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The Wisconsin Engineer

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VOLUME XXXIII NUMBER IV

AN UNFREQUENTED NOOK ON THE CAMPUS

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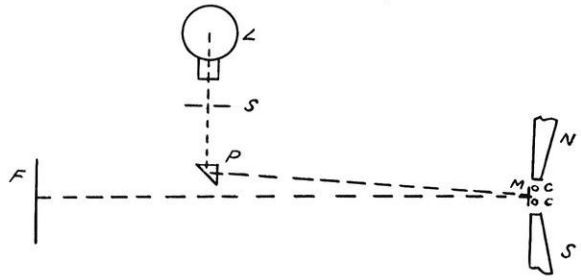

Plan View of the Elements of the Oscillograph.

The Oscillograph

An Engineering Tool

By EDGAR D. LILJA, e'27, *Barber-Colman Company*

THE OSCILLOGRAPH is one of the most useful of our present day engineering tools, and for this reason an article describing a few of the many uses to which the oscillograph has been put in the past may be of interest.

It might be well to review the general principles underlying the operation of the oscillograph so as to clarify the article. The figure at the top shows, in plan view, the elements of the oscillograph which has been most popular for general tests in this country. (There are other types, such as the cathode ray, the electrostatic, and the single reed oscillographs). N-S are the poles of a powerful magnet. c-c are the two cross sections of a relatively long, narrow, rectangular coil, the middle of which lies directly in the path of the magnetic flux between N-S. M is a small mirror, which is cemented onto the two coil sides at the middle of the coil. L is a source of light, usualy an arc lamp. S is a magnetically controlled shutter. P is a prism which directs light from L onto M. F is a light sensitive film which is moved vertically (toward the reader, in this view) at uniform speed. (Details of the instrument are purposely omitted to shorten the description). Light striking the mirror M is reflected onto the film F. The dotted line shows the light path.

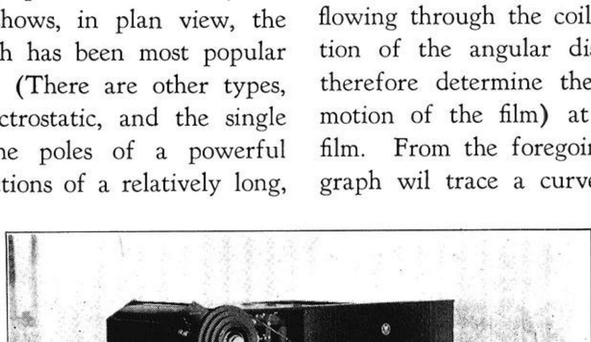

FIG. 1: Multi-Element Oscillograph.

From our study of the electrodynamic theory we know that the passage of current through the coil c-c will result in a reaction between the magnetic field of the exciting magnet N-S and the coil. One of the coil sides will be elastically displaced toward and the other away from the film F. This results in the mirror M assuming a different angular position than it does with no current flowing. The magnitude and direction of the current flowing through the coil determines the amount and direction of the angular displacement. These two quantities therefore determine the position (at right angles to the motion of the film) at which the light beam strikes the film. From the foregoing it may be seen that the oscillograph wil trace a curve whose scale of abscissae depends on the rate at which the film moves, and whose ordinates are a function of the current flowing through the coil. When it is desired to know the time scale more accurately than it can be obtained by reading the film drum speed with a tachometer, one coil is connected across an alternating current source of known frequency. The distance between successive peaks on the curve traced by this element will then correspond to a time in seconds equal to one divided by the frequency. Ordinarily the oscillograph contains three coils and mirrors so as to permit the recording of three currents simultaneously.

Often it is desired to know the relation between the voltage impressed on a circuit and the currents flowing in its various parts. By placing a resistance in series with one element (as the individual coils in the oscillograph are called) this element may be connected as a voltmeter and used to graph the voltage. The current in the coil will at all times be equal to the voltage across the coil circuit divided by the sum of the coil and series resistances. The object of the series resistance is to protect the coil against

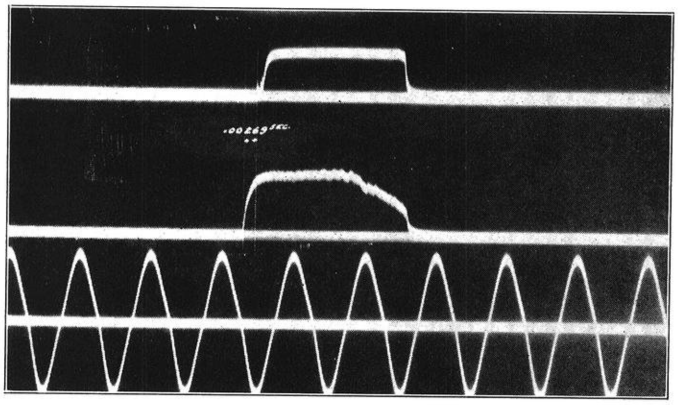

FIG. 2: OSCILLOGRAM SHOWING THE TIME REQUIRED FOR A RELAY TO CLOSE.
The upper curve was traced by an element connected in series with a D. C. circuit which the relay contacts closed. The middle curve shows the current through the relay coil and, incidentally, the time at which the relay coil circuit was closed. The lower curve is a 60 cycle timing wave.

excessive currents, which might burn the coil out. The currents in various parts of the circuit may be recorded by passing them directly through the other elements, or, if the currents are too high, by placing shunts (resistances of relatively low value) in parallel with the elements so as to pass only a part of the current through them. For alternating current tests, not involving transient phenomena, potential and current transformers may be used in place of the protective resistances and shunts. Often, in high voltage work, it is desirable to use such transformers, owing to the fact that they insulate the oscillograph from the high voltages.

The voltage element may be calibrated by impressing a known D. C. voltage across its circuit (which includes the protective resistance) and observing the deflection of the light beam from its zero voltage position. This observation is readily made by removing the drum which carries the film and sliding a ground glass screen in its place. For most purposes it is sufficient to assume that the ratio of deflection to voltage is the same over the entire range as at the single calibration point. For very accurate work it is necessary to obtain a calibration curve showing the relation between deflection and voltage, since the relation is not strictly linear. The current elements may be calibrated in the same manner, by passing known direct currents through their shunts, and observing the deflections produced. It is obvious that the three elements might be used to record three voltages, three currents, or two voltages and one current, as desired.

In one of the automatic hydroelectric plants in northeastern Wisconsin, it was desired to know the time required for various operations to take place upon tripping one of the controls. Two of the operations manifested themselves in electrical disturbances and were readily recorded by the means mentioned in the previous paragraph. The third was a strictly mechanical operation; namely, the automatic closing of the turbine gates. It would have been difficult, although not impossible, to place the oscillograph in the turbine pit and arrange a system of reflecting prisms for carrying a light beam to and from a control member. The problem was solved in an expeditious manner by linking the gate control with a rheostat arm. The rheostat was placed in series with the third oscillograph element across a D. C. control circuit. The current through the element and the deflection of its light beam were accordingly a function of the rheostat setting, and therefore, of the gate opening. This arrangement permitted the oscillograph to be set up in a convenient place (only the rheostat being placed in the pit). An excellent record of all quantities was obtained.

The automobile industry recently put the oscillograph to use in determining the cause of engine knock. A number of small carbon discs were stacked up in a tube so as to form what is called a carbon pack resistance. (The resistance of such a pack depends on the pressure exerted between the discs). By screwing the tube into a hole in the cylinder under test and making electrical connections to the end discs, a pressure indicator of high natural period was obtained. The carbon pack was connected in series with one element of an oscillograph and this circuit was connected across a D. C. supply line as for the gate opening test mentioned above. The current, and therefore the deflection of the light beam on the oscillograph film, was a function of the pressure exerted by the expanding gases on the discs in the tube, increasing with increasing pressure, and vice versa. Because of the slight movement required and the low moment of inertia of the moving parts, it was possible to obtain a record of high frequency

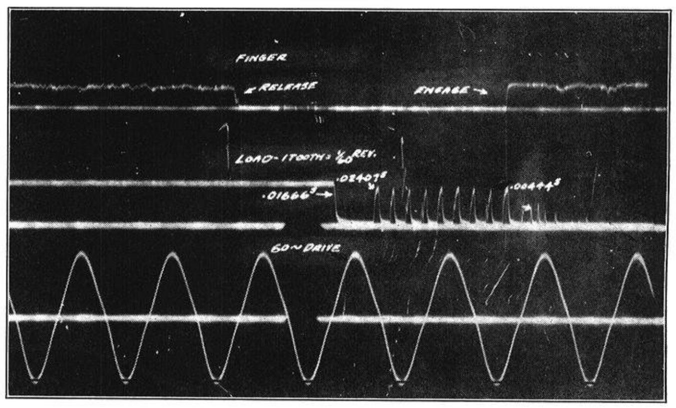

FIG. 3: OSCILLOGRAM SHOWING THE CONTROL OF A HIGH INERTIA LOAD BY A FRICTION CLUTCH.
The middle curve was traced by an element connected in series with a ratchet wheel contactor rigidly connected to the load. The contactor was so adjusted as to make contact when the load was stationary. The space between any two peaks in this curve represents the time required for the load to move through the angle included between the corresponding two ratchet teeth. The upper curve was traced by an element in series with a contact controlled by the clutch tripping mechanism. The lower curve was traced by an element across the motor supply line and therefore serves to show the motor supply voltage as well as the film speed.

pressure waves which the standard indicator would have missed entirely due to its inherent sluggishness.

The oscillograph is often used in the analysis of complex waves. An example is the study of noise. Often it is

(Continued on page 152)

Beyond the Campus

Article by J. D. LEVIN, c'27*
Illustrations by R. R. SMITH, m'28**

TO the senior in the last year of his engineering course the world beyond the campus looms as a magic touchstone, dwarfing in comparison all that has gone before, and bringing out in strong relief the problems which must be faced after commencement.

In the role of a guide, rather than a preceptor, I shall point out a few of the problems and situations which confront the young engineer as he bridges the gap between the campus and the world beyond. The observations in this article, while based primarily upon conditions within the construction industry, are readily applicable to other fields of engineering.

The outstanding difference between the college curriculum and that of the world outside is in the degree of responsibility carried. Some thrive with responsibility; others shirk it. Yet no measure of success was ever attained without responsibility. It is almost axiomatic that the responsibility a young engineer is capable of carrying is in direct proportion to the confidence he develops in doing under rigorous field conditions what he has learned to do in college under ideal conditions. A necessary corollary to the preceding statement, however, is that the capacity for responsibility is dependent in no small degree upon common sense and judgment. Let us test the significance of this paragraph in a concrete illustration.

When our present building project, the construction of an 11-story cold storage plant at a cost of about three million dollars, was begun in Chicago, I was confronted with the problem of establishing a property line upon a shifting railroad retaining wall. Of course, I had run traverses through the pines near Lake Mendota and closed within the allowable error. At Devils Lake, too, I had surveyed in what an unseasoned sophomore thought was pretty tough country. Yet when it came to establishing property lines in the city of Chicago, I sensed the responsibility in the job. Every time the Baltimore & Ohio railway's Capitol Limited thundered by with tandem locomotives on its daily trip to the nation's capital, or the Great Western's Legionnaire swept by with a long train of dusty cars, several thousand tons of masonry retaining wall moved in a fraction of an inch closer to the interior of the lot. Until the retaining wall had finally been braced by the beams and struts of two stories of reinforced concrete structure, so that even Paul Bunyan and his fifty-seven henchmen could not have budged the wall, that north property line had to be established and reestablished more than a dozen times. Were the property line established within the lot, the owners would have less than their due; were it outside the lot, the owners would be liable to future law suits for encroachment upon the property of others.

Closely related to the subject of responsibility is that of accuracy in construction. Accuracy has been defined as

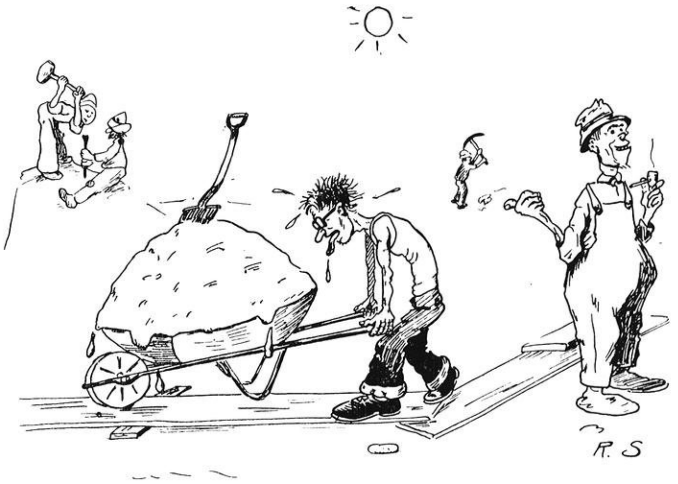

FIG. 1: Summer Vacation Work in Chosen Fields.

"the obtainment of results without blunders or mistakes within the limit of precision of the methods or instruments employed". In this day of keen competition every wide-awake contractor demands of his men that they do their work accurately the *first* time they do it -- not the second or third time -- for the correction of blunders is a costly luxury which the contractor can ill afford. Since the majority of large building operations are carried on with a time limit for completion specified, it is doubly important that the work be done with accuracy and dispatch if there is to be a profit at the end of the job. Let there be no hidden bones about it; the contractor is in the business of construction to make money, not to lose it!

As an individual who is interested in seeing that the work is carried on expeditiously, the engineer must know what the allowable error is in the various construction operations. Obviously, it shows lack of judgment on the part of a young engineer to insist that concrete column forms be set to a sixteenth of an inch, when under ordinary conditions the concrete cannot be poured more accurately than to an eighth or even quarter of an inch. On the other hand, baseplates and bolts for steel columns should be set as accurately as possible if the fabricated members are to fit. Although judgment is tempered by theory and

*Wells Brothers Construction Co., Chicago.

**International Harvester Co., Chicago.

perfected through practical experience, the capacity for it must be inherent in the young engineer.

Besides the capacity for responsibility and a modicum of common sense, the young engineer is expected to bring a knowledge of fundamental construction methods to the contracting organization which employs him. Take it from

FIG. 2: The Construction Worker is a Type.

one who has begun to sharpen his wisdom teeth: rubbing elbows with the practical men in the field, supplemented of course by home study, is the shortest road to learning the details of construction procedure. Knowledge of construction machinery and rigging, construction plant layout, design of formwork and temporary structures on the job, organization of men so that work will proceed smoothly and efficiently, practical details of excavation, foundation and caisson work, bricklaying, reinforcing, concreting, -- these are only a few of the manifold divisions of the building craft which can be acquired only through a thorough apprenticeship in practical construction work. Spending your summer vacations working in your chosen fields will yield rich dividends in experience and self-confidence. Pushing concrete buggies, digging muck, laboring with reinforcing steel, helping carpenters -- any of these methods of breaking into the game is advisable in order to impress upon the novice a respect for physical labor under exacting field conditions, and to instill in him an understanding of the feelings and the problems of the unskilled laborer in construction. Besides grounding the young engineer in the fundamentals of labor psychology and management -- a valuable asset in his later work as foreman, inspector, engineer, or superintendent -- the practical experience obtained during summer vacations will mean much in the winning of the first job. Remember that your prospective employer is interested not in how many credits or honors you have amassed, but in what you can do for him.

Bearing in mind that the business world is inexorable and selfish (despite the attempt of some to dodge the issue), and expends nothing except for value received, you have the key to the situation which accompanies the landing of a job. You must *sell* yourself to your prospective employer as you would any other commodity. Your scholarship at college, your varied interests and extra-curricular activities are of importance in getting your first job insofar as they answer the question of your would-be employer, "What can you do for me? In what way would you fit in my present organization?" Bluntly stated, his query is, "How can you bring dollars and cents into the company's coffers?" That question each of us must answer for himself and in the manner he thinks best.

It is the belief of those in the construction game, that a first hand acquaintance with the major building crafts is necessary for ultimate success in the work. A friend of mine who is a member of a well-known firm of architects in Chicago told me the other day that his work as a construction carpenter for over a year following his graduation gave him a more thorough knowledge of the details of formwork and building construction than he could have acquired in any other manner. That training, by the way, is bearing rich dividends to an engineer who, ten years out of college, knows the building game from A to Z. Incidentally, my own work as a carpenter for a period of six months following graduation supplied a strong selling point in landing my present position. Although the engineer is not expected to handle a trowel with the skill of a mason, or a saw with the swing of a carpenter, he must know what differentiates good brickwork from poor; he must know whether the formwork in question will satisfactorily serve the purpose for which it is intended, or whether it is faulty; and similarly with other building crafts, the construction engineer must be able to distinguish between good and bad practice.

More important than the methods and machinery of construction is the vast army of workers from which the members of the building crafts are recruited; for, of what earthly good are all the methods and ideas in the world

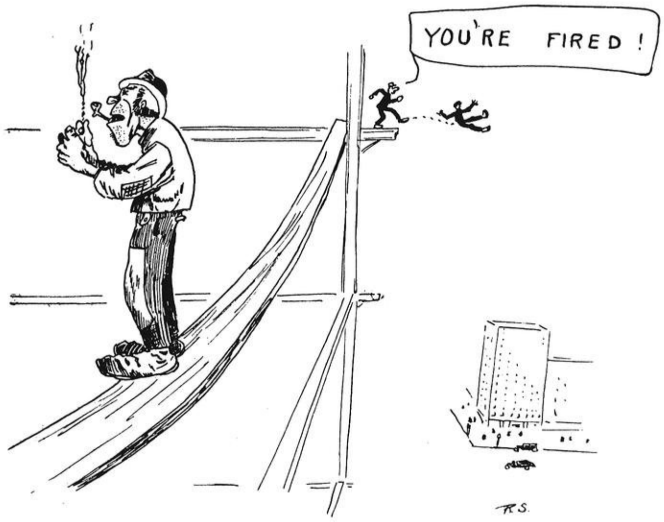

FIG. 3: Working on Springy Planks Many Stories High Becomes Commonplace.

if the man-power is not there to make tangible those ideas? Despite the fact that most of the engineer's relations are with men, very little has been taught him regarding the human element with whom he must work in hand.

Just as soon as the young engineer begins to realize that, like his cousin the lumberjack, the average construction worker is a rough and noisy, but withal good-

(Continued on page 148)

Municipal Ownership *and the* Cost *of* Electric Energy*

A Dialogue Between A Citizen And An Engineer

By EDWARD BENNETT, *Professor of Electrical Engineering*

COMPARISON OF GENERATION FROM WATER POWER AND FROM COAL

Cit. Will you compare the figures you gave for the costs of generating energy from coal and from water power?

Eng. The representative cost of generating electric energy in a modern steam plant was given as 0.8 cents per kilowatt-hour, and of generating by water power on the undeveloped midwestern rivers was given as 0.6 cent, a saving by water power of 0.2 of a cent (1/5 of a cent) per kilowatt-hour. You should bear in mind that such a saving can be realized only by operating the water power station in conjunction with a steam station which can carry the system load at time of low water.

Cit. How much would a reduction of 1/5 of a cent per kilowatt-hour in the cost of generation, lower the electric bill of the average household?

Eng. 8 cents per month, — one street car fare per month.

Cit. Is a power company which owns a water power, or which, under the Federal Water Power Act, acquires a license to develop a water power, able to "hold up" the public by charging prices which yield excessive profits?

Eng. You can draw your own conclusions after considering the facts in the case.

One fact to bear in mind is that energy generated in water power plants is in competition with energy generated in steam plants and only in the case of the more favorably located water power plants is there a striking difference between the cost of generation by the two methods.

The second thing to consider is the conditions under which a company can obtain a license to build a power plant upon a navigable stream or upon the public lands. Among other conditions the Federal Water Power Act specifically provides,

a. that net investment is to be the basis of rates, issue of securities, and recapture price by the state;

b. that profits in excess of a reasonable return on net investment must go to the public either in the form of a partial reduction of the net investment, or in the form of an annual rent paid to the U. S.;

c. that the licensee must submit to state regulation of his rates, service, and security issues under penalty of forfeiture of the Federal license.

d. that licenses shall be issued for a period not exceeding 50 years, at the end of which period the U. S. may renew the license, or it may take over the project upon payment to the licensee of his actual net investment, or upon like payment it may grant the license to a new licensee. In the granting to a new licensee, states and municipalities are to be given preference.

Cit. I am amazed to learn of these provisions of the water power law. From the speeches of many of the candidiates for public office, I have been led to believe that immense power monopolies are obtaining absolute control of the water power resources and are possessed of the power to charge any price for energy which the market will bear.

FIG. 1: An Electric Ironer costs ½ as much as a Ford.

Eng. There is no foundation for these notions. Under the provisions of the Federal Water Power Act, the public would seem to be as effectively guarded against exploitation as it would be under state development of the water powers.

Cit. Why do water power sites remain undeveloped?

Eng. Because under existing conditions, in competition with steam generated energy, it is not profitable to develop them.

Cit. Should not the development of idle water powers be encouraged?

Eng. Yes, but primarily with the idea of conserving the coal resources for our children's children 10 generations or more removed, and not with the expectation of materially affecting the cost of energy delivered to the residential consumers of the present generation.

*EDITOR'S NOTE: This concludes the article on Municipal Ownership of Public Utilities. The first installment appeared in the December, 1928, issue.

COST OF TRANSMITTING ELECTRIC ENERGY FROM THE GENERATING STATIONS OVER THE HIGH VOLTAGE LINES TO THE SUBSTATIONS IN THE CITIES AND VILLAGES

Cit. Is the cost of transmitting energy from the generating stations to the substations a large item in the cost of supplying energy?

Eng. In a system supplying many small cities and villages, the cost of transmitting the energy to the cities and villages may equal or exceed the cost of generating it.

FIG. 2: Neither Dealer nor Customer can distinguish a a good appliance from a poor one.

Cit. In such a system, how much may the transmission costs amount to for each kilowatt-hour of energy sold?

Eng. From .5 to 2.0 cents per kilowatt-hour.

Cit. Can you give me the relative amounts of money invested in transmission lines as compared with generating stations?

Eng. No, but it may help to compare the amounts spent during the two year period 1926 and 1927 by the electric light and power industry of the U. S. for the building of generating stations with the amounts spent in building transmission and distributing systems.

For generating stations	$470,000,000
For transmission lines and substations	530,000,000
For the distribution system	454,000,000

In other words, the money invested in the past two years in providing additional transmission and distribution facilities was more than twice as great as that expended in adding generating capacity.

Cit. It seems to me that the cost of transmitting energy by the intangible electric over high voltage lines ought to be much less than the cost of sending energy by rail in the form of the bulky coal.

Eng. On the contrary, the cost of transmitting a given amount of electric energy over high voltage lines from a generating station in the coal fields to a large city several hundred miles away exceeds the cost of shipping from the coal fields to the city, all the coal necessary to generate the same amount of electric energy.

COST OF DISTRIBUTING THE ENERGY FROM THE SUBSTATIONS TO THE RESIDENCES

Cit. Is there any loss of energy in transmitting and distributing it?

Eng. Yes, the power utilities of the U. S. generate 20 per cent more energy than they sell.

Cit. What becomes of this 20 per cent?

Eng. It is unavoidably lost as heat in transmitting and distributing the energy to the customers.

Cit. What bearing does this loss have on the cost of energy to the users?

Eng. It means that for every kilowatt-hour of energy used the customers must (on the average) pay for the generation of 1-1/5 kilowatt-hours.

Cit. How much money do the power companies have invested in the switching and regulating devices, the poles, lines, transformers, service wires, meters, etc., necessary to serve their residential customers?

Eng. From $40 to $80 for each residential customer, say $60 on the average.

Cit. How much will the fixed yearly charges against this investment amount to?

Eng. 7 per cent for interest and profit to security holders plus
2 per cent for taxes
5 per cent for depreciation, or a total of
14 per cent on the investment, or $8.40 per year per residential customer.

Cit. What will this fixed charge for distribution amount to per kilowatt hour?

Eng. Since the average yearly consumption of the residential customers is 429 kilowatt-hours, the fixed charge per kilowatt-hour will be $8.40 divided by 429 or 1.96 cents per kilowatt-hour; or more than twice the cost of generating the energy.

Cit. Is the cost of operating the distributing system which serves the residences an appreciable item?

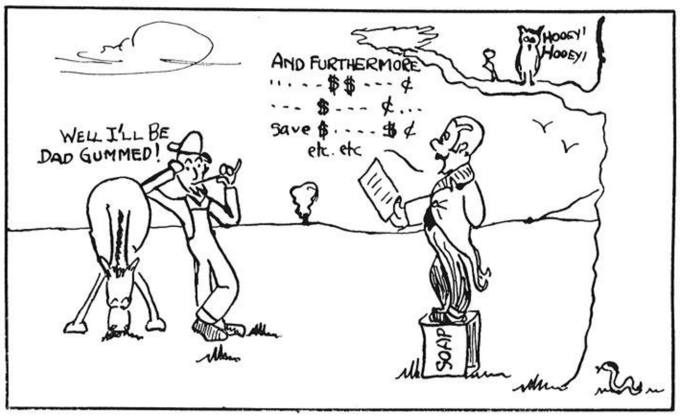

FIG. 3: From the speeches of many candidates for Public Office.

Eng. Well, consider only one item in the cost of operating and maintaining the distributing system, namely, the cost of reading and testing meters, billing, and collecting. This costs the company from $1.20 to $3.00, or say $1.80 per customer per year.

Cit. What does this amount to per kilowatt-hour for the residential customers?

Eng. Since the average residential customer takes 429 kilowatt hours, the cost of reading, billing, etc., is $1.80

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The Exponential Horn

By L. W. Morrison, e'30

THE development of the exponential horn in the last three years has marked a new era in the field of sound reproduction. Before Dr. J. Slepian and C. R. Hanna, of the Westinghouse Research Laboratories, announced their method of the design of horns for loud speakers or other reproducing instruments, the primary aim of the workers in this field was to design a horn which would give the bass notes their correct prominence. The modern exponential horn, besides realizing this, makes possible the radiation of large quantities of sound using a comparatively simple and small vibrating mechanism. With the present apparatus it is possible to reproduce a concert by Sousa's band with the original volume without overloading or distortion.

Contrary to the popular conception, the horn does not amplify, in the usual sense of the word. The horn is merely a sound radiator. The power of radiation of a horn is the same as the input power with the exception of the friction loss.

The best horn is the one which radiates the most uniformly over the entire range of audio frequencies. Of all the types of horns, the exponential is the most uniform radiator. By an exponential horn we mean a horn whose cross-sectional area doubles at equal intervals along the length. A horn whose cross-section doubles at smaller intrevals would be said to expand at a greater rate, than one whose area doubled at greater intervals.

This rate of expansion is an important factor in the design of a horn, for upon this rate of expansion depends the lowest frequency above which the horn is a uniform radiator. This "cut off" frequency, as it is called, is about 64 cycles per second for a horn whose area doubles every foot. If this horn expanded twice as rapidly, this limiting frequency would be 120 cycles per second. The horn with a cut off frequency of 64 cycles is the most desirable in most cases since the absence of, or the reduction of frequencies between 64 and 120 cycles per second, is very noticeable to the ear.

The problem of horn resonance now confronts us. If we make the mouth of the horn large enough to transmit the pressures, emanating from the horn, to the room without reflection, this horn reasonance is done away with. The length of the horn has been found, by experiment, to be of such dimensions that the diameter of the mouth of the horn is 1/4 of the wavelength of the lowest frequency in feet. For a horn with a cut off frequency of 64 cycles per second, the wavelength is the velocity of sound (1120 feet per second), divided by the frequency, or 1120/64 which equals 17.5 feet. The diameter of the horn should be 1/4 of 17.5 or about 4.5 feet. If we have a square horn, it should be about 4 feet by 4 feet.

FIG. 1: Exponential Horn on the Westinghouse Building in New York City. Signals from it Were Audible for Many Blocks Along Broadway.

Upon considering the coupling between the diaphram and the horn proper, we find that the area of this cavity is dependent upon: (1) the mass of the diaphram, (2) the area fo the diaphram and (3) the highest frequency at which the horn must radiate uniformly. Another great factor in the size of the coupling is the presence of what is called radiation pressure, when the frequency is greater than the lower cut off limit.

This radiation pressure has been found to vary as the square-root of the velocity of the air particles in the throat. With the decrease of area of the throat, the radiation pressure increases. Since a great radiation pressure is necessary to transmit the greatest share of the driving force to the medium, we can see that a small throat area is necessary.

To summarize, let us consider an exponential horn with a cut off frequency of 64 cycles per second. The throat area is 1/2 sq. in. and the mouth is 4 feet square or 2304 sq. in. in area. For an output of one watt of sound, it is necessary to have a displacement of 50 cu. in. per second at the throat. Along the length of the horn the displacement of air particles varies as the square-root of the area. Therefore at the mouth of the horn we have a displacement of 50 times the square-root of 4608, or 3400 cu. in. This means that at the mouth of the horn we are displacing approximately 70 times the amount of air that is being agitated at the throat. What we gain in displacement we lose in pressure so that the power value

(Continued on page 140)

Campus Notes

BAND NUMBERS MANY ENGINEERS

Thirty-five of the 195 men enrolled in the University combined bands are engineers, according to information received from Major Morphy's office. Statistics show that this percentage is practically equivalent to the ratio of total engineering enrollment to total male enrollment, and thus we arrive at the conclusion that engineers are as active as the hill students at least as far as this musical organization is concerned. The bands, this year, are divided into three groups, a purely concert band of 65 pieces, a football and pep band of 100 pieces, and a military band of 30 pieces. Of these 22 engineers are in the football and military bands and 13 are in the concert band.

The men are: C. J. Daniels, C. R. Stoelting, J. K. Colehauer, V. C. Mars, Kenneth Auhus, G. V. Archie, E. R. Kruke, Millard Hill, B. R. Kieweg, Wesley Klatt, M. H. Kirby, L. A. Dodge, Melvin Sterba, T. R. Moyle, Bruno Weishappel, H. Q. Martin, J. W. Zibell, D. E. Krause, B. M. Borrud, K. W. Voss, R. J. Altpeter, and R. L. Machael in the football and military bands; and J. E. Martin, F. K. Vilen, J. F. Haight, G. J. Harder, M. R. Schroeder, H. E. Rex, Gordon Brewer, A. M. Hove, E. A. Johnson, F. C. Ladwig, H. L. Stokes, B. R. Teare, and E. C. Brandt in the concert band.

FAMILY QUARREL

Mr. Molecule: "Pardon, but haven't we met before?"

Miss Electron (haughtily): "I don't know you from Atom."

NEW APPLICATION

Radio Nut: "Do you carry "B" eliminators?"

Clerk: "No, sir, but we have roach powder and some fly swatters."

The classes in Engineering English are continuing to take an awful beating in their bout with old man Vocabulary, as witness some of their recent attempts to define words:

Septic — pertaining to seepage.

Quay — wagon used for large objects.

Pylon — a Mexican boy.

Plebiscite — a rock formation.

Bucolic — relating to the bacteria B-coli.

Welkin — a bell.

Antipodes — apes.

Olfactory — factory for manufacture of ale.

Fluvial — flowery.

Forensics — ants and similar insects.

Malodorous — melody pleasing to the ear.

Posthumous — decaying.

BEHOLD A BOON TO MANKIND!

Prof. R. S. Owen announces that all contours have already been picked up and stored in the storehouse at Azimuth City. With the aid of his famous contour hound, Hodge, he did the work in remarkably short time. There is no longer any danger of anyone tripping on the contours and the bluffs are again open to tourists who need not fear of becoming tangled up in them.

Prof. Owen also purchased two cottages from the Kirkland Hotel which will be moved to the camp-site as soon as the civils arrive at Azimuth City next summer.

TAKE MUSIC 1 A

They laughed when I sat down at the piano. Some darn fool had removed the stool.

EIGHT ENGINEERS MAKE PHI KAPPA PHI

In the announcement of Phi Kappa Phi elections for the current school year, eight engineers were included.

Elections to this fraternity, a coveted honor, are based on both high scholarship and leadership in campus activities. This is the only campus honorary scholastic organization that elects both arts and technical students.

The men elected are: Wilfred W. Behm, Marvin Hersh, Gerald C. Ward, civils; Robert G. Garlock, Frederick A. Maxfield, Richard G. Jewell, electricals; Robert V. Brown and Harland E. Rex, mechanicals.

STEAM AND GAS LAB. MAKES IMPROVEMENTS

The 25 Horsepower Curtiss steam turbine in the team and Gas laboratory has recently undergone repairs and is now equipped with an entirely new rotor, this one having only two rows of moving blades whereas the old had three rows. The first row of blades on the old rotor had become badly eroded due to the high velocity steam passing over it since 1905 when it was installed. The old rotor was shipped back to the General Electric Co. for repairs. However, when the part arrived there, being one of the first rotors manufactured by them ,it was found that the blades had been milled directly into a solid disc of metal. Accordingly new blades could not be inserted and an entirely new rotor was manufactured having replaceable blades. The old rotor is now on exhibition as an example of the erosive effect of high velocity steam.

An electrical time stamp has also been installed recently. This machine automatically stamps the time, date, and year on reports turned in. It is unique in that it contains no clockwork. Its motive power is furnished by a synchronous motor running at

(Continued on page 142)

Alumni Notes

CHEMICALS

Beglinger, Richard T., ch'22, has changed his address from Pittsburgh to Caixa 3773, Sao Paulo, Brazil, S. America. He is a sales-engineer for the Allis-Chalmers Company of West Allis, Wis.

Kemnitz, Harold C., ch'26, was married to Alice M. Ziebarth of Madison on New Year's day. Mr. Kemnitz is chemical engineer for the Ruberoid Company at Joliet, Ill.

Kubista, W. R., ch'26, has left the employ of the Wisconsin Power and Light Company and is now working in Tulsa, Oklahoma.

Rabbe, John A., ch'26, has been transferred to the Atlanta, Ga., plant of the Proctor and Gamble Company.

MINERS

J. H. Warner, min'04, Consulting Mining Engineer, Denver, Colorado, returned on October fifteenth from examining a mining property about sixty-five miles from the City of Guadalajara, Jalisco, Mexico. This region in Mexico is at present infested by bands of rebels and bandits due to the political and religious disturbances, and American mining engineers find it quite unsafe to travel overland without a guard or convoy of Federal troops. These bandits seem to enjoy kidnapping mining engineers and holding them for ransoms varying from $2,500 to $10,000. Some eight or ten of these kidnappings have occurred in the past year. In June of last year the manager and superintendent of the property examined by Mr. Warner were captured and released only on ransom after twelve days captivity. Airplanes are used to some extent in the transportation of men and materials between mine and railroad station, though Mr. Warner's party found it necessary to go on horseback. He reports it was quite thrilling on this overland trip to find himself quartered in some catholic church edifice, these buildings now being generally used for sheltering Mexican Federal troops.

Davis, Ralph E., min'06, consulting engineer, has opened up an office in the Trinity Bldg., at 111 Broadway, New York.

Weiss, Harold C., min'27, is now inspecting engineer with the Reitan-Lerdahl Insurance Company of Madison. His marriage to Miss Helen Zeimet of Madison, was recently announced.

CIVILS

Ball, Walton C., c'11, is now chief draftsman for the Washington State Highway Department. His address is 903 San Francisco Ave., Olympia, Wash.

Bespalow, E. F., c'21, is supervising engineer of the Shearman Concrete Pipe Co., Jacksonville, Florida.

Boley, Charles U., c'83, was honored by a banquet arranged to celebrate the completion of forty years of service as city engineer of the city of Sheboygan, Wisconsin. Mr. Bolye is living at 514 Park Ave. of that city.

Case, J. Frank, c'90, is among the engineers who will be awarded honors at the meeting of the American Society of Civil Engineers which will be held in New York City on January 16-18. Mr. Case will receive what is known as the James Laurie prize for his paper on "The Ancient Roman Aqueduct at Athens." He has spent much of his life abroad in the interests of his profession.

Eriksen, Erik T., c'89, CE'90, associate engineer for the U. S. Bureau of Reclamation, for the past two years has been engaged with the construction of a dam across Stony Creek, about forty miles from Orland, Calif. **Savage, J. L.**, c'03, was the chief designing engineer.

Gelbach, Warren A., c'07, general building contractor of Chicago, has decided to devote all his efforts to plastering contracts closing out all other lines. At present Gelbach has a daughter, Dorothy F., who is enrolled as a freshman in the Letter and Science school at the University. His home address is 7444 Malvern Avenue, Chicago, Ill.

Halbert, Charles A., c'08, is State Chief Engineer of the Wisconsin Railroad Commission, Madison, Wis. He lives at 114 S. Allen St.

Jacobs, E. A., c'13, was the engineer for the concrete stadium at Brigham Young University.

Lacher, Walter S., c'07, is Managing Editor of Railway Engineering and Maintenance, with editorial offices at Chicago. His home address is 440 N. Spring Ave., La Grange, Ill.

Ludberg, A. P., c'11, C.E.'23, who was formerly Associate Professor of Civil Engineering at the University of Idaho, has changed his address from 256 Ellsworth St. to 455 Roosevelt St., Gary, Ind.

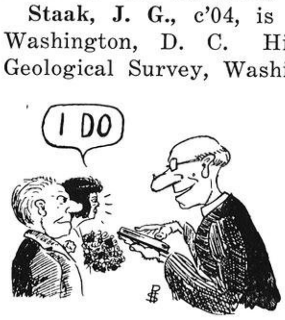
MacLeish, K. C., c'25, is installing the water wheels for the plant which is being constructed at Necedah by the Wisconsin Power and Light Company. He was married to Miss Dorothy Olson at Wausau, August 25. Mr. and Mrs. MacLeish spent their honeymoon in Canada.

Price, J. R., c'21, is now located at 858 North Cambridge Avenue, Milwaukee, Wisconsin.

Shore, Franklin K., ex'25, has recently been granted his BS degree in civil engineering as of the class of '28. Since leaving school, he has been engaged in structural design, most of the time with the firm of Purdy & Henderson (**Purdy**, c'85) of New York. He has been active in Chinese affairs and, as a side issue, has taken voice and piano training. He plans to return to China in a short time.

Smith, Leonard S., c'90, C.E.'95, who is engineering a new project in Southern California, gives his present address as 462 Speedway Drive, Beverly Hills, California.

Staak, J. G., c'04, is now living at 1520 Webster St., Washington, D. C. His address was formerly U. S. Geological Survey, Washington, D. C.



Thiel, Walter C., c'22, assistant efficiency engineer of the bureau of budget and efficiency of the city of Los Angeles, Calif., was married to Miss Selina Marty, L & S'26, at Monticello, Wis., on September 29. Mr. and Mrs. Thiel were in Madison for the Notre Dame game. They motored to their home at 1006½ Mariposa Ave., Los Angeles, where

(Continued on page 140)

Editorials

ENGINEERS IN CAMPUS POLITICS No such unified support as that shown by the engineering school in the last two student elections has been noted on our campus for years. Today in political camps, real regard for the strength of the engineers votes is evidenced by coalitions and concessions in their favor.

In the fall elections, sixty percent of the Junior Engineers voted, which is about twice as much as the general average for the class. In the elections last spring, the same ratio of votes was noted, especially in those offices in which engineers were competitors. Previously it was uncommon if more than ten percent voted. The engineers, it seems, are suddenly emerging from the apathetic state which has characterized them on the campus for so long. Now once awakened to the realization that they can have a very definite power in student government, it would not be surprising to see capable engineering students in many offices.

Yet we must be discriminating in our choice and not let simple prejudices keep us from supporting a capable non-engineer or be exploited by just any office seeker whose sole claim to distinction lies in his being an engineer.

FOUR MARKS OF A FINE MIND A good mechanic studies the tools of his trade continuously and critically. The better he knows his tools, the better he can use them. He knows that good craftsmanship is impossible unless he keeps his tools adjusted to his tasks.

President Glenn Frank has said that our brain is, of course, the major tool we bring to the task of living. Like good mechanics, we profit from keeping our brains under continuous and critical study. As a sort of primer to guide us in such a study of our own minds, I suggest that a first-class mind bears these four marks:

First, *humility*. A first-class mind is never cocksure; it is always willing to admit that it may be wrong; it is never afraid to say that it does not know; it does not specialize in closed questions; all questions are open questions to it; it is always ready, in the presence of new knowledge or fresh challenges, to question the soundness of its earlier observations and the sanity of its earlier conclusions.

Second, *curiosity*. A first-class mind is never satisfied with surface observations; when, in its humility, it has admitted that there is a question to be considered, it turns a restless and ruthless curiosity on the question; it is never satisfied with a sweeping judgment; it ferrets out every detail and tries to see just what bearing each detail has on the whole question.

Third, *courage*. A first-class mind is marked by a subtle blending of courage and imagination, the result of which is that it takes the results of its analysis of a problem it has worked over and puts these results into various new combinations in an effort to find some new and better theory for action; it is willing to follow a new idea, even if it upsets former notions and former ways of doing things.

Fourth, *responsibility*. A first-class mind has a sense of responsibility in handling its new theories; it puts them through all sorts of tests to prove both their logical soundness and their practical utility.

The practical fruits of the intellectual virtues are obvious; Humility makes for open-mindedness. Curiosity makes for careful analysis. Courage makes for creativeness in blazing new trails. Responsibility makes for reliability in action.

A SMALL GIANT A penny is an insignificant little thing, seeming to have about as much power as a half-grown gnat. Usually the penny isn't much good in this day of dollars and dimes unless it has company — a lot of company.

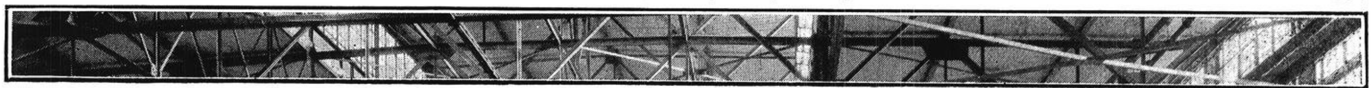
The federal bureau of standards has just proved, however, that the penny is a little giant. According to its purchasing power in the field of electricity, here are some of the things a penny can do: It will heat a six-pound flat iron approximately 50 minutes. It can run a vacuum cleaner approximately 40 minutes. It can heat a waffle iron long enough to cook six waffles. It can heat a toaster long enough to toast 16 slices of bread. It can brew five cups of coffee in a percolator. It can heat a curling iron once a day for three weeks.

The above figures convince one that it is worthwhile to save the pennies.

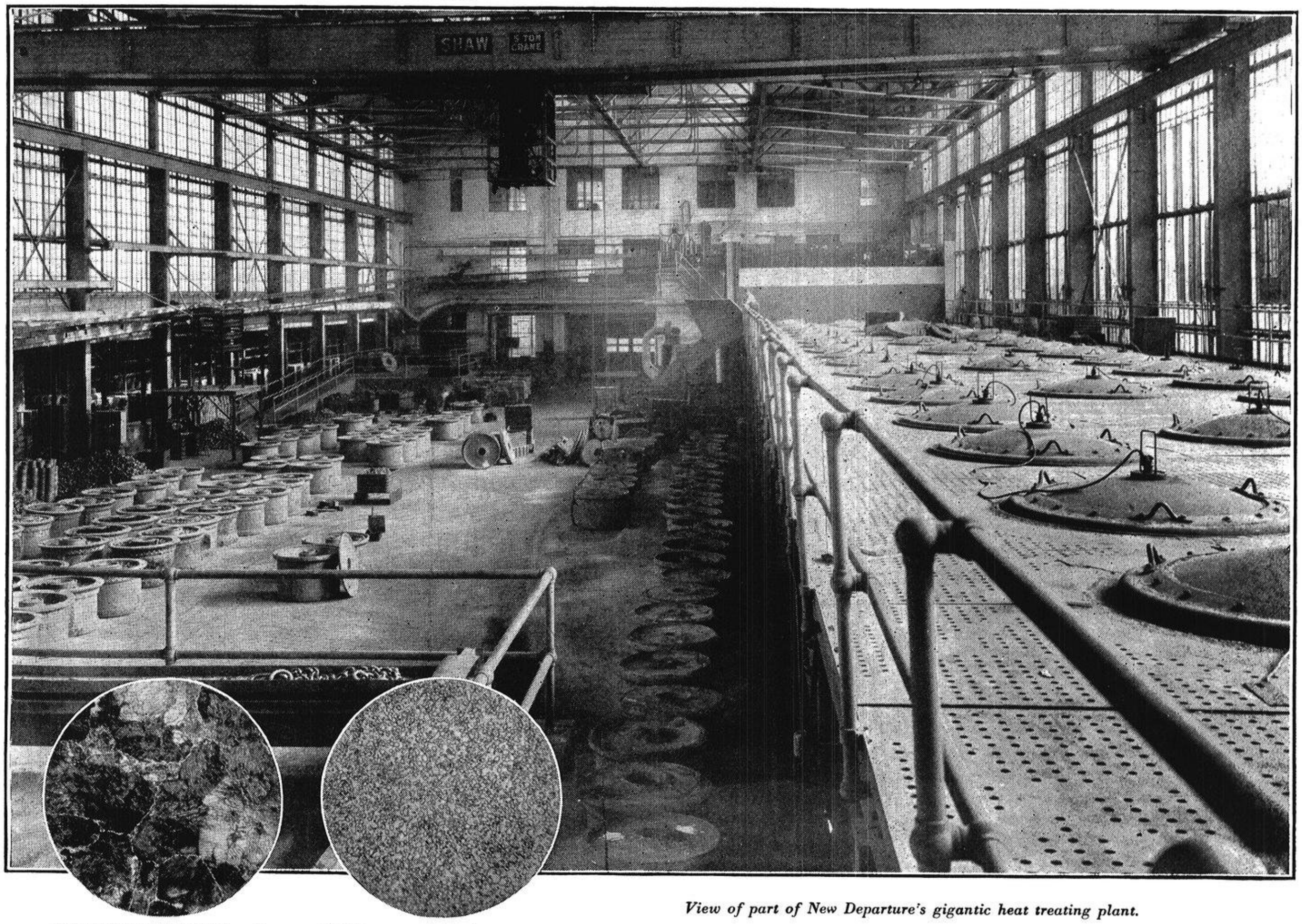
DO YOU READ THE CURRENT MAGAZINES? An unusual opportunity, and one that should not be heedlessly neglected by the undergraduate, is the shelf of technical magazines in the Engineering Library.

A total of two-hundred and forty publications containing all that is important in modern engineering is at the disposal of every student. Not only is there a large representation of American achievements and discoveries but also there are periodicals from Canada, England, France, Germany, and other foreign nations, covering a variety of fields from aviation to mining, and with varying degrees of technicality.

A few minutes each week spent in reading this material wlil form a habit which will keep the engineer acquainted with the most up-to-date ideas, not an asset to be lightly under-estimated.



Controlling the Unseen in Steel



View of part of New Departure's gigantic heat treating plant.

PHOTOMICROGRAPH of bearing steel after forging, etched with nitric acid and magnified 1,000 diameters.

THE same steel after normalizing and annealing. Showing fine spheroidized grain structure so important to strength.

AFTER forging, the next step in the preparation of the steel for New Departure Ball Bearings is to relieve all internal strains . . . to refine the grain and to soften the steel to a point where it may be readily machined.

The grain is refined by normalizing in the batteries of oil-fired furnaces shown above where a relatively high temperature is maintained uniform by the use of electric pyrometers.

After a precisely determined time the forgings are removed and allowed to cool in air. This operation removes the heterogeneous structure of the steel and puts it in the best possible condition for annealing.

Annealing is required to soften the steel and eliminate strains from forging. This heat treatment brings the forgings to a temperature just below the hardening or critical range of the steel and holds this temperature for a relatively long time.

Through special processes unique with this company the steel is spheroidized—or brought to a structure of minute spheres. By this method can New Departure's special analysis, high carbon chrome alloy steel be cut with relative ease without tearing.

Only by an intimate knowledge of metallurgy and the ability to control the unseen in steel are New Departure Ball Bearings produced with a uniform endurance unsurpassed elsewhere in industry.

New Departure Ball Bearings

The New Departure Manufacturing Co.,
Bristol, Connecticut
Chicago • Detroit • San Francisco

1115

Engineering Review

ACID RESISTING ALLOY

The Barber Asphalt Company, Philadelphia, has developed and is now ready to market "Barberite", a high copper-bronze alloy containing nickel. The manufacturer claims that the new alloy has corrosion resisting properties superior for many uses to various white nickel alloys and other high copper bronzes. Its tensile strength is comparable to mild carbon steel. This new alloy may be cast and is said to give a very fine crystalline structure which has a uniform texture and uniform strength and which can be easily machined.

A test on "Barberite" in 83 per cent sulphuric acid at 96 degrees Centigrade showed a loss equivalent to 0.0819 grams per square centimeter per year. The alloy is recommended for use with sulphuric acid of any strength at any temperature up to 96 degrees Centigrade. It is also recommended for use with such acids as arsenious, boric, fatty acids, pyrogallic and various other organic acids. It is suggested for use with various salts of both strong and weak acids. It is further recommended for use with a number of alcohols and solvents.

—*Chemical and Metallurgical Engineering.*

NAVY EXPERIMENTS WITH SUBMARINE ESCAPE DEVICES

Following last winter's disaster with American submarine "S-4", and in the light of the lessons learned from the Italian experiences with the Italian submarine "F-14", the Navy has conducted a number of experiments with the so-called "lung", invented and perfected by Lieut. C. B. Momsen, Chief Gunner C. O. Tibbals, and F. M. Hobson, Navy Engineer. The apparatus used in effecting an escape from a sunken submarine weighs less than 2 pounds and consists of a bag containing oxygen and a mouthpiece through which the oxygen is released. The device has been used with success in the compression tank of the Navy Yard under compression equivalent to a water depth of 225 feet, and men have escaped from a diving bell at depths of 110 feet and 160 feet. Further tests are underway, and if the apparatus is found successful it will be adopted and all submarines will be equipped with a suffiicient number to afford protection for all members of submarine crews.

—*Bulletin American Engineering Council.*

STANDARD PERIOD FOR CONCRETE MIX

The Bureau of Public Roads, following an investigation, has declared that the quality of concrete mixed in standard pavers is at its best if the mixing period is reduced to 45 seconds, which is less than half the time usually required by state specifications. In a general way, the research conducted has indicated that there is a difference between strength of concrete mixed for very short periods and that mixed for a long period of time. The data collected indicates that where standard 21E and 27E pavers are used, which are in good condition, neither strength nor uniformity of material is secured by mixing concrete over 45 seconds.

—*Bulletin American Engineering Council.*

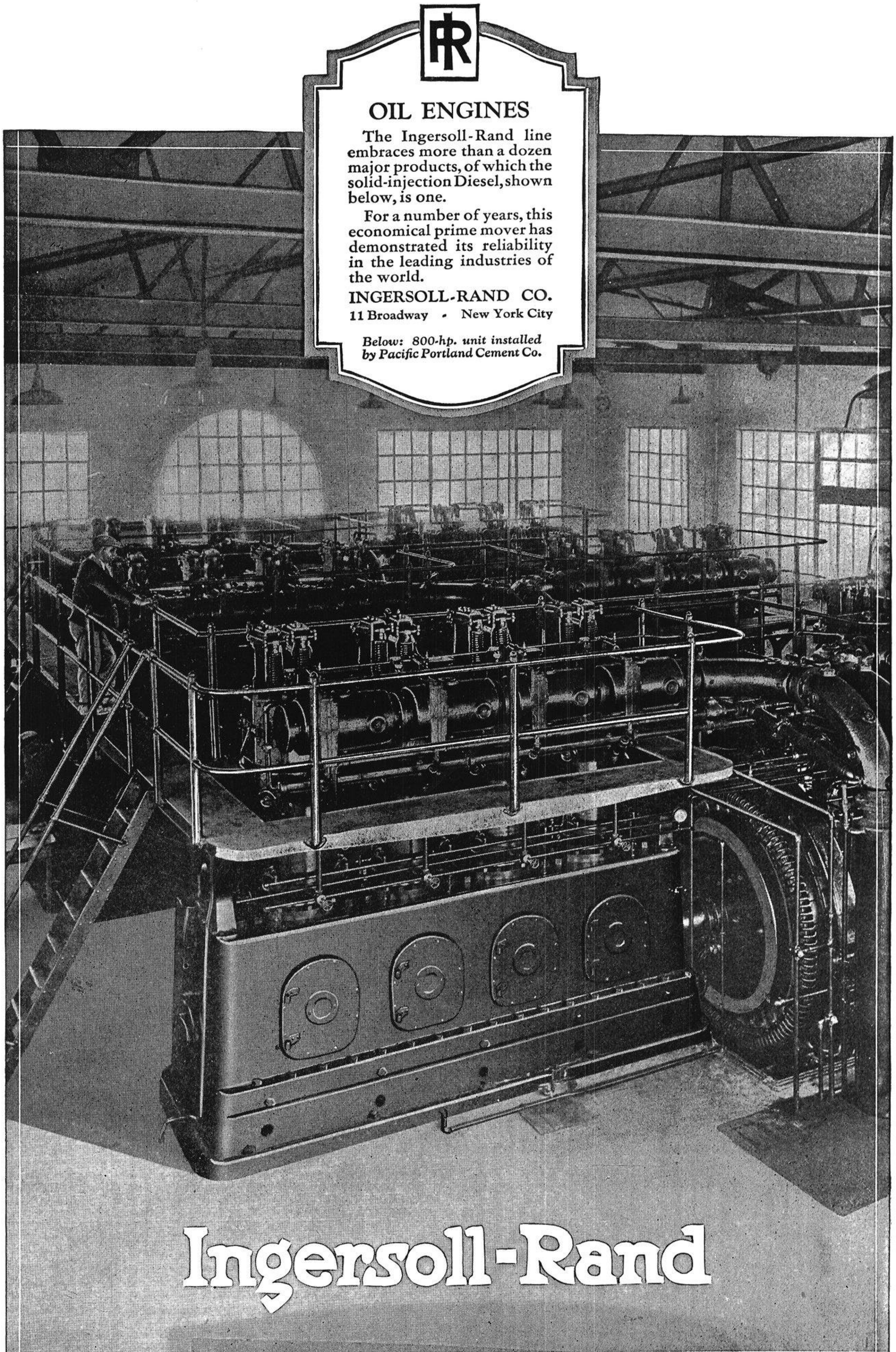
MODERN METHODS OF FABRICATING BRONZE SCREENS

After many years of use of iron, galvanized iron, and copper wire, each of these materials has failed for one reason or another to serve successfully as a screen material. Iron wire screen, of course, requires yearly painting to give it even brief existence, while in some climates the life of the galvanized iron wire screen is almost as brief. Copper wire cloth resists rust in most climates with entire success, but its strength is insufficient to give satisfactory service. The use of bronze wire cloth, which is merely a strengthened copper, has been the solution of the problem of obtaining the right material for screens.

Then arose the problem of a permanent frame for a permanent screen material. A report from the International Acetylene Association, tells us how this has been solved by the introduction and use of a frame fabricated from a material corresponding to the wire used in the cloth, the most satisfactory of these materials being what is known as commercial bronze and red brass. The former is an alloy of 90 per cent copper and 10 per cent zinc, and the latter is 85 per cent copper and 15 per cent zinc. Red brass, having a lighter color, finishes up to harmonize better with the cloth and also as a rule with the color of paint generally used on residences and apartment houses than the other.

Because red brass and commercial bronze contain zinc, it is difficult to make the joints by spot welding as can be done when galvanized iron or steel is used for the frame material. It, therefore, is necessary to use the oxy-acetylene process in welding these screen frames, and entire success in this work is made easily possible by using the smallest size welding torch, producing a flame having a cone about the size of a lead pencil point, and filler rods known as Tobin or manganese bronzes. These welding rods are alloys of copper and zinc, in each case of approximately 60 per cent copper and 40 per cent zinc. The alloys differ in that Tobin bronze contains 1 per cent tin, and manganese bronze 1 per cent each of iron and manganese. Being high in zinc as compared with the red brass and commercial bronze used in the frame ma-

(Continued on page 142)


IR
OIL ENGINES
The Ingersoll-Rand line embraces more than a dozen major products, of which the solid-injection Diesel, shown below, is one.
For a number of years, this economical prime mover has demonstrated its reliability in the leading industries of the world.
INGERSOLL-RAND CO.
11 Broadway • New York City
Below: 800-hp. unit installed by Pacific Portland Cement Co.
Ingersoll-Rand

EXPONENTIAL HORN

(Continued from page 131)

remains the same. This increased displacement is equal to the displacement of air caused by a diaphram of an area equal to the size of the mouth opening, and being driven at the same velocity and having the same input. The mechanical difficulties and the low efficiencies encountered in driving such a large diaphram makes this system impractical.

We see then that the exponential horn has two great advantages, (1) it allows the use of comparatively small and relatively simple vibrating mechanisms; and (2) it makes for high efficiency, thereby reducing the size and cost of amplifiers for the loudspeaker.

ALUMNI NOTES

(Continued from page 134)

they keep permanent open house to all friends and class mates who might come to Los Angeles. Mr. Thiel was on the staff of the Wisconsin Engineer while in school.

Witt, William H., c'10, was killed on the morning of October 10, when the automobile in which he and two companions were riding was struck by a fast passenger train near Seattle, Wash. Mr. Witt, better known as Bill to his schoolmates, was very prominent while in school. He was a member of Iron Cross, was varsity basketball captain, secretary of his sophomore class, president of the junior class, and a member of the student court, a strong organization at that time. His home is at Marshfield, Wis.

CAMPUS NOTES

(Continued from page 132)

of the a. c. it operates on. That the clock is quite accurate is a tribute to the constancy of the frequency.

A system of cooling coils connected to the refrigerator have been installed in the air-washer equipment which makes it possible by adjusting temperatures to change the humidity of the air used at will.

ENGINEERING REVIEW

(Continued from page 138)

cial bronze used in the frame materials, these welding rods melt at a much lower temperature so that in making the welds it is not necessary to melt the red brass or commercial bronze but only to bring them up to a dull red heat and melt the Tobin and maganese bronze on the heated surface. A good brazing flux is essential in this work.

MUNICIPAL OWNERSHIP

(Continued from page 130)

divided by 429, or 0.42 cents per kilowatt-hour; that is to say, the expense to which the company is put in metering and billing the average residential consumer is half as great as the cost of generating the energy he uses.

The electric utilities have many residential customers who take less than 80 kilowatt-hours during the year. To reimburse the company for nothing whatsoever but the cost of metering and billing, such a customer would have to pay $1.80 divided by 80, or 2.25 cents per kilowatt-

Where Ocean Breezes Blow

AT Ocean City, New Jersey, a new boardwalk — one of the finest of its kind in the world — was recently completed. The entire structure is of concrete with the exception of the decking and rails which saved the name, boardwalk, from becoming concrete walk.

Supporting this sea shore promenade are 780 concrete piles, each 18 inches square, 32 feet in length and sunk 24 feet in the sandy beach. Each pile, which weighed more than six tons, was lifted and located with a Koehring Heavy Duty Crane.

Another feature of this construction was the speed and adaptability of the Koehring Crane in setting the piling. The last pile was sunk four days ahead of the specified schedule. The entire contract was completed and accepted one day before the time limit.

Again a Koehring product is identified with the successful completion of an unusual project!

"Concrete—Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, will be gladly sent on request to engineering students, faculty members and others interested.

KOEHRING COMPANY
MILWAUKEE, WISCONSIN
Manufacturers of
Pavers, Mixers — Gasoline Shovels, Cranes and Draglines

KOEHRING HEAVY DUTY

KOEHRING

Please mention The Wisconsin Engineer when you write hour. This is almost three times the cost of generating a kilowatt-hour of energy.

Cit. Well! this is amazing. To think that the electric company can generate all the energy which the small short hour user takes for 1/3 of what it costs the company to meter his energy and to collect from him. I begin to see why 1 cent or less per kilowatt-hour will cover all the costs incurred in supplying the large long hour user, while 8 or 10 cents per kilowatt-hour may not cover the cost of supplying the small user.

But you have told me of only one item in the cost of operating the distributing system.

Eng. To make it short. The operating expense in distributing energy to residential customers, exclusive of metering and billing, is of the order of $4.00 per customer per year.

Cit. What does this operating expense in distributing energy amount to per kilowatt-hour?

Eng. $4 divided by 429 or .93 cents per kilowatt-hour.

Cit. Do you mind writing the costs you have given me in the form of a table?

Eng. The costs in supplying energy to residential customers per kilowatt-hour of energy delivered are of the following order:

Generation in a modern steam plant	.8	of a cent
Lost energy	.16	of a cent
Transmission	1.	of a cent
Fixed charges on distributing system	1.96	of a cent
Metering and billing	.42	of a cent
Other operating expenses	.93	of a cent
Total	5.27	of a cent

A part, and only a part, of the energy can be generated in water power plants. The cost of generating this part will be 1/5th of a cent per kilowatt-hour less than the cost of generating in a modern steam plant. This 1/5th of a cent is only 4 per cent of the cost of getting the energy to the residential user.

If the municipality owns the water power it will pay the investors in the plant a smaller rate of interest. This reduction in interest would reduce th cost of generating energy in the water power plant by 1/8th of a cent per kilowatt-hour. This 1/8th of a cent is 2.5 per cent of the cost of getting energy to the residential user.

Cit. Can an electric utility sell electric energy to any customers at 1 cent or less per kilowatt-hour with profit to itself and with justice to its other customers?

Eng. Yes, it can do this in the case of large long hour customers to whom it can deliver the energy at little or no expense for transmission and distribution.

Cit. Well! I can't tell you how satisfying it has been to get at the facts in the case. I feel that I am now in a position to form my own judgment relative to the value of water powers and the possible results of municipal ownership.

COST OF CUSTOMER APPLIANCE FOR USING ELECTRIC ENERGY

Eng. I suppose that in the case of the labor saving appliances used in your own home, you have dug out the facts as to the important items in the cost of operating them.

Cit. No, I haven't.

Eng. Well, suppose we interchange roles and I question you about your own affairs. What did you pay for the labor saving appliances in your own home?

Cit. The first cost of the appliances is so high that we haven't been able to afford very many appliances. Why, you have to pay about half as much for an electric ironing machine as for a Ford touring car!

All we have is four indispensable labor saving devices, namely, a vacuum cleaner, an electric washing machine, an electric hand iron, and an electric ironing machine. The first cost of these four appliances was $380.00.

Eng. What items go to make up the yearly cost of operating these four appliances?

Cit. Well, if my $380 were not invested in these appliances I could have it in utility securities, or in a building and loan association which would bring me in, say 5½ per cent, or $20.90 each year.

Then, I am constantly paying for minor repairs on the appliances, and the appliances will not last indefinitely, so I suppose that the annual cost for repairs and depreciation is at least 5% of the first cost, or $19.00 per year. This makes a total of about $40.00 per year for repairs and interest and depreciation on the first cost.

The only other item is the cost of the electric energy which the four appliances take during the year. How much will they take?

Eng. In the average household these appliances will require about 300 kilowatt-hours per year. At the average residential price of 6.8 cents per kilowatt-hour this energy will cost the householder $20.40 per year.

Cit. Great Caesar! You mean to say that what I pay the utility for the energy these appliances take is only 1/3 of what it is costing me to own and operate the appliances! Why those reductions we were considering of 4 per cent and 2.5 per cent in the yearly bill for energy are about 1 per cent or less of my total bill for using labor saving appliances, are they not?

Eng. Now you are getting at the root of the matter. Another way to see the part played by the first cost of the labor saving appliances is to consider what it will cost the 17,000,000 residential customers in the U. S. to provide themselves with the four appliances you have. Sevnteen million purchasers at $380 apiece is a bill of 6½ billion dollars ($6,500,000,000.00). This is almost equal to the entire investment in all the generating stations, transmission lines and distributing systems in the U. S.

But if you are somewhat troubled by the investment of the residential customer, consider that of the dairy farmer who desires to use labor saving appliances on the farm. If in addition to your four appliances, he purchases an electric milking machine, a separator, an electric water heater for the separator, and electric drive for his water pump, an electric range, and a 5 horse-power general utility motor, his total bill for appliances is about $940.

Cit. It seems, then, that any reduction which can be made in the price of energy will have comparatively little influence on the rapid introduction of labor saving appliances in the home. The big opportunity for saving lies in reducing the first cost of the appliances to the consumer. Is there any possibility of doing this? Are the profits in the marketing of appliances excessive?

Eng. At the present time, electric appliances are retailing to the user at a price which, on the average, is about 3 times as great as the cost of these appliances in the storeroom of the manufacturer. I do not suppose that this tripling in the prices of the appliance in its journey from the storeroom of the manufacturer to the customers, is to be taken as evidence of excessive profit at any step of the process of marketing. I am inclined to regard it as evidence of the high cost of the competitive method of marketing and servicing electric appliances.

You see, neither the users of appliances nor the local appliance dealers are in a position to distinguish a well designed and a well constructed electric appliance from a poor one. Consequently, with a score or more of appliance dealers in each city of any appreciable size, any manufacturer of a hastily thrown together appliance can have it foisted upon the public, for a while at least. The cost of introducing and servicing these inferior articles is high. You can see how costly it is to sell appliances under such conditions.

A reduction in price is possible when the electric utilities of the country wake to the fact that theirs is

the obligation and the great opportunity to work out and to effect economies in the marketing and servicing of electric appliances similar to the economies which now characterize the supply of electric energy by non-duplicating agencies.

When that awakening occurs, and when the utilities acting through their association, the National Electric Light Association, arrange for a real testing laboratory at which appliances submitted to its members may be given the most searching tests, and when the utilities then see to it that they market only the well-worked-out appliances they should be in a position, by large scale transactions, to greatly reduce the cost of selling and servicing. It will then be reasonable to expect the selling prices of appliances to the consumer to drop, perhaps to levels as low as ½ of what they now cost.

Cit. Then you regard the high selling prices of electric appliances as the natural result of the wasteful duplications of competition?

Eng. Yes, such wastes are inherent in the competitive method of marketing appliances of a technical nature.

Cit. But isn't competition inherent in human nature? Isn't it the "life of trade"? You can't eliminate competition, can you?

Eng. Isn't human progress largely a matter of consolidating the gains made through competition by substituting cooperative forces for competitive. This does not eliminate competition from the scheme of things. It frees the competitive forces for operation upon the new fronts.

Cit. Well! don't the proposals that are being made to authorize municipalities to duplicate the plants and systems of the electric companies now serving them, mean a return to the old intolerable duplication of service in a field which is most economically served by a single system?

Eng. Yes, such a duplication would result in a real waste. You might call it a return to a pre-La Follette, stone age stage of electric supply.

Cit. I begin to wonder whether the people who are saying so much about the possible reduction in electric bills by municipal ownership and the development of water powers, and who are saying nothing about the high cost of appliances, may not be barking up the wrong tree.

BEYOND THE CAMPUS

(Continued from page 128)

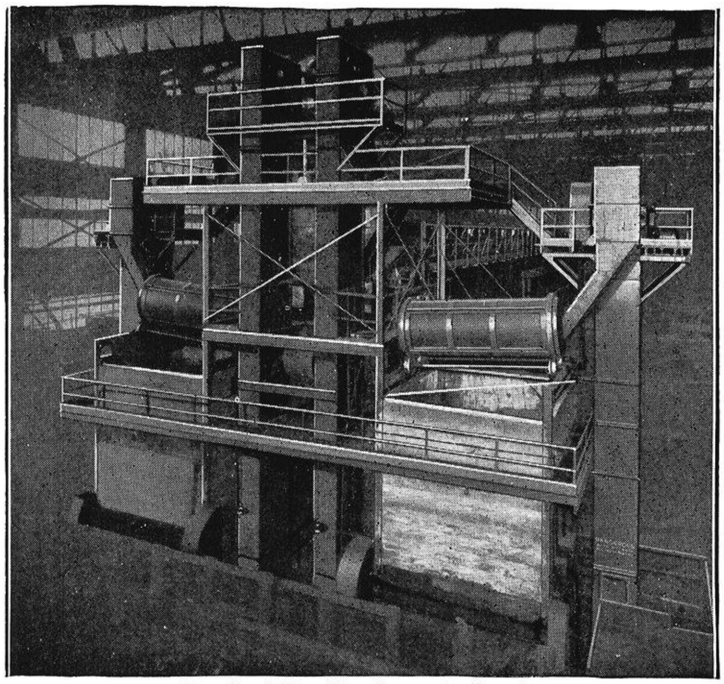
natured, member of the genus homo sapiens, he has laid a sound foundation for understanding the psychology of the great proletariat in the construction industry. In contrast to the office worker as we know him, - - anaemic for lack of fresh air, stoop-shouldered from the daily grind at the desk, and bored with everything at the end of the day, - - the out-of-doors worker, be he construction craftsman, forester, engineer, cowboy, Indian, or whatnot, has a super-abundance of energy and pep. Because the work itself uses up only a fraction of the splendid vitality of the construction worker, the remainder finds a partial outlet in gruff talk and "fish stories" which rival in magnitude even those of the Arabian Nights. Let me mention here that the construction worker, from laborer to super-

intendent, feels a pride in his calling like unto which there is none other. Even within the brotherhood of workers there is a gradation of pride and conceit. The carpenter looks down upon the laborer; the bricklayer, in turn, condescendingly splashes the essence of mortar upon a lowly carpenter; while from his lofty perch above them all, the devil-may-care ironworker nonchanantly drops a red-hot rivet on whatever and whomever fate has brought below.

You have undoubtedly read how some men are attracted by the desert, by tropical exploration, by polar adventure, by some force which they themselves cannot explain, despite the inevitable hardships and dangers they must endure. Construction work has practically the same kind of an influence over the men who are in it to play the game. On the job in all kinds and varieties of weather - - rain, shine, snow, frost, - - you tast work under primal field conditions. Foundations and footing work give you the promised chance to stand in mud and water all day, slide along slippery timbers, have 4 x 4's thrown all around you, and sometimes at you. As a young carpenter you will be given the honor of setting forms in such tight corners and at such inconvenient angles that, with dirt and water forming a protective layer between body and clothes, your impatience actually gives way and you cuss quietly to yourself, so as not to discourage your partner. Of course, as the building gradually approaches the heavens as a limit the work becomes dryer and cooler, but there is no let-down in the pace. Schedules must be maintained, and the weeding out of these who fall behind vividly impresses upon your mind how inexorable and just is the "survival of the fittest".

Thrills in construction work exist in sufficient number to emphasize the importance of watching your every step. As a rule, construction workers, by reasons of the superabundance of energy mentioned in a previous paragraph, take far too many chances; and the results of that chance-taking are reflected in the rates life insurance companies demand of those in the building trades. The one rule regarding safety in construction is never to take any needless risks; there are sufficient necessary ones! It may be nothing in your young lives to walk all day across wood joists or plank scaffolding ten stories or so above sidewalk level, but the first time I experienced a springy plank below my feet I experienced a simultaneous feeling in the pit of my stomach. Such a small matter, however, becomes commonplace after a while. Frankly, however, I would not want of my own accord to take the place of one of our ironworkers who stood on a couple of planks placed across the open top of a 250-foot steel tower gently swaying in the breeze. Here again it is a question of common sense, not of dare or bravado.

From the moment you leave the sheltering roof of your Alma Mater life becomes an uphill fight - - a battle for your right to exist in the world and in your chosen profession. To have had a thorough grounding in the fundamentals of your vocation is only half of the battle; the remaining and more difficult half of the battle is the



Rex Sand Handling System in Foundry

Showing (right to left) Rex Elevators (buckets on belt) for knockout sand, screens and bins (center) Rex Elevators for tempered sand discharging to disintegrators and belt conveyor to foundry floor. Paddle mixers are below.

CHAIN BELT Engineering Solved this Problem *—And Many More*

Sand Handling and Reconditioning was once one of the Major Problems in transforming metal into castings. It need no longer be so—

In foundries, large and small, Rex Sand Handling Equipment has eliminated hand labor, saved valuable floor space, and, in keeping with the modern trend, has speeded up production generally throughout the plant.

The plant view shown above is a unit of one of the largest American corporations, where the use of Rex Sand Handling Equipment, coupled with a change in the character of the work, resulted in an increase of 300% in production.

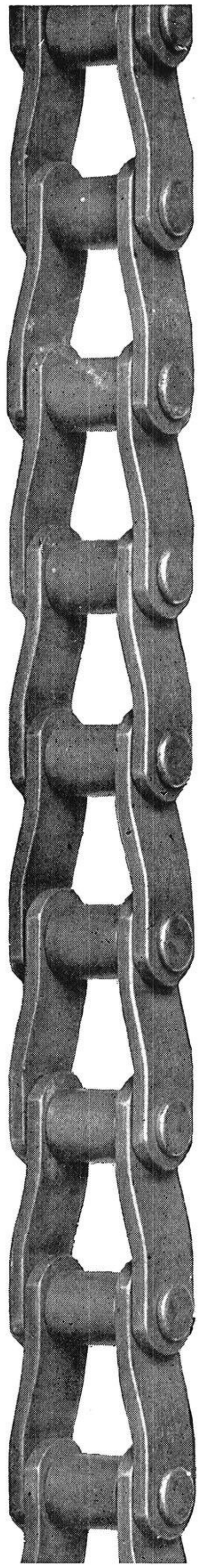
Many similar industrial problems of handling have yielded to Chain Belt engineering skill plus Rex equipment.

Whether you are a Student, a Manufacturer or a Graduate Engineer, it may be well to investigate the possibilities that Rex Handling Equipment holds for you. We will gladly furnish information to anyone interested.

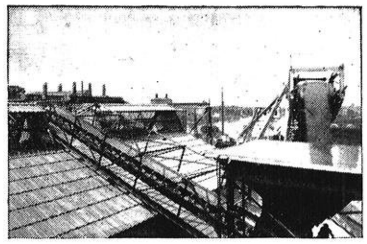
REX

(Reg. U. S. Pat. Off.)

CONVEYING SYSTEMS

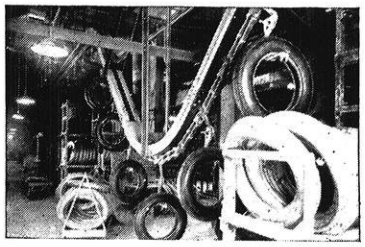


At left: strand of Rex genuine Chabelco 1030



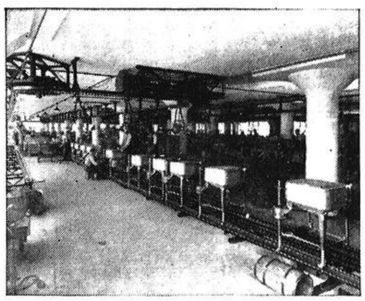
Rex Installation in Cement Mill

The Chain Belt Company and The Stearns Conveyor Company (owned by the Chain Belt Company) provide practically all equipment for mechanical handling of cement from the raw state through the kilns and mills to the finished product. The installation shown is at the plant of the Peerless Portland Cement Company.



Rex Overhead Conveying

At the Firestone Plant, tires ride high on the ceiling, come down to the floor at desired intervals, move to many destinations, and go from floor to floor on this Rex Overhead Conveyor.



Progressive Assembly

Since the Maytag Company of Newton, Iowa, manufacturers of washing machines, installed Rex Conveying Equipment, production has greatly increased, inspection made easier and fewer hands needed in the assembly operations.

CHAIN BELT COMPANY

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THE STEARNS CONVEYOR COMPANY, E. 200th St. and St. Clair Ave., Cleveland, Ohio (*Owned by* Chain Belt Company) adaptation of your knowledge to the needs and demands of the world beyond the campus. In addition to the knowledge of fundamental construction methods, understanding of worker psychology, common sense, and judgment, cultivate a spirit of helpful co-operation and sense of intelligent loyalty to the organization which employs you. If you are part of an institution, give it your undivided loyalty and support, or get out! When it comes to keeping faith, the engineer cannot compromise!

THE OSCILLOGRAPH

(Continued from page 126)

possible to locate and eliminate many sources of undesirable noise in machines by analyzing the wave form of the noise and determining the parts of the machine which might vibrate at the frequencies shown in the wave. For converting the sound waves into electrical waves the ordinary telephone transmitter usually proves satisfactory. The transmitter is connected, either directly or through a vacuum tube amplifying circuit, through an oscillograph element so that the deflection of the oscillograph light beam is at all times directly proportional to the pressure of the sound wave on the diaphram of the transmitter. A graph of the sound wave with time as abscissae and wave pressures as ordinates is the result. The wave analysis is carried out by measuring the ordinates at a number of points and applying this data to determine the coefficients of the terms in an equivalent Fourier series.

For the study of mechanical movements in small models, a mirror is usually cemented directly onto a rotating or rocking member of the part under observation, and the entire model is placed inside the oscillograph case. The light is then reflected from the mirror on the model instead of from an element mirror. Such an arrangement is highly satisfactory for determining the vibration or the time of movement of the part, and the relation of this time to other quantities. When the model is too large for placing inside the case, a system of reflecting prisms can frequently be used to carry the light to and from a mirror on the moving part. For some cases, where neither of these schemes can be used, the arrangement of a series of contacts for making and breaking an electrical circuit including an oscillograph element will serve the purpose.

Varying magnetic fluxes are readily studied by means of the oscillograph. The part carrying an unknown flux is circled by a coil of wire whose ends are connected across an oscillograph element. The voltage induced in the coil, and therefore the current through the element, is directly proportional to the rate of change of the flux through the encircled part. By integrating the voltage curve obtained on the film, and determining the initial flux, the flux curve may be plotted. The scale of ordinates is determined by carrying out the foregoing test with the part excited so as to set up a known flux.