instrument should be promptly returned to the maker.

During the past nine years this university has purchased about 45 transits and levels for the use of the rapidly increasing num-

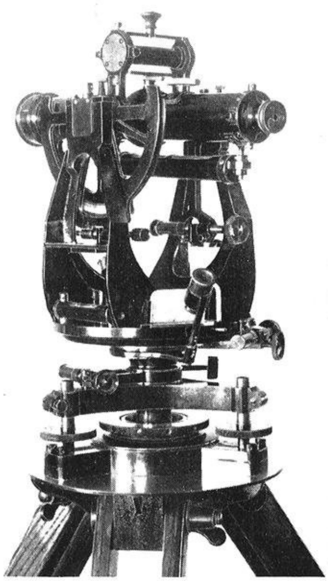

Fig. 5. Improved German Transit with "U" Standards.

ber of students in the engineering college. Thinking that the specifications under which these instruments were in most part purchased would be of interest to the reader, they are here given in full. It may be remarked, that the custom of purchasing instruments by competitive bids and of allowing each bidder to write his specification is obviously unfair to all concerned. Besides making all bids comparable, carefully drawn specifications should insure the purchaser receiving exactly what he proposed to buy. Surely the specifications of so important a part of the field engineer's outfit as is his transit and level, should receive at least as much thought and care as he gives to the purchase of his thirty-five dollar bicycle. That this care and caution should be often entirely lacking is alike discreditable to his professional knowledge and business skill.

SPECIFICATIONS FOR COMPLETE ENGINEER'S TRANSITS TO BE FURNISHED TO THE UNIVERSITY OF WISCONSIN.

General Conditions. All constructive details shall be of superior workmanship and design. Weight not essential to the stiffness of the instrument, shall be avoided by the standard rib construction. The instrument without tripod should weigh not more than ten pounds. Especial attention shall be given to making extra strong all parts likely to be injured by accident. Only the hardest bell metal and phosphor bronze shall be used for centers and telescope axis, and soft brass shall be everywhere avoided. Tangent screws and head of tripod shall be made of aluminum bronze and provided with German silver spiral springs. Prices shall be F. O. B., Madison, Wis.

Horizontal Circle. The diameter at the edge of graduation shall be five (5) inches. The graduation shall be to half degrees on solid silver, frosted finish, and every ten degrees shall be distinctly numbered from zero to 360 in both directions, the numbers sloping in the direction they are incresing.

The circle shall be provided with two double verniers, A and B, exactly 180 degrees apart, and reading to single minutes.

The zeros of the verniers shall be placed at an angle of 35° to the line of sight, and shall be provided with ground glass reflectors. Eccentricity of vertical axis and of all verniers must be as perfectly eliminated as the highest mechanical skill will allow.

Complete Vertical Circle. Transit shall be provided with a complete vertical circle with a diameter not less than 5 inches, graduated on solid silver and read to single minutes by two double verniers. The verniers shall be provided with an easy and reliable means of adjustment. The vertical circle shall be furnished with a cast metal guard to protect the entire edge of the graduation. An extra level vial sensibility 1-10 inch = 20 seconds with suitable means of adjustment, shall be firmly

2—Eng.

mounted on this guard so as to control the zeros of the verniers. The horizontal axis shall have a radial clamp and slow motion screw with a gradienter.

Magnetic Needle. Instrument shall be provided with the usual compass box and a sensitive and accurate needle about 3½ inches long.

Telescope. The objective shall have a clear aperture of not less than 1⅜ inches in diameter, perfectly achromatic and with a flat field, suitable for accurate stadia measurements. Both the objective and ocular lenses shall be mounted so that their optical centers lie in the geometrical center of telescope tube, and provision shall be made to insure that the optical centers shall describe straight lines when focused.

Eye piece shall be inverting and magnifying between 22 and 28 diameter and be free from chromatic aberration. It shall also be provided with a prismatic eye piece with a solar shade.

The regular eye piece shall have the usual focusing screw or worm and a dust guard.

The horizontal axis of the telescope shall be provided with the most improved means of adjustment and shall be fitted with a suitable base for the attachment of a Saegmüller solar attachment.

Stadia wires. Two extra fixed stadia wires, very fine and opaque, shall be furnished and placed equidistant from the middle crosswire. The total distance apart of the stadia wires shall be 1-100 of the focal length of the objective. They shall be of such size as not to cover more than 0.02 of a foot on a rod held at a distance of 1000 feet.

Telescope level. The level shall be ground to a uniform curvature of $\frac{1}{10}$ inch = 20 to 25 seconds. The graduations shall extend over the entire exposed length and shall be numbered on the vial both ways from zero at the center.

Plate levels. Both plate levels shall be accurately fixed to the transit with the most approved and stable provision for their adjustment. Both levels shall be graduated and their curvature shall be 1-10 inch = 40 seconds.

Clamps. The heads of all clamps shall be one-third smaller than usual pattern to prevent injury from inexperienced hands.

Finish. The telescope, telescope level, vertical circle guard, and standards shall have the so-called "cloth finish," the remainder any good standard finish.

Tripod shall be of the split leg pattern and provided with shifting center. Its weight shall not exceed seven pounds. The steel shoe of tripod shall be provided with a shoulder for forcing it into the ground.

Box. The instrument shall be furnished in a neat hardwood box with lock, together with a sun shade, reflector, magnifying glass, plumb bob, wrench, adjusting pins, and silk or water proof bag. The box shall have a leather strap and rubber cushion on the bottom, and shall be so constructed as to allow of transit being packed flat instead of upright.

Engineers' Leveling Instruments.

A discussion of the relative merits of "wye" and "dumpy" levels is aside from the main purposes of this paper, and yet it may not be out of place to briefly state the writer's views on this point. The American engineer is clearly behind his European brother, who has long recognized the merits of the dumpy type of leveling instruments. The greater steadiness claimed for the wye level is more than offset in the dumpy level by its simplicity of construction and adjustment, with the resulting certainty of the relation between the line of sight and the axis of the level vial. The supporters of the wye level have little ground on which to stand. The most perfectly constructed leveling instrument ever made, both from the theoretical standpoint as well as evidenced by its completed work, is the latest type of precise level designed by the U. S. Coast and Geodetic Survey. This level is of the dumpy type. With it 250 miles of single level lines have been run per month, and that too with greatly increased accuracy over that claimed for commercial leveling.*

The merits of the dumpy level are already proved and its general use will be delayed only by the difficuly of "teaching old dogs new tricks."

The following brief discussions include the important points in the specifications for a wye level used at the University of Wisconsin.

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* See Eng. News, July 2, 1903, for an article by J. F. Hayford, on this subject, giving the experience of the U. S. C. & C. S.

1. *Telescope.*

(a) The object glass should have a clear aperture of not less than 1⅜ inches and should have the other requisites given in the discussion of the transit. It is doubly important in the level that the object glass should be so securely and accurately mounted that when focused at different distances its optical center shall describe a straight line coincident with the geometrical axis of the telescope. Any wobbling is fatal to accurate work. Stable conditions can be best secured by the use of long object glass slide, extending nearly to the reticule. In general it appears that this detail is most often slighted by the makers.

(b) It is imperative that the diameters of the rings or collars should be the same if the axis of the bubble is to be made parallel to the line of sight by the "indirect method." The possibility of making the above adjustment by the indirect method is sometimes given as one of the arguments for the use of the "Wye" level, and yet if the diameters of the rings differ by 1–5000 part of an inch the resulting error in a rod reading 300 feet distant would amount to about .01 of a foot even when the instrument appeared to be in perfect adjustment.

(c) The eye piece should be inverting, magnifying 35 diameters, and protected by dust shade.

2. *Level vial.* The level vial should be carefully ground to a uniform curvature of 1–10 inch equal to 8 to 10 seconds of arc. The graduations should be etched on to the bubble tube itself and not attached to a scale as is frequently done.

3. A clamp and slow motion should be provided to the vertical axis. Tripod specifications are similar to those of the transit with this addition. The accuracy of any work is in large measure dependent upon the mental state of the observer. If he can observe in a comfortable position in the long run his work will show an increased accuracy over that performed under uncomfortable circumstances. For this reason it would be well to have the length of the tripod legs increased so that the engineer could observe in a nearly upright position. If a tripod be provided like that of the U. S. C. & G. S. precise level, no unsteadiness will result from this increased length.

Finish. The cloth finish should be specified on telescope and level vial. Frequently it would be convenient if instrument-makers would provide interchangeable tripods so that both the transit and level would fit on same tripod.

Dumpy level. The only modifications in the specifications suggested in the dumpy level would be to decrease the magnifying power to 30 diameters and the sensibility of the level vial to 1–10 inch=12 to 15 seconds of arc. The eye piece should by inverting. The small extra charge for the clamp and slow motion to the vertical axis is well worth the cost. The university has paid $75 for the above described instrument. The average accuracy of the leveling work done at the university by sophomore students is 0.035 ft. into the square root of the distance in miles. This is the error determined by the closure of circuits about 5 miles long.

The pesent type of "dumpy" level made in this country would be greatly improved by the adoption of some of the improvements made on the new U. S. Coast and Geodetic Survey precise level. Briefly stated these are as follows:

(a) A micrometer for making the final pointings of the line of sight after the level is approximately level.

(b) Inserting the more sensitive level vial in the top of the telescope and as near to the line of sight as possible.

(c) The use of a reflector which will allow a view of the level bubble at the same time as the rod reading is made.

That there may be no doubt in the reader's mind regarding the need of definite specifications similar to the foregoing, it may be said, that before this plan was adopted at the university, the instruments were seriously lacking in important details. For example one of the oldest and best known American firms furnished a transit whose telescope level had a sensibility of 1-10 inch = 72 seconds, (about suitable for a hand level), and whose plate bubbles had a sensibility of one-tenth inch = 360 seconds. Though the horizontal circle of this instrument is nearly *seven* inches in diameter, the vertical circle furnished has a diameter of only *four* inches. The results obtained by this instrument have shown a uniformly larger error than that attained by the standard instruments purchased under the above specifications.

A comparison of the plate bubbles of ten similar instruments purchased simply by catalogue number, shows that not only do different firms use widely different levels on the same grade of instrument, but even the same firm does at different times; the range on plate bubbles being from 40 to 360 seconds, and on telescope levels from 8 to 72 seconds per one-tenth inch division. The conclusion, that makers frequently use whatever they happen to have in stock, quite regradless of suitability, seems warranted by the facts. Some will not fail to urge the impossibility of buying a transit at a reasonable price under such rigid specifications as suggested above. In answer it can be said that the average price paid for a transit under these specifications has been considerable less than formerly, without specifications. It should be said, however, as bearing on this point, that later contracts have called for larger numbers of instruments. The present year the lowest bid, from an American maker, was $175 per transit. The University owns several transits made by this maker, and severe field tests have shown them the equal of any both in accuracy and durabillty. The transit, shown in fig. 5, was purchased of a German firm this season. It cost, delivered in Madison, about $136, being admitted duty free. This instrument would cost about $225.00 in this country. Repeated tests of this type of instrument have shown it equal both in accuracy and durability to any made in the U. S.

GAS ENGINEERING.*

THE GAS ENGINEER'S EDUCATION AND THE PROBLEMS OF THE INDUSTRY.

FRED B. WHEELER of the Semet-Solvay Company,
Syracuse, N. Y.

When a man enters the University of Wisconsin for his life work, for his college course is the initial step of his future life, he has about him everything necessary to produce enthusiasm, to kindle his imagination and to fire his energies.

I am going to talk ramblingly today about some of the necessities a gas engineer must be equipped with, in order to handle the problems which are before us.

One of the first requisites is the combination of indomitable energy, enthusiasm, and cultivated powers of imagination. Let me illustrate with a few examples of what I mean by "cultivated imagination."

This morning I walked down to the shore of Lake Monona. On the dock was a fisherman's shanty for selling bait. The owner had, in a burst of imagination, put upon it a large sign "Angle-Worm Station." That is one kind of imagination, but not the kind I mean.

I went a little further on the street, and saw a foundry cupola mounted on wheels, operated by an electrically driven blower, and smelting pig iron for welding trolley rails in the street, on the spot. That was a higher kind of imagination, more trained; but the kind of imagination I mean is quite different. That man who can work his fertile brain into schemes of better organization in his corporation, into plans which he visualizes before his mind's eye, and then sets the plans before his superiors, first for approval, then for actual accomplishment, has done and imagined better and higher things.

You have the example of such a man right here in your local gas company. The president of your company, Mr. Doherty,

*A lecture delivered before the engineering students of the University of Wisconsin Nov. 3, 1905.

has in a short life accomplished prodigies of attainment by his energy, his enthusiasm and his fertile, visualizing imagination. This has enabled him to make a great reputation, which is an example to us all.

Hence in starting your courses here keep this in mind, and follow up your "keeps" in later life.

You have a broadly planned course here in Chemical Engineering, and a chain of Laboratories and Engineering testing plants of which Wisconsin may well be proud. Here you must learn to discipline yourselves in the fundamentals of your chosen profession.

Before continuing my remarks on your educational equipment, I will interject a rapid sketch of a condition in the gas industry now confronting us.

A century of effort has been expended on artificial gas manufacture. In hastily surveying the directions in which this effort has been expended, we se that the field has been divided in the various improvements made, between English, Continental, and American engineers. We see that nearly all changes in the manufacture of coal gas have come from our foreign brothers. In the field of water gas manufacture and purification, America holds the palm. In producer gas work, the honors are evenly divided, and in the development of the by-product coke oven, the Continental engineers have done most of the work.

Gas manufacture began in a most humble way with one small retort, and through the progressive growth of modern education, in the comforts and conveniences of life has expanded until in our English gas works, the output consumed daily is astonishing, when the volume of materials consumed, and acreage of ground in plant required, are considered.

The industry has always been conservative and to a most singular degree, in this country until recently, has been mainly in the hands of technically uneducated men.

Here lies opportunity. The chances that lie before a technically educated young gas man today are numerous as well as promising. Let me impress upon your minds the fact that the mere manufacture and distribution of artificial gas from gas works (so-called), is soon to be only one section of the gas engineer's profession.

The installation of producer-gas works is upon us, the demand is to be tremendous, and some must be prepared for this important work.

The modification and reconstruction of blast furnaces, where the waste gases are used for boiler firing and for power upon an enormous scale, is an integral part of our profession. The great installations of producer gas in steel mills, metal refineries, and electric power houses are bound to grow. The growth of inventiveness is soon to bring into operation a countless host of suction gas producers for small factories, gas engines in ever increasing numbers, and coke oven plants are to be more numerous.

All of this development will require technical men, therefore you can, I trust, now begin to grasp the breadth of the possibilities open to you.

If you have the prime requisites of enthusiastic energy and a lively imagination, the next requirement is a working knowledge of the a, b, c, of chemistry, some mathematics, well grounded physics and mechanics, and especially a full understanding of thermodynamics, for without it, you can do but little. A knowledge of techncial German is a great advantage in following foreign work. Study the English language so that you can express yourselves well both in writing and speech. An awkward phrase, a misspelled word in a letter of application for a position, has lost many men their opportunities.

After your college course here has assisted your efforts, for you must get your training yourself by real constructive work, you will be prepared to seek a situation. Here you may meet with two disappointments upon first attempting to cross the threshold of your active life. No matter how many places there may be open waiting for a bright energetic young man, you will most of you find it hard to locate them.

In the second place, when you have located and been accepted "upon trial," you will find that you will receive generally a monthly wage seldom over $45.00 or $50.00 per month. From this time on, you will be watched by those over you and also by others in the industry, connected by the gas associations. After an apprenticeship, variable as to length, but usually no longer than two years, you will branch out, your possibilities will increase and you will be further launched, we will hope.

In going through your apprenticeship, you must always be courteous, tactful and be a student of men. Study men, their ways and methods, their art of organizing work. When you have a gang of men, study them as well as your work, and you will better organize your forces; study the art of meeting people and making friends.

The possibilities are great in the line of your service. The earnings of some gas engineers are very large. I know several whose collective fees and salaries reach $50,000.00 per year. The supply of technical men does not equal the demand.

Now that we have briefly outlined your line of opportunities let us take up some of the essentials necessary for you to ground yourselves in.

In the first place you must know a lot about coal. The different kinds of coal, their characteristics and their respective chemical analyses. You will have to accustom yourselves to figure from these analyses the heat units per cubic foot and the gas output per ton, together with the probable effect of deleterious components upon coke and gas productions. The whole subject of coal gas, coke-oven gas and producer gas, rests upon these fundamentals. The qualities and analyses of the coke produced, and of the gases made, follow in natural order. Upon these figures depend the dividends of the companies in a large degree. As a starter, you should systematize all of your work and arrange with index and tabulated figures carefully kept notebooks.

In figuring upon various gas problems, it is vitally essential that you figure from a standard. One of the great outcries now is:—"We have no standards"—"That each gas man is his own little god."

This has no doubt been true. Here follow some standard gas analyses which you will find very convenient to use all of your lives. They are actual analyses upon a big scale and made most carefully.

TABLE OF STANDARD GASES.

Composition.	Coal Gas, English.	Coal Gas, American.	Coal Gas, German.	Solvay. Coke oven 8 c. p.	Solvay. Coke oven 16 c.p	Mond Producer.	Morgan Producer Bituminous.	Wilson Producer.	Taylor Producer.	Carburetted Water Gas.	Blue Gas.	Carburetted Water Gas.	Carburetted Water Gas.	Blast Furnace Gas.
CO_2	.60	1.07	3.01	.83	1.61	14.6	4.0	3.4	4.5	4.6	3.5	.14	3.8	11.5
C_6H_6	1.00	1.80	1.33	.45	1.04	......	......	......	......	21.2	......	1.53	14.6	......
C_2H_4	2.47	4.11	3.76	3.20	4.89	......	......	.8	......			11.29		
O_2	.49	.15	.65	1.10	.57	.50	.60	......	.6	1.0	......	.06	......	......
CO	4.23	5.60	8.88	3.00	3.05	10.3	25.0	25.3	25.5	14.8	43.4	28.26	28.0	27.5
H_2	52.22	45.52	46.20	52.10	39.80	23.5	19.4	9.2	12.0	18.4	51.8	37.20	35.6	5.0
CH_4	34.76	37.91	34.02	36.60	39.21	5.3	9.6	3.1	1.0	30.7	......	18.88	17.0	......
N.	4.23	3.84	2.15	2.70	9.83	55.8	41.4	58.2	56.4	9.3	1.3	2.64	1.0	60.0
BTU	635.00	720.0	642.0	648.0	688.7	163.5	223.0	155.0	132.0	......	......	650.1	764	112-128
Sp.gr	.46	.408	.458	.40	.42	......	......	......	......	......	......	.591	......	......
c. p.	16.00	18.00	16.00	8.08	15.87	......	......	......	......	26 0	0.	22.06	26.0	......

Gross B. T. U. per Cu. ft. Conversion Table.
0°C. = 32° F. and 760 mm pressure.

H_2	343
CO	341
CH_4	1065
C_2H_4	1673
C_6H_6	4011

For 60° F and 30″ barometer multiply by $\frac{1}{491.4} = .002035$ for each degree rise.

The tables represent English, American and German coal gases, Solvay coke-oven gas from Milwaukee and Detroit, Mond, Morgan, Wilson and Taylor producer gases, blue water-gas, three different grades of carburetted water-gas, also blast furnace gas, The tables show the B. T. U. per cu. ft., also the candle power.*

I show a table of gross B. T. U. per cu. ft. for 0°C. and 760 mm. The volume per cents of the chemical components multiplied by the factor, will give when all are added together, the gross B. T. U. To change the volumes to 60°F multiply by the factor shown per degree. I want to note here the importance of your knowledge of the entire metric system of units.

The next great thing to have impressed at your very finger tips is a complete understanding of vapor tensions and their great importance in actual work.

(*For additional data see Journal of Society of Chemical Industry, June, 1905, p. 592-604.)

To fix this in your minds, I will give you an example which I had recently.

The magnitudes of the volumes produced in the operation will, I hope, rivet your attention.

At a certain works it was proposed to measure daily, at the point D, 90,000,000 cu. ft. of gas at the standard temperature 60° F = 15.5°C.

A B C D

This gas produced at A would have actually at the B point where it enters the machinery, the temperature 212° F = 100° C the temperature of boiling water. On account of the peculiar properties of water vapor tension, the volume of this gas if saturated, would be the enormous quantity of 3,375,000,000. cu. ft. This mass of gas would have to be cooled down to the required volume 90,000,000 cu. ft. at D.— In other words, it would be reduced in bulk 37–1/2 times under this condition. Every piece of machinery between B and D under this condition would have to be designed to handle this mass scientifically as well as practically. About 640,000,000 gallons of water would be required and this would need a centrifugal pump station of 30,000,000 gallons per hour capacity.

In cooling down this gas we run against the vapor tension of ammonia at the point C, and extract there the ammonia liquor. The water thus produced there daily is the equivalent of 90 tank cars of 6000 gallons each and it has to be distilled daily to a reduced bulk of three tanks. 3,000,000 cu. ft. of gas per day, and 30 to 36 tank cars of liquor are handled daily now.

At the point B, a mass of gas whirls through the machinery at the rate of 2,343,000 cu. ft. PER MINUTE or as much as would supply the capitol city of Wisconsin ONE WEEK.

You will thus see the necessity of your knowledge of vapor tensions, and also of the laws of flow of liquids and gases, the mechanics of moving machines, the applications of power, the principles of thermodynamics; all are used in the calculations of this single problem. We of course soon find in our calculations that we can reduce the enormous bulk at the point B by preventing *complete* saturation, without reducing the temperature.

I have said nothing about the acres of coal fed into the furnaces, and the rivers of coke poured out of the furnace doors to round out this operation. Nor have I said anything about the thousands of gallons of coal tar and benzol that have to be cared for at this plant.

Is it not an inspiring thing to consider a vast problem like this in its entirety?

Think of the anxious care with which this cooling operation has to be conducted to bring out at D the required volume and temperature, robbing it on the way of tar, benzol, ammonia and water.

A large quantity of this gas is washed in a veritable river of hydrochloric acid, the strength and temperature of which has to be carefully watched and allowed for. A part of the gas is cleansed of sulphur impurities in beds of oxide of iron, and a part is washed in heavy oil to absorb Benzol, the gas being required for different purposes. The capital cost of this plant runs into the millions.

At the point B to C is a place where it is quite possible to make large improvements in the first cost of installation, and also in the opertion cost, by a change to an entirely new principle, the principle of Mechanical Condensation by rotary centrifugals.

This mechanical condensation is being accomplished in several different ways in Europe, and American engineers are now thinking it over. I believe two or three experimental trials are being made here now. Personally I have given a great deal of study to the idea of the extraction of tarry and aqueous matters by rapid rotation, especially in helicoidal screws.

It is believed the idea of centrifugal extraction of matter will be productive of good results in practice.

Gas Engineers have now before them several important general engineering problems. They are,

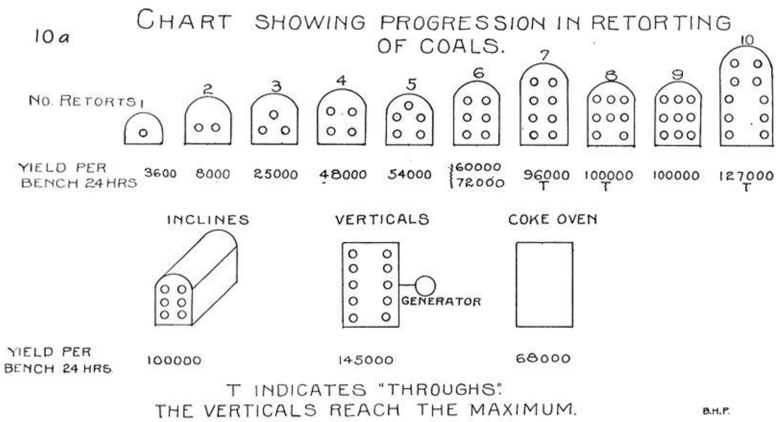
1. Vertical retort distillation of coal.
2. Modified coke ovens inside of retort houses.
3. The high pressure distribution of gas.
4. Gases for power.
5. Producer gas development.
6. Chemical treatment of residuals.
7. Naphthalene recovery.
8. Benzol Enrichment of lean coal gases.

9. Proper condensation.
10. The development of large unit gas engines for central station work.

As an example of evolutionary growth in one item of gas works manufacture,—the retort furnace—I will run over the line of development that has lead up to the Vertical Retort.

The retorting of coal began with a gradual succession of 1, 2, 3, 4, 5, and 6 retorts in a furnace, called a bench. The retorts were first of iron, then of clay, heated by an open fire. Benches of 4's and 6's of this type are today in extensive use. They consume from 20% to 33% of the coke produced. These furnaces receive the air in the combustion chamber but slightly heated.

Recuperative and regenerative furnaces were next made and the number of retorts increased from 6 to 8, 9, and 10 per bench. The air supplied to the fire in the combustion chamber was highly heated by the waste heat products of combustion before passing to the chimney. In the German Munich patent benches with the fire outside the bench in a generator, long runs of as low as 16% of coke made, consumed as fuel, have been made; the yields per bench of these standard 6's running to 72,000 cubic feet per bench per day.



The next stage was inclined retorts, elaborate affairs, the retorts being tilted at an angle of inclination proper for hot coke to slide down and out, when suitably burned. A good installation is to be seen at Louisville, Ky., also in Brooklyn. These produce 100,000 cubic feet or more to the bench.

The coke oven in the shape known as the By-product Coke Oven came in ahead of the inclines. It is a successful producer of gas as well as coke on a large scale. A coke oven of this type is now built 35'x8'x16'," holding 7¼ tons coal and burned off in 18 to 20 hours, producing 9000 feet of gas per ton from coals only partially gas coals.

The next scheme was to house these ovens on a smaller scale in retort houses. Three installations of these are now on trial in Germany.

Simultaneously with this development was revived a very old idea of having the retorts vertical.

Six experimental installations have been tried out successively at Dessaw. At present 20 verticals there produce an average of 14,500 cubic feet of 13 candle gas each or 193,333 cubic feet per man, it only requiring 1½ men practically to run the carbonizing plant.

This system produces better coke, more ammonia, more and better tar, with less labor than does any other known form. The patent is bound to be a success and will surely spread in use. It is a coming thing. These retorts are built in blocks of 10 with one generator which only has to be fed with coke once in 24 hours and clinkered once in 48 hours. The fuel consumption is 20% of the coke produced. A plant is now also being built in Berlin. The remarkable fact is shown that the retort temperature is 1400°C, yet the waste gases escape at 310°C. It is a triumph of the art of thermie analysis.

Throughs. The plan is also used of putting two retorts into one, by setting the retorts end to end, the benches being built back to back, knocking out the back walls. Thus two 10 foot retorts are made into a 20 or 22 foot retort. They cease to be charged by hand. Coal is fed in and coke pushed out by machinery. A fine example of throughs is to be seen in Milwaukee.

Producer Fed Furnaces. It is a common thing to build a block of benches and have a common producer feeding them all. This is an economical practice.

The facts to be considered in laying out a retort system are: The largest output per retort, with the lowest fuel consumption and the lowest labor, everything being done by machinery.

The question of long life of retorts and low repairs is a most vital one. Coking time is an important factor.

English practice runs from 5 to 8 hours.

American practice runs from 4 to 5½ hours.

Coke ovens practice runs from 18 to 24 hours.

Verticals practice runs from 8 to 10 hours.

The figures of yield per bench per 24 hours in the chart show that the industry has moved during the century of its existence.

Outside of the large cities like New York, Philadelphia, St. Louis, Boston, Detroit, Milwaukee, Cincinnati and Louisville, Ky., there are few noteworthy gas engineering achievements. It is to Europe we must turn for examples of engineering on a great scale in gas works, especially in Great Britain and Germany.

Dessau, Germany, has a noteworthy record. Here was installed the first retort setting fired with producer gas 30 years ago. Here was installed the first electric station run by gas engines 20 years ago. Here was installed the first tramway with gas locomotives 10 years ago, and now there is being installed the first successful vertical retorts.

Madeburg, Germany, first made a very low candle power gas of high heat units, and distributed it to the whole city using Welsbach mantles—abolishing completely open flame burners.

Vienna and Berlin have taught the world how to construct inclines. Brussels has shown us marvels in residual recovery, and in Great Britain we have a blaze of gigantic installations of the greatest feats of engineering, Sheffield leading the world with 26 cent gas.

The high pressure distribution of gas through large cities, and from centers of population to outlying towns, which would otherwise have either to go without gas, or suffer a higher price by the operation of a separate works, occupies a commanding position in the minds of all gas engineers, as well as the thoughtful attention of investing capitalists.

Natural gas men long ago executed prodigies of skill in transmitting enormous volumes, long distances under high pressure, with relays of gas engines along the line, acting as "boosters,"

The gas men of California are doing some great work in artificial gas high pressure transmission.

A large installation is soon to be in operation at Joliet, Ill., and another at Chester, Penn.

You will find the study of this question of high pressure transmission one of the most facinating problems, and worthy of all your efforts in the study of details necessary to master it sufficiently to produce results.

Producer Gas. Pressure and Suction Types.

Here is a promising field. The most noticeable difference between ordinary coal gas and producer gas is, the latter is non-illuminating and possesses only from 1–3 to 1–5 of the heat units per cubic foot. It is the cheapest gas made per unit of heat, and contains more of the original energy of the coal than does any other known gas.

There are several varieties of gas producers, divided practically into three classes, the Mond, saving by-products, the pressure systems, the suction systems.

The standard requirements are: Continuous performance, cheapness in operation, consume all carbon in coal, gas to be uniform.

They are now built with continuous automatic feed, and designed to use cheap inferior grades of slack, fine coal and coke refuse.

Producer gas does not carry well or economically therefore it is especially adapted for manufacturing establishments, which desire to make and control their own power or fuel supply.

A brake HP per pound or less of coal has been attained by the Mond process, and I think by other systems as well.

The suction producer is striding ahead. It is so designed that each forward motion of the gas engine aspirates gas from the producer and when the engine shuts down, the fire practically banks itself until start is made next day. Small space occupation and low cost of everything makes it a winner in every sense for small establishments. Pressure systems are better for large plants.

Gas engineers must of necessity be energy engineers,—versed in all the phases of energy. We are light engineers, so we have to be more or less familiar with optics, with the principles of reflection and refraction, the theory of color absorption, etc.

The well known Luxfer prism glass, and the equally familiar holophone glass gas and electric globes, are ingenious scientific adaptations of optical principles. (The little things count. One degree of temperature may mean a good many thousand dollars per year.)

In closing this scattering talk, your attention is called to the obligation of judicious reading. I would advise the reading of Bell's "Art of Illumination" and Butterfield's, "Chemistry of Gas Manufacture," and for the Juniors and Seniors a glance at a few parts of Schuster's "Optics," and Ernest Mach's "Science of Mechanics," an inspiring book, on a hard subject, but which puts imagination into play.

Lastly let us remember that the "whip of discipline" is a good thing. It is well to live under a sturdy discipline. You must govern yourselves if you would govern others, and at the same time you yourselves will be under corporate government and under strict accountability to discipline.

THE UPWARD INDICATION OF THE SEMAPHORE ARM.

L. R. CLAUSEN, '97, SIGNAL ENGINEER, C., M. & ST. P. RY.

The traveling public is little cognizant of the extent to which railway signaling enters into or affects the safety and dispatch with which it journeys over the country. The average individual's conception of railway signaling may be summed up in one or two words, "Block" or "Block System" about which he has the vaguest of ideas. That a considerable amount of traffic may be handled over a road rapidly and safely, it is as necessary for a good installation of signals as it is that the rails be continuous and after reliability, the most important item in a good system of signals is the indication or form of the unit signal.

Throughout the history of signaling we find the word "semaphore," descriptive of a particular type of signal. The word is of Greek origin, derived from words meaning "a sign"—to bear," hence "to bear a sign or signal."

The original construction introduced but two members, one vertical and one horizontal. This combination was either of "T" shape with a portion of the horizontal member either side of the vertical or an inverted L shape, the horizontal member projecting either to the right or left of the vertical, the latter being the form of semaphore now used almost exclusively for railway signaling purposes.

It is not hard to see now why in medieval or ancient times this form of signal was adopted, and especially is this true when one has made a study of the appearance of many shapes and colors of signals with different backgrounds and under the various conditions of wind and weather. Further, the mechanical simplicity of arranging the horizontal arm so that it would revolve rather than slide up and down is obvious. Either of the two methods would give a position signal, but the wisdom of the selection of the former method of construction is proven when we consider that there has been no change in the elements of construction from the earliest known semaphores to the present day.

The first purpose for which the semaphore was used was, without doubt, as the name would indicate, that of conveying messages or information, and there were regularly established lines of communication in sections of Europe, where information was sent and received by their means previous to the discovery of electrical methods of signaling from place to place. The semaphores, usually of a "T" shape, were of large size and were erected on the tops of hills that the ideal sky background could be had and that the best view would be furnished in both di-

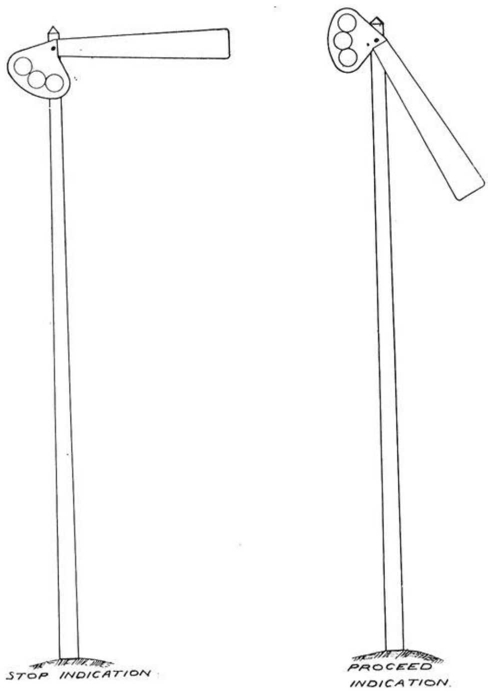


Fig. 1.

rections along the line of communication. By the adoption of codes covering the various angles of the horizontal with the vertical member of the signal, or successive positions or combinations of the same, fairly good speed was obtained in clear weather.

Very soon after the first trains were placed in service, the necessity for some form of signal to control their movement was felt, which soon resulted in the use of a large number of kinds of signals (mostly of form and color) for giving information as to switches, fouling points, crossings, train orders, etc.

The variety of the signals on several roads in England and Scotland used for similar purposes brought to the attention of their officials the advisability of the adoption of one standard for all lines, and a meeting was held for this purpose in the year 1841. The suggestion of a Mr. Gregory proposing the semaphore type to replace the many other shapes was agreed upon, and the semaphore of a shape shown in Figure No. 1—horizontal arm for the Danger or Stop indication, downwardly inclined arm for the Clear or Proceed indication—, was made standard.

As it is a cardinal principle of railway signaling that any derangement of a signal or breakage of parts shall result in the arm *gravitating* to the stop position, it is hard at the present day to understand why the board entrusted with the selection of a proper signal should have agreed on the downward indication for Proceed and its action in the matter is now very generally considered a very serious mistake. To speculate on the reasons for the action may not be digression:

The proceed indication referred to may have been considered for the following reason: In the operation of trains it is customary, and probably has been from the first, for a man to stop a moving train by holding one or both hands in a horizontal position; also to permit a train to continue by allowing the arms to hang at the sides in a natural position. The adopted semaphore indication would conform to this custom of hand signaling, but the latter has the bad feature of being based on the principle, a signal for stop and no signal for proceed, i e., proceed unless you see a signal to stop. Again it is possible that the upward position of the arm for proceed was either not considered, or it may have been dropped for the reason that the angle between the arm and the vertical mast was considered easier of interpretation when such angle was in the lower quadrant, where the whole length of the mast could be utilized as one leg of the angle.

The similarity of the operation of the semaphore to the hand signal seems to be the strongest argument in favor of the downward indication, and if such argument was the determining feature in the selection of a proceed indication, it was allowed to outweigh the excellent reasons against such selection.

The present semaphore in railway service is of the general shape and design shown in Figure No. 1, and this type is used, as stated before, almost to the exclusion of other types. There is one country, however, where the bad features of the downward proceed indication and the good features of the upward

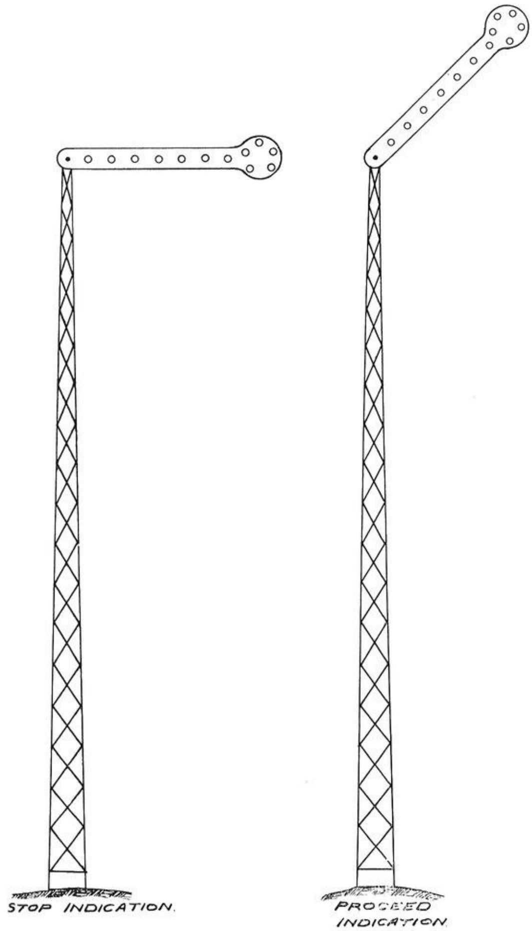


Fig. 2.

proceed indication were realized some years ago, and in this state (Germany) the latter has been very generally in use for a number of years. I understand that the German design of semaphore (Fig. 2) is also used to a limited extent in Austria and Belgium.

The question of changing from the downward to the upward proceed indication has within the last month reached dimensions of importance and is attracting the attention of Signal Engineers throughout the United States. That the advocates of this change will meet with opposition is to be expected, and there are two very good arguments in favor of a continuance of the present signal practice, i. e., 1st. a change would involve considerable expense, and 2nd, such a change would be a radical departure from the standpoint of the trainmen. Let us review the principle arguments for and against the proposed change.

Further than the two stated next above, there are probably no strong arguments in favor of continuing our present practice, and it must be granted that the change would involve more or less expense and would be radical as to signal practice. With this much granted to warrant the change, the bad features of the old combined with the good features of the new must be sufficient to condemn the old and outweigh the arguments in its favor.

The following may be mentioned as unfavorable to present practice:

1st. The arm must be counterweighted to cause it to gravitate to the Stop position.

2nd. The counterweight for summer weather will not be safe for winter, on account of the amount of ice and sleet or snow which may accumulate on the signal arm. As this amount is indeterminate, and may vary from a few pounds to 25 or 30, or even more, depending upon local conditions, the excess of counterweight must be rather large.

3rd. The counterweighting makes heavy construction necessary throughout and the blows delivered to the stops at the end of the upward and downward stroke due to the increased weight of the arm and casting, become excessive.

4th. The increased violence of the blow delivered to the stops introduces an element of danger and expense as the colored glass roundels, which are also carried on the arm casting, may become broken.

5th. To reduce the amount of counterweight required, and also the lever arm of any icicles which may collect on them, the blades must be made as short as possible.

This will readily be recognized as a bad feature as it shortens one side of the angle and neutralizes the true semaphore indication.

6th. To still further reduce the amount of counterweight required, it is customary to design the arm casting to carry the colored glass roundels on the opposite side of the shaft or axis of revolution from the arm or blade. This practice has a tendency to still further neutralize or obscure the true semaphore indication, as may be seen in Figure No. 3 illustrating what is known as the universal arm casting.

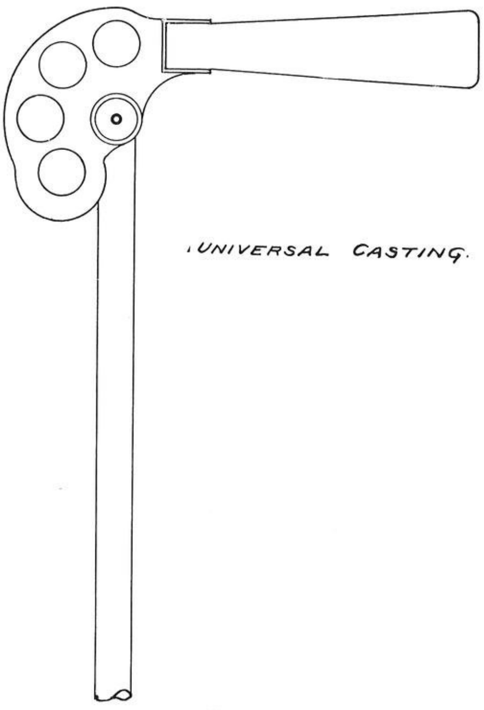


Fig. 3.

7th. As shown above, semaphores giving the downward proceed indication are excessively counterweighted to provide for certain contingencies, and it is obvious that this excess weight must be lifted day after day, and month after month in the operation of the signal, that we may have safety during the one hour or two hours perhaps in a year when the conditions are unfavorable. This is not a serious defect where signals are manually operated or where a power plant is used, but it becomes a very important argument against the present practice where primary and storage batteries are used for the operation of the semaphore, and the watt consumption per signal movement has to be considered. As the great percentage of automatic signals is operated by primary or storage cells, and as automatic signals are now being and will continue to be installed very rapidly, the latter question is of ever increasing importance.

In the following I will attempt to enumerate the more important arguments in favor of the upward indication of the semaphore arm for Proceed.

1st. In the early days of railroading it was considered necessary to have fixed signals show only danger or caution and no indication was shown when it was safe for a train to proceed. This principle may be seen exemplified in the older forms of train order signal and switch targets, which consist of sheet iron blades of various shapes which stand parallel to the track, and therefore can not be seen by enginemen, when the conditions are right for the train to proceed. When it was desired to stop a train these discs or targets were turned at right angles to the track, and of course, readily attracted attention.

At the present time the principle of signaling just outlined, is considered faulty, and it is deemed just as important to give the engineman a proceed signal or indication as it is to give him a stop signal, so that under any conditions he obtains decisive information. Such being the case, the upward proceed indication of the fixed semaphore complies most closely with the standard of hand signaling. When giving the proceed or go-ahead signal (in railroad parlance "the high ball") it is customary to hold the hand nearly vertical over the head, which you will note by reference to Fig. No. 4 is just the position taken by the arm of the proposed new semaphore.

2nd. It has become a recognized principle of signal practice that every semaphore should assume the stop position immediately after the engine of a train has passed it. This can be, and is now effected by the track circuit and electric control. To carry out this idea to its fullest extent gravity must be depended on to bring the arm to the stop position and there probably will be none to dispute that an arm which falls downward to the stop

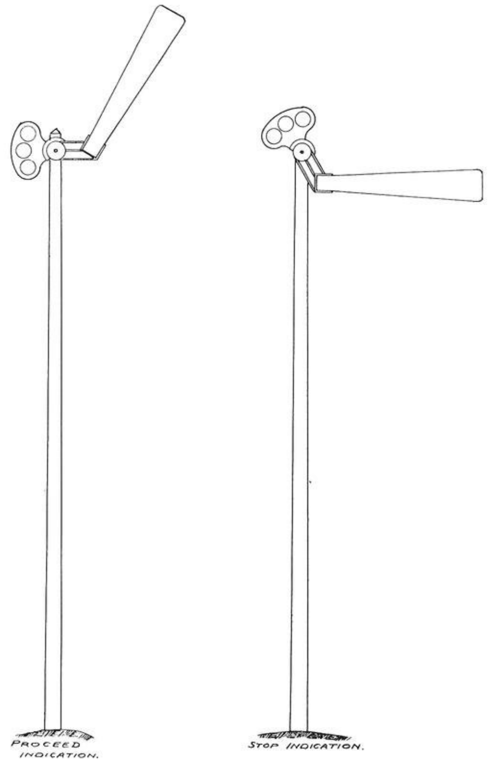


Fig. 4.

position is more to be depended on, all things considered, than one which moves upward due to a counterweight.

3rd. It is obvious that snow and sleet collecting on the arm will but increase the tendency to assume the stop position.

4th. The arms or blades may be as long as desired.

5th. The glass may be applied to the arm casting without enhancing the true semaphore indication to any considerable degree.

6th. The power required for operation may be reduced to a minimum.

As to the argument that the upward indication is a radical departure in signaling practice:

The writer is firmly of the opinion that the new indication can be introduced on any division of a railroad with the simplest of rules for the guidance of employees, and that any delay or trouble caused by such introduction will be negligible .It can be but reasonable to anticipate that trainmen will almost immediately grasp and interpret the indications of a fixed semaphore which correspond so closely to the present hand signals.

Signaling in the United States is at the present time in its infancy, and is experiencing a remarkable development. Apparatus placed on the market two years ago is now out of date. One road has contracted for installation of apparatus worth one and one-half million dollars. Another road has submitted specifications and undoubtedly will shortly contract for an installation costing over three million dollars. Numerous other large contracts have been made, all of which show the tendency of the times. The best answer that can be made to the argument that the proposed change will involve expense is to appeal to the good judgment of those who control the finances. Let us not permit a mistake of choice made years ago, when railroads were but tramways influence our correct action at this day. If it costs blank dollars to change today what will it cost tomorrow.

THE ENGINEER'S INTEREST IN FORESTRY.

E. M. GRIFFITH, STATE FORESTER OF WISCONSIN.

Although forestry is an old profession in the well settled countries of Europe, it is only within the last ten years that the government and the people of the United States have awakened to the fact that our forests are by no means inexhaustible and that it is imperative to adopt forestry methods in order to avoid a timber famine. Forestry has as many branches as an oak tree but among its manifold aims, the two most important being to "conserve the forests by wise use and protect the water supply," I wish to emphasize only, in the following article, those which are of particular interest to the up-to-date engineer.

FORESTRY AND IRRIGATION.

One of the most important engineering feats of today is the building of large irrigation works throughout the west under the direction of the Reclamation Service of the United States Geological Survey. This work was made possible through the passage of the Reclamation Act of June 17, 1902, and the fund at the disposal of the Reclamation Service amounted in January, 1905, to over $25,000,000. Great reservoirs and irrigation systems are being constructed so that the arid plains may be watered and changed, as if by magic, into wonderfully fertile farms. These works are being built to last for generations and are very costly, as the Arizona Dam at Roosevelt, $3,000,000; the Carson project in Nevada, $4,000,000; and the Gunnison Tunnel in Colorado, which will be 30,000 feet long. But the protection and permanence of almost all of these enormous systems is dependent upon the proper care and use of the forests, especially those on the higher mountain slopes, as they are nature's great reservoirs. The whole question is a national, not a state, one, as for example the headwaters of the Rio Grande in Colorado must be protected in order that there may be a permanent flow of water to supply the irrigation works which are being constructed in Colorado, New Mexico and Texas.

The engineers of the Reclamation Service and the foresters of the Forest Service have worked together to make possible the reclamation of millions of acres of arid country which without water are so barren that only sage brush and cactus can exist. When the engineers found streams that could be utilized, by means of flumes, reservoirs, etc., the foresters saw to it that the forests protecting the head waters and supplying these streams were included within a forest reserve and carefully managed. The total amount expended upon each system will be assessed on the lands benefited, so that if 100,000 acres have been irrigated at a cost of say $4,000,000 then each acre must pay $40 in ten installments. When the entire amount has been paid for in ten annual installments the system will be turned over to the people who own the land. At first there was considerable opposition to the creation of forest reserves but as soon as the people found that they could purchase the mature timber and that the young growth, water supply and grazing were carefully looked after, so as to preserve them through wise use, the feeling immediately changed and now the local settlers, especially those who are dependent upon irrigation, would be up in arms if there were any danger of the forest reserves being abolished.

DEVELOPMENT OF WATER POWER AND FOREST RESERVES.

Wisconsin is particularly rich in water powers but as yet their development is in its infancy. The water powers of our rivers are one of the most valuable assets of the state but unless the forests at the headwaters of these rivers are protected the melting snows will cause freshets for a few weeks in the spring and during the summer months the water will be so slow that mills depending upon these streams must either shut down or else run only a portion of the time. Some of the water powers of our most important streams give a relatively even power throughout the year only from the fact that at the headwaters dams have been constructed at the outlets of the lakes in order to store the spring freshets until the summer months when the water is most needed. But this is only a temporary makeshift and it will readily be seen that it is very unwise to allow a few companies owning dams to thus virtually control many of the great water powers of the state. A regular and even flow depends in every case upon the conservation of the forests on the headwaters and the systematic control of those important matters is purely a state function. In this connection the following statement by Mr. Geo. W. Rafter, consulting engineer, New York, in the "Future Water Supply of the Adirondack Region" is of interest. "Moreover the streams issuing from the Adirondack region are, with one or two exceptions, very much less subject to severe floods than other streams of the state. They are therefore particularly valuable for mill streams because the expense of repairing damage will be materially less. The reasons for this fortunate condition are two fold, 1, They mostly issue from lakes, frequently of considerable magnitude and, 2, The area is still largely covered with forests, in some cases with dense primeval forests of pine, spruce balsam and hemlock." Many people do not understand in just what way forests regulate stream flow, and often imagine that it comes solely from the effect forests have upon rainfall. In the great plains and mountains of the west, where often for months very little rain falls, the cooling influence of forests undoubtedly increases the rainfall, but in the immediate region of the Great Lakes, the forest cover probably has a relatively small influence on the rainfall. But the forests everywhere and under all conditions act as a great sponge in holding water and giving it off gradually, thus saving forested countries from the disastrous effects of floods and maintaining a more or less even flow in the streams. Anyone who will go into the forests in early spring will find plenty of snow in the dense shade, melting slowly and sinking into the ground finally to reach the streams after weeks or months, while the surrounding open country is bare of all snow and the streams flowing through it are in flood. This is so well known in all foreign countries, where forestry is practiced, that the cutting of timber on or near the headwaters of all streams is very carefully regulated by law. In the San Bernardino Mountains in California observations on stream flow have been taken for several years and clearly show the connection between run-off and forests, or in other words the influence which the forest has in regulating stream flow. In the forested area the run-off was only 3 per cent of the precipitation, while on the non-forested area it was 40 per cent. This indicates the tremendous influence which forests have in checking and holding the run-off, but still more instructive is the fact that three months after the rain had ceased to fall the forested areas were giving off over 15 per cent of the original precipitation while the non-forested areas were absolutely dry. The time is certainly coming when the dormant power in all our rivers and streams will be utilized to the fullest extent and made available for many new industries by means of electrical energy. Wisconsin is extremely fortunate in having so many hundreds of lakes which can be used to hold the excess precipitation until it is most needed. In addition reservoirs must be constructed and so far as possible the streams supplying such reservoirs must be well wooded in order that the water may be clear and free from silt.

FORESTRY AND MINING.

The two indispensable needs of a mine are wood and water and as both are dependent upon the proper use of the forests the miner is gradually coming to realize that the forester is his best friend. When the Federal Forest Reserves were first created there was some opposition on the part of the mine owners as they feared that they could not secure the necessary timber to conduct their business. But as soon as they saw that forestry is systematic lumbering, that they could always buy the mature ripe timber and that the conservation of the forests means the protection of the all important streams, opposition ceased and now they are inclined to be over-cautious and anxious lest the forester cut too heavily. The amount of timber which goes into a large mine is almost unbelievable and it has been estimated that it is doubtful if 10,000,000 acres of timber would permanently supply the mines of this country. Dr. David T. Day of the U. S. Geological Survey is authority for the statement that it requires about a cubic foot of timber for each ton of anthracite, say 70,000,000 cubic feet per year, somewhat less for each ton of bituminous, say 250,000,000 cubic feet yearly. Iron ore needs at least 20,000,000 cubic feet, precious metal mining needs about 75,000,000 cubic feet. Probably 400,000,000 cubic feet a year is used by all the mines together. The mining engineer must carefully husband the timber resources of the region in which the mine is located and this is especially true where, as is often the case, the mine is at such an altitude that the better grades of timber cannot grow. Fires at a high elevation are very apt to make a clean sweep of the scrubby growth, which has matured so slowly, and therefore the logging operations should be unusually clean, so that no slash will be left on the ground. But in the rush and craze of a new mining camp wasteful methods are the rule and, after a few years, the increasing scarcity and exorbitant price for timber make the operation of many mining properties almost impossible.

FORESTRY AND RAILROADS.

It is only within the last few years that the railroads of this country have begun to seriously consider the subject of forestry and they have come to it through necessity as it is increasingly difficult for them to secure the timber which they need, especially cross tie timber. In order to have good and safe tracks they must have ties and the demands upon the forests for this one item alone are enormous. Mr. Howard Elliot, president, Northern Pacific Railway, states that "the total consumption of ties for renewals only, by all of the railroads of the United States, is at least 100,000,000, to which add 20,000,000 for additional tracks and yards, and for the construction of new railroads, and the total is equivalent in board measure to more than 4,000,000,000 feet. The significance of these figures is more apparent when it is remembered that about 200 ties is the average yield per acre of forest, varying greatly in different localities, so that to supply this single item necessitates the denudation annually of over 500,000 acres of forest. But the cross tie supply is only one of the forest products required by the railroads. There are bridge timbers, fence posts, telegraph poles, building timbers of all kinds including car material, all of which together it is estimated will equal in board measure the cross tie item, so that it is possible that the railroads of the United States require for all purposes, under present practices, the entire product of almost 1,000,000 acres of the forest annually." Dr. Herman von Schrenk, the foremost authority in this country on the subject of timber preservation and particularly in reference to the needs of railroads, says, "Up to within recent times most of the tie and construction timbers used by the railroads were timbers like the white oak and long leaf yellow pine. These were used because they combined great durability with strength and good wearing qualities. They were abundant along the lines of the roads and were obtainable in large quantities and at a comparatively low cost. A purchasing agent had no difficulty, not more than ten years ago, in getting any number of first class white oak ties in the middle or central states at from 35 to 60 cents. While the price for such timbers is not yet excessive owing to local supplies, it is nevertheless becoming increasingly difficult to obtain large regular supplies of such timbers, and with an ever increasing demand the question has been asked for several years, and with increasing anxiety, where the supply is to come from in the future. As a result of the uncertainty in getting a sufficient number of ties which could be used in the natural condition, many roads turned towards the so-called inferior woods, like red and water oaks, beech, gum, the softer pines, hemlock, etc. None of these woods can be used without preservation, because they decay with great rapidity when in contact with the ground. It is a fortunate circumstance that these so-called inferior woods, because of their greater porosity, can be treated with chemicals so as to preserve them very effectively. Some day we may duplicate the conditions prevailing in Eastern France, where the treated beech ties last until another crop of beech ties furnishes a new supply. Preservation will therefore be an almost indispensable factor in any consideration of future supply, and when one considers the good results obtained, its importance will be fully realized.

TABLE SHOWING ANNUAL CHARGES.

Timber and Treatment.	*Length of Service.*	*Original Cost.*	*Cost of Treatment.*	*Annual Charge.*
White oak, untreated	10 years.	$0.85	......	$0.121
Red oak or loblolly pine, untreated	5 "	.40	......	.124
Red oak or loblolly pine, with zinc chloride treatment........	10 "	.40	$0.16	.085
Red oak or loblolly pine, with zinc creosote treatment.............	16 "	.40	.25	.065
Red oak or loblolly pine, with creosote treatment	20 "	.40	.45	.069

The conclusion to be drawn from such a table is that the treated timber in every case is cheaper in the long run than the untreated timber; furthermore that the better treatments, although more expensive at first, are very much cheaper in the long run."

PLANTING TIMBER FOR CROSS TIES.

The Pennsylvania Railroad Company, which is one of the greatest systems in this country, after looking into the matter very carefully have decided to grow on their own land a considerable part of the tie timber which they require. They use annually east of Pittsburg and for repairs alone over 3,000,000 ties besides 500,000 for new work. Three years ago they started to plant seedling locust trees, two or three years old, which cost when planted about 8 cents each. Most of the trees have been planted ten feet apart or about 400 to the acre but in 1904 some 54,871 trees were planted six feet apart and 88,127, eight feet apart. The total number of trees planted to date is approximately as follows:

Fall, 1902	13,610	Fall, 1904	153,535
Fali, 1903	43,364	Spring, 1905	200,000
Spring, 1904	70,021	Fall, 1905	600,000

This road figures that at present, allowing 10 per cent for the immediate future increase, they will need about 3,850,000 ties per year and that their requirements will be constantly increasing. With their present consumption of 3,850,000 ties and figuring three ties to the tree, 1,300,000 trees must be cut each year. As it takes the yellow locust about thirty years to reach tie size, the Pennsylvania must have 39,000,000 growing trees and plant 1,300,000 each year, which would require about 97,500 acres for the purpose. Several other railroad systems have followed the example of the Pennsylvania not so much with the idea of growing all the ties which they require as to show the farmers and other land owners along their lines how profitably their waste land can be utilized.

Many of the railroad companies, especially the Land Grant roads, own great tracts of timberland and now that they are well started not only in timber preservation but also in raising their ties, it is only natural that they should manage their forests systematically. Engineers should study Timber Physics so that they may know exactly for what work each species is best suited and also should be well grounded in the various preservative treatments for railroad timbers, which is certain to become increasingly important as time goes on.

FORESTRY IN WISCONSIN.

The Forestry Law, Chap. 264, Laws of 1905, provides that all the state lands north of town 33 shall constitute the state forest reserve. This means that some 300,000 acres are reserved with the provision that any of this land which is found to be more suitable for other purposes than for a forest reserve may be sold and the proceeds used to buy other timberland. It is one of the tenets of forestry that no land should be held for forestry purposes which is more valuable for agriculture and every forty within the state forest reserve which is agricultural in character will be sold, for Wisconsin, as is the case in every other state and country, has large areas which are only suited to the growth of timber, and such, but only such, should be permanently held as forest land.

As previously stated, this state has, on the head waters of the Wisconsin River, one of the most remarkable lake regions in the world and it is here that the main forest reserve will be located in order to protect this magnificent watershed. The forest reserve in this section now comprises some 120,000 acres and by purchase and gift it is hoped that this area will be very greatly increased within the next few years. Wisconsin now ranks second among the manufacturing states of the union and if her numerous fine water powers, developed and undeveloped, can be protected, it will mean lasting prosperity to her. The forest reserves in the future should be of untold value to the whole state in supplying the industries using many of these water powers and dependent upon the forests for their raw material. It is also planned to have smaller reserves on the Brule River in Douglas County and the St. Croix River in Douglas and Burnett Counties. The latter will not only safeguard the very valuable water powers on the St. Croix but will aid in checking the fearful annual floods of the Mississippi which are caused by the destruction of the forests on its many feeders.

In the forest reserves the mature timber will be cut in accordance with the provisions of a systematic working plan which will be made for each tract. All the tops and brush, which is called "slash," will be piled and burned, as this is absolutely necessary in order to prevent severe forest fires, and the young growth which is to form the future forest will be protected.

Sections which have been cut and burned over and are not restocking, will be planted with valuable species, 1,200 trees to the acre, and at a cost of not to exceed $5 per acre. Wisconsin must pursue a very broad forest policy for the continued prosperity of so many sections of the state is dependent upon a constant, even supply of both timber and water.

PROGRESS OF THE COLLEGE OF ENGINEERING.

DEAN F. E. TURNEAURE.

The readers of the Wisconsin Engineer have doubtless learned of the liberal action of the last legislature, whereby the university has been placed upon a much more substantial basis, financially, than ever before. From this improved condition the College of Engineering will undoubtedly receive its full share of benefit, and measures have already been taken involving considerable improvements, some of which are now under way and others are planned for the immediate future.
ago and who returns for a visit to his Alma Mater, the most
To the outsider, or the alumnus who graduated several years striking change which has taken place in the college during the past few years is, doubtless, the large growth in numbers, both of students and of faculty. Those who were students in the old days when the college was housed in a few rooms in Science Hall are apt to be quite amazed at the present extent of the space devoted to its work. The Engineering Building seems to them a very recent improvement, and they well appreciate that its construction was a very important factor in our growth. To us on the ground, however, the opening of this building seems now to be a matter almost of the remote past, and our quarters are painfully over crowded and inadequate in several ways. A growth from an attendance of 325 students when the building was constructed to a total of about 800 is sufficient explanation for these conditions.

It is, of course, the expectation of the authorities to make adequate provision for the students who enter the university in increasing numbers to prepare themselves for the engineering profession. But not only is it expected to provide sufficient equipment and instructional force to carry on the work as heretofore, but in many ways it is intended that the work shall be extended and improved. It is not the purpose to make special effort to secure a rapid increase in the numbers in attendance, as the strength of the school is not so much a question of quantity as of quality of product, a matter which the engineer will at once appreciate. It is rather in the direction of improvements in quality of instruction and in the encouragement of productive research in applied science that the best efforts of the immediate future will be expended.

For the first time in many years the entering class shows a small decrease as compared to the previous year, but the quality has apparently improved. This condition is doubtless due to the increased rigidity of the entrance requirements, particularly in algebra, in which an examination has been required for admission to the regular classes on that subject. Next year the requirements are to be somewhat greater in this direction to the extent of a half year's additional algebra. It is very desirable that the preparation of students entering the Engineering College be increased as rapidly as practicable to the point where it will be unnecessary to teach in the university such subjects as German or English, or most of the freshman mathematics. Whether such work can be done in the high schools or whether a part of it should preferably be done in college is a question which the future must answer. It is certain, however, that the future engineering school is to be a more distinctively professional school, in which the teaching is confined to the sciences of engineering with their professional applications; and it is towards this idea that we must continually strive. In this connection a very favorable movement and one of considerable importance is the growing tendency for students to spend two to four years at a college like Ripon or Lawrence before entering upon the engineering course.

The improvements in the college which are now under way, or contemplated for the immediate future, include additions to space, additions and improvement to equipment, increase in instructional force, addition of new courses of instruction, and provisions in space, equipment, and assistance for increasing the usefulness of the college in investigations in applied science.

One of the most noteworthy improvements which has been made this year is the establishment of the long desired course in chemical engineering. The importance of this work has been urged for many years, but until the present year sufficient funds were not available for its inauguration. Fortunately the construction of the new chemical laboratory left available in the old building space which could be utilized partially for this work, otherwise it would have been impossible to begin it at this time. A course has been arranged which, it is believed, offers very superior training in this broad field. By reason of the fact that this work must cover both chemistry and mechanical engineering a thoroughly good course requires more than four years' time, and it was therefore decided that the course should be made one of five years. The inadequacy of a four-year course has been recognized by other institutions offering this work, but this is the first school to place it distinctly on a five-year basis. The importance of the more adequate training is widely felt, and we anticipate no difficulty in holding the better students of the course for the entire five years.

Chemical engineering includes a great number of branches, among which is that of gas engineering. This College is especially fortunate in having many alumni already in the gas business, and partly for this reason we are in a favorable position to emphasize this branch of the work. Special provision has accordingly been made in the course for advanced work in gas engineering, and this effort has been very favorably received by prominent gas engineers and associations. There will undoubtedly be for many years a far greater demand for men trained in this work than we can possibly supply, and to those inclined in this direction there is no more promising field in the industrial line. Although the course was necessarily announced very late in the year, about 25 students of the various classes have selected this work. The department is in charge of Professor Burgess, who still retains his special work in applied electro-chemistry. Chemical technology is provided for by the appointment of Mr. J. C. Dickerman, a man of much experience in chemical industries, as assistant professor of chemical engineering. A considerable amount of instruction in this department will also be in charge of Mr. Brown, formerly of the University of Indiana.

Another very considerable improvement under way is the construction of a building on the lake shore for the hydraulic laboratory. Up to the present time laboratory work in hydraulics has been confined to a very few small experiments in cramped quarters in the engineering building. Last year the regents voted an appropriation of $20,000 for the laboratory, together with part equipment, and the work of construction is now well progressed. The building is placed on the lake shore so as to have available a convenient supply of water, and will consist of two main stories and a basement, the dimensions of the building being 48 ft. x 96 ft. The basement consists largely of measuring tanks and channels for large-scale experiments, and the first main floor will be occupied by piping and various hydraulic machinery. The second floor, for the present, will be used as a store room for the University, but will be given up to the hydraulic department as needed. It is the intention ultimately to have a large lecture room on this floor, where the lectures in hydraulics may be given with apparatus at hand for illustrative purposes. The building is designed not only for instructional purposes, but also for work of investigation, and in the latter respect the opportunities which it will afford will in many ways surpass anything so far offered in this country. Much interest is shown on the part of hydraulic engineers in this work, and several have already expressed their desire to have undertaken in this laboratory various important series of experiments. Provisions are already made for carrying out during the coming winter a series of tests on centrifugal pumps, a special pump for the purpose having been constructed by our mechanician. Other valuable experimental work will be begun as soon as practicable and without question this laboratory will be able, within the next few years, to turn out work of value much beyond anything which has been done in recent years.

In another direction the work in hydraulics has been much improved during the past year. Previous to that time the theoretical and applied work in this subject was distributed among four different departments, no one of which had for its chief object the development of this work. By reason of changes made necessary by the death of the late Dean Johnson, it seemed desirable to combine the scattered courses and establish a new department of hydraulic engineering. This was done, and Professor D. W. Mead, consulting engineer of Chicago, was placed in charge. Professor Mead has had a long experience in hydraulic engineering of all descriptions, and under his direction the work in hydraulics has been given a great impetus. In these days of power development, irrigation, and the improvement of water supplies of large cities, the subject of hydraulic engineering ranks as a very important branch of the profession.

Productive research is now engaging greater attention on the part of all departments, for the Engineering school cannot be of the greatest service to the state unless it utilizes its resources in endeavoring to solve the many problems in applied science which are constantly arising in the industrial and engineering field. Furthermore, such work carried on partly by the aid of senior students, partly by the aid of graduate students, and partly by special assistants will serve greatly to improve the quality of the instruction.

Somewhat outside of University authority is the important work begun last year by Professor Burgess through the Carnegie Institution of Washington. His important research on the production and properties of pure iron lead this institution to give him a considerable grant of funds with which to carry on his investigations, and for the present year Mr. O. P. Watts, formerly a graduate student, is employed to assist in this work. The field is such a large one that these investigations will be likely to continue for many years.

The laboratory for the testing materials will be much relieved in the matter of space when the hydraulic apparatus is moved from the engineering building to the new laboratory. In the subject of structural materials there are great opportunities for research work and better facilities for this are being provided.

In the mechanical laboratory important additions in the way of a steam turbine outfit and a producer gas plant are expected to be made at once. This laboratory greatly needs more space, particularly for thesis and research work.

The electrical laboratories will gain somewhat in space by the occupation of the old chemical building, but here too there is a lack of suitable rooms for research and thesis work. The usual additions to standard equipment are being made in the dynamo laboratories and also considerable improvements in the department of electrical testing, which moves from the basement of the new building to the old chemical building.

We are looking forward to the construction in the near future of new and up-to-date shops, and the establishment of a mining course for which there is a constant and growing demand. It is also expected that the construction of the new heating plant soon to be started by the University will open up the way for the enlargement and improvement of laboratory facilities in several directions. On the whole, there has been no time in the history of the college when the outlook for the future in solid and substantial improvements was better than at the present time.

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Upon entering the tenth year of its existence, the engineer sees signs of extension and general prosperity on all sides. The College of Engineering is forging ahead rapidly and expanding in all directions. While it is true that there is a slight decrease in the number registered this is due to the more rigid entrance requirements which went into effect this year. More attention is being given to research work and special investigation is very heartily encouraged. New faculty members have been added to carry on and assist in this work. The new hydraulics laboratory which is being built will stimulate activity along this line. The chemical engineering course which was organized this year, offers opportunities along several lines for original work. The standard of the work done is constantly being raised and the opportunities open to the students are rapidly increasing. Never was the College of Engineering in a stronger and more progressive stage and students and alumni may well feel proud of it.

At the time of going to press the senior engineers are on their annual trips of inspection. A great deal of interest was manifested by the men this year and they will no doubt have very profitable trips.

The senior mechancial and electrical engineers will go east as has been the custom for several years. The route as planned is in short as follows:

Friday, Nov. 17. Leave Madison via Illinois Central R'y at 3 P. M.

Saturday, Nov. 18. Arrive at Ann Arbor 8 A. M. 2 P. M. Wisconsin–Michigan football game.

Sunday, Nov. 19. Arrive Niagara Falls. Visit Niagara Falls Power Co.'s plant. Gorge route trip and general sight seeing.

Monday, visit canal power development and various industries using this power. Leave Niagara Falls for Buffalo.

Tuesday, visit sub-station and power house in Buffalo, Buffalo water works pumping station, copper refinery, Lackawana Steel Works, Great Northern Elevator and American Dry Docks, Buffalo Forge Co.

Wednesday, leave Buffalo for Dunkirk where Brooks Locomotive Works is visited. Leave Dunkirk at 1:17 P. M. Arrive Pittsburg at 7 P. M.

Thursday. Westinghouse Electric & Mfg. Co., Westinghouse Machine Co. at East Pittsburg and Westinghouse Air Brake Co. at Wilmerding. Evening. American Window Glass Co. and Flint Glass Works, Jeanette, Pa.

Friday, A. M. Rail mills and open hearth furnaces. Homestead, Pa. National Tube Co., McKeesport, Pa.

Saturday. Nernst Lamp Co., R. L. Nuttall Co., Standard Underground Cable Co., Pittsburg Telephone Co., Phipps Power Bldg., Frick Office Bldg.

Sunday. Leave Pittsburg, 7 A. M., arrive Chicago, 9 P. M.

Upon arriving at Chicago, November 26, part of the men will remain there for several days visiting the various large industrial plants about that city, while the others will return at once to Madison.

The Senior Civil Engineers will leave on November 27 for Chicago and will spend three days there visiting the Illinois Steel Company's plants at South Chicago, the Pullman Car Shops, etc., and will also see the track elevation which is in progress there as well as visiting the Illinois Telephone Company's tunnels under the downtown streets. They will close the trip by attending the Chicago–Michigan football game Thanksgiving Day. Professors Beebe, Thorkelson and Shaad will accompany the students on the eastern trip, while Professor Taylor will be in charge of the civil engineers' trip.

During the ceremonies in connection with the installation of President James at the University of Illinois on October 18, two degrees were conferred which are of especial interest to Wisconsin students. The degree of Doctor of Engineering was conferred upon our dean, F. E. Turneaure, in recognition of his prominent work in the profession. The Engineer in common with the entire engineering college, extends congratulations to Dean Turneaure. The second degree was conferred on Ex-President Chamberlain, who received that of Doctor of Science. Professor Chamberlain was at Wisconsin during the early years of the College of Engineering and is now a member of the faculty of the University of Chicago.

The students of the Engineering College are to have the privilege of hearing a number of the leading engineers of the country this winter in the non-resident lecture course. Dean Turneaure is endeavoring to secure a larger number of lectures than usual and already has arranged for a number of lectures by prominent men.

Mr. Fred B. Wheeler gave a very interesting lecture on Friday, November 3, on Gas Engineering, and on November 4, he spoke to the advanced students on some further details of the same subject. Mr. G. M. Davidson, Chemist and Engineer of Tests for the C. & N. W. Ry., lectured on November 17 on the Purification of Locomotive Feed Water. Both lectures were interesting and very instructive to the students.

Mr. J. N. Faithorn, President of the Chicago Terminal Railway Company, was scheduled for November 17th, but was obliged to postpone his lecture, and now expects to be here December 8th. He will lecture on the subject of The Regulation of Railroad Rates. Mr. B. A. Behrend, Chief Engineer of the Bullock Electrical Mfg. Co., Cincinnati, Ohio, will lecture January 12th on a subject to be announced later. Mr. L. R. Clausen, one of our alumni, and now Signal Engineer of the C., M. & St. P. Ry., will lecture February 23rd on some phase of Railroad Signaling. On March 9th Mr. Ralph Modjeski will lecture on the Construction of the new Thebes Bridge over the Mississippi river south of St. Louis.

It is expected to add several others to the list, but definite arrangements have not yet been made.

The students are strongly urged to attend these lectures for it gives them an opportunity to learn many of the practical points along the various lines from men who are authorities on their respective subjects. An hour spent at one of these lectures is more valuable than an hour in the drafting room or recitation. By dismissing classes during these lectures, the faculty is trying to encourage the men to attend and every one ought to take advantage of the opportunity.

G. G. Thorpe, '91, has resigned his position as general manager of the Clairton plant of the United States Steel Corporation at Clairton, Pa., to become president of the Illinois Steel Company. In accepting this position, Mr. Thorpe becomes the head of one of the largest corporations in the United States, and his success reflects credit upon our College of Engineering as well as upon himself. The ENGINEER extends its congratulations.

The seniors are going at the minstrel show question this year in the proper spirit by starting to work early. The various engineering societies have talked the matter over somewhat and started the ball rolling. On Friday, November 10, a meeting of the senior engineers was held and committees appointed to formulate plans and start work at once. Mr. D. H. Keyes was appointed chairman of the general committee and is already getting the various committee-men at work. There is plenty of talent in the class if the men will each lend a hand to make the show a success. Get busy, seniors, and everyone help it along.

At the close of his lecture before the students on Friday, November 3, Mr. Wheeler announced that he would offer $50 to be divided into two prizes, for the two best theses prepared this year by students in the mechanical, chemical and electrical engineering courses, the award to be made by the faculty here. Mr. Wheeler is greatly interested in our College of Engineering and in this way, is endeavoring to stimulate original investigation. The student body feels grateful to Mr. Wheeler for his gife and it is the hope of the Engineer that the work done by the seniors in competition for this prize may cause him to feel that his kindness is appreciated.

At the semi-annual election of Tau Beta Pi, the following seniors were elected to membership: F. W. Lawrence, C. E., Sheboygan; E. A. Lowe, E. E., Colgate; A. E. Van Hagan, E. E., Chicago, Ill.; J. W. Reid, C. E., Oconomowoc; R. T. Herdegen, E. E., Milwaukee, and W. E. Warren, E. E., Stoughton. As the man of highest standing from the junior class, J. D. Sargent, M. E., of Milwaukee, was elected. The candidates were initiated October 18, and were given a smoker November 11.

The treasurer of last year's Social committee has requested that we print the following report:

I wish to submit the following report for funds entrusted to me as treasurer of the "Engineers' Social" committee for 1904-1905:

RECEIVED.

Seniors	$16.25
Juniors	21.00
Sophomores	13.00
Freshmen	9.75
	$60.00

DISBURSED.

Music and entertainment	$24.50
Tickets, janitor, etc	11.95
Part payment of back rental on auditorium piano	23.55
	$60.00

Respectfully submitted,

BERT H. PECK.

CHANGES AND ADDITIONS IN THE FACULTY.

In the department of Hydraulic Engineering the work has been considerably rearranged. Mr. Charles J. Davis has been appointed instructor and takes mainly the work given last year by Mr. Stewart. Mr. Davis was formerly an instructor here in the department of Civil Engineering. He is a graduate of Cornell University and since his previous work here has had a very good experience in hydraulic engineering at Grand Rapids, Michigan. Mr. Ewald, of the class of 1905, has also been appointed assistant in this department.

In the department of mechanics, Mr. H. F. Moore was promoted from instructor to assistant professor and most of his work is in the testing laboratory. Mr. F. M. McCullough, formerly instructor in topographical engineering, was transferred to the department of mechanics, and Mr. M. O. Withey, a graduate of the Thayer School of Civil Engineering, Hanover, N. H., was added to the instructional force. In place of Mr. McCullough the instructorship in topographical engineering is now filled by Mr. Ray Owen, a U. W. man of 1904. Mr. Owen has, since graduation and during vacations while a student, had much experience on the Geological Survey.

In Electrical Engineering the most important change has been the appointment of Mr. M. C. Beebe as associate professor in place of Professor Swenson, who resigned to accept a position in New York City as secretary and treasurer of the American Street Railway Association. Professor Beebe was, some years ago, an instructor here, but resigned to go into practical work. He has been very successful as an engineer, especially in the working out of new problems, and the University is very fortunate in inducing Mr. Beebe to turn his attention to instructional and research work in the University. Additions to the staff have been made in the appointment of Mr. F. J. Petura as instructor and the promotion of Messrs. G. C. Post and J. C. Potter from assistants to instructors.

Professor Burgess, while retaining his own special work of applied electro-chemistry, has now charge of the department of

Chemical Engineering. To assist in this work Mr. J. C. Dickerman of Massachusetts has been appointed assistant professor of Chemical Engineering. Mr. Dickerman is a graduate of the Massachusetts Institute of Technology, and since graduation has been employed in various capacities in chemical works. As instructor in this department Mr. O. W. Brown, formerly a graduate student here, has been appointed. Mr. Brown has had considerable experience in teaching at the University of Indiana and is specially qualified for this work.

In the department of Machine Design the increase in work and resignation of Professor Zimmerman led to the appointment of two instructors, Messrs. J. H. Vosskuehler and R. Mc A. Keown. Mr. Vosskuehler comes from the University of Ohio, where he has taught machine design for some years. He has already spent one or two summers at this University. Mr. Keown is a graduate of the New Hampshire State College and has taught machine design at the University of Pennsylvania. Both of these men have had very excellent practical experience in manufacturing establishments.

In the department of Steam Engineering Mr. E. M. Shealy, who replaces Mr. McPherson, is a U. W. man of 1904.

In the department of Drawing, instructors E. S. Moles and J. E. Boynton replace Messrs. Kinne and Van Hagen of last year, Mr. Kinne being transferred to the department of structural engineering where he replaces Mr. Price.

During the year there were numerous and persistent offers on the part of other schools and outside interests made to a large number of the faculty, which, financially, were very flattering; and it was only because of the superior advantages offered them by this institution that the University was able to retain their services. In some departments, at least, University of Wisconsin men have a reputation second to none in the country, and one of the former members of our instructional force stepped into a position in which the salary was three times that which he was getting here.

ALUMNI NEWS.

'05.

The present year has been a very active one in engineering lines and this fact is well illustrated by the wide area over which the class of 1905 is now scattered and the positions which they hold. Although less than six months since commencement, the members of this class are now located in fifteen different states and two foreign countries, ranging from Boston to Seattle and from the Iron Range in Northern Minnesota to Mexico City and Panama. The graduates this past year were very fortunate in securing good positions and the underclassmen will be interested to learn where the various men are located. The positions and addresses which the '05 men are now occupying are given below.

GENERAL ENGINEERING.

Eyvind H. Bull, Brooklyn, N. Y., with H. W. Johns-Manville, Co.

Lancaster D. Burling, Madison, Wis., Ass't, U. S. G. S.

Ralph T. Craigo, St. Joseph, Mo., with the St. Joseph Gas Co.

Harry Gardner, Urbana, Ill., instructor in civil engineering, University of Illinois.

Ray L. Hankinson, Brighton, N. J., draftsman, U. S. Lighthouse service.

Walter D. Morgan, Reedsburg, Wis., superintendent of city water works.

Walter P. Sawyer, Chicago, Ill., bridge department, Illinois Central R. R.

Frank J. Sherron, Elwood, Ind., with the American Tinplate Co.

Harold K. Weld, Chicago, Ill., Engineering Department, Chicago Telephone Co.

CIVIL ENGINEERING.

Aden W. Andrews, Chicago, Ill., field draftsman, C., B. & Q. R. R.

Leland R. Balch, Washington, D. C., engineering aid, United States Reclamation Service.

John Berg, Ames, Iowa, instructor in civil engineering, Iowa State College of Agriculture and Mechanic Arts.

Bernard C. Brennan, 876 Federal Bldg., Chicago, Ill., U. S. G. S.

Wm. E. Brown, 4 Toledo Ave., Elmhurst, Long Island City, N. Y., Rodman, East River Tunnel, Penn., N. Y. and L. I. R. R.

Thomas J. Burke, Buffalo, N. Y., M. of W. Dept., Erie R'y.

Louis A. Burns, Watertown, N. Y., City Engineer's office.

Forbes B. Cronk, Bovey, Minn., Oliver Mining Co.

Robert F. Ewald, Madison, Wis., Assistant in Civil Engineering, U. of W.

Donald P. Falconer, Pittsburg, Penn., Engineering Department, Penn. R. R.

Howard B. Gates, New York City, N. Y., tunnel work, engineering department, Penn., N. Y., and L. I. R'y.

Solon Gold, 313 La Salle St., Chicago, Ill., draftsman, Lake Shore and Michigan Southern R'y.

Guy A. Graham, New York City, N. Y., East River tunnel, engineering department, Penn., N. Y., and L. I. R'y.

Geo. H. Haley, Watertown, N. Y., City Engineer's office.

Llody R. Harlacher, Bovey, Minn., U. S. Steel Corporation.

Chas. Van E. Hopper, Jersey City, N. J., Terminal Improvements, Erie R. R.

Thomas J. Irving, Green Bay, Wis., Instrumentman, Construction Department, C. & N. W. R. R.

Wm. N. Jones, Cincinnati, Ohio, City Water Works Department.

Max W. King, Empere, Canal Zone, Panama, Rodman, Panama Canal.

Clarence M. Larson, Mexico City, Mexico, Chief engineer's office, National R'y of Mexico.

Franklin H. Mann, Spokane, Wash., time-keeper, Great Northern R. R.

Adolph F. Meyer, St. Paul, Minn., U. S. Engineer's office.

Edwin G. Orbert, Green Bay, Wis., City Engineer's office.

Renben S. Poetter, Madison, Wis., Inst. in Engineering Mathematics, U. of W.

Frederick A. Potts, Empere, Canal Zone, Panama, Rodman, Panama Canal.

Sylvester Schattschneider, Washington, D. C., U. S. Coast and Geodetic Survey.

Harry J. Seyton, St. Joseph, Mo., M. of W. Dept., C., B. and Q. Ry.

Edw. F. Sinz, Empere, Panama, rodman, Panama Canal.

Wm. F. Tubesing, Cincinnati, Ohio, Ass't Engr., city water-works department.

Roscoe G. Walter, St. Paul, Minn., M of W. Dep't., Great Northern Ry.

Ralph H. Whinery, Minneapolis, Minn., Sanitary Engr., Minnesota State Board of Health.

MECHANICAL ENGINEERING.

Bernhard F. Anger, 330 20th St., Milwaukee, Wis., with the Merpel Mf'g. Co.

Jos. R. S. Blaine, Milwaukee, Wis., Draftsman, with Pawling and Harnishfeger.

Albert F. Blossey, St. Louis, Mo., with La Clede Gas Light Co.

John E. Boynton, Madison, Wis., Inst. in Mechanical Drawing, U. of W.

Earle S. Burnett, Madison, Wis., Grad. Scholar, U. of W.

Fred H. Dorner, Milwaukee, Wis., Turbine Dep't., Allis-Chalmers Co.

Chester A. Hoefer, Boston, Mass., Fellow at Mass. Institute of Technology.

Elmer G. Hoefer, Madison Wis., with D. C. and W. D. Jackson, Consulting Engineers.

Albert Larsen, Milwaukee, Wis., Graduate apprentice, with Allis-Chalmers Co.

Harold St. C. MacMillan, Ladd, Ill., Roundhouse foreman, C., M. & St. P. R'y.

Frank H. McWethy, Aurora, Ill., Consolidated Gas Co.

Arthur H. Miller, South Milwaukee, Wis., Filer and Stowell.

Patrick W. Morrissey, South Milwaukee, Wis., Filer and Stowell.

Carl S. Reed, Racine, Wis., J. I. Case T. M. Co.

Walter H. Richardson, Pittsburg, Penn., Westinghouse Machine Co.

Chas. M. Rood, Seattle, Wash., Sec. Y. M. C. A., U. of Wash.

Frank B. Rowley, Madison, Wis., Graduate Scholar, U. of W.

Frank J. Saridakis, Milwaukee, Wis., Inst. in Manual Training, West Div. H. S.

Albert W. Vinson, Milwaukee, Wis., The Wisconsin Telephone Co.

Major E. Wharry, Madison, Wis., the Gisholt Machine Co.

Wm. S. Wheeler, New Castle, Penn., Penn. Engr. Co.

ELECTRICAL ENGINEERING.

Philip S. Biegler, Chicago, Ill., Draftsman, Chicago Edison Co.

Edgar J. Bolles, Milwaukee, Wis., the Wisconsin Telephone Co.

Chas. E. Brenton, St. Louis, Mo., the La Clede Gas Light Co.

James F. Casserly, Milwaukee, Wis., Wisconsin Telephone Co.

Nicholas J. Conrad, Chicago, Ill., Operating Dep't., Chicago, Edison Co.

Wm. R. Harvey, Milwaukee, Wis., Wisconsin Telephone Co.

Walter R. Heidemann, Denver, Colo., Denver Gas and Electric Co.

Arthur W. Helmholtz, Chicago, Ill., Chicago Edison Co.

Arthur E. Helzer, Milwaukee, Wis., Wisconsin Telephone Co.

Ray S. Hoyt, Boston, Mass., Fellow, Mass. Inst. of Technology.

Herbert S. Inbusch, Chicago, Ill., the Western Electric Co.

Walter H. Inbusch, Milwaukee, Wis., Wisconsin Telephone Co.

Richard Jones, Milwaukee, Wis., Wisconsin Telephone Co.

Vincent E. McMullen, Evansville, Wis., Draftsman with the Baker Mf'g. Co.

Edward S. Moles, Madison, Wis., Inst. in Mechanical Drawing, U. of W.

Roy C. Muir, Schenectady, N. Y., Testing Dept., Gen. Elec. Co.

Harry M. Olson, Pittsfield, Mass., the Stanley Electrical Mf'g. Co.

Willis D. Perkins, Milwaukee, Wis., Signal Engineering Dept., C., M. & St. Paul Ry.

John R. Price, Schenectady, N. Y., Testing Dept., Gen. Elec. Co.

Leverett E. Rice, Schenectady, N. Y., Testing Dept., Gen. Elec. Co.

Ray F. Robinson, St. Louis, Mo., Union Elec. Lt. and P. Co.

Geo. A. Rodenbaeck, Boston, Mass., Ass't at Mass. Inst. of Technology.

Wm. R. Schmidley, St Louis, Mo, with Union Electric Light & Power Co.

Wm. F. Schmidt, Chicago, Ill., Chicago Edison Co.

Geo. M. Simmons, Chicago, Ill., Operating Dept., Metropolitan, West Side Elevated Ry.

Ray T. Wagner, Schenectady, N. Y., Testing Dept., Gen. Elec. Co.

Chas. D. Willison, Chicago, Ill., Chicago Telephone Co.

Harry E. Wulfing, Chicago, Ill., Elect. Dept., C., R. I. & P. Ry.

APPLIED ELECTRO-CHEMISTRY.

Chas. A. Hansen, Schenectady, N. Y., Research Laboratory, Gen. Elec. Co.

Clarence P. Hatter, Chicago, Ill., Chicago Gas Co.

Edward Wray, Madison, Wis., Graduate Scholar, U. of W.

M. C. Beebe, '97, formerly consulting engineer at Pittsburg, Pa., is now Associate Professor of Electrical Engineering at the U. of W.

Mr. A. H. Ford, '95 has resigned his position as Professor of Physics and Electrical Engineering at the Georgia School of Technology at Atlanta, Georgia, to accept a professorship in Electrical Engineering at the State University of Iowa at Iowa City.

G. H. Burgess, '95, formerly assistant engineer with the Pennsylvania Railroad at Pittsburg is now with the Erie Railroad in charge of terminal improvements at Jersey City, N. J.

R. W. Hargrave, '98, has severed his connection with the Northern Electric Company at Madison, Wis., and is now Professor of Mechanical Practice in the Georgia School of Technology at Atlanta, Georgia.

J. G. Staack, '04, topographer with the U. S. G. S. has been transferred to Jackson, Miss.

H. J. Saunders, '03, has resigned his position as assistant engineer with the U. S. R. S. at Cody, Wyoming, to accept a position with the Union Pacific Railroad in connection with the terminal improvements at Omaha and South Omaha, Nebraska.

J. C. Hain, '93, formerly engineer of masonry construction with the C., M. & St. Paul R. R. at Chicago, is now consulting engineer with J. G. White & Co. of New York City.

W. J. Bertke, '03, formerly with the Sioux City Gas and Elect. Co. of Sioux City, Iowa, is now Assistant Manager of the Union Gas Improvement Co., of Kansas City, Mo.

H. P. Boardman, '94 has resigned his position as assistant engineer in the B. & B. Dept. of the C., M. & St. Paul Ry., and is now with the Fitz Simmons & Connel Co., contractors, Chicago, Ill.

J. M. Boorse, '95 who, since his graduation, has been with the Chicago Telephone Co., is now chief electrician for the Schlitz Brewing Co., of Milwaukee, Wis.

Wm. Bradford, '04, who was an instructor in Experimental Engineering in the university last year, is now with the Lincoln Gas and Elec. Co., of Lincoln, Neb.

O. B. Cahoon, '04, formerly with the Madison Gas & Elec. Co., is now Sup't. with the Wisconsin Light & Power Co., of La Crosse, Wis.

S. P. Conor, '99 has left the employ of the G. A. Fuller Const. Co. of New York City to enter the contracting business for himself.

J. E. Dutcher, '97, formerly with Swift & Co., is now with the Chicago Edison Co.

E. M. Evans, '94, is now draftsman with the American Bridge Co., at their Lassig Plant, Chicago.

E. W. Galloway, '04, who has been with the La Clede Gas Light Co. of St. Louis, is now Ass't. Chemist with the Sugar Land Sugar Refinery, Sugar Land, Tex.

A. J. Grover, '81, formerly Resident Engineer in charge of Revision construction on the P., S. & N. R'y., at Smithport, Pa., is now Resident Engineer with the Wisconsin Central Ry., at Owen, Wis.

A. J. Hoskins, '90, formerly Chief Engineer with the Leyden Coal Co., Denver, is now Prof. of Mining Engineering, at Golden, Colo.

A. F. Krippner, '04, formerly Supt., Electric & Water Co. of Fennimore, Wis., is now Instructor in Electrical Engineering at Washington University, St. Louis, Mo.

C. McDonald, '97, has been transferred from Locating Engineer of the C. & N. W. Ry. at Casper, Wyoming, to Roadmaster at Chicago. Ill.

E. T. Munger, '92, has resigned his position as manager of the Havana Elec. Co. of Havana, Ill., to become Master Mechanic with the Metropolitan Elevated Railway, Chicago, Ill.

T. G. Nee, '99, who has been with the Chicago Telephone Co., as Electrical Engineer has been transferred to Mexico City, Mexico, where he is assistant to the Manager of the Mexico Telephone Co.

Ray Owen, '04, has resigned his position with the U. S. G. S. to become Instructor in Topographic Engineering at the University of Wisconsin.

W. C. Parmley, '87, is now Asst. City Engineer in charge of Sewer Construction in Cleveland, Ohio.

F. J. Petura, '04, formerly with the Lincoln Gas & Elec. Co., is now Instructor in Electrical Engineering at the U. of W.

A. V. Scheiber, '99, who was formerly with the Chicago Telephone Co., is now Manager of the Independent Telephone Exchange, at Oran, Mo.

G. A. Scott, '02, has entered the Testing Dept. of the Chicago Edison Co.

H. H. Scott, '96, is now Gen. Supt. of the Madison Gas & Electric Co.

E. M. Shealy, '04, formerly Insurance Inspector with the New York Fire Insurance Exchange is now Instructor in Steam Engineering at the U. of W.

W. F. Sloan, '04, who was with the Electric Ry. Test Commission, is now employed in the Testing Dept. of the Chicago Edison Co.

J. A. Stewart, '04, who was Instructor in Manual Training at Fond du Lac last year, is now Chief Draftsman for the Wisconsin Telephone Co., with offices in Milwaukee, Wis.

B. V. Swenson, '01, who was formerly Assistant Professor of Electrical Engineering at the U. of W., is now Secretary of the American Street and Inter-urban Railway Association, New York City.

L. F. Va nHagan, '04, who was Instructor in Mechanical Drawing at the U. of W. last year, is now with the Interoceanic Ry., at Mexico City, Mexico.

F. C. Weber, '03, formerly with the Electric Telephone Manufacturing Co. of Rochester, N. Y., is now Manager of the Plattsmouth Electric Light Co., Plattsmouth, Neb.

A. A. Wedemeyer, '03, who was formerly with the Northern Electric Co., at Madison, Wis., has gone to the Galena Iron Works, Galena, Ill.

The following alumni were granted higher degrees during the year 1904–05.

CIVIL ENGINEER.

Clarence E. Abbott, (U. W. '01) Eveleth, Minn.
James C. Hain, (U. W. '93), Chicago, Ill.
Osmund M. Jorstad, (U. W. '04), Madison, Wis.
Ernest A. Moritz, (U. W. '04), Madison, Wis.

MECHANICAL ENGINEER.

Lemuel M. Hancock, (U. W. '88), Fortuna City, Cal.
Arthur J. Hoskins, (U. W. '90), Golden, Colo.

BOOK REVIEWS.

Statically Indeterminate Stresses.—By Isami Hiroi, C. E., Dr. Eng'r., Professor of Civil Engineering in the College of Engineering, Tokyo Imperial University, New York; D. Van Nostrand Company. Cloth, 5x8; pp. 174. $2.00 net.

This work, quoting from the preface, "contains the solution of those problems most commonly met in the practice of a bridge engineer, the aim of the author being to save time and labor of those intent on a more rational design of the class of structures treated, than is generally followed, by furnishing them with necessary formulas for which rough approximations or even guess-work frequently forms a substitute."

The introductory chapter (6 pages) deals with the general principles and the general method, that of work, employed throughout the book. Then follow chapters on Trussed Beams (14 pages), Viaduct Bents (19 pages), Continuous Girders (27 pages), Two Hinged Arches (39 pages), Hingeless Arches (30 pages), Suspension Bridges (10 pages), and Stresses due to Rigidity of Joints (20 pages).

The introductory chapter is too brief for a beginner. Article 2 of that chapter is unsound. In the succeeding chapters, the author develops formulas for numerous special cases and illustrates them fully with numerical examples. Design is not treated at all. The book presents a mathematical appearance but one equipped with the elements of Statics, Strength of Materials and Calculus can readily master it.

Engineering Contracts.—By Dr. J. A. T. Waddell, Civil Engineer, New York.

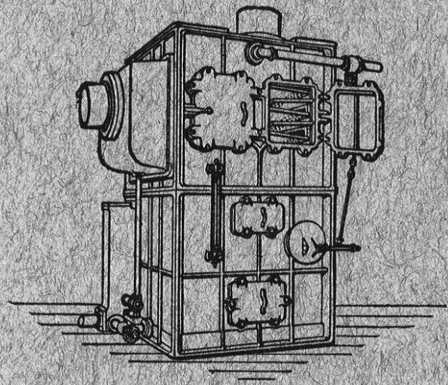
While originally the basis of a lecture delivered before the students of Renssaeler Polytechnic Institute, this article has been revised and printed in pamphlet form. Like the Professional Papers of Dr. Waddell which appeared last spring, this paper is founded upon the author's personal experience. He has made a study of the writing of contracts and specifications in connection with his professional work and is especially fitted to write upon this subject by reason of his years of practical work as consulting engineer in charge of important enterprises where specifications and contracts have to be drawn up. Dr. Waddell draws a line between specifications and contracts, preferring to throw as much of the matter as possible into the specifications and to make the contract as short as possible. He enumerates the essential parts which should be included in a contract, then takes up each section and explains and defines it. As he says, "Nine out of ten of the contracts an engineer has to prepare are in connection with construction...... but this style is by no means the only one with which an engineer is concerned for he is sometimes called upon to draft agreements between promoters of enterprises and capitalists, between himself and promoters of enterprises, between two engineers, between two contractors or between a bond company and a contractor." In accord with the above he not only gives complete sample construction contracts, governing the various ways in which such contracts may be let but also submits sample contracts governing the relations between the promoters or engineers and the capitalists who are to finance some project, etc.

The article goes into much detail and is written from the stand point of an engineer, the ordinary confusing law terms being displaced by the more familiar engineering terms. This makes the paper readily readable by the ordinary engineering student and is a valuable article for one to have in his library. Mr. Waddel has prepared the pamphlet for complimentary distribution.

Steam Power Plant.—A book drawn up for making a complete report of a power plant, by Prof. C. E. Lucke of Columbia University, New York. D. Van Nostrand Company, Publishers and Booksellers, New York. $1.00.

In getting out this book, Prof. Lucke attempts to get out a form for recording all the results of a power plant test so they will be easy of access and readily understood. The report is arranged with separate parts for the details and data on the cost of operation, coal and ash handling apparatus, boilers, engines, steam piping, condensers, etc., and is a very convenient form for one who has tests of large plants to make. The entire arrangement shows care in arranging all the details and properly classifying them.

Please mention the Wisconsin Engineer when you write.



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