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The WISCONSIN ENGINEER

VOLUME 35, NO. 8 MAY, 1931

How Power Surges and Transients Are Recorded by

Automatic Oscillographs

By JAMES DILLON COBINE, e'31

THE electric light and power industry is particularly interested in studying the effects of power surges on the various types of equipment of the electric system; the operation of, and time required for the relays to isolate the fault causing the surge; and the effects and duration of transients caused by various switching operations. These transients may occur at any time and, with the exception of those due to switching operations, are the result of phase-to-phase, or phase-to-ground short circuits, lightning strokes, and similar causes These transients may have components in a large range of frequency; they may have a large range in amplitude; and they may be very short, very long, or intermittent.

JAMES D. COBINE

Madison, Wisconsin

The writer of this article spent the summer of 1930 on a joint investigation by a telephone company and a power company in which use was made of the oscillographs that he describes. The article is a condensation of a paper presented at a joint meeting of the Madison and student sections of the American Institute of Electrical Engineers on Feb. 19, 1931

When the phases of a long, high-tension line become unbalanced and a large residual current flows in the ground circuit, voltages are induced in parallel signal circuits that are near the power line. These voltages cause interference and at times interrupt the signal service. Telephone and telegraph companies are interested in studying these voltages induced by power line surges — their magnitude, wave shape, and duration — and also in the operation of the communication line protectors. Through a knowledge of these disturbances equipment may be developed which will improve the service.

Two automatic oscillographs have been developed to meet the requirements of this type of investigation. One is the polar oscillograph which records the wave upon a circular time axis; the other is a cartesian co-ordinate oscillograph, or, as it has been named, movie oscillograph, that records the wave on rectangular co-ordinates on standard moving picture film.

The polar oscillograph records the initial impulses and wave form of transients of short duration, the latter part of long transients being cut off. This type, while it starts automatically, requires the attention of an operator upon completing a record if continuous operation is desired. The movie oscillograph will record an entire transient of any duration with the exception of the initial impulse. This type is entirely automatic in operation and will record a large number of disturbances before the attention of an operator is required. The date and time of the disturbance that caused the operation of either machine is recorded on the film with the wave.

The Movie Oscillograph

The vibrating elements of the movie oscillograph are of the string-galvanometer type. They have been found to respond to high frequencies, up to approximately three thousand cycles, and also they permit the recording of three simultaneous waves from different circuits on the same record. They consist of a fine wire placed in a strong magnetic field produced by a coil carrying direct current at all times. Whenever the wire carries a current it is deflected in a direction perpendicular to the plane of the magnetic field and the current. Under certain conditions it is necessary to calibrate the elements at frequent intervals because of the possibility of the stretching of the strings beyond their elastic limit by excessive voltages. The light is placed directly behind the elements so that they cast a shadow through a narrow slit onto the film. The shadow produces a well defined trace on the film and brings out all the irregularities of the impressed wave.

The source of light is a six-volt flash light bulb. This light is brought to full brilliancy in a short interval of time by the circuit shown in Fig. 1. A 24-volt battery, A, is connected permantly across the lamp and a series resistance, R. The current passed by R is just large enough to heat the filament to a dull red. This does not affect the film but greatly shortens the time required to bring the light to full brilliancy. When the relay operates, the condenser is charged to the voltage of battery B, usually a 135-volt radio battery. The charging current passes through the filament and brings it to full brilliancy in less than one-hundredth of a second. Once lighted the permanent current from B is passed thru the resistance r, and this current added to that from A, the heating current, produces full brilliancy. The light path from the bulb to the film is completely screened by a light-proof cover.

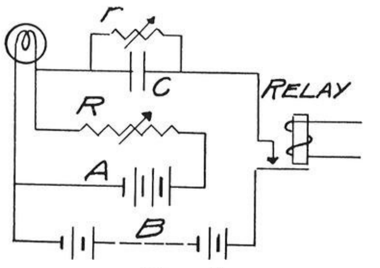


FIG. 1

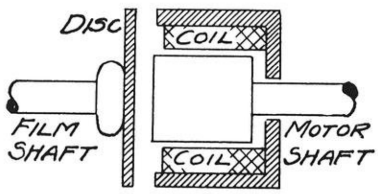


FIG. 2

FIG. 1: *The circuit by which the light is brought to full brilliancy in a short interval of time.*

FIG. 2: *The magnetic clutch through which the film is accelerated in a minimum of time.*

Standard 35-mm. moving-picture film is used in this oscillograph. The unexposed and exposed sections of film are kept in standard moving-picture-film magazines so placed in a light-tight container that as the film is passed from the first to the second magazine by the driving mechanism, it crosses the light beam. The machine is loaded with two hundred feet of film.

In order to save film it must be stationary except when a transient occurs. The acceleration of the film to its proper speed in a minimum of time is accomplished by the use of a magnetic clutch shown in Fig. 2. The driven element is a light iron disc, or armature, that is connected to the shaft driving the film sprockets by springs as shown in the diagram. The driving element is a rotating iron cylinder placed in the center of a stationary circular coil. The cylinder is driven at a constant speed at all times by a small electric motor. As soon as a surge starts on the circuit under test, a high-speed relay operates which by closing the clutch circuit supplies the magnetizing current to the coil. The coil thus energized draws the armature to the rotating cylinder through the small clearance space. Since this a friction clutch the film is brought up to speed in a minimum of time without throwing an undue strain on the film.

At the end of each oscillogram the film is stopped and the illuminated face of an identifying clock is photographed, recording the date, time, and any other desired information, on the film. Then fresh film is brought under the path of the light beam and the machine is ready for the next disturbance.

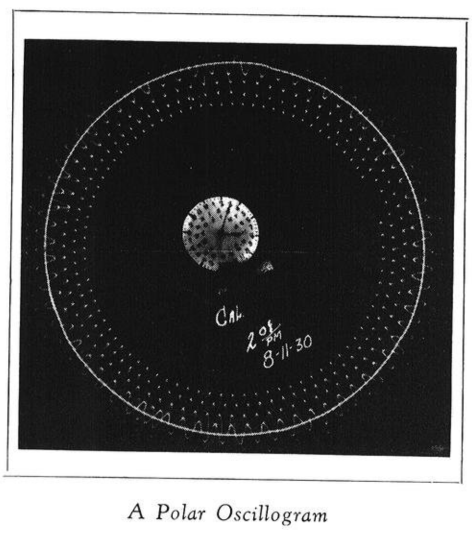
The High-Speed Relay

The various operations of this oscillograph are controlled by a rotary sequence-switch driven at a constant speed by an electric motor. The motor is started by the operation of the high-speed line relay, and comes to the desired speed in a short time, for it starts and runs at almost no load. As soon as the switch starts, the oscillograph is under the complete control of the cams of the switch, which are set to cause a sequence of properly timed operations, each cam closing its switch at the desired time. Once started, this rotating switch locks itself in and completes its cycle of operations in one revolution and then stops its own motor. The oscillograph is then ready for the next record.

One of the possible sequences of operation of this oscillograph is as follows: A surge operates the high-speed relay; the initial currents of the magnetic clutch and the light are supplied through the contacts of this relay for quick operation, and at the same time relays are operated which carry the permanent currents of the clutch and light; the operation of the high-speed relay starts the motor of the sequence switch; after a given length of time the sequence switch opens the light circuit, stops the film, illuminates the clock and photographs its face by operating a camera shutter, then it advances the film; the switch then stops its own motor and is ready for the next transient.

The key to the application of the movie oscillograph to transient studies is the high-speed line relay which starts the sequence of operations. This relay is shown in Fig. 3 and is seen to consist of a combination of two polarized relays connected in opposition; this is done so that either a positive or negative current impulse will operate the oscillograph. By means of the biasing battery and series resistance, the current in the upper, or biasing coils, is varied; thus the relay may be adjusted to trip at any desired value of line voltage. The contactor is of soft steel and is wound with the two opposing coils, the lower one being the line coil. The biasing current produces a magnetic pole at the upper end of the contactor causing it to be held, by attraction and repulsion, in the unoperative position as shown. As soon as sufficient voltage is impressed upon the line terminals, the poles of one of the contactors are reversed, causing it to move to the other contact and start the sequence of operations of the oscillograph.

The time which elapses from the start of a transient until the oscillograph begins to record is controlled by the slowest operation, usually the clutch. The high-speed line relay may be adjusted to operate in a few thousandths of a second, the lamp



A Polar Oscillogram

lights to full brilliancy in approximately one-hundredth of a second, and the magnetic clutch operates in something more than one hundredth of a second; so the record lost is that occuring in an interval of time that is probably never more than two-hundredths of a second, and probably quite

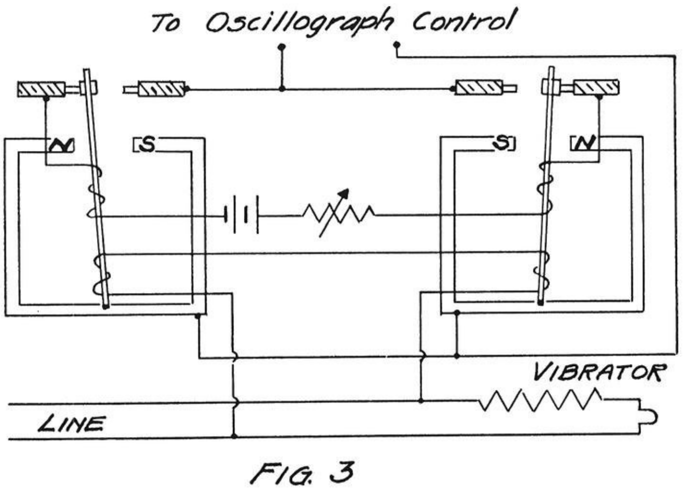


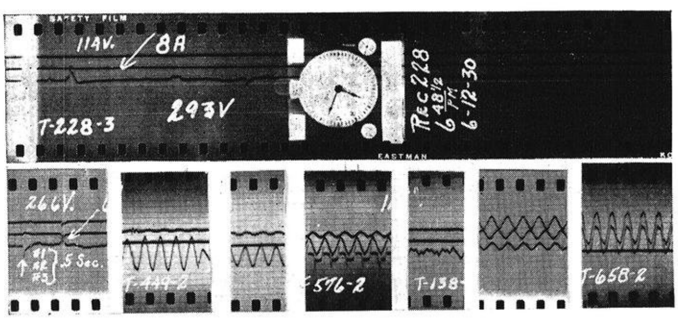
FIG. 3: *The high-speed line relay which permits the use of the oscillograph in the study of transients. It operates within a few thousandths of a second.*

near to one-hundredth of a second. Since the vibrating elements are connected across the line they are vibrating from the time the transient occurs.

The Operation

The ideal method of using these oscillographs is to place the polar and the movie type in parallel on the circuit to be tested. In this way a complete record of an entire disturbance is obtained, the polar catching the start of the wave and movie recording the entire wave following the first half cycle or so. The movie oscillograph has the advantage of recording all of a series of intermittent disturbances such as result during a lightning storm, and in isolated locations where it is only occasionally checked, it will faithfully record all disturbances.

It has been found that long communication circuits which are not near power lines will, during a storm, carry a series of steep wave-front disturbances of considerable magnitude and short duration, caused either by direct lightning strokes



Records made by the Movie Oscillograph

or the effects of bound charges grounding. The disturbances caused by the grounding of bound charges on power lines usually induce voltages on parallel signal circuits which are of the fundamental of the power system frequency with a wide range of superposed harmonics, the harmonics often being of considerable magnitude. The power-line disturbances are usually of much longer duration than those on isolated signal systems. The difference in the waves induced in the above types of signal circuit conditions may be due to the shielding effect of the power lines. Signal circuits which are operated grounded are more seriously affected by power disturbances than are metallic circuits.

In the inductive co-ordination work of studying conditions such as outlined in the preceding paragraph, with these oscillographs, it has been found profitable to place one machine in the ground circuit of the power system, as in the residual of a transformer bank, and another on the signal circuit by means of suitable current transformers and resistances. The trips of the two high-speed relays are connected so that simultaneous records are obtained of the conditions on both circuits whenever there is a disturbance of sufficient magnitude on either to operate its relay. This method has resulted in some interesting records.

The oscillographs described in this paper have been used on a number of inductive co-ordination projects of the Bell System and the National Electric Light Association and have given satisfactory results.

THE MAY COVER
Editor's Review

This month's cover illustration is a photograph of a 205,-000-volt electric spark discharging between needle-points 70 cm. apart. The picture was taken in the high tension laboratory of the university by Richard W. Coolbaugh, m'32, and Ralph Benedict, graduate electrical. In making the discharge the voltage was brought up rapidly to the maximum when the circuit-breaker kicked out giving an instantaneous flash. A Graflex camera with a lens aperture of f22 and Eastman Speed Film was used in making the photograph. Considerable difficulty was experienced by the two men before they discovered the necessary technique for making successful pictures of the discharges.

FARADAY'S SARCASTIC JEST COMES TRUE

After seven long hard years of labor with one object in view, Michael Faraday in 1831 succeeded in producing an electric current by induction. One day in his laboratory he explained the experiment to a friend, who was one of those matter-of-fact sort of chaps, who said:

"Very interesting, but what is the use of it?" To which Faraday somewhat sarcastically replied: "Perhaps some day you can tax it?"

When it is considered that the great electrical industry of the present is based primarily upon Faraday's epochal discovery, the truth of his great jesting remark may be understood. Today the electrical industry is the third largest taxpayer of corporation taxes in America, and will doubtless soon stand at the head of the list.

The electrical industry in the United States paid last year in taxes $163,000,000.

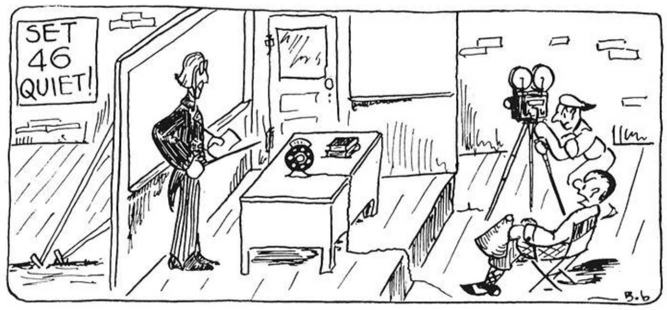
Can the Teacher Justify His Job?*

By Francis T. Spaulding
Associate Professor of Education, Harvard University

TO most classroom teachers it would doubtless seem unthinkable, if so preposterous an idea should ever occur to them, that education might go on quite as effectively as at present even if classroom teachers were to be universally abolished. Teachers in general are apparently accustomed to take it for granted that they, as teachers, are indispensable to any orderly and effective scheme of formal education. So widespread is this assumption that any serious questioning of the classroom teacher's importance is likely to be rare. Yet such questioning does occasionally take place. It has most recently taken place as a result of certain investigations which have been concerned with the direct results of the classroom teacher's work. In so far as these investigations have brought forth even tentative conclusions, they have almost uniformly given room for serious doubt as to the average teacher's real contribution to his student's learning.

Numerous educational experimenters have developed plans for teaching, of which the Dalton and Winnetka plans are perhaps at present the most widely known, which largely or entirely displace the classroom teacher in many phases of the teaching process. Instead of teacher-conducted recitations, these plans provide for individual work on the part of the students. The work is based on assignment sheets, which contain references to appropriate reading and practice material, directions for laboratory exercises, and examinations for rating the student's achievement. These new methods have been introduced with apparently promising results not merely in elementary schools and high schools but in colleges as well. They have been tried with a great variety both of subjects and of types of students. In the light of the results from such tests as these, the classroom teacher would seem to find himself hard pressed to defend his supposed indispensableness. The teacher cannot fairly claim to be indispensable unless he can demonstrate his ability either to perform some duty which no other agency can perform, or at least to perform some duty better than it can otherwise be performed.

Certain other investigations raise no less serious questions as to the teacher's importance, though from a different point of view. If the classroom teacher does succeed in stimulating and inspiring his students and in adapting his instruction to their individual needs it is reasonable to suppose that his teaching will be more effective when he has to deal with small groups of students than when he is confronted with large. Extensive studies have been made of the effectiveness of teaching in large classes as compared with small. One of the most recent of these studies, and one of the most comprehensive and carefully planned, was carried out in the University of Minnesota. Its tentative conclusions agree with those to which nearly all previous objective studies of this sort have led: that, largely irrespective of what is being taught or who is being taught or who is doing the teaching, students in large classes learn at least as much, on the whole, as do students in small classes. There is here no evidence, of course, that the classroom teacher can profitably be dispossessed of his job. But there is also no evidence that he fulfills his responsibilities on any other than a chiefly routine and automatic basis; so that those prophets of a new day who foresee some mechanical device—a talking motion



Talking moving pictures may supplant the present-day class room teacher.

picture, for example, displacing the teacher of the present order, can find in these investigations much with which to buttress their prophecies.

There is little exaggeration in saying that the classroom teacher, even though he may not be aware of his predicament, is face to face with a serious problem: can he actually justifiy his job? If the results of these investigations mean what they seem to mean, the teacher cannot fairly assume that his position in the classroom is permanently assured. Talking pictures may some day be less expensive that salaried human teachers. Individual-instruction materials are already available for numerous subjects and various types of students, and are less costly than the teachers whom they might displace. Unless the teacher can establish for himself a place in teaching which cannot be filled by these mechanical systems or others of a similar sort, he is likely slowly but surely to find himself one of a vanishing race.

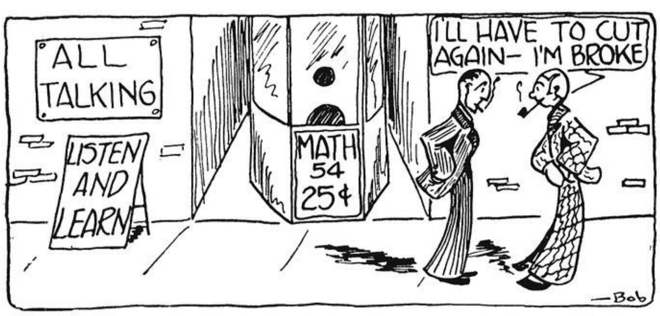
This, then, would seem to be the status of the classroom teacher in college and secondary school alike: the teacher teaches and his students learn, but the teacher teaches after such a fashion that purely mechanical devices can successfully reproduce both the methods and the results of his teaching. The teacher can prove himself actually indispensable in the teaching process only if he can bring about some change in this status. There is obviously one direction, and one direction only, in which he can make a change which will be adequately effective. That is in the direction

*Abstracted from a summary, printed in the January issue of the *Journal of Engineering Education*, of a discussion presented at the Civil Engineering Session of the Summer School for Engineering Teachers, Yale University, July 3, 1930.

of improvement in his own methods of teaching. Somehow or other he must find for himself a scheme of teaching which contributes unmistakable values to the learning of his students, and which at the same time cannot be reproduced, either in method or in effect, by any purely mechanical system.

That such a scheme of teaching may be found is by no means inconceivable. No such scheme has as yet, to be sure, had its value objectively proved, since none has been tried long enough, or comprehensively enough, or by enough teachers, to give a measure of its strength. At least one scheme of this sort, however, seems of particular promise. It is one which mechanical devices can hardly imitate because it involes more than a routine setting of tests and imparting of information. It is one which may be looked to for results of undoubted value, since it tends not toward mere rote acquisition of formal knowledge and skills, but toward development of the ability to use essential knowledge and skills under conditions in which their use is important. It is a scheme which demands a broader background, greater adaptability, and more exertion on the part of the teacher than does customary classroom procedure. But it gives the classroom teacher full opportunity to prove himself indispensable; so that it is well worth the attention of any teacher who is seriously concerned to justify his job.

The teacher who would adopt this scheme needs to recognize certain facts which in the long run will have much to do with determining the relative success of his teaching. In the first place, he needs to recognize the fact that class-teaching involves the teaching of *groups* of students. He has before him a group of persons at least potentially interested in the same problem, able to contribute in varying ways and varying degrees to the mastery of those problems, and possessed of a "group psychology", so-called, which is likely to be of no small significance in their learing. In the second place, he needs to recognize that the process of group learning involves a procedure more or less distinctly its own. In the third place, he needs to recognize that his own part in teaching is chiefly to be found in the contribution he can make to group learning. Whereas individual learning can be more or less successfully guided through various mechan-

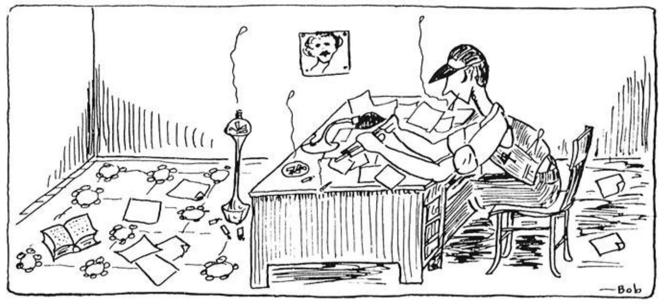


Movie theaters in place of class rooms will offer another problem in finances to the student.

ical "systems", the effective conduct of group learning seems likely to be beyond the scope of any merely mechanical device. Hence it is in the conduct of group learning that the class-room teacher must probably seek his own eventual justification.

(Editor's note: The writer here describes how the citizens of a certain town, through public discussion and committee work decided what sort of a sewer system they would build).

This is the process of group learning as it is likely to take place when people come together of their own accord to



Student doing no problem at all, except the obvious one of satisfying an authoritative teacher.

get something done. Between such a process and the procedure which goes on in the average classroom there are obvious differences. The usual classroom procedure insists on no problem which awakens the interest of the group as a whole—insists, in many cases, on no problem at all, except the obvious and irksome problem of satisfying an authoritative teacher. Classroom procedure recognizes little or no responsibility on the part of individual students to the group.

May it not be a fair conclusion, then, that the teaching procedure which offers greatest promise of truly justifying the classroom teacher is one which combines the advantages of group learning with the further advantages of group learning *under guidance*. Were this conception of the process of teaching to be put completely into effect, it would involve numerous and radical departures from the usual method of class-conduct. Instead of arbitrarily setting tasks, the teacher would find himself faced with the necessity for interesting his students in the discussion of major problems, for guiding their discussion toward clarification of the subordinate problems involved, for suggesting to them methods and materials which would be of value in the solution of these problems. Instead of presenting formal lectures, it would be the teacher's function to supply merely such information as students could not readily or economically find for themselves or to give information which would interest them in further study of the problems at issue. Instead of examining, as sole arbiter of excellence, the students' efforts to perform assigned tasks, it would be the teacher's duty to guide discussion by the class itself of the results of such outside work as had significance for the group as a whole. The teacher would become, in effect, stimulator, critic, and guide, rather than dictator or dispenser of knowledge; and the teacher's skill would be measured by his success in getting his students to learn for themselves, rather than by his ability merely to "teach" in authoritative terms.

Were this conception to be completey adopted, it would bring about further changes in the formal ordering of class work. In contrast with the systematically mechanized arrangements by which administrative "justice" is done to students and teachers alike, class discussions and demonstra-

(Continued on page 234)

Acoustical Engineers Devise Scientific

Measurement of Noise Intensity

By LAWRENCE T. SOGARD, c'24
Engineer, Acoustical Engineering Corporation

SOGARD, former staff member on the *Wisconsin Engineer*, explains the unit of noise measurement, the Decibel, and describes two instruments that are being used in the scientific measurement of noise intensity, the Acoustimeter and the Audiometer.

HARKING back to fundamentals, *noise* is sound. Sound has its origin in the vibration of the body whence it emanates. The vibrating body sets up a wave-motion in the air consisting of alternate compressions and rarefactions. When this disturbance of the air strikes the ear-drum the sensation known as hearing results. Generally speaking, sounds which are sustained at definite pitches for a comparatively long time produce a musical sensation; whereas sounds with no definite pitch and with great variation both in frequency and intensity result in the sensation we call noise. The jumble is too complex for analysis and therefore it cannot be appreciated by the brain. Naturally it is impossible to establish a definite line of demarcation between music and noise. Tastes differ; the vibrations emanating from a piano under the coercion of a red-hot "blues" pianist may be music in his ears, but it is probably noise and anathema to the man in the apartment below who is afflicted with insomnia.

The measurement of energy in most of its forms is comparatively simple. Heat is measured by the B. t. u.; the unit of electrical energy is the watt; and light is gauged by candle-power. With sound, particularly noise, measurement is much more complex. The energy in noise is so small when measured in the common physical units that its exact measurement would be difficult. Further complications arise in the wide variation in frequency and intensity. As a matter of interest, the speech energy output of the normal voice is only about 125 ergs per second. At this rate if all the energy from the voices of a million persons, talking steadily for an hour and a half, could be converted into heat there would be about enough to make a good five-cent cup of coffee. And yet we are charged with being purveyors of hot air!

The Decibel

Pioneer in the field of sound is the telephone industry, and to it the acoustical engineer has turned for a unit of noise measurement. This unit is called the *decibel,* abbreviated *db,* and is used in telephone engineering throughout America and Europe. Strictly speaking, the decibel is a measure of the ratio of the intensities of two sounds. If I_1 and I_2 are the intensities of two sounds being compared, the ratio of these intensities, expressed in decibels, is $10 \log_{10} I_1/I_2$. To understand this more readily let us tie it to a common datum. When the intensity of a sound is continuously decreased it reaches a point where it produces no stimulation of the auditory sense. That intensity which is just sufficient to be heard is called the *threshold of audibility.* The intensity at threshold is arbitrarily taken as 1, so for a sound with an intensity 10 times that of threshold intensity, the difference in intensity, expressed in decibels would be $10 \log_{10} 10/1$ or 10. Similarly, the difference between threshold intensity and a sound 100 times that of threshold intensity would be $10 \log_{10} 100/1$ or 20. The following table shows the relation between the decibel scale of noise levels and noise intensities as multiples of threshold intensity.

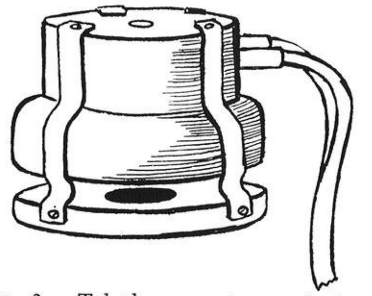


FIG. 2: *Telephone receiver with face plate used in the Audiometer.*

Decibels	*Intensity as a Multiple of Threshold Intensity*
10	10
20	100
30	1,000
40	10,000
50	100,000
60	1,000,000
70	10,000,000
80	100,000,000
90	1,000,000,000
100	10,000,000,000

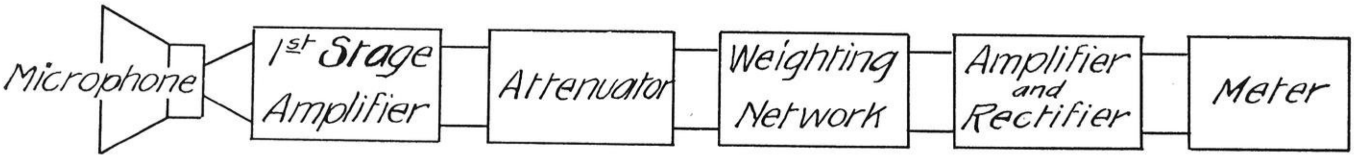


FIG. 1: *A simplified diagram of the Acoustimeter.*

It is seen that the decibel is not an absolute unit, but instead, a symbol for expressing a ratio. Inches are absolute units; the difference between 10 inches and 20 inches is the same as that between 90 inches and 100 inches, whereas, between sounds of 10 decibels and 20 decibels above the threshold of audibility there is a difference of intensity of 90, while the difference between sounds 90 and 100 decibels above threshold is 9 billion. The decibel is approximately the smallest change in noise level which the ear can detect. Loudness, as sensed by the ear, follows the decibel scale very closely. Thus, while loudness increases by simple arithmetical progression from ten to one hundred, intensity increases by logarithmic progression, leaping from ten to ten billion.

Formerly measurements were made in the familiar physical units such as ergs or dynes per square centimeter. However, the range of amplitudes in noises is so great that the use of the common units involves astronomical magnitudes tending to obscure the vital point which is the effect of noise on the ear. Since the response of the ear to sound is approximately logarithmic, the decibel unit appears to be much more satisfactory. In connection with this it is of interest to note that the intensity of sound at the threshold of audibility is approximately 7×10^{-16} watts per square centimeter.

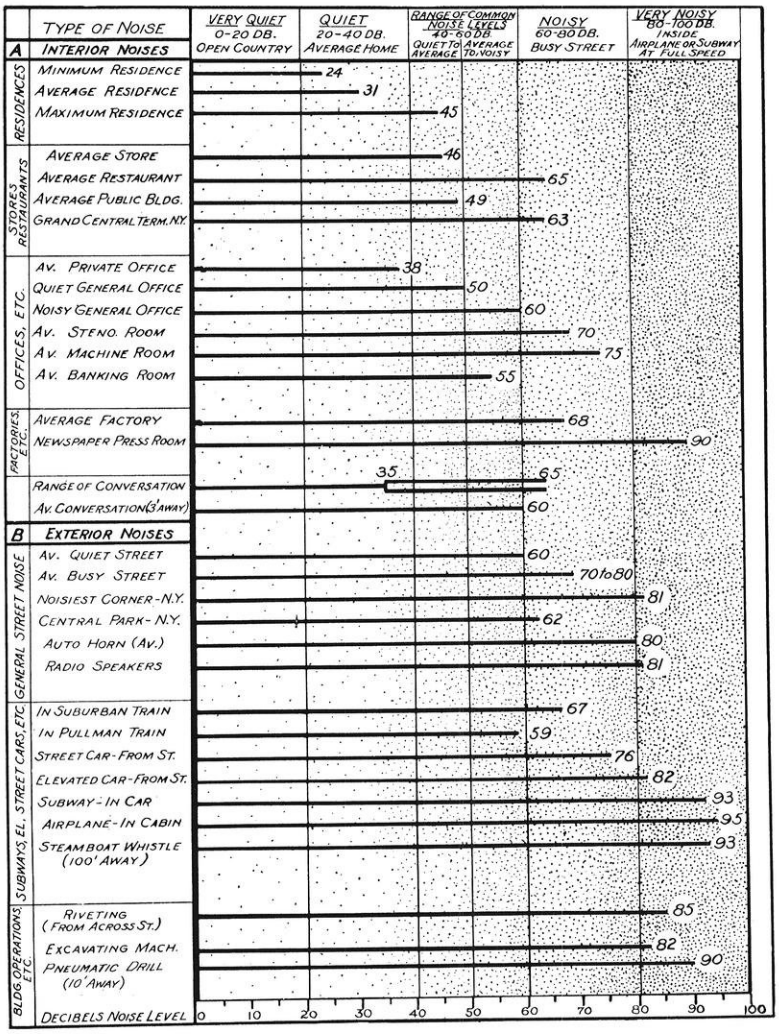


FIG. 3: *This chart gives a comparative picture of the intensities of common noises encountered both indoors and outside.*

Measuring Insruments

There are two distinct types of instruments commonly used in measuring the intensity of noise. The first is the Acoustimeter which yields a purely physical measurement; the other, the Audiometer, involves the use of the ear of the observer. Both can be calibrated to give readings directly in decibels.

The principles of the Acoustimeter is the conversion of sound energy into electrical energy. Figure 1 is a simplified diagram of this instrument. The microphone picks up the sound wave and converts it into electric oscillations which are then amplified and rectified. The output of the amplifier is measured by the meter which is calibrated in decibels. The attenuator serves to control the amplitude of the oscillation by large steps. When an extremely loud sound is encountered a known amount of attenuation may be quickly inserted to keep the needle from being driven off the scale of the meter. The weighting network is designed to render the Acoustimeter more sensitive to certain single frequencies to which the ear is more sensitive, thus reproducing in the Acoustimeter an action somewhat similar to the effect of sounds in the ear.

In its simplest form the Audiometer consists of an electrically operated buzzer producing what is called a standard noise, an attenuator, and a telephone receiver. The buzzer generates electric oscillations which are supplied to the telephone receiver. The receiver, in turn, emits the standard noise which may be varied in amplitude by the attenuator. The telephone receiver is provided with a supplementary face-plate fitted to the front of the receiver with an open space between as shown in Fig. 2.

The standard noise from the receiver enters the ear through the hole in the face plate while the noise to be measured enters the ear simultaneously through the space between the plate and the receiver. The observer hears both noises at the same time and by varying the loudness of the standard noise with the attenuator he can "mask", or render inaudible, the outside noise which he is measuring. The scale of the attenuator having been previously calibrated against noises of known loudness, the scale settings of this instrument at which "masking" is just complete provide a measure of the noise. The audiometer is reasonably accurate if the frequency of the noise being measured does not vary too greatly from the noise produced by the standard buzzer, but the acoustimeter furnishes a far more flexible, accurate, and reliable means of noise measurement.

The chart, Figure 3, gives a comparative picture of the intensities of common noises encountered both indoors and outside. To study noise in New York City and to develop means of abating it a commission was appointed by the department of health. A scientific survey and analysis of city noise was undertaken by acoustical engineers attached to

(Continued on page 234)

Editorials

JUST A FEW SIDE SHOTS Newspapers recently reported the introduction into the legislature of a bill that would require the university to play football with Marquette. Legislative dictation of such details seems rather silly, but perhaps it will give us a schedule that we can win.

* * *

The investment in highways, garages, bus terminals, and motor vehicles in this country now totals 25 billions according to the A. A. A. This is about equal to the investment in railways. The engineer has a great field for his efforts in transportation.

* * *

The Milwaukee railroad introduces the Locomotor, a new type of steam locomotive that looks like a baggage car, uses oil fuel, and generates steam at 700 pounds. It is said to represent ten years of experimentation.

* * *

Madisonians, according to Dr. E. F. Bean, state geologist, quaff water that fell about the time Christ was born. Madison's water comes from deep wells in a rock stratum that outcrops about 150 miles north of the city. Water that falls on the outcrop spends 2000 years in working its way to Madison. It tastes okeh even though it has been out of circulation for a long time.

* * *

The latest rocket motor, developed at Paul Heylandt's liquid oxygen plant in Berlin, is said to use a mixture of liquid oxygen and alcohol, which is ignited in a cannon-like muzzle. Heylandt believes it has possibilities as motive power for airplane flights through the stratosphere.

* * *

Grinnell College (Iowa) comes forward with its contribution to the year's collection of educational "plans". It has announced that it will admit a selected group of high school students with only three years of secondary education. Write your own ticket.

"Why does this magnificent applied science, which saves work and makes life easier, bring up so little happiness? The simple answer runs: Because we have not yet learned to make a sensible use of it."—Einstein.

TO DAVID MACK At the risk of being accused of making invidious comparisons among the members of our staff, we take this opportunity of expressing the appreciation of those who are in the know for the generous labors of David Mack during the current year. Mack looked after local advertising, which is a tough job at best and doubly tough in such times as these. He handled the assignment without any fuss and feathers and with great success. He made the job look easy, although we know it wasn't. Probably all of this would have passed without comment as what is to be expected of a staff member, but Mack put the finishing touch to an excellent job by stepping forward after he thought his job was done, and pulling the April issue out of the fire. At short notice he rounded up the local advertising in a masterly fashion and saved what promised to be an embarrassing situation. Therefore, to him goes the laurel wreath and the thanks of all the staff.

"The successful person is almost invariably the one with unusual ability to choose what is most important."
—Arthur E. Morgan.

ILLEGAL EIGHT-O'CLOCKS The recent refusal of a student to join the fraternity to which he was pledged because he didn't like to be subjected to hell week has caused considerable comment in the press. Our diligent legislators at the Capitol, finding themselves short of material, have leaped on the subject with avidity and the newspapers not long ago carried the notice that a law had been proposed which would make hell week illegal. A new field has been opened. Perhaps, if the solons again run short, it would be possible to suggest that the student body doesn't like to be subjected to eight-o'clocks or Saturday classes. To have that last hour of sleep in the morning protected by state statutes would be a real luxury.

"The power of instruction is seldom of much efficacy, except in those happy dispositions where it is almost superfluous."—Gibbon.

LO, THE POOR TEACHER A classic piece of sculpture represents "Lo, the poor Indian" mounted on a weary pony, both of them hunched against the sweep of hostile winds at their back and nerving themselves for the last blow that will drive them into the Pacific Ocean and oblivion. Does the classroom teacher now stand in the place of "Lo"? Professor Spaulding, in his paper which is abstracted in this issue, is of the opinion that he does and that he will have to sit up and take notice if he is to prevent his being exterminated by modern efficiency.

While there is not the whole-hearted understanding and sympathy between teachers of education and teachers of other subjects that would be desirable, and there may be a tendency to dismiss Professor Spaulding's warnings as unjustified, a little consideration of the methods and the successes of correspondence teaching will give credence to his ideas. Is the classroom teacher a luxury, a convenience, or a necessary?

The first reaction of the classroom teacher in the face of this attack seems to be to fall back upon his stimulating and inspirational powers as a defense, but Professor Spaulding takes away that prop. In any case, the number of inspiring classroom teachers is relatively few.

The article suggests that the classroom teacher will find his greatest justification in his ability to handle a class as a *group* instead of as an aggregation of unintegrated individuals. He suggests a method of teaching that is old stuff to engineering teachers, a method in which each student contributes a share to the solution of a class problem. The famous power plant test of the steam and gas department, or the railway location survey at Devils Lake are representative of his suggested group teaching. Such group teaching is interesting and effective, but it has its limitations. Probably it could be extended to advantage far beyond its present use. Group teaching is involved in Professor Bennett's present experiment with the "board of inquiry" method.

One important advantage possessed by the classroom teacher, but not mentioned by Professor Spaulding, is that he is in a position to present to his students new ideas and new information at the earliest possible moment. The interested and alert teacher eliminates the lag that necessarily exists between the appearance of new ideas and their incorporation into a text book or into assignment sheets. His advantage in that respect is a considerable one.

Engineering teachers would do well to read Professor Spaulding's article in full, for the abstract does not do him justice. The subject deserves attention. Economic pressure is building up behind our educational system and will undoubtedly lead to a search for efficient and economical methods of instructing the country's youth. Perhaps the classroom teacher *should* go the way of poor Lo.

An old Scotch preacher once said: "If a man lacks knowledge, he can get it from books; if he lacks grace, he can pray for it; but if he lacks judgment, the Lord help him": and he might have added: "The Lord help all who are in any way associated with him."

GOODBYE, I'VE ENJOYED THE VISIT The time of year draws near for the appearance of the usual crop of elegies, swan-songs, or memoirs penned by seniors who are to graduate and who wish to leave behind them a (sometimes) wistful and (almost) literary impression of Wisconsin.

They usually take this form—"fall again and school is just commencing—brisk mornings—clear blue skies—friendships being renewed—timid-faced freshmen, eager and yet afraid—a rainy day on the hill—slickers and raincoats red, green, yellow, blue, and brown—everyone hurrying"—and so on ad infinitum.

There have been others sung in a more mournful cadence —"Wisconsin was a big disappointment to me"—"Why did I waste four years at university?"—

Then there are the farewells perpetrated by the more optimistic rotarians—"I am to be a college graduate, the world lies at my feet"—"We who graduate go forth to battle with the realities of life armed only with a diploma"—"Farewell, Wisconsin, builder of men and women."

The writer has never questioned the sincerity of the seniors who write such things; but is there no one who will eulogize a university because it made him realize just how little he actually does know, and how little he can hope to learn in one life-time, however long? Perhaps it is because we are ashamed to admit our ignorance to the world at the one time in our life when we would like to proclaim our knowledge (?) from the house tops.—D. J. M.

"Concern for man himself and his fate must always form the chief interest of all technical endeavors, concern for the great unsolved problems of the organization of labor and the distribution of goods,—in order that the creations of our mind shall be a blessing and not a curse to mankind.

—Einstein.

THE GIFT HORSE AND HIS TEETH The gift policy of the university is in a fair way to become hopelessly snarled through unwise interference. The action of the trustees of the Brittingham Fund in requesting that money from the fund no longer be used to pay Dr. Meiklejohn's salary precipitated the most recent storm. Above the uproar caused by that action the voice of the editor of the Wausau Record-Herald rises with the most level-headed suggestion:

> It is unwise and foolhardy to refuse all gifts from wealthy men or large estates, but if there are any "strings" attached to the gifts, that fact should be made clear at the time of the gift, and if the board of regents feels the plan under which the donor offers the money is incompatible with the regents' ideas of what a university should be, why by all means reject the gift.

This suggestion is workable, while most of the other suggestions are not. It implies that the university is not for sale to the highest bidder, and it implies that the regents are people of intelligence and good judgment able to reach sound decisions in such matters. It is the best suggestion that has as yet been made.

WHAT IS A STRING? Wisecrackers of a generation ago convulsed themselves and their admiring audiences with the quaint query: "How long is a piece of string?" That was a wise crack. Right now, in all seriousness, we arise to ask: "What is a string?" The word has become prominent in connection with the policy of the university toward gifts. Recently, the trustees of the Brittingham fund requested that the proceeds of the fund be transferred from the chair of philosophy to the chair of bio-chemistry and raised a storm because there was a "string" to their gift. Shortly thereafter a defunct seminary left $230,000 to the university with instructions that it be used for teaching German,—and there wasn't even a peep about a "string". To the casual observer, both gifts seem to have attached to them the same kind of a condition, or "string", but one raises a furore and the other does not. Just what is a "string"? Can anyone explain this funicular mystery.

Alumni Notes

Among Our

Successful Wisconsin Engineers

is

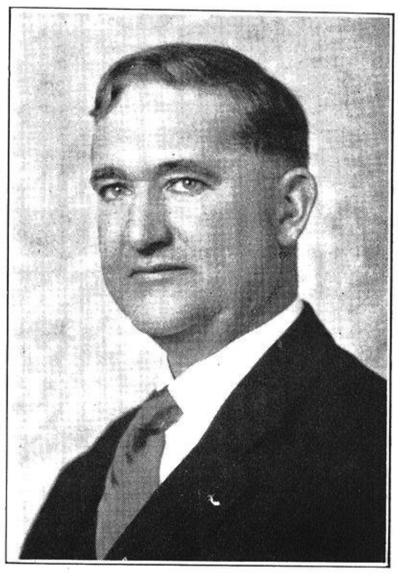
Jerry Donohue

Jerry Donohue, chairman of the Wisconsin Highway Commission, controls the activities of a great many Wisconsin engineers. He stands among the leaders of his profession in the state, a fact that is attested by his election in 1922 to the presidency of the Engineering Society of Wisconsin. His appointment to the Highway Commission in July, 1929, by Gov. Kohler was looked upon not as the conferring of an honor or a sinecure, but as the drafting of a competent citizen for public duty. At the time of his appointment, the new commissioner was the head of an engineering firm that handled a large amount of municipal work.

Jerry Donohue was born in Milwaukee on January 20, 1885. His father, who bore the same name, was born in Ireland and came to this country when a child of five. His mother, Abby Clark, was born in Providence, R. I., and came to Wisconsin in the early '50s. The family moved to Sheboygan in 1890, and there Jerry grew up and went to school.

The elder Donohue, though not a graduate engineer, was active in the construction of Wisconsin's first railroads and had charge of building the Lake Shore road from Milwaukee through to Ashland. It was a natural thing for the son to turn toward civil engineering. He entered the state university and enrolled in civil engineering, receiving his degree in 1907.

During the two years following graduation, 1907-1909, Jerry was division engineer in charge of eight iron mines of the Tennessee Coal, Iron & Railroad Co., at Bessemer, Alabama, and gained experience in mining engineering and railroad construction.



In 1910 he returned to Sheboygan and began private practice which he has continued ever since. In 1921 he incorporated the Jerry Donohue Engineering Company. His practice is in the municipal field and includes some twenty cities and villages. Among his outstanding accomplishments is the design and construction of the sewage disposal plant at Antigo, in which the gases of decomposition were collected, burned, and used to heat the sewage so that decomposition would continue during cold weather. This was the first plant of its type in the United States. Engineers throughout the country have showed their approval of the idea by incorporating it into their own designs.

Combined with high professional attainments, there is in Jerry Donohue a warm humanness that wins him friends among all classes of people. He is no mere technician. People like him and show their appreciation of his personality and his ability by putting him in positions of honor and responsibility. The Rotary Club of Sheboygan made him president in 1925, the Association of Commerce conferred the same honor in 1926, and Sheboygan Country Club followed suit in 1928.

The out-of-doors has always appealed to Jerry and he knows his northern Wisconsin and its hunting and fishing, and is a member of the Isaac Walton League. He has been slowed up a little by an accident that left him with a limp, but can still enjoy his golf and finds relaxation in "hunting" with a movie camera. He spends his summers with his family at his summer home at Elkhart Lake near Sheboygan. The family includes his wife, who was Leila Marion Bishop of Sheboygan, and three children, Gail, Kathleen, and Jerry third.

The list of professional societies of which he is a member includes the American Society of Civil Engineers, American Society of Municipal Engineers, American Concrete Institute, American Road Builders Association, and Central States Sewage Works Association. He was chairman of the committee on sanitation of the American Society of Municipal Engineers in 1928.

'06 MEN ROW IN JUNE

Among the members of the class of 1906 who plan to be back for their reunion next month are the following engineer members of the 1903 freshman crew: **Stroke F. Ellis Johnson** who is head of the Department of Electrical Engineering at Iowa State College, **Guy M. Johnson** who is with the Northern Indiana Public Service Company at South Bend, Indiana, and **William M. Conway**, Madison, a building and paving contractor. Some of these men hint at the need of additional air tanks in the shell due to their change from the schoolboy figure to a more manly shape.

ELECTRICALS

Adhya, G. M., e'26, is a resident engineer for the Giridih Electric Supply Corporation, Limited. He writes that he has just completed the erection of a powerhouse which shall generate 33,000 volts at 150 kilowatts. His address is: Giridih, E. I. Ry., India.

Ajer, Oliver, e'29, is a member of the research laboratory of the General Electric Company at Schenectady. Recently he entertained Sir Hubert Wilkins, North Pole explorer, and Robert Ripley of "Believe It Or Not" fame by showing them through the "House of Magic".

Bittner, Theophilus V., e'22, died on September 13, 1930, in Aurora, Ill. He was a power sales engineer for the Western Gas and Electric Company, and was formerly employed by the Commonwealth Edison Company, Chicago.

Brewer, R. W., e'21 is manager of the Ford Hire Service in Shanghai, China, which operates a fleet of over one hundred taxis. He writes, "We have a small factory in which we build our own taxi bodies. We employ about four hundred Chinese." Address: 77 Route Vallon, Shanghai, China.

Carpenter, Earl F., e'27, is an electrical engineer with the Ohio Public Service Company of Sandusky, Ohio.

Gould, A. H., e'21, is teaching physics at the Boys' Technical High School at Milwaukee.

Johnston, Stewart L., e'30, former staff member of this magazine, was married recently at Schenectady, N. Y., to Mildred B. Vethe of Baraboo, also Wisconsin '30. Johnston is with the General Electric Company.

Pratt, Robert H., e'29, is a sales engineer with Cutler Hammer, Inc., Milwaukee.

Rasmussen, Clarence F., e'23, is president of Rasmussen & Company, sales engineers and accountants. Offices: 6 North Michigan Avenue, Chicago.

Sipp, Edward A., e'15, is manager of the lighting division of the Pyle National Company, Chicago.

MINERS

Turneaure, Stewart, min'21, son of Dean Turneaure, has been awarded the Emmons geological fellowship at Columbia University. He is at present doing graduate work at Harvard.

White, R. F., min'29, is in charge of the geo-physical work for the Gulf Oil Company in Mexico.

CIVILS

Abendroth, Emil A., c'27, is engaged to Edith Huerth of Sauk City. Miss Huerth is a graduate of Wisconsin, holding a degree of bachelor of science and a certificate of graduate nurse.

Broyles, John S., c'16, gives his residence as 1319 West Bell St., Houston, Texas. Since leaving school his experience has covered sewer tunnel construction in Milwaukee, aviation in the U. S. Navy, highway and railway location and construction, and the design, location, and construction of pipe lines. From June, 1926, to June, 1930, he was chief engineer of the Houston Gulf Gas Co.

Hain, Elmer L., c'10, who was detailed by the U. S. G. S. as instructor in plane table work at the university survey camp during the summer of 1927, is technical and administrative assistant to the chief topographic engineer of the U. S. Geological Survey.

Koenig, Meinhardt Carl, c'11, announces the arrival of a daughter, Patricia Wright, on February 21 at El Paso, Texas.

Lange, William H., ex-c'18, is salesman and construction engineer with the Bark River (Mich.) Bridge & Culvert Co. He dropped out of school in 1916, although he had a good scholastic record, and went to work for the Green Bay and Western RR. During the war he was lieutenant in charge of highway repairs in France. He returned to the college for the spring of 1920. His work has been in the railway and highway fields. Address: 917 Fourth St., West De Pere, Wisconsin.

Lembke, Louis, c'27, is superintendent of construction with the Universal Construction Company of Milwaukee.

Levin, Jake D., c'27, who has been taking graduate work at this college during the current semester, withdrew during the spring recess to act as superintendent for Bentley Brothers of Milwaukee on the construction of two concrete bridges in that city. Address: 1139 W. Maple Street.

Luedtke, E. R., c'26, is in the marine construction business under the name of the Luedtke Construction Company. His office is located at Frankfort, Mich. He has just received a contract for some breakwater work at Waukegan, Illinois.

Lyneis, Claude, Jr., ex-c'32, former circulation manager of the "Wisconsin Engineer", is now employed by the Hutter Construction Company at Sewickley, Penn.

Rheingans, William J., c'20, test engineer with Allis-Chalmers Company, has recently returned from two and a half months in Costa Rica where he was engaged in diagnosing and curing some ailments in a hydro-electric plant that was troubled with vibrations. Rheingans, who was manager of this magazine during his senior year, is an archery enthusiast and has a wife, who he admits is a better archer than he. They both compete in state and national meets. Bill has also done some hunting with bow and arrow, but has not yet worked up to lions. He is still in the rabbit class.

Shuman, Everett C., c'24, M. S.'26, about the end of April took charge of the research laboratory of the Pennsylvania-Dixie Cement Corporation at Richard City, Tenn., a small town about 35 miles west by a bit south of Chattanooga.

Sogard, Lawrence T., c'24, is sales engineer with the Acoustical Engineering Corporation at 230 N. Michigan Ave., Chicago. The company is a subsidiary of the Johns-Manville Corporation and was established a year ago to sell and install sound-control materials. Sogard is devoting himself largely to sales effort, which he reports as "tough picking in these times of stress".

Steinmetz, Geo. P., c'23, is celebrating the arrival of a baby boy, George Phillip, Jr., born April 21st.

Wootton, Clarence J., c'30, is with the U. S. army engineers in the Federal Building, Milwaukee.

Zahorick, Peter, c'20, is sales engineer with the Kalman Steel Company of Milwaukee.

CHEMICALS

Cummings, Harold F., ch'30, is in the sales promotion department of the Mallinckrodt Chemical Works at St. Louis. Address: 920-A South Kingshighway, Kingsworth Apts., St. Louis.

Rick, Thad T., ch'29, formerly with the E. I. DuPont de Nemours Company at Parlin, N. J., is now with the A. O. Smith Corporation in Milwaukee.

Campus Notes

TAU BETA PI ELECTS

Tau Beta Pi, national honorary engineering fraternity has conferred upon the fifteen juniors whose names are given below the highest scholastic honor attainable by engineering students, membership in the fraternity. Only juniors standing in the upper eighth of the class are elegible for election at this time. At Wisconsin, membership in Tau Beta Pi has been honestly awarded and carefully guarded and carries much prestige.

New Members

Harry C. Dever, *Civil*
Bertin J. Dittmer, *Mechanical*
Rudolph A. Dobrogowski, *Mechanical*
Eldon R. Dodge, *Civil*
Sidley O. Evans, *Electrical*
Aake Jonassen, *Mechanical*
Ralph H. Kehl, *Mechanical*
Lawrence L. Krasin, *Civil*
Robert L. Miller, *Civil*
Carl H. Ramien, *Mechanical*
Melvin J. Sterba, *Chemical*
Robert L. Van Hagan, *Civil*
Olaf F. Vea, *Electrical*
Aubrey J. Wagner, *Civil*
Kyle C. Whitefield, *Mechanical*

SIGNAL FRATERNTY ELECTS OFFICERS

New officers of Pi Tau Pi Sigma, honorary Signal Corps fraternity, elected on April 22 are: Donald E. Graves, e'32, president; Elmer R. Kolb, e'33, vice-president; George H. Lorenz, m'32, secretary; Philip B. Buenzli, e'33, treasurer; Shirley G. Blencoe, e'33, historian.

OWEN TO RE-DISTRICT MADISON

Ray S. Owen, professor of topographical engineering, and alderman from the tenth ward, has been appointed chairman of a special committee to re-district Madison. Prof. Owen has been quite active in affairs of the city of late. Perhaps it would be well to remember him the next time a cop hands you a ticket in Madison, but be sure that your T. E. work is up to date.

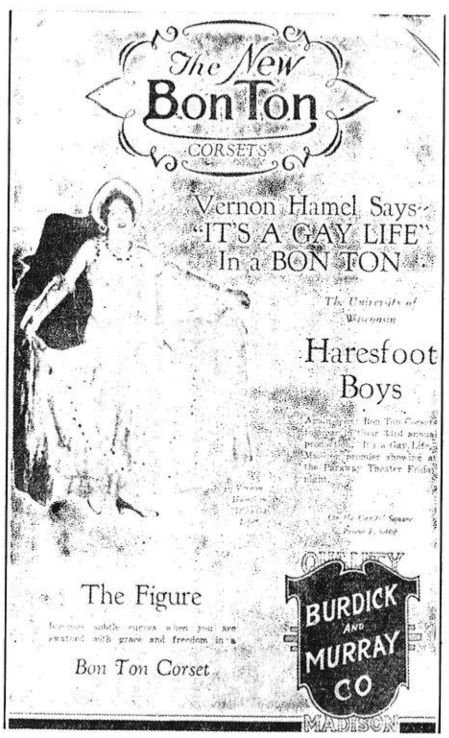
CHI EPSILON INITIATES EIGHT

Professor F. M. Dawson became an honorary member of Chi Epsilon, honorary civil engineering fraternity, and seven juniors were initiated into the organization at the spring initiation banquet held on April 21 at the Park Hotel.

The juniors initiated were Lawrence L. Krasin, of Marshfield; Otto R. Herrmann, of Milwaukee, Robert H. McMicken, of West Allis; John A. Strand, of Wauwatosa; Robert J. Buehler, of Baraboo; Louis L. Berg, of Pierre, S. D.; Harrison F. Thrapp, of Chicago, and Robert L. Van Hagan, of Madison.

HAMEL STARS IN HARESFOOT

Vernon S. Hamel, listed both as a senior civil and as a law student, stars for the third season as leading lady of



Figures accurate to three significant places.

Haresfoot. Although there is nothing effeminate about Vern when he dons the high boots and takes to the field, he makes a lovely lady on the stage. Two other engineers, Joseph A. Lucas, m'31 and Karl Peters, m'31, also contribute to Haresfoot's 1931 show.

ENGINEERS MAKE SCABBARD AND BLADE

Among the 16 men recently elected to Scabbard and Blade, national honorary military fraternity, were the following engineers: Francis J. Euclide, c'31; Norbert Steckler, m'31; Perry R. Ferguson, c'32; Charles H. Novotny, m'32; Philip B. Buenzli, e'33; and George H. Lorenz, m'32.

ENGINEER SINGERS ARE NUMEROUS

Ten engineers are listed among the singers in the university Glee Club this year. This follows tradition, for engineers have been prominent in the organization for many years and have furnished officers for the club, as well as many soloists. The list this year includes: Louis L. Berg, c'32; John T. Drow, c'31; Sidley O. Evans, e'32; Loys A. Johnson, graduate in electrical engineering; John W. Meinhardt, m'33; William J. Morrow, min'31; William Penn, m'32; Orin J. Swingle, ch'33; Frederick E. von Schlichten, e'31; Ken E. Youngchild, ch'33. Loys Johnson proved himself a competent and pleasing soloist in the home concerts in February.

CHI EPSILON OFFERS PRIZE

Chi Epsilon, honorary civil engineering fraternity, is offering a prize to the freshman civil with the highest scholastic rating at the end of the semester. In place of the slide rule which they offered last year, they will present this year's winner with a civil engineer's handbook to be selected with the aid of the faculty.

WATTS TALKS ON CHROMIUM PLATE

Chromium plate is characterized by its resistance to tarnish, by its extreme hardness, and by a slipperiness that finds application in small bearings, according to Dr. O. P. Watts, professor of chemical engineering, who spoke before the Madison section of the American Institute of Electrical Engineers in the Memorial Union on April 29.

LINDE PROCESS SERVICE Assures Dependable Welds

WHEN American industry is called upon for welded construction or assembly where the joint must be dependably strong and tight it adopts oxy-acetylene welding under Linde Procedure Control.

Linde Procedure Control is available to users of Linde Oxygen as a part of Linde Process Service. It provides design assistance, careful attention to selection of materials, instruction in correct welding technique and all other essential factors of good welding practice. It translates methods proved from a fundamental welding background into the actual needs of the specific welding application. It permits the Linde organization to focus upon the problems of one user of Linde Oxygen the combined experiences of thousands and the day-by-day discoveries of a large research staff.

Several valuable and interesting technical booklets describing the application of the oxy-acetylene process of welding and cutting in design, construction and fabrication are available. Tomorrow's engineers will be expected to know how to apply this modern metal-working process. Write us if you are interested.

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MEASUREMENT OF NOISE INTENSITY

(Continued from page 227)

the commission. With their measuring apparatus mounted on a truck, an itinerary was followed in such a way that extremes of noisiness and quietness throughout the city could be observed. The maximum noise observed was produced by a pneumatic riveter at a distance of 35 ft. The level was 101 decibels. Three tests made in quiet locations of the city at 4:30 a. m. showed a level of 38 decibels. In a special test made in an airplane a reading of 115 decibels was obtained 18 ft. from the propeller rotating at 1600 r. p. m. A quiet whisper at 5 ft. registers 10 decibels.

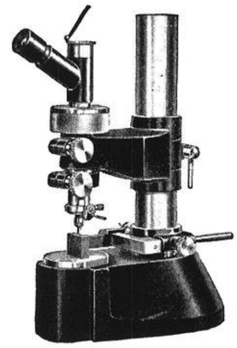
The reward of a thing well done is to have done it.

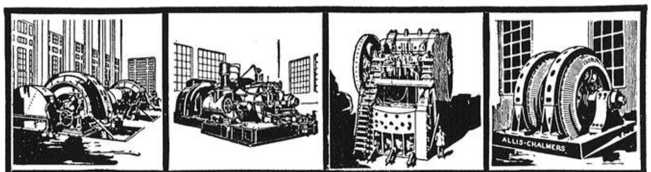
CAN THE TEACHER JUSTIFY HIS JOB

(Continued from page 225)

tion might occupy several class meetings, with no intervening assignments to individuals; individual laboratory work would presumably follow upon group discussions, instead of paralleling them independently; class meetings and laboratory periods both would extend over longer or shorter periods of time, depending on the nature of the work which they involved; outside study would be assigned somewhat irregularly, whenever it might be needed for its contribution to class discussion or laboratory work. The mechanics of learning, that is to say, would be at every step duly subordinated to the demands of learning itself.

(Continued on page 238)





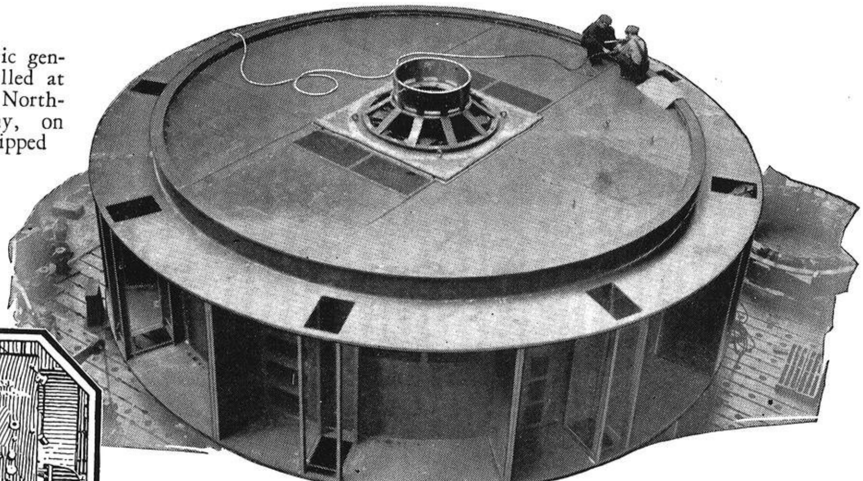
CAN THE TEACHER JUSTIFY HIS JOB

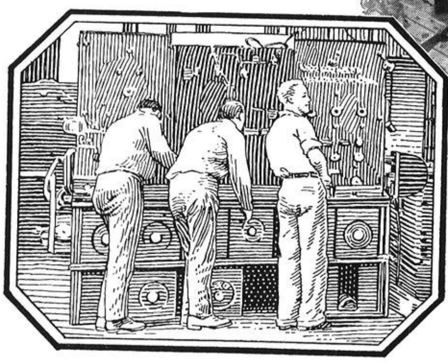
(Continued from page 234)

Yet it is perhaps only too obvious that no one can reasonably look forward to any such fundamental revision as this conception might seem to imply. However desirable it might seem to everyone concerned that the projected scheme of teaching be put into effect, its complete adoption either now or in any near future would be inevitably prevented by at least three overwhelming obstacles: by the nature of people in general, by the limitations of students, and by the life-long experience of teachers. There must be concessions to all three of these obstacles if a workable procedure is to be evolved. In spite of these obstacles to its complete adoption, however, the proposed plan is by no means devoid of practical value. To the extent to which it can be put into even piecemeal effect, it is likely to bring about an improvement in the quality of classroom teaching. And parts of it can be put into immediate and important effect.

He can, for example, so organize his teaching that each assignment of laboratory work and outside study is based upon problems related to those being treated in current class discussions, and he can encourage his students to draw upon each phase of their work for its contribution to other phases. Even if these things and nothing further represent the extent of his accomplishment, he will have established for himself a plan of procedure which goes far beyond the traditional method. With a plan of this sort as the basis of his teaching, it seems safe to predict that he need have little fear of competition from mechanical systems or devices, nor of his own ability to justify his job.

56,250-kv-a. hydroelectric generator now being installed at the Ariel Plant of the Northwest Electric Company, on "test" before being shipped





One Power Giant for a *Million* Lamps

WHEN the waters of the great Northwest turn the wheels of this vast machine—and at only two revolutions per second—enough energy will be furnished to light a million lamps. The huge 56,250-kv-a. hydroelectric generator is 37 feet in diameter and weighs 440 tons. After being set up, this generator was balanced, tested for losses and overspeed, and was adjusted—all by recruit engineering graduates, supervised by experienced "Heads of Test."

Each year many college men discard their caps and gowns for the experience to be gained by actual test of major G-E apparatus in the different factories. Having completed this postgraduate course, which helps fit them for future responsible positions, these men will be largely intrusted with the research, design, planning, supervision of construction, and sale of this equipment.

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