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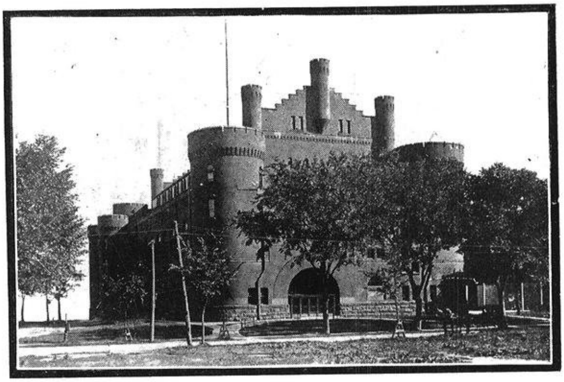
Vol. 19 MARCH, 1915 No. 6



The 1915 University of Wisconsin Exposition

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**MARCH, 1915**

# The Wisconsin Engineer

VOL. XIX MARCH, 1915 NO. 6

## THE 1915 UNIVERSITY OF WISCONSIN EXPOSITION

This is the year of expositions. Every periodical to-day blazons forth the glory of the twin expositions of the Pacific Coast in both article and advertisement. Every other page that we turn over bears a photographic reproduction of the Court of the Universe, the Arch of the Rising Sun, or the Tower of Jewels. Our own university band is to give a series of concerts across the continent, ending finally at the expositions. Expositions are very common occurrences in these strenuous days and we hardly catch our breath from one until another takes the stage.

But with all the eagerness to exhibit that we of America are showing to-day, it has been left to our own University of Wisconsin to lead the way and show the feasibility of a university exposition. To our knowledge, no other university or college has ever attempted such an exposition of her work, such a proof of fulfillment of purpose, and of efficiency of everyday work, as for the second time we are to have on the dates of March 26 and 27. Four years ago when the idea was started by the Wisconsin Union it was scoffed at and derided. Wiseacres said that mere students could not make a success of such a vast undertaking, that it was merely another fool activity that would fizzle out into a highly amusing spectacle of failure. But the exposition was held, and it was a success, and the scoffing was quieted, and moreover the university was infinitely benefited.

Year after year the taxpayers all over the state pay out their good money to keep the University of Wisconsin in the top rank of the state universities. They know that there is a class of about 750 men and women leaving the campus every year with some sort of degree, who are taking their places with greater or less success in some phase of the activities of the state. They know that there are professors here who are making indefinite tests on a hazy something, and that the results are going to help an impersonal somebody. They know that there is a College of Agriculture which occupies a large number of mysterious buildings and which takes four years of a man's time to make him a successful farmer. That there is something in the Engineering Building that adds to a man's abilities, multiplies his opportunities, subtracts some faults, and then turns him out an engineer, is well known. What the process is, is the mystery.

And this is what that exposition four years ago did for the people, not only of Madison, but of the whole state. Moreover it was a first rate advertisement for the university, which took front page space at free rates.

The cycle of life in the university is four years long, and thus we have coming back to us this year the exposition of what the university accomplishes for us, who are here now but who were not here at the time of the last exposition. The aims of the whole exposition are the same as before, to let you get acquainted with us and to acquaint us with each other. If the university is still accomplishing its mission there should appear not a repetition of exhibits but a continuity of efforts which should dovetail perfectly with the last cycle of achievements. New minds are responsible for every exhibit, and they have new products, new achievements, new ideas, and new purposes to draw from to make a new and entirely different exhibition.

From the nature of their work the engineers are in perhaps the best position of any of the other colleges of the university as far as tangible exhibits are concerned. Even the agrics will admit in an unguarded moment that they enjoy seeing the wheels go round, the lights flash, and the bells buzz. They have even consented to occupy the Gymnasium Annex jointly with the engineers, but will probably extend themselves to the utmost to draw all the crowd to their exhibit. To be well prepared for any such emergency, every department of the College of Engineering has prepared a special feature to prevent any stampede toward the rustic exhibits. Every department is ready to show just what excuse it has for existence and what it contributes to the College of Engineering as a whole and to the Commonwealth. Committees of students in each department have been working for some months on their exhibits, and at this writing, just one month before the doors of the gymnasium open to the crowds, every exhibit is either fully completed or is receiving the finishing touches. For this reason we are able to give you real advance news on the exhibits of the college.

The Departments of Drawing and Railway Engineering will occupy the same booth. For the convenience of the tired visitor who has to find his way in the labyrinth of exhibits of the exposition, the drawing department has prepared a tracing of the floor plan of the whole exposition, and will have a blue-printing machine in their booth to turn out copies of this plan to every one who asks. The usual exhibit of unusual drawings will be in evidence, and you should be able to discover whether the senior is any better acquainted with his ruling pen than the freshman. It has been claimed by some knockers that the upper classmen forget their first love, the ruling pen, in their search for greater gods. This is their chance to disprove this assertion publicly. The Railway Engineering Department will show typical railway drawings, charts, and curves, and will feature a model of a road that is not a model. You will see the defective crossings in all their variations, and all the other appurtenances that increase the danger of the railway to the public. In this connection the work of the Railroad Commission will be shown in some detail, so that you may see the service that they are rendering the people of the state.

The Forest Products Laboratory, while not strictly a part of the Engineering College, has cast its lot with us and will occupy a complete booth by itself. A display of all the varieties of wood that are used commercially, together with polished samples of the same and examples of the uses to which the different varieties are put, will be provided. A series of products made of paper, which in turn comes from wood, will appear. Among other interesting exhibits there will also be a machine which they are using in the laboratory for testing the inflammability of shingles. Numerous fireproofing compounds for shingles are now on the market and this machine is the result of a desire to compare the efficacy of the different brands.

The Shops always have an immense amount of material from which to select a most interesting exhibit. The work of the various classes in the mcahine shop, from the plain cylinder turned out by the freshman to the accurate machine tool fashioned by the upperclassman will be shown in detail. Some of the men have been making a marine engine—we say making, not assembling—and this will be moved to the gymnasium for your appreciation. You that have wondered about the matter of the boring of automobile cyliders *en bloc* will be interested in a typical boring bar used for this purpose. The work of the men in the pattern shop, the tool making course, the blacksmith shop, and the foundry will also have a corner of the shops' exhibit. The men in charge of this department have adhered to the time honored custom of giving souvenirs, and will cast while you wait a beautiful embossed watch fob for you to wear in loving memory of the exposition.

The mining engineers have divided their work into two sections, that of Mining and that of Metallurgy. To most of us they mean much the same, but the miners seem to see quite a difference. You that have lived all your life in Milwaukee or in Beloit and have never seen anything more like a mine shaft than a three story elevator, here is your chance to see the real thing in working order. Its small size will not detract from its accuracy, nor from its interest. There will also be a slope shaft in working trim, and a pneumatic drill will bore pneumatic holes in very pneumatic atmosphere for the placing of large sticks of non-explosive dynamite. A shaft pump will be added to the rest of the apparatus. We are not told whether there will be a drinking fountain attached or not.

The metallurgists are preparing to alleviate your hard feelings as a result of possible gold bricks handed you in other departments by having a complete assaying outfit on the job to ascertain how badly you were deceived. They will assay the nuggets on your watch fob if you desire to part with them or any other stray bit of ore you may carry around as a pocket piece. A magnetic separator will also be on exhibition, as well as a Riffle Table form of separator.

The Department of Mechanics is endeavoring to acquaint you with the many machines that are used in the testing of all kinds of materials. The layman often hears of tile, brick, beams, both wood and steel, columns, and myriad other commercial articles, which are sent to the university to be tested as to their relative strength for the purpose for which they are intended. The machines in the exhibit of the department are taken out of the testing laboratory of the college, and represent, at least in a general way, the whole field of testing machines. Among the most interesting of these machines will be the 50,000 lb. Universal Testing Machine, the Permeability Apparatus, Repeated Stress Tester, Foundry Tester, Bunnell Hardness Tester, a complete cement testing equipment, including a mold for the making of bricquettes, and a Deval Abrasion Machine. A wall case will contain samples illustrating the typical cases of fracture found in testing.

The Machine Design Department has a wonderful opportunity for an interesting display and all advance information indicates that they are taking due advantage of their opportunity. There will be a complete array of lecture-room models of an infinite variety of mechanisms. The department has a very complete set of such models. Some of the designing already done by students in the courses of the department will be exhibited. Several models of machines, such as automobile chasses, will take up another corner of their space. The little machine, well known to the engineer, but foreign to most laymen's knowledge, the planimeter, will be well represented. A gear case and a chain of gears will be in operation. The feature of the exhibit will be a special cam, which was designed in summer school last year, that upon turning a crank provided, writes the word WISCONSIN. Seeing is believing.

We all expect something very interesting from the Department of Electrical Engineering. The booth will be lighted by a host of all possible varieties of lamps, both old and new, the current coming from a motor-generator set in the booth. The new tungsten lamps, filled with inert gas, will be much in evidence. The "bucking broncho" of the dynamo laboratory will perform in its usual act. A mercury-arc rectifier will be in operation, with its attendant wierd lighting effect. A singing arc flaming arc combination will also attract its due share of interest. The problem of what makes the ball go round in the bottle will again be propounded, never failing as an interest-holder. The men in charge will run a quick-lunch counter, all cooking being done in the magnetic frying pan. A combination of a little local color and patriotism will be found in the flaming "W" in this exhibit. A lightning arrestor in the form of a "W" will carry

500 volts and the discharge will provide a rim of flame for the "W." In addition a wireless telegraph apparatus will be on display.

The Hydraulics Department will exhibit a working model of a power plant. This is an excellent opportunity for the layman to get down to fundamental considerations on the great industrial problem of water power. One corner of the booth will be devoted to some of the theses that are now occupying the attention of the department. Among these are some Pitot's Tube experiments, and one in the determination of the loss in overhead gearing in a turbine. The action of submerged weirs will be shown, a large quantity of running water being provided for this purpose. For the edification of housewives who can not understand why the water bill is so high, the department has prepared a section of a water meter, like that used in every house. There will also be a case devoted to the apparatus that has been used in the preparation of the University Bulletins. The department of Sanitary Engineering, in the same booth, will exhibit a complete model of a sewage disposal plant for the city of Madison.

The department of Chemical Engineering will occupy a large booth. The work of the metallography section will be illustrated, with typical examples of carbon in steel, and sufficient microscopes will be furnished to enable every one who is interested to examine the specimens. Two electric furnaces and a number of pyrometers are to illustrate the high temperature work of the laboratory. Several instruments belonging to the United States Bureau of Standards will be on exhibit. One display will consist of the products of the department's investigations and tests. Among the more interesting of the machines and apparatus will be commercial filter presses, gas furnaces, calorimeters, machines for the testing of lubricating oil, apparatus for gas analysis, and the Castner Cell for the manufacture of alkali.

Of outstanding interest is the exhibit of the department of Topographical and Geodetic Engineering, or, as we usually know it, the Surveying Department. A tent, fully equipped as it appears in the summer camp of the civil engineers at Devil's Lake, will occupy a large space in the booth. The annual summer encampment is one of the most interesting side channels of our university routine. The camp organization, management and discipline is very unique, and we will no doubt get an interesting side light into the life of the camp through the medium of this exhibit. The various types of apparatus for measuring the flow of water will be fully exemplified, as will all the regular instruments used in the general field work of the surveyor.

Another department where the wheels will ''go round'' is that of Steam and Gas Engineering. A small model of a Corliss Engine will develop the power for generating light for the booth and you may obtain a sample of compressed air from an air compressor working in the booth. Two automobile engines, a Ford and a Case, will be stripped for your study at close range. The entire steam and gas engine laboratory will be represented in a model made in the mechanicians department of the university. For the motorist there will be a board showing actual sections through several makes of carburetors, and split chasses of Buick and Cadillac automobiles will show the workings of the different parts of the automobile power and transmission plant that are usually hidden under the floor.

We have attempted to give you only those features that seem to stand out above the others. It would be an injustice to the men who have spent so much valuable time on this work to say that this is all that you will see in the exhibit of the College of Engineering. We have touched only the high spots. We predict many surprises in store that the management could not let us anticipate at this early date. We feel that we are going to learn many things about ourselves that we had not suspected before and if we expect to profit, how much more will those profit who are not in such close daily touch with the things that are to be exemplified.

We have attempted only to give some idea of what could be expected from the College of Engineering. The other colleges are preparing to do their share and to do it well. We know that if their efforts are as sincere as those of the men in charge of the engineering exhibits, the exposition is going to repeat, nay manifold, the success of its forerunner of four years ago. Its benefits are going to be mutually divided between those of us who are showing and those of you who are seeing. And it is only by the resulting mutual understanding that its success can be measured.

## A STUDY OF VORTEX MOTION IN WATER

A Thesis by J. G. Hirsch, c '08 and S. G. Lunde, c '08
*Reviewed by* Chas. I. Corp, *Assistant Professor of Hydraulic Engineering*

The whirlwind in the air, or the analagous whirlpool in streams and the whirl of water in an emptying wash basin are familiar to everyone. With the advent, a few years since, of the low head turbine for the commercial development of power, came conditions of service in which vortex whirls were formed frequently in the turbine pit over the wheel. This results in air being drawn through the turbine, into the draft tube, causing sudden loss of head and erratic operation of the machine. Similar trouble is sometimes experienced with pumps when for any cause, the end of the suction pipe is not of a sufficient depth below the water surface.

When the lake is low the end of the suction pipe for the large centrifugal pump at the Hydraulic Laboratory is only about eighteen inches below the water surface. At such times it cannot be operated at its full capacity (35,000 gallons per minute) because vortices are continually forming with the result that air is drawn into the pump which causes it to lose its priming at the larger discharges.

The formation of vortex whirls about a suction pipe or over a turbine wheel may often be prevented by the use of floats. *In 1907 Professor Daniel W. Mead had a series of tests made at the Holyoke Water Power Company's turbine testing flume, in which a so-called "umbrella" of sheet metal was suspended above a turbine to prevent the formation of vortex whirls under low heads. The results of these tests indicated that such a device, when of proper size and properly placed, would prevent the formation of vortex whirls. They further showed that the presence of the "umbrella" would not reduce the efficiency of the turbine.

The thesis which is being reviewed was suggested by Professor Mead at this time, and, in the words of its authors, had for its object "more the study of the nature, behavior and formation

* See "*Water Power Engineering*," pp. 726–730, by Daniel W. Mead.

of the vortex than a search for conclusions [underlying principles] or preventatives."

THEORY. Such discussion of the theory of vortex whirls as we have deals almost exclusively with the meteorological phenomenon. The writers review this briefly. The greater part of their discussion deals with direction of rotation.

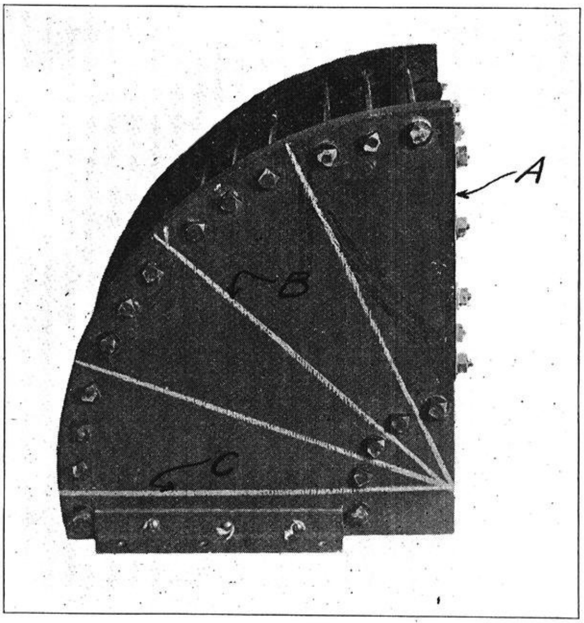


FIG. 1.—*Special Orifice Piece.*

APPARATUS. A large cylindrical tank was placed above a weir box in such a way that the discharge through a bottom opening would fall into the box and be measured by the weir. Over the opening in the tank bottom was placed a curved tube or passage on which the orifice plate could be fastened. A photograph of this is shown in Fig. 1. Two incandescent lights were placed in the bottom of the tank to illuminate the water. Two series of orifices were used. The first series was of constant width but each of different height; the second series was of constant height but with various widths. The first series would correspond to the cylinder gate turbine as the gate was changed and the second series to the register gate. Three positions of the plane of the orifice were used: perpendicular to the bottom, at an angle of forty-five degrees with it, and parallel to it. This was accomplished by cutting the curved tube as shown in Fig. 1 on lines marked B and C. In addition two rectangular tubes each twenty-four inches long were attached flush with the sharp edge of an orifice, to obtain the effect upon the formation of vortex motion with tubes.

METHODS OF OBSERVATION. The tank was filled to heads varying from one to three feet above the center of the orifice and allowed to become quiescent. The orifice was then opened and by sprinkling a little cement in the water the lines of flow were observed and the formation of any whirls watched from their beginning until they developed into vortices or until they were broken up by currents or collisions with other whirls.

RESULTS. The authors divide the formation of the vortex into three distinct stages which they thus define:

"First—Whirls: These are local eddies apparent on the surface of the water only. The motion centers about a point adjacent to which the angular velocity of the particles of water become very high, diminishing with increasing distance from the center.

"Second—Beads: These are whirls, the centers of which are distinctly depressed to a cup shape.

"Third—Vortices: These are funnel-shaped, with mouth and throat contracting more or less gradually into the funnel, the latter designating particularly the lower tubular portion."

Fig. 2A is a diagram showing the three successive stages. Sketches B, C, D, E, F, G, H, I of Fig. 2 show some of the typical forms of vortices observed.

CONCLUSIONS. After a study of the observations which had been noted for the various conditions, the following are the conclusions, with some slight modifications, as given by the authors:

1. *Formation of Vortices.*—It was noticed in every case in which the process of formation of a vortex was watched closely, that it developed through the three stages as outlined above. The flow toward any orifice is generally radial. The first change is to the whirling motion about a point somewhere above the orifice. This point is originally directly over the center of the orifice, but may be shifted, shortly after the starting of the whirl, by disturbance in the water. If the whirl persists, as a rule it

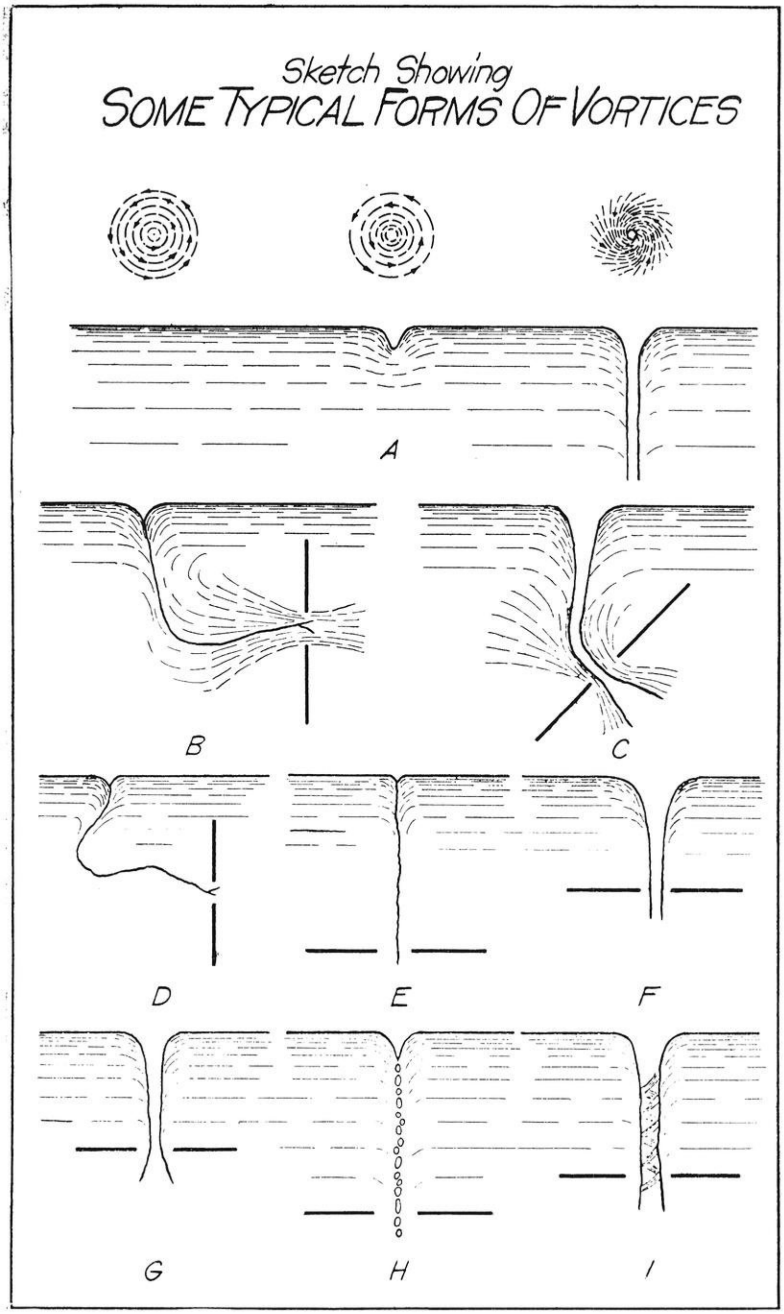


FIG. 2.

gradually increases its speed of rotation until the decrease of gradient at the center causes a cup to develop. We now have a bead. Sufficient decrease in head in the tank, or other favorable condition, now causes the funnel tube to dip down to the orifice and the particles of water take up a spiral path in moving downward. When the water is quiet, the persisting vortex is generally straight and steady; but a very slight disturbance causes a quivering of the funnel, and a spiral belting of the tube results, somewhat as is shown by Fig. 2—I. In disturbed water, at practically constant level, the whole process of formation, from the initial whirling motion to the dipping of the vortex, often takes place in a fraction of a second. It would appear also that the particles of water take up a spiral path only after a funnel dips into the orifice, i. e. only after a true vortex has developed.

2. *Effect of Disturbed Water and Obstructions on Vortex Motion.*—Disturbance of the water, as caused by water being supplied during the runs, had a decided effect upon the formation and persistence of the vortices. Were it not for the circular motion imparted by the entering water in the case of our experiments, the formation would be materially delayed. In many instances a tendency to form a whirl or vortex was counteracted by transverse or opposing currents or motions. And even after the formation of the vortex, these cross-currents tend to push the funnel against the edge of the orifice, cut it off, and thus break up the motion. Obstructions also have an effect upon the formation of the vortex, in that they produce whirls or eddies, which on passing over the orifice tend to increase in size and in some cases form vortices. These whirls also caused vortices to form at higher heads than when they were not present.

Such motions as were existant in the water prior to the formation of whirls, beads and vortices, were found to influence the time of and head at formation more than any other one factor. It soon became evident that upon the initial direction of rotary motion of the water, depended the direction of rotation of all the whirls and vortices which subsequently developed, no matter how slight the initial motion. Water which appeared to be entirely without initial motion, evidently had some motion which had been unnoticed before running the experiment. To settle this point, a number of scattered runs were made with water which had been allowed to stand from six to eight hours, after which interval it was assumed to be practically without internal movement. The result was that in every case lefthanded vortices developed and persisted as they should according to the theory. value to others.

It thus becomes evident that the extent of initial rotary motion of the water is largely responsible for the direction of rotation

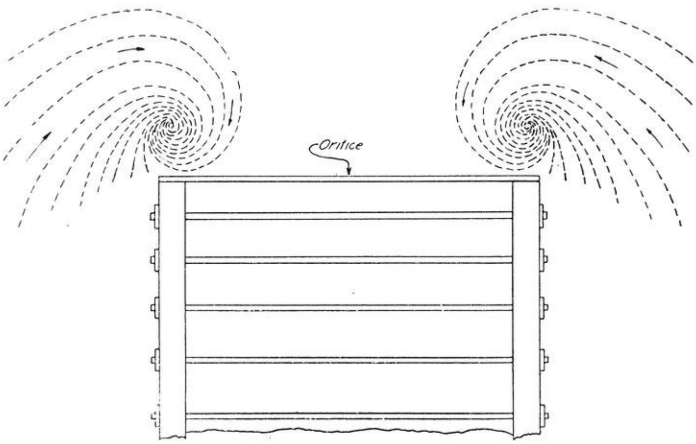


FIG. 3.—*Showing Double Vortex Formation.*

assumed by a vortex and its earliness of formation. Other induced motions such as eddies in the water, excited from obstructions in the channel, or by other causes, greatly hasten the formation of vortices by the production of considerable initial angular velocity.

3. *Effect of Inclination of the Orifice with the Vertical on Vortex Motion.*—In the experiments with the plane of the orifices vertical, few vortices were encountered. Numerous whirls, both right-hand and left-hand were observed passing over the orifice while the feed pipe was open. It was at first supposed that none of these whirls and beads developed any of the characteristics of vortices, but on illuminating the bottom of the tank, it was found that a large majority of them developed a filamentary funnel tube of the type shown in Fig. 2B. The hair-like funnel in every case followed the direction of the stream lines entering the orifice. A few of these vortices gradually moved away from the orifice and finally broke up, but the majority gradually moved

toward it until they broke up by colliding with another similar vortex or with the orifice itself. It was noticed that many whirls formed after the fashion indicated by Fig. 3. When the level of the water was about that of the top of the tube, both a right-hand and a left-hand whirl developed on opposite sides. It was also observed, that in nearly every case the left-hand whirls were the more permanent, especially those which later developed into beads and vortices.

An angular position of the orifice seemed to facilitate the formation of vortices. With the smaller sized orifices, such orifices as developed were small and filamentary except under very low heads. Vortices obtained with larger orifices, however, were of fair size. We believe that in the case of discharge under draft tube conditions, vortices would seldom, if ever, form over an orifice in an angular position, unless nearly horizontal, since the relatively high velocity of entrance of the water into the orifice would cause the tube of the vortex to be driven against the edge of the orifice almost immediately after its formation thus causing it to break up and disappear. Under very low heads, the velocity of entrance of the water evidently became low enough to allow a vortex to become permanent. In this series a double vortex often formed as shown in Fig. 3, when the water was at the level of the top of the tube, and both a right-handed and left-handed vortex (one on each side of the orifice) generally persisted.

A horizontal position of the orifice seems to offer the best conditions for the development of vortices. In this case, most of the stream lines enter the orifice in an approximately vertical direction. In every case it has been observed that the tube of the vortex takes up a position along the direction of these stream lines. It is evident then, that since these lines coincide with the path along which the vortex is most easily formed and most stable, the *optimum* conditions are offered.

4. *Effect of Size and Shape of Orifice on Vortex Motion.*—On account of the numerous factors entering into the formation of vortices, only general relations of shape and size of orifice to vortex formation can be given. In our various experiments we find that the head at which a vortex forms increases with increased orifice area. A more evident conclusion is, however, that the head increases rapidly as the ratio of length to width

of the orifice approaches unity. This appears reasonable when we consider the conditions of a flow through a square or circular orifice. Assuming such a case and very low head, so that the water would flow over edges as over a weir, and leave an air space at the center, we have the conditions of pressure gradient entirely suitable for vortex conditions. If one dimension of the orifice is now decreased, making its form rectangular, the total pressure gradient across the width of the orifice will gradually decrease. Finally the two nappes of water will meet, and the gradient and width will become zero together. It is therefore the smaller dimension of an orifice which mainly determines with what facility a vortex will form. It was noted also the vortices were more frequent and stable when the longer dimension of the orifice was vertical than when horizontal.

5. *Effect on Vortex Motion of Extending a Tube Below the Orifice.*—The two short tubes used in the experiments increased the head at formation of vortices to a considerable degree. When the water had a decided initial rotary motion the formation was very rapid, the different stages occurring in a fraction of a second, generally, the whirl first formed changing at once into a bead and this in turn dipped immediately, forming a large, powerful vortex. On the tubes reaching the orifice, a loud sucking noise was noted which ceased as soon as the vortex became steady. After passing below the plane of the orifice, the vortex spread out to a greater degree than in the case of orifices without tube attached.

Under all conditions of experiments, vortices formed more readily, were more powerful and more persistent than in similar cases where no tubes were attached. Although the tubes were of the same cross section and shapes as the orifices to which they were attached, their influence was undoubtedly due to the draft or suction produced. The experiments certainly show that, as in the case of turbine vents, this suction or draft increases the head at formation and the persistency of vortices.

The experiments also included a study of the effect of vortices upon the discharge through orifices. While upon this point the results are too meager and contradictory to draw conclusions, the reviewer feels information has been brought out concerning the conditions surrounding vortex motion which may be of practical value to others

# THE ENGINEER AS A CULTIVATED MAN

*A Plea for Independence of Thought*

BY A. E.

## THE FREE MAN AND THE DRUDGE

Anticipating that the readers of the *Wisconsin Engineer* may, in glancing at the title of this article, expect it to counsel the study of English and to preach the eleventh commandment of the faculty to the engineering student, "Thou shalt read good literature," the writer wishes to emphasize in the beginning that no such general advice is intended. Its message is not even addressed to engineering students as a whole. Most men will do well to spare themselves the mental effort of glancing through its lines by passing on to other messages to which their temperaments may better respond. Nor can one reproach these men for their attitude of indifference. Simplicity and narrowness in certain persons may be a virtue. A cab driver attempting to adjust his domestic life to the formalities of Fifth avenue could be no more humorous than a one-sided technician waxing enthusiastic over a Fifth Symphony. The world needs its unthinking and soulless drudges, its trench diggers, clerks, and so-called "engineers" whose range of vision extends only from the point of their ruling pen to the bottle of Higgin's ink on the corner of their drafting board. Any plea for freedom of thought must and should meet deaf ears when directed toward the latter contented, self-satisfied species of burden bearers.

Every profession has its black sheep, its mugwumps, bolters, heretics, and sinners against conventions and standards; and engineering can muster its quota of such iconoclasts no less in importance than the leaders in other professions. They are the men who are not afraid to profess that they believe that there is more to the universe than is visible to them from the bottom of their well of technicalities. They will doubt others and believe in themselves. Their dissatisfaction and their courage to follow hazardous courses mapped out by well-grounded convictions lead to new visions, new ideas and new discoveries.

While every profession notes with pride its discontented heroes, every college cannot with even an approach to such facility in selection point out those valuable individuals who as potential leaders are smouldering in the unfavorable cellar conditions college life imposes upon them. The writer harbors no greater desire than that this plea might stir up some latent capacity for enthusiasm into a flame of self assertion.

### BE UNPRACTICAL

Can a person whose profession demands the major part of his time and energy in the production of material things be a person of culture? Can the engineer whose business consists of the designing and building of engines, bridges, railroads, and endless other useful machines and equipments ever aspire to the rank of a cultivated man? Yes and no. The honor must be denied those inherently unfit for it, who can not possibly conceive of a higher value then that of utility, whose selfishness rasps against cultural values. If, however, his life training has not entirely vitiated the inborn yearning or curiosity to know merely for the pleasure of knowing, the engineer may tear himself away from the associations that prevent a development of such desires. Lofty experience of great variety and ideas of great minds may then enter into his life.

Will power and determination can tear down the barriers that usually surround the engineer. The obstacles that he must first overcome are the ideas expressed in such popular slogans as, "Be practical," "Get there," and "Don't be a theorist and a dreamer." Every man who wishes to liberate himself must dare at times to be unpractical, to forget results entirely, and to dream. Having decided upon this, the engineer may hope to reach the heights of vision in a world known only to the cultivated man.

### OPPONENTS AND COMPANIONS

Whatever phase of culture the engineer may pursue, he must prepare himself for an attack by those who cannot appreciate his views. To reach a stage where the best in music, art, poetry, and literature can be fully enjoyed is in itself no easy task and the difficulties in realizing one's aims here may be greatly augmented by the somewhat hostile air of superiority many people have toward the aspirant for culture, who is usually regarded as a weakling and an effeminate person by those who are themselves unfit and incapable of culture. A very simple diagnosis will prove their sneers and jests to be only the symptoms of a harmless although chronic case of sour grapes. Most men can never follow the course of the cultivated man because the latter is usually an idealist and the former will remain a gross materialist. In place of the strain of dissatisfaction with things as they are and the yearning to make things better which is so characteristic of the former, the majority of men show complacency, self-satisfaction and indifference. The attitude of *laissez faire* has to be combated. To overcome it and the other obstacles placed before him by an unsympathetic majority, the individual must have an abundant supply of enthusiasm. He must show grim resolution to follow his convictions, irrespective of unfavorable comments by those whose easy existence he disturbs. Compromise must often be ruled out of the question. The leader must not relax in his efforts by yielding to the static influences of contentment. He must brave all destructive criticism.

Where then does the cultivated man find himself after achieving some degree of success in his aims? Probably the most obvious change is that of companionship. He is in the midst of an aristocracy, not only in the association of living persons, but more especially by coming into contact with great minds through books. It is not an aristocracy of wealth or birth but of the mind. He has taken himself out of the class of those men of whom Arnold says,

They eddy about,
Here and there,—eat and drink,
Chatter and love and hate,
Gather and squander, are raised
Aloft, are hurled in the dust
Striving blindly, achieving
Nothing; and then they die,—
Perish,—and no one asks
Who or what they have been.

To stand out and above the unthinking, mechanical crowd whose interests rarely extend beyond its immediate surroundings is a worthy aim. To gain the admission into the company of great minds merits the ambition of any man.

### FAVORABLE AND UNFAVORABLE SOILS FOR CULTURE

Not only will we profit from such superior associations, but the work of capable men in all branches of higher endeavor, such as literature, art and science, will be greatly enhanced when there is an audience to appreciate their work. The Parthenon frieze would hardly have been made if the artistic Athenian citizen had not lived to read its story; the plays of Shakespeare would never have been written if there had not existed an appreciative audience. German philosophy and German music require the German temperament.

Great scientists, as well as other mental workers, need proper environment before they can rise. As engineers, and therefore as advocates of applied science as opposed to pure or theoretical science, we are largely responsible for the dearth in our country of noted scientists. It is a melancholy fact that the United States stands at the very bottom of the list of so-called civilized countries in the number of Nobel Prize recipients. And to add to our shame we are told that the two Americans who have received the Nobel Prize are not even natives of this country. Dr. Carrel is a native of France and Professor Michelson came to this country from Germany. As engineers we must plead guilty to the charge of propagating the pernicious doctrine which demands the measurement of all values by the dollar. No business man uses the phrases, "What will it bring?", "What is it good for?" more often than the engineer. For an engineer to urge that something has a value in itself and is good for nothing but itself would be rank heresy. It is extremely difficult for most of us to grasp the conception that great fields of knowledge, such as astronomy, have a value in themselves. Truth and wisdom, like music, are superior to use; they are an end in themselves. Pure science can flourish only when people can see good in its laws and discoveries. To expect the man of pure science to work in the society of people who cannot understand his aims is almost as absurd as to expect orchids to thrive in the cold tundra. We must recognize and honor him; then he will rise.

FROM SCIENCE TO PHILOSOPHY

In order to be able to honor the scientist the engineer must first acquaint himself with the scientist's work. The overwhelming magnitude and extent of scientific investigations will, of course, prohibit a mastery of all fields, but the more prominent truths can be learned. And what may those be? At the risk of seeming to pose as one informed in the matters of pure science, the writer suggests a cursory study of the more fundamental principles of biology, astronomy, physics, and chemistry. When approached merely for the sake of knowing, the sciences are a never-ending source of enjoyment. They lay bare the wonders and secrets of nature. A great array of revelations unfolds itself to the inquisitive eye.

The vastness of scientific knowledge need dismay no one in an attempt at acquainting himself with its teachings. No one can ever expect to cover the whole field of knowledge, not even that of the sciences, nor even one branch of the latter. Aristotle, who is said to have been the most learned man of his time, and who is regarded by some historians as the most learned of all men, knew only a small part of what was to be known in his day. He had, however, mastered all the greater generalizations and broader truths, omitting the maze of details. Such a task can be accomplished to-day, nor need we be Aristotles to attempt it.

For gripping the imagination astronomy has no peer among the sciences. It comes first in the sublimity of revelations. In no other manner is it possible to experience that sense of one's impotence in contrast to the external grandeur of space and its bodies, that feeling of awe which comes in moments of quiet contemplation under a clear starlit sky. At such times a whisper seems to be all the speech one is entitled to. What can be more wonderful than our knowledge of the size of many stars, planets, and nebulae, their relative ages, the speeds and directions they have in space, and even their composition?

A study of nebulae and their development leads to geology and biology and an inquiry into the history of the earth as the home of living creatures. This brings us to the subject of the evolution of life. No discovery of the nineteenth century has so revolutionized thought and speculation as has the conception of the gradual development of life from very simple to highly complex organisms, including man. Not to grasp the significance of this thought, to realize the consequences its general acceptance must have, is to forfeit the knowledge of an idea which future historians may apply as a name to the time in which we live.

The student of astronomy, if audacious enough to follow where his studies lead, will face the problem of the origin not only of worlds, but of motion; the student of chemistry faces the problem of the origin of matter; the physicist is confronted with the problem of real nature of light, gravitation and electricity. All of these, starting from experimental knowledge at widely separated points are brought together into problems which experiment can never clarify. Theory and speculation alone can give solutions. Reflective persons, if honest thinkers, must also concern themselves with the problems of metaphysics. This, however, should dishearten no one. On the contrary, it should cheer, since quiet meditation is often a relief from the stress and anxity of more active engagements. Meditation is a draught of pure air in the midst of the "dust storm of activities." Thus the engineer in his interest in the sciences may be lead from them to a search for truth in philosophy and religion, a search marked by a genuineness and spontaneity not always found in the specialists who pursue these studies.

IN LITERATURE: POPULARITY=MEDIOCRITY

Although the engineer is pre-eminently qualified to delve into the sciences, and can understand generalizations and laws of nature better than the laws of style and syntax in good English, he cannot be a really cultivated man unless he also familiarizes himself with the best literature. The best literary works of all languages are available in good translations for him if he is not sufficiently proficient in foreign languages to read the originals. It would be presumptious for the writer to outline a course of reading for the engineer. Five-foot-shelf and gilt-star collections of books selected by experts may be referred to, but for true satisfaction no prescribed list can serve all persons. Moreover, rigid outlines and programs usually destroy the pleasure to be derived from books.

As a general rule to follow, the reader who desires and who can enjoy the best books may guide himself, if not to the good books, at least away from the poorer ones by avoiding those that everybody reads. In literature, popularity too often signifies mediocrity, superficiality, and scrap. Giving an honest desire free rein seldom vitiates a literary taste, hence it is well for each person to be independent in his selections, and to follow his own promptings irrespective of what others are reading. The person who wishes to exalt himself through the medium of literature must be especially cautious not to choose his books according to the dictates of "everybody." The best that has been written can be understood by comparatively few people. A work of art and of profound thought such as Faust can be studied for a lifetime and yet reveal previously undiscovered gems each time it is read. It will always remain a "book with seven seals" to most people, because it requires effort and preparation for its appreciation. Again, the person who desires must dare. He must dare to read what other people do not read, scorning their jests and sneers in his freedom from their narrowness and little prejudices.

### THE UNCULTIVATED "HIGH BROW"

The advancement of the cultivated man out of the rank and file need not place him out of touch with the ordinary man. The "high-brow" who cannot see the world from the point of view of the unschooled and untrained man is no cultivated man. In place of a haughty arrogance and superciliousness toward the common man he shows sympathy and fellowship. He can appreciate and in a measure experience the hopes and fears, all the yearnings and strivings of the other man. Breadth and depth of feeling liberate the cultivated man from the narrow bonds of more common place lives and raise him above his less fortunate fellow men. He strives to live the supreme and universal life.

### ENGINES AND ENGINEERING NOT FOREIGN TO CULTURE

As a necessary complement to his interest in men, the cultivated man will also interest himself in their labor and its results. And what is more obvious and persistently before us than the products of the engineer's labor? Certainly the civilization that is largely the result of several great inventions must recognize these inventions as objects worthy of interest. Here the engineer with his technical training is peculiarly able to understand and appreciate. Where the untrained man sees "just a track," the engineer sees problems in grading, in ballasting, and curvature; in the rails he sees processes of manufacture, great furnaces, rolling mills, steamers, and mines. Even such a simple thing as a trolley wire is not just a wire that "carries the electricity;" there are insulators, problems of resistance, strength, and support. The joy of knowing the "reason for it," of being able to explain particular construction, and of understanding why "it works" belongs singularly to the engineer.

No engineer, if he honors his profession, can neglect the study of the history of that profession and its achievements. The significance of many machines and industrial processes can impress itself only when seen in the light of history. The locomotive, the steamship, the aeroplane, the automobile, in fact the whole array of modern inventions that come and pass before us daily are seen and never thought of again, and in most cases not even noticed in the first place. For, are they not the established order of things? To the engineer acquainted with the history of inventions they are, however, far from commonplace. To him the electric street car is no fixed machine, planned and built in a few weeks; it is a development, and even now has not reached a stage of permanence in design. The paths from the Clermont to the Luisitania, from the Rocket to the Mogul compound locomotive, or from Newcomen's simple condensing steam engine to the modern vertical quadruple-cylinder pumping engine record untold numbers of trials and difficulties which pioneer inventors had to overcome.

Historic perspective gives a third dimension to the daily panorama of ordinary things. What price would a person living in Franklin's time not have paid for a glimpse into the present day world? If the wheel of time had suddenly slipped as Franklin paid his first visit to New York and he could have seen the great steel spans now connecting Manhattan Island and Brooklyn, with the steamships plowing the river below, how he would have marvelled. Could we of to-day peer into the future of a century or two hence, what wonders we would find! Yet, people living two hundred years from now will look upon all such wonders as so many commonplace objects. Why? Because, just as we do to-day, they will lack the introspective vision provided by a knowledge of the history of inventions and discoveries. They will, just as we do, see things as they appear at the time and not as they once were. The past furnishes a background or setting with its lights and shadows to offset the present. When a knowledge of the past is lacking, the present is a monotonous, colorless, and meaningless picture.

### THE GOAL

A knowledge of the achievements of his profession, of the development of manufacturing processes and machines, of industries and commerce, should then be a part of the equipment of every engineer. This, coupled with a desire for truth in science, in art, and in religion, and a yearning to make things better mark the potential cultivated man. President *emeritus* Eliot describes the ideal whom we may hold up for emulation as a "man of quick perceptions, broad sympathies, and wide affinities, responsive but independent, self-reliant but deferential, loving truth and candor but also moderation and proportion, courageous but gentle, not finished but perfecting."

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Apropos of the recent fire at the Edison factory, the following statement is interesting:

"The report of our engineers shows that 87 per cent. of the reinforced concrete buildings, which were subjected to a very intense heat, are in good condition, and of the machinery which they contain about 85 per cent. can be used, with small repairs. Buildings of other materials, together with contents, were entirely destroyed.

"(Signed) Thos. A. Edison."

# CONTINUOUS DETERMINATION OF THE CALORIFIC VALUE OF FUEL GASES WITH JUNKER'S CALORIMETER

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Junker's Calorimeter, as commonly placed on the market in this country, is provided with thermometers graduated in degrees Centigrade, water measuring receptacles graduated in cubic centimeters, and a gas meter that reads in cubic feet. Thus the B.t.u's. in a volume of gas, measured in cubic feet, are given up to a quantity of water measured in cubic centimeters and therefore weighed in grams, whose temperature is raised a number of degrees Centigrade thereby.

In order to determine the B.t.u's. per cubic foot of gas it is necessary to reduce the temperature range of the cooling water in degrees Centigrade to an equivalent range in degrees Fahrenheit, and to reduce the water quantity in cubic centimeters, or grams, to pounds. A single reduction factor for this purpose may be developed from the relation between the British thermal unit and the calorie: namely, one B.t.u. equals 252 calories. We may then write our equation:

$$\frac{\text{c.c. of water} \times \text{range in degrees Cent.}}{252 \times \text{cubic feet of gas}} = \text{B.t.u. per cu. ft.}$$

From this it will be seen that if the water quantity is made $10 \times 252 = 2520$ c.c., the B.t.u. given to the water by the gas in the corresponding time will be $10 \times$ range in degrees Cent., or the temperature range with the decimal point moved one place to the right, and the B.t.u's. per cu. ft. will be this quantity divided by the number of cubic feet of the gas passing the meter during the same interval.

The following special log, based on the above reduction factor, makes it possible to secure continuous determinations of calorific value over periods of indefinite length. Table 1 shows the results of an actual test of illuminating gas. Table 2 is taken from a gas producer test of twenty-four hours duration where practically continuous determinations were made. A little study of

TEST OF ILLUMINATING GAS

| TIME | TEMPERATURES IN DEGREES C | | | | | | B T U | | WATER QUANTITY | | | GAS METER | | | B.T.U. PER CU. FT. | | PRESSURES | | CONDENSATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ENTERING GAS | LEAVING GAS | ENTERING WATER | LEAVING WATER | DIFF. | AV. DIFF. | PERIOD | TOTAL | READ. | PERIOD | TOTAL | READ. | PERIOD | TOTAL | PERIOD | TOTAL | AT FLAME IN MM $H_2O$ | BAROMETER IN HG. | IN CC OF WATER |
| 9:52-10 | | | | | | | | | 0 | | | 2.900 | | | | | | | 0 |
| 9:54-30 | 29.2 | | 22.17 | 33.12 | 10.95 | 10.950 | 109.5 | 109.5 | | 2520 | 2520 | 3.083 | .183 | .183 | 598.3 | 598.3 | 12 | 29.953 | |
| 9:56-40 | 29.2 | | 22.17 | 33.13 | 10.96 | 10.955 | 109.6 | 219.1 | | 2520 | 5040 | 3.265 | .182 | .365 | 602.2 | 600.3 | 12 | | |
| 9:58-45 | 29.1 | | 22.18 | 33.10 | 10.92 | 10.943 | 109.2 | 328.3 | | 2520 | 7560 | 3.450 | .185 | .550 | 590.2 | 597.0 | 12 | | |
| 10:1-1 | 29.1 | | 22.17 | 33.10 | 10.93 | 10.940 | 109.3 | 437.6 | | 2520 | 10080 | 3.633 | .183 | .733 | 597.3 | 597.0 | 12 | | |
| 10:3-15 | 29.2 | | 22.15 | 33.10 | 10.95 | 10.942 | 109.5 | 547.1 | | 2520 | 12600 | 3.816 | .183 | .916 | 598.3 | 597.2 | 12 | | |
| 10:5-25 | 29.2 | | 22.15 | 33.10 | 10.95 | 10.943 | 109.5 | 656.6 | | 2520 | 15120 | 3.997 | .181 | 1.097 | 605.0 | 598.5 | 12 | | |
| 10:7-40 | 29.2 | | 22.14 | 33.14 | 11.00 | 10.951 | 110.0 | 766.6 | | 2520 | 17640 | 4.182 | .185 | 1.282 | 594.0 | 598.0 | 12 | | |
| 10:9-50 | 29.3 | | 22.13 | 33.08 | 10.95 | 10.951 | 109.5 | 876.1 | | 2520 | 20160 | 4.336 | .184 | 1.466 | 595.1 | 597.6 | 12 | | |
| 10:12-5 | 29.3 | | 22.12 | 33.10 | 10.98 | 10.954 | 109.8 | 985.9 | | 2520 | 22680 | 4.549 | .183 | 1.649 | 600.0 | 597.9 | 12 | | |
| 10:14-18 | 29.3 | | 22.11 | 33.10 | 10.99 | 10.958 | 109.9 | 1095.8 | | 2520 | 25200 | 4.733 | .184 | 1.833 | 597.3 | 597.8 | 12 | | |
| 10:16-35 | 29.3 | | 22.11 | 33.08 | 10.97 | 10.959 | 109.7 | 1205.5 | | 2520 | 27720 | 4.917 | .184 | 2.017 | 596.2 | 597.7 | 12 | | |
| 10:18-14 | 29.3 | | 22.10 | 33.03 | 10.93 | 10.957 | 109.3 | 1314.8 | | 2520 | 30240 | 5.099 | .182 | 2.199 | 600.5 | 597.9 | 12 | | |
| 10:21-0 | 29.3 | | 22.11 | 33.09 | 10.98 | 10.958 | 109.8 | 1424.6 | | 2520 | 32760 | 5.280 | .181 | 2.380 | 606.6 | 598.5 | 12 | | |
| 10:23-7 | 29.3 | | 22.14 | 33.12 | 10.98 | 10.960 | 109.8 | 1534.4 | | 2520 | 35280 | 5.463 | .183 | 2.563 | 600.0 | 598.7 | 12 | | 44 |
| | | | | | 153.44 | | 1534.4 | | | | | | | | | | | | |

TEST OF PRODUCER GAS

| TIME | ENTERING GAS | LEAVING GAS | ENTERING WATER | LEAVING WATER | DIFF. | AV. DIFF. | BTU PERIOD | BTU TOTAL | WATER READ. | WATER PERIOD | WATER TOTAL | GAS READ. | GAS PERIOD | GAS TOTAL | B.T.U. PER CU. FT. PERIOD | B.T.U. PER CU. FT. TOTAL | AT FLAME | BAROMETER | CONDENSATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.27 | | | | | | | | | | | | 78.065 | | | | | | | |
| 6.31 | 20 | | 5.0 | 21.0 | 16.0 | 16.0 | 160. | 160. | | 2520 | 2520 | 79.192 | 1.127 | 1.127 | 142.0 | 142.0 | 19 | 30 | |
| 6.35 | 20 | | 5.0 | 21.0 | 16.0 | 16.0 | 160. | 320. | | 2620 | 5040 | 80.326 | 1.134 | 2.261 | 141.1 | 141.5 | 19 | | |
| 6.39 | 20 | | 5.0 | 20.9 | 15.9 | 15.97 | 159. | 479. | | 2520 | 7560 | 81.465 | 1.139 | 3.400 | 139.6 | 140.9 | 19 | | |
| 6.43 | 20 | | 5.0 | 21.1 | 16.1 | 16.00 | 161. | 640. | | 2520 | 10080 | 82.610 | 1.145 | 4.545 | 140.6 | 140.9 | 19 | | |
| 6.47 | 20 | | 5.0 | 21.3 | 16.3 | 16.06 | 163. | 803. | | 2520 | 12600 | 83.755 | 1.145 | 5.690 | 142.4 | 141.1 | 19 | ASSUMED | 13 |
| 6.52 | 20 | | 5.0 | 21.5 | 16.5 | 16.13 | 165. | 968. | | 2520 | 15120 | 84.894 | 1.139 | 6.829 | 144.9 | 141.8 | 19 | | |
| 6.56 | 20 | | 5.0 | 21.6 | 16.6 | 16.20 | 166. | 1134. | | 2520 | 17640 | 86.048 | 1.154 | 7.983 | 143.9 | 142.0 | 20 | | |
| 7.00 | 20 | | 5.0 | 21.8 | 16.8 | 16.275 | 168. | 1302. | | 2520 | 20160 | 87.210 | 1.162 | 9.145 | 144.5 | 142.3 | 20 | | 25 |
| 7.04 | 20 | | 5.0 | 21.9 | 16.8 | 16.333 | 168. | 1470. | | 2520 | 22680 | 88.376 | 1.165 | 10.310 | 144.2 | 142.6 | 20 | | |
| 7.08 | 20 | | 5.1 | 21.8 | 16.7 | 16.370 | 167. | 1637. | | 2520 | 25200 | 89.542 | 1.167 | 11.477 | 143.1 | 142.6 | 20 | 30 | 34 |
| | | | 5.1 | | 163.7 | | 1637 | | | | | | | | | | | | |

*Special Log for Use with Junker's Calorimeter.*

these tables will reveal the fact that the B.t.u. for any period (where the period is the time necessary for 2520 c.c. of water to pass the calorimeter) are obtained by moving the decimal point one place to the right; that the total B.t.u. in the gas burned at the end of any period is the average difference in temperatures of entering and leaving water with the decimal point moved one point to the right and multiplied by the total number of periods; that the B.t.u. per cu. ft. for the various periods will show the fluctuations in the calorific power of the gas; that the total B.t.u. per cu. ft. will show the calorific value of the gas from the beginning of the test; that the longer the test is continued the more nearly accurate will be the final value; and that the work may be checked from observation to observation to insure the absence of errors.

If local conditions do not permit a range of cooling temperatures sufficient to make the periods of at least three minutes duration it is advisable to have two men on the job, one taking observations and the other keeping the log. In testing producer gas, if a range of about 15 degrees Cent. be maintained, approximately four minutes will be required for 2520 c.c. of water to pass the calorimeter, which is sufficient time for one man to make and enter all observations, and to make and check the necessary calculations. While it is not an easy matter to read the water of condensation at the end of each period, observations at regular intervals will reveal the hydrogen content of the gas and hence the producer action.

## THE ADVANTAGES OF EIGHT CYLINDER MOTORS

ROBERT B. WHITE

That which may be termed a vagary of mechanical evolution has been the exceedingly remarkable advancement of the internal combustion motor into the engineering and business worlds. As one takes a retrospective view of this almost incredible advancement, the first attempts with the one cylinder motors are seen, and following these first experiments in that perpetual and ever growing quest for power in combination with silence, flexibility, and speed, with its concomitant decrease in vibration, we see the growth in popularity of the two cylinder motor Thus on the stage of the internal-combustion-motor world, we watch the debut of the two cylinder motor with its undeniable improvement over the vibrational, inefficient monocylinder motor, and see it heralded, like any other fundamental improvement, with the usual pessimistic denunciations. Then, with the success of this large step in motor design established, the experiments with the multiple cylinder motors are observed, the first of which was the four cylinder motor, whose efficiency, power, and astoundingly high crank-shaft speed have led to its undenied success and tremendous popularity throughout the European nations and America. Close onto the adoption of the four cylinder motor as the standard motor, laboratory experiments with the six cylinder motors are observed, their first appearance being made on the American highways. These too, received the same denunciations that the four cylinder motor incurred from engineers, and yet this motor is but playing its part in the evolution of the eventual type. Then in the last scenes of this retrospection we observe the rapid increase in the popularity of the six cylinder motor, and finally as a last word in the search for decrease or total elimination of vibration, the eight cylinder motor is introduced as the ideal, as the motor of almost constant torque. With the eight cylinder V-type motor have come the greatest condemnations of all the types or improvements of hydro-carbon motor designs, and although at first it was seen only in the laboratory, as was the six in its experimental stages, it is now fast coming onto the highways of America and France, demonstrating its remarkable smoothness and flexibility.

It has been shown by some of the largest and most successful of European engineers or automobile manufacturers that to build a four cylinder motor of maximum efficiency and power for a given weight and size the bore must not exceed seventy-five or ninety milimeters, if extreme durability is desired. Owing to the fact that the road conditions of America are far more exacting than those found on the continent of Europe, a large amount of power is extremely important in motor design. Consequently as a corollary of the foregoing statement, an increase in the number of cylinders is essential if the bore is thus limited. By increasing the number of cylinders to six, we make the error of increasing the weight of all parts with an increment also in the length of the wheelbase, and as this article will endeavor to prove, it will be expedient to build the eight cylinder V-type motor for all purposes, excepting use in low-powered and low-priced pleasure cars.

In a consideration of the eight cylinder motor the question as to the gain in flexibility, power, and general efficiency with the increment in the multiplicity of parts, both reciprocating and stationary is of primary importance. The superior advantages in the flexibility of the eight as compared with any other type of gasoline engine can best be shown by manograph readings and by the calculation of relative crank-shaft turning moments. Considered from a theoretical standoint, we see that if the velocity of spark propogation through the charge is fast enough to create a pressure on the piston head at zero degrees of crank-shaft travel, there is a tendency to impart a motion to the crank-shaft while on dead centre. From the readings it is observed that as the crank-shaft revolves between twelve and fifteen degrees from upper dead center that the pressure is slowly becoming effective, that is to say that it is beginning to impart a turning moment to the shaft. This is due to the relatively small effective lever arm of the crank and the connecting-rods. Then since the exhaust valve generally opens at about forty degrees below lower dead center, the pressure of any actual value occurs between thirty degrees and about one hundred and twenty degrees thus giving ninety or one hundred degrees of effective turning moment to the shaft. From this it is evident that the smallest number of cylinders that will approximate constant torque or turning moment will be two, and that a smaller number of cylinders than eight will cause synchronic vibrations and will necessarily depend on the flywheel to attain their attempt at uniform angular velocity. Owing to this practically uniform turning moment of the eight, it is therefore evident that this motor will have a uniformity of torque approximately twenty-five per cent. higher than that of the six cylinder motor and approximately fifty per cent. higher than the four cylinder motor.

The next consideration is that of the relative resulting vibrations of the eight, V-type, and the six cylinder motors. In the former type, in which the cylinders are set at an included angle of ninety degrees, the inertia disturbances are at right angles to each other and to the stresses due to torque reaction, while in the six cylinder, all-in-line type of construction the effect of the aforementioned inertia disturbances is directly upon the supporting members in a vertical direction. Likewise, the torque reactions of the six cylinder motor are in a vertical direction and the resulting critical speeds and vibrations of the motor at certain angular velocities can be eliminated only by increasing the number of cylinders or by extremely accurate balancing of light weight reciprocating parts. The logical question following the success of the eight-cylinder, V-type motor, is concerning the reasons for the absence of the six-cylinder, V-type motor. Were such a type of motor built, it is to be admitted that it would have a shorter overall length and a shorter crank-shaft, subject to fewer stresses. This type of motor is nothing more than a combination of two three cylinder motors. Since the latter are practically impossible, on account of unbalanced moments produced by the inertia forces of the piston connecting-rods and like reciprocating parts which cause rocking in a longitudinal direction, the six cylinder, V-type motor would only increase this difficulty. Perhaps a greater disadvantage than this lies in the fact that the explosions are unevenly spaced, occurring at intervals of ninety degrees and one hundred and fifty degrees. From this, then, it is very evident that to eliminate vibration and torque reactions and in order to attain flexibility and stamina, we are limited to the light, counterbalanced crank-shaft, four cylinder motor, or to the eight-cylinder V-type, if in practice the eight is as good as in theory.

In the discussion of the eight cylinder motor with its advantages and disadvantages, the question arises as to what extent this multiplicity of the cylinders and their accompanying parts affect the general efficiency of the motor. Let us first consider their mechanical efficiencies. It has been shown by many automobile builders that since the most efficient operation of the motor can not be obtained unless the crank-shaft is very rigidly supported, the seven-bearing crank-shaft is a necessity in six-cylinder motor design. Although the total mechanical efficiency may be lowered with this increase in the bearing surface area, and although it may cause an excessive cost in construction, it is evident that the seven bearing crank-shaft is needed to overcome the periodicity and the thrashing of the long crank-shafts. With the eight-cylinder, V-type, a five bearing crank-shaft would easily sufficient, and owing to the conditions of operation of the eight motor, three bearings have proved satisfactory. This was shown by the De Dion car, which after thirty thousand miles of hard usage in the state of New York, showed a very small amount of wear in the bearings and during which distance experienced absolutely no trouble. Since the area of the bearing surface has been considerably decreased in the eight motor, and since the cylinder surface area has been increased by the addition of two cylinders, the question arises as to which way the balance of mechanical efficiency is thrown. The power output at a given number of revolutions per minute is directly proportional to the piston displacement, neglecting number of bearings and other frictional parts, and hence with an increase of two in the number of cylinders, to produce an equivalent amount of power as compared with the six, and the bore and stroke of the cylinders may be decreased. Thus with the decrease in the bore and the stroke, we approximate the smaller frictional area of the six without ever equalling it, thereby giving the six less frictional power loss. But after consideration of the gain in efficiency through the one camshaft of the eight and of the losses of power in the six through the greater surfaces of the valve plungers and tappets, it is to be concluded that the mechanical efficiencies in the two motors are approximately the same.

The thermal efficiency is slightly higher in the eight, although greater wall area may be present, for in the consideration of this it should be well established in mind that higher compression is obtainable, because for a given amount of foot-pounds of work to be done, the more uniform turning moment, with the accompanying equalization of the torque reactions and inertia disturbances, permits an appreciable decrease in the bore. With this decrease, higher compression is obtainable, the gain in heat of which is sufficient to counteract the increased heat loss into the water jackets by the increase in wall area.

Since there is a gain in the thermal efficiency, the question of volumetric efficiency immediately arises. Is an equal amount of gasoline consumed per horsepower-hour in the two motors? If, as was stated in preceding paragraph, the mechanical efficiency in the eight is the same as in the six, and since there is a slight yet perceptible gain in thermal efficiency, the relative mileages per gallon consumed should be the same, and this is proved in the recent tests of the Cadillac Automobile Company of Detroit, which showed that twenty-two miles to the gallon would be obtained and that the average driver would get from twelve to fourteen miles to the gallon.

Perhaps one of the most potent factors in the introduction of the eight V-type motor into the automobile motor world has been the advantages gained through the crank-shaft of this motor. It is to be seen that the crank-shaft of the eight would be far shorter than the six cylinder motor, and through this decrease in length come the multiple advantages. First is the elimination of the thrashing and the periodicity, so destructive to bearing life, which is prevalent and inevitable in all crank-shafts of extreme length. Second is the simplified machining of the "eight" crank-shafts and its accompanying decrease in cost, both in machining and drop-forging. Third is the simplicity of the shaft, which makes the use of ball bearings more practical for the high-speed high-efficiency motor. Although these advantages are evident, the advocates of the six-cylinder motor may claim that the disadvantage from the disturbances occurring at certain speeds can be overcome by heavy construction. This seriously interferes with the mechanical efficiency and, moreover, it never totally eliminates the periodicity, even if the crank-shaft be made larger and heavier than may be practical.

Investigation of the European and American tendencies shows that the trend in the casting of the cylinders is toward the en-bloc method. In the assembling of the six, two men are needed in order that one may guide the pistons into their respective cylinders while the other manipulates the complicated tackling necessary for placing the cylinder block in position. With the eight-cylinder V-type whose cylinders are offset forty-five degrees from the vertical, this motor can be assembled successfully by one man, since he is not obliged to stand on the chassis to place it into position. As to the cost of machining or boring the cylinders, the six undoubtedly has the advantage, but this economy is surely offset by its more costly crank-shaft.

With the increase in the number of cylinders the question arises as to a possible increased difficulty in the adjustments of the valve tappets, and as to a possible lowered efficiency of operation in other details, due to their increase in size or number. These details may be enumerated as follows: (1) accessibility of valves and other similar parts with their accompanying adjustments, (2) increase in the intricacies of the ignition system and in carburetion, (3) the weight and strength of parts, (4) the silence of the valves and of the muffler.

As has been previously stated, the fact that the cylinders are set on an angle of forty-five degrees from the vertical led us to conclude that the placing of the cylinders of the motor is facilitated, and we may likewise conclude that the valve adjustment is likewise facilitated. On examining the eight-cylinder motor, it will be observed that the mechanician can lean over the right cylinder block and with a slight amount of skill can adjust the valves of the left side with comparative ease. The accessibility of the carburetor, magneto breaker points, or generator-starter brushes or distributors is far superior to that of the vertical type of motor, this being due to the height above the frame of the layshaft. Again, in regard to the intricacies of ignition and carburetion, it may be said conclusively that the necessity of duplicate carburetors and magnetos is a preposterous idea. This has well been proved by the De Dion Bouton cars, the Romano racer, the holder of the dirt track record for twenty-five miles, and by the well known Antoinette aviation motor. Although carburetion may be difficult it is not as great a problem to solve as on the six-cylinder motor and although condensation due to the inertia of the intake gases is increased, equal distribution of the gases is obtainable, this being the more potent factor of the two. If the intricacies of ignition have been increased it is by a very small amount, for the breaker is no more complicated and synchronous firing is unaffected by the placing of the two extra plates in the distributor block. The wiring of the motor is further complicated only by the addition of the two extra wires running from the distributor to the terminals of the spark-plugs.

To demonstrate the third question, the weight, it may be said, as before, that for a given power output the eight is lighter than the six. This surprising fact is due to the decrease in weight of the reciprocating parts, such as the pistons, connecting-rods, and the valve driving mechanism, all of which are made as light as possible. Furthermore, the crank-shaft is far lighter, as has been explained, and such is also the case with the crankcase and lastly with the flywheel. The decrease in the weight of the crankcase is apparent from its decreased length and from the lighter construction which may be used on account of the greatly decreased strains to which the case is subjected. Subtract this decrease in weight together with decrease in weight of the flywheel, and the motors are surely not to be doubted in regard to their weight. The decrease in weight of the flywheel is accounted for by the undeniable fact that only motors which are capable of rotating with uniform angular velocity have a constant torque. To approximate uniform angular velocity in motors of non-uniform torque, a flywheel is used to store up kinetic energy, and since as has been proven, the torque is far smoother in the eight-cylinder motor, it can be easily seen that a smaller flywheel rim can be used.

Let us next consider the last of the questions—that of muffling the exhaust gases and the valve tappet noises. With the eight-cylinder motor, the muffling of the exhaust is really a simple problem and can be accomplished by a smaller and lighter muffler than in either the six or the four. With the use of two manifolds, usage of the multiple exhaust manifold is eliminated. The dilution of the incoming charge by the blowing back of the exhaust gases in the six-cylinder motor is entirely eliminated in the eight-cylinder motor, since two consecutively firing cylinders are in opposite blocks of cylinders. Thus it is that the dilution of the charge does not occur and with the use of two expansion chambers for the gases, the noise is even less than in the six. In regard to the valve tappet noises, it should be understood that the valve tappets in the eight have a smaller frictional area, thereby making them more silent although they may be more numerous. Moreover, even were this not the case, it would be a simple matter to overcome the difficulty of the noise, because the one camshaft of the eight would facilitate the use of the oil bath.

In summarizing the multiple advantages found in the eight-cylinder V-type motor, we see first the equal distribution of the power impartations, this remarkable flexibility giving rise to its relatively high thermal efficiency, its uniform angular velocity and torque, and to the minimum wear on the differential and transmission gears and bearings as well as the tires. With this type of motor, all critical speeds, inevitable both in six and four motors, are eliminated, thereby reducing crystallization of parts from vibration, and finally we have a light powerful motor which occupies no more space than a four and which weighs no more than a six of equal power.

With this motor, when constructed properly, a unique sensation in driving should be experienced, the overlapping of the power impulses being so definite and complete that all unite to produce that wonderful smoothness which is the luxury of motoring. Yet, with this motor type, such a large stride has been taken from the ordinary practice that it has been met, like any other fundamental melioration in the internal combustion motor, with studied skepticism on the part of the manufacturers of other types. Nevertheless it seems to be the beginning of the final chapter of the eventual motor.

## MIXING, CONVEYING AND PLACING CONCRETE BY COMPRESSED AIR

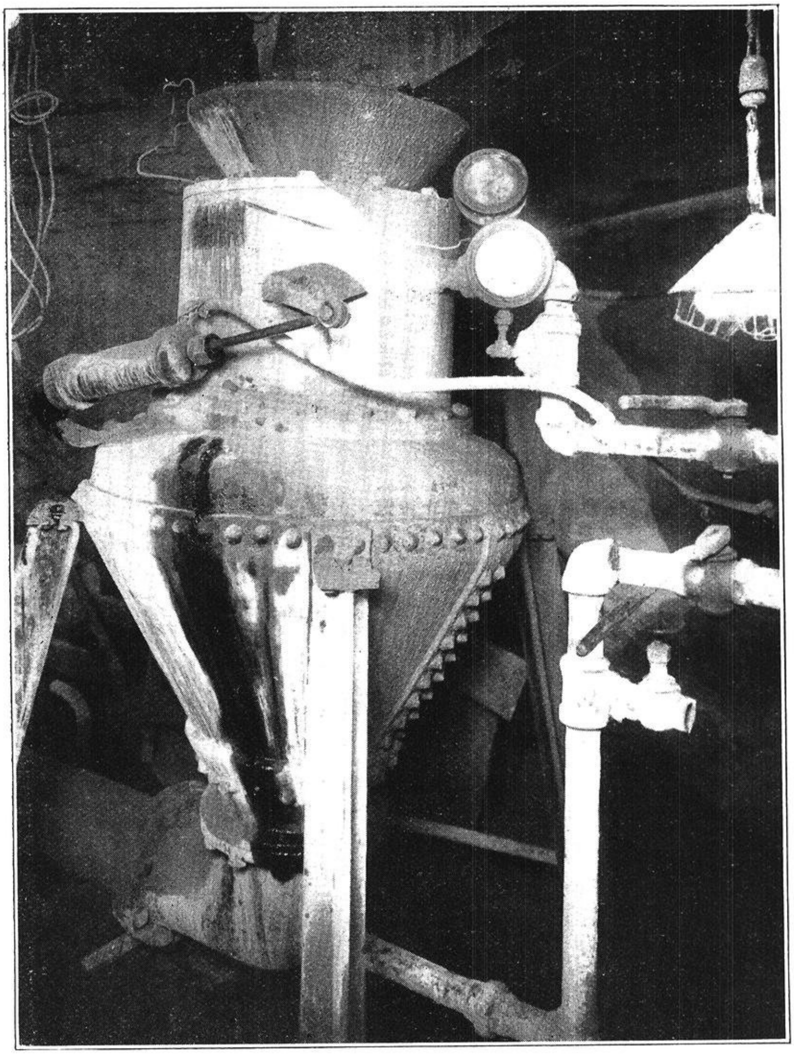
The Pneumatic Method of mixing and placing concrete has been in process of evolution for ten years or more, but in the last two years has become more widely known because of the larger works upon which it has been used. The method was first used for tunnel lining work (and it is by all means the most economical method that can be used for this class of work) and it has also shown great economy for heavy concrete work such as dams, retaining walls, and foundations

The mixer consists of a cone-shaped receptacle with door at the top and discharge pipe connection at the bottom. After each batch is placed in the machine the door is closed by the small air cylinder, shown in the accompanying illustration. Air connection is made to the machine at the point above the batch and at a point below the batch through the heel of the bottom elbow. When the air is admitted the upper stream of air tears its way through the batch forcing it downward in the same way that sand flows in an hour glass. The lower stream of air encounters the batch at right angles and the combination produces a thorough mixture and simultaneously conveys the batch through the discharge pipe to place in the forms. Concrete has been mixed and conveyed in this way more than a quarter of a mile and the limit is by no means reached.

The amount of air which is required to operate the machine depends upon the length of the delivery pipe, the number of turns in the pipe line, the kind of material used for aggregate, and the vertical distance involved in the delivery. From measurements taken, however, the amount of air is shown to be approximately, one cubic foot of free air compressed to eighty pounds, for each lineal foot of eight inches delivery pipe for each one-fourth yard batch of concrete.

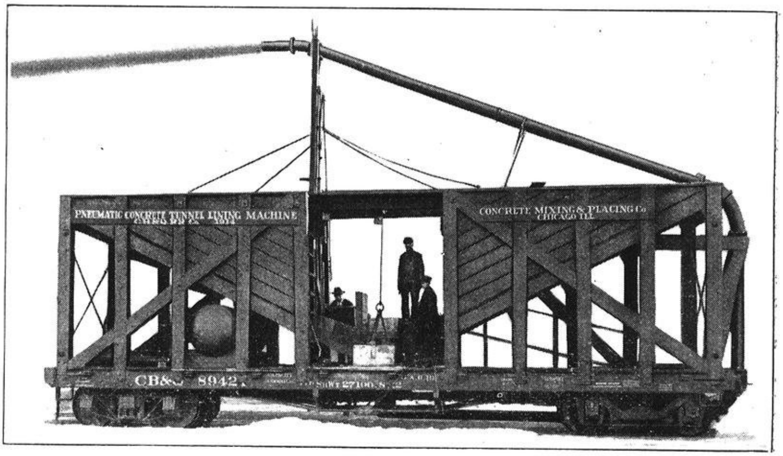
The quality of the concrete produced is excellent, since each grain of sand gets a thorough coating of cement, and each piece of rock or gravel in turn gets a thorough covering of concrete. The velocity of the material as it is discharged from the end of the pipe is approximately 100 feet per second, and the impact makes a very dense concrete. Another feature of the impact is in forcing grout to the surface of the forms.

One of the first tunnels upon which this machine was used was the La Salle Street tunnel in Chicago. The machine was here set on the bank of the river and the delivery pipe extended from



the machine horizontally about fifty feet, then down a shaft forty feet deep, and then horizontally 300 feet. Later the O. K. Creek sewer tunnel in Kansas City was lined by placing the machine at the bottom of the shaft. This method was also followed in St. Louis on the Water Works tunnel during the past year.

In small tunnels where the shafts are great distances apart, the machine is taken into the tunnel and sunk into a hole made by blasting out a place for it. The hole is made deep enough so that the top of the machine can receive batches dumped from




the narrow gauge cars direct. In this way tunnels of any length may be concreted by using 500 to 800 feet of delivery pipe and moving the machine back for each corresponding length of tunnel.

A most economical method for larger tunnels such as railroad tunnels is that used by the C. B. & Q. R. R. for the Alkali Summit tunnel in Wyoming. This outfit is illustrated by the accompanying photograph. The mixer is mounted on a flat car upon which bins are built. These bins hold enough material for about twenty-six yards of concrete and one car load will correspond to about five or six lineal feet of tunnel lining.

The pneumatic method is also being used for outside concrete work, such as railway track elevation work. During the coming season about $3,000,000 worth of work will be done by the pneumatic method in Spokane, Washington, in elevating the Northern Pacific tracks through Spokane.

These machines are leased and operated by the Concrete Mixing & Placing Co., 123 W. Madison St., Chicago, of which Mr. Edward Wray, U. W. ch. '05, EE '06, is secretary and treasurer and Mr. H. B. Kirkland, U. W. ex '05, is president.

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## EDITORIALS

The appointment of Mr. Walter Alexander, U. W. 1897, as a member of the Wisconsin Railroad Commission is a matter of much interest to the engineering faculty. This interest is twofold. In the first place it seems especially fitting that on this commission, which has to do so largely with engineering matters, one or more members should be engineers. That this fact is recognized in the appointment of Mr. Alexander is, of course, gratifying to all engineers. In addition to this, however, the faculty is especially pleased to see an engineer appointed who is not only an alumnus of this college, but who is so well known among his friends for his engineering ability and soundness of judgment. Engineers are proverbially modest, and partly, we think, for that reason have not taken as much part in public affairs as their training and experience would warrant. Recent appointments of engineers to public utility commissions and as city managers is an indication of public recognition which should be welcome on the part of all.

F. E. Turneaure,
*Dean, College of Mechanics and Engineering.*

* * *

It is not often that an article written by an engineer for engineers in an engineering publication aims as high as does Mr. Elmendorf's article in this number of the Wisconsin Engineer. To say that it is not only good reading but also good literature may kill your desire to read the article at all. Mr. Elmendorf does not want you to read his article, he would far rather that you pass over it. He kindly warns you to look before you leap, but he has treats in store for those who leap that make you mightily glad before you finish that you did take the chance. We should like to tell you what it is all about and save you the necessity of answering the few pertinent questions which are asked,—but here we are spoiling the whole thing!

* * *

More skyrockets ascend every day here on our campus than the average good sized city can boast of for her Fourth of July Celebration. We skyrocket everything that catches our passing fancy. We skyrocket a man if he is late to class; we skyrocket the stray photographer peering at the horizon from under his black cloth. The dog going across the campus, the instructor with an armful of bluebooks, the annual joke in the lecture, a loud necktie, the convocation speaker and the speaker before the Pincushion Club, the football captain and the cowering frosh rolling peanuts with his nose, all these fall in the same category apparently and all get a lusty-lunged skyrocket. Fortunately most of them are spontaneous, for there would otherwise be no excuse for such indiscrimination.

But there is really no excuse for the indiscriminate skyrockets that we engineers are in the habit of shooting off from our vantage point on the front steps of Engineering Building. Between classes everything appeals to us as worthy of a rocket. The otherwise very common matter of fussing seems to us the most grieveous sin in college ethics as we watch the couples trail up and down the hill. A green veil is the funniest thing on the campus, seen from this point, especially if we know its wearer is fully expecting a skyrocket for her benefit. We skyrocket a combination of red hat, blue veil, green coat, yellow-uppered shoes, and girl, and then file into the auditorium and repeat the same greeting to Professor Youknowwho of the University of Noname, who is to speak to us on the matter of the Relation of the Invention of Calculus to the Inquisition. And we do it with straight faces!

It can hardly be possible that we mean the same thing, and yet what else could Professor Youknowwho infer, if he had heard the first skyrocket mentioned before ascending the platform. We are just plain thoughtless, that is all. We do not think of the vagaries of our rockets, or the humor in our selection of their recipients. We do not stop to think that perhaps we are being boorish in our own glee at some one else's expense. We do not believe that an engineer must be ungentlemanly. And we certainly need to be more careful in our conduct on those front steps. It is all right to be funny, but not at some one's else expense. Discriminate in our skyrockets there and we will gradually return to the original condition of things, where the rocket meant real appreciation of real worth, and not a passing spontaneity of mirth or enthusiasm.

# CAMPUS NOTES

Introducing Mr. George (Happy) Booth. Mr. Booth, Our Readers. Readers, Mr. Booth. If you can not understand the change in the tone of these pages any other way, look at the nickname of their new editor. *Now for Happy.*

* * *

Did you rush up the hill when you heard that the fire was in the Engineering Building? So did we. Nothing like exercise after eating. When we saw that it was the steam lab. we were so fearful of missing a class that we wanted to help the firemen. All we got was a faceful of the chemical and a regular Pantorium cleaning for our clothes. Anyway it was a little diversion, but it set our nerves so much on edge that we didn't get to sleep until that one-thirty was nearly half over.

* * *

The only damage from the fire that we could find was the loss of one set of lockers. Were you one of the late ones who is still looking for a place to put his overalls?

* * *

When it comes to producing smoke and sparks, a fire can not compete with some of these Juniors in the dynamo lab.

* * *

We suggest that the Hydraulics department construct an open flume from the new reservoir to the lake and thereby provide us with a *regular* toboggan slide.

* * *

A flash of real genius: A freshman suggests that the potential energy of the hill studes be utilized by lowering them on a sort of tread-mill, the power to be tapped off at the Engineering Building and used to run an elevator up to the drawing classes on the fourth floor.

* * *

Signs of spring: The meetings of the Loungers' Club are again being held in front of main hall and are being greeted with increasing attendance. Isn't it about time to stir up those Law studes with a real skyrocket?

The Sunday night meetings in Music Hall have enjoyed continued success and are with us to stay. Engineers, here is an opportunity to acquire some of that broader culture which will be so essential to your future success. The meetings have been so timed that they interfere with nothing at all. These are not meetings to be passed over lightly.

* * *

Mr. Goodenough, Professor of Thermodynamics at the University of Illinois, spoke in the auditorium on Friday, Feb. 19. He outlined the development of the steam tables in a clear and comprehensive manner. The explanation of the work of his own department at Illinois was of especial interest His genial smile and his allusion to athletics won the audience at the very start; he held its interest so intensely that it followed him, not through the expected labyrinth, but through a meadow clear as day. Suspension of classes gave every one an opportunity to enjoy the treat, and it is needless to say that no one failed to avail himself of it.

* * *

If Prof. Goodenough knows athletics as well as he knows thermo, is it any wonder that Illinois is winning every championship in the conference?

* * *

With the arrival of warm days, Lake Ehler is coming to its own again. Warm days also suggest baseball. Are we going to have another trophy to hang in the libe? Now is the time to decide.

* * *

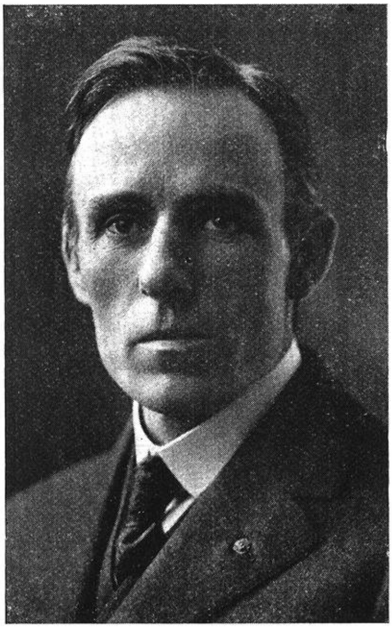
I ask you, is the product of a milliampere and a millivolt equal to a milliwatt?

* * *

Did you attend the meetings of the Engineering Society of Wisconsin? It was an opportunity to rub elbows with the men who are actually out on the jobs. This phase of the opportunity at such meetings is even more important than the valuable technical information that may be acquired. Let's not miss the next chance.

## SUCCESSFUL WISCONSIN ENGINEERS

WALTER ALEXANDER, m. '97, M. E. '98.



The recent appointment by Governor Philipp of Mr. Walter Alexander as a member of the Railroad Commission of Wisconsin and his confirmation by the Senate gave great pleasure to his innumerable friends.

Mr. Alexander was born in Glasgow, Scotland, Jan. 22, 1872, but before he was one year old the family came to Milwaukee, which, with the exception of a few years, has been his home ever since. He learned the machinist's trade in the Milwaukee shops of the C., M. & St. P. Railway, working in the shops for six years until 1893, when he entered the Mechanical Engineering course in the University of Wisconsin.

Those who knew him during his college course will remember his wide interest in student activities, and also that he could do all these things and still keep his college work up to a high standard. He played football four years on the Varsity team and was one of Wisconsin's great tackles. He also rowed in the Varsity boat two years, being captain of the crew in '96. This year was a high water mark in rowing, for that year we won two races, Yale Freshmen and Minnesota Boat Club, a 1,000 per cent. average. Among other student enterprises, he was a charter member of the U. W. Engineers' Club and Tau Beta Pi, and was president of the Co-op. He has kept up his interest in athletic matters, being at the present time chairman of the Alumni Athletic Committee.

After graduation from the university, Mr. Alexander was a member of the instructional staff of the College of Engineering. Departments then were not so sharply defined as now, and he gave instruction in mechanical drawing, descriptive geometry, steam engineering, and machine design. After leaving Wisconsin he taught one year at Armour Institute, and the following year, 1901–2, at the University of Missouri. In 1902 a determined effort was made to persuade him to come back with us but he preferred railroading and went to Minneapolis as assistant division master mechanic of the C., M. & St. P. Railway, remaining there for two years, when he was transferred to Milwaukee, where for the past five years he has been division master mechanic.

Mr. Alexander is a thorough railroad man, and brings into the work of the Railroad Commission a highly practical training in the Mechanical Engineering side of railway operation, a side which is in many respects, nearest to the public. This same mechanical engineering experience is applicable in the other utilities work of the commission.

It is this training coupled with Walter Alexander's absolute sense of justice and fair play, known to every one who ever had any dealings with him, that makes his appointment so admirable.

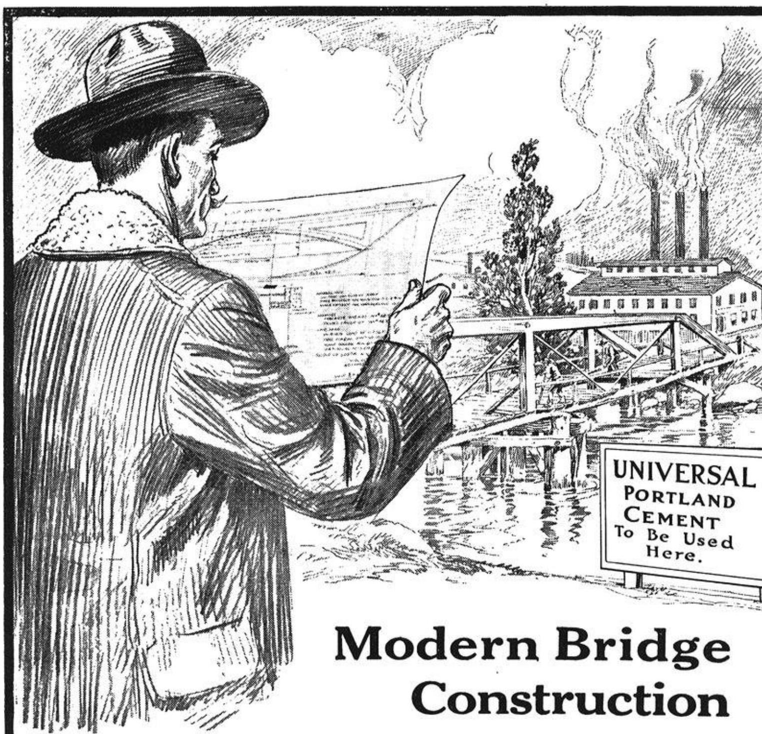
J. G. D. MACK.

* * *

## ALUMNI NOTES

Mr. E. K. Morgan, m '13, was married on the 26th of December to Miss Florence Wurtz, of Rockford, Ill. Mr. and Mrs. Morgan are at home at 707 N. Church St., Rockford. Mr. Morgan is one of the more successful of the younger alumni, now holding the position of superintendent of the Rockford Drilling Machine Company.

We are pleased to report the marriage on February 27 of another of our graduates, Mr. Clarence Nathan Johnson. The lucky woman was Miss Olivia Monona Goldenberger of this city. Since graduation from the course in electrical engineering in 1909, Mr. Johnson has been connected with the Westinghouse Company at Pittsburg. The couple will make their new home at 811 Swissdale St., Wilkinsburg, Pa.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