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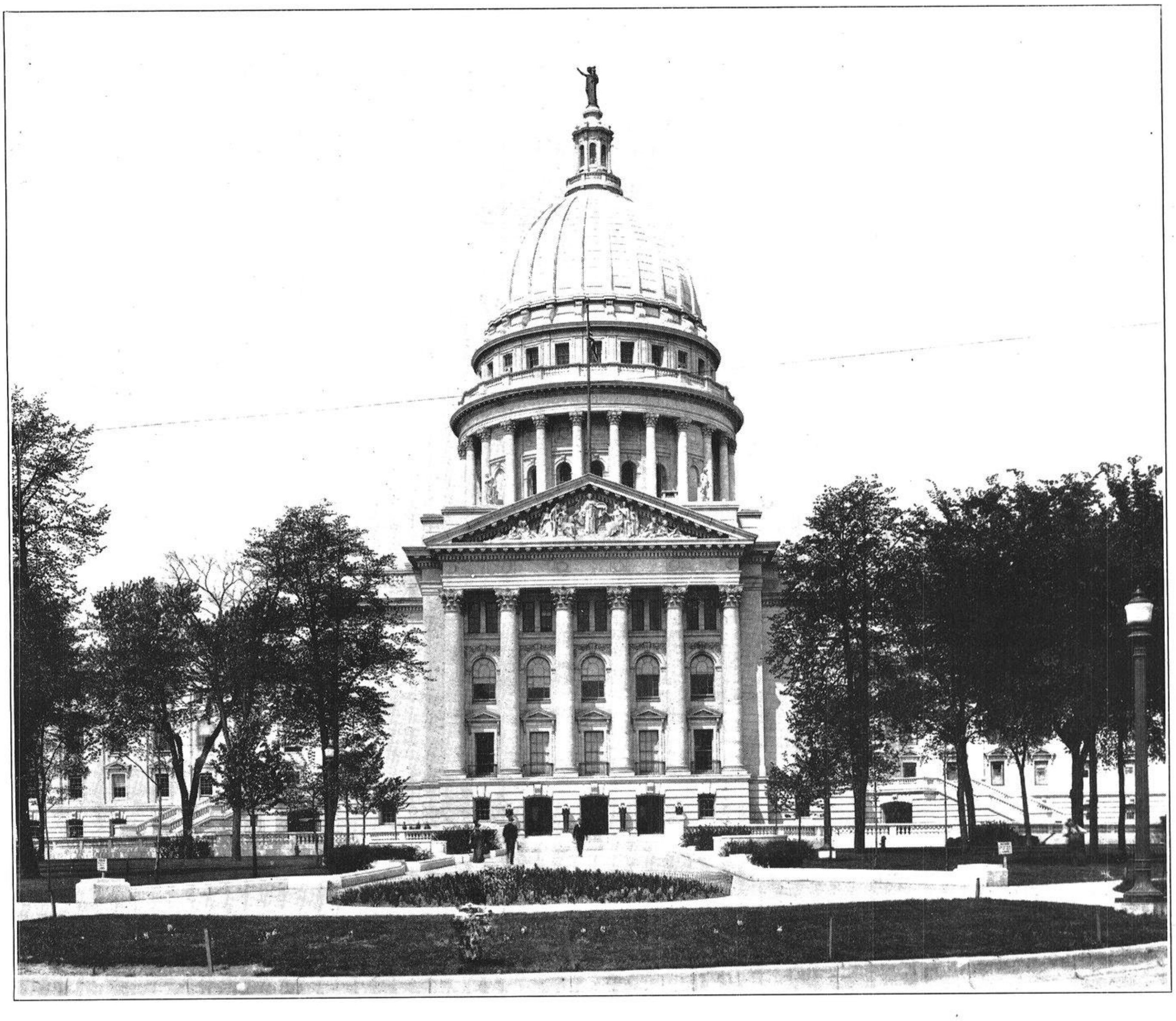

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A Reclassification of the Engin-
ing Courses", by A. F. Rufsvold
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l be distributed at the Engineer-
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This issue carries an article on
he Engineer as a Salesman," by
. T. Ennor, which points out the
alifications of a plumber for oth-
purposes than working a slide
le. N. E. French '23, has des-
ibed the "Eastern Trip" in an
teresting manner.
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ay Field" by Prof. J. T. Hood and
Proposed Legislation for Financ-
g Highways" by M. W. Torkelson
the Highway Commission.

The

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The Wisconsin Engineer
UNIVERSITY OF WISCONSIN

VOL XXVII, NO. 5 MADISON, WIS. FEBRUARY, 1923

MAKING STEEL CASTINGS AS TOUGH AS FORGINGS

By L. R. Mann, Min. E. '22

It is a common belief among users of steel that, where strength and toughness are requirements, the metal must be subjected to mechanical work previous

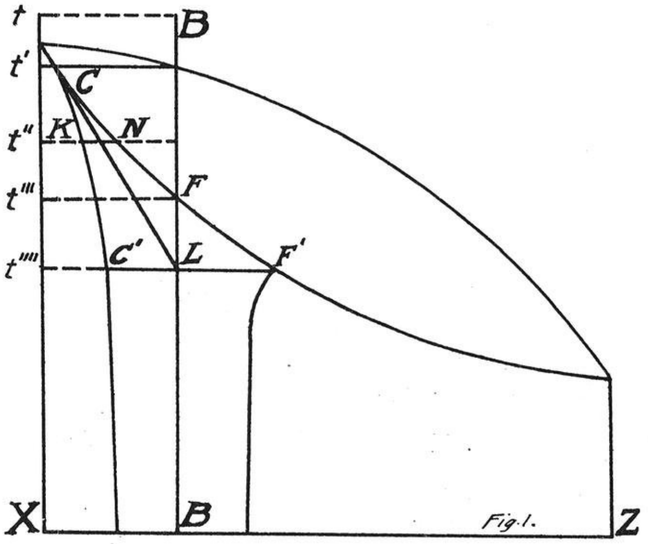


Fig. 1. Any Binary Alloy in Which the Components are Soluble in All Proportions in Both Liquid and Solid States.

to final heat treatment. In pursuance of this belief, the history of some such common part as an automobile crank shaft from the time the metal leaves the steel-making furnace to the time when it is ready for the machinist is a long and expensive one, whereas, in the majority of cases, the steel may be poured directly from the furnace into molds giving it its final shape, and, by proper heat treatment, properties may be imparted to the metal which are comparable to those found in the best forged steels.

A preliminary requirement for such high grade castings is the pouring into the molds of "dead", or thoroughly deoxidized steel. For this reason the steel should be made, or at least finished, in the electric furnace. Such steel has approximately the same specific gravity as forged steel, so any superior qualities that may be found in the latter must be due to more suitable internal structure. Hot work followed by proper heat treatment gives to medium carbon steel a very fine-grained structure, and tiny particles of ferrite embedded in the sorbite matrix are completely isolated by the sorbite. In an untreated casting this weak ferrite is found in a network, or at least in a broken reticule. Subjected to *ordinary* treatment, this network is only slightly affected and remains in sufficient degree to differentiate cast steels physically from forged steels.

For a long time this was accepted as an unchangeable condition and no inquiry was made into the causes underlying the manner of ferrite separation. Recent theory, tested by experiment, is that the course of secondary crystallization of the ferrite, as the temperature falls through the critical range, is dependent on the degree of homogeneity existing in the austenite from which this separation takes place. A preliminary treatment to bring about homogeneity in the austenite is therefore necessary to obtain an ideal structure in cast metal. To show why the austenite lacks homogeneity, the course of cooling in an alloy of the solid solution type will here be traced.

Consider XZ (fig. 1) any binary alloy in which the components are soluble in all proportions in both liquid and solid states. Now an alloy of composition B, being

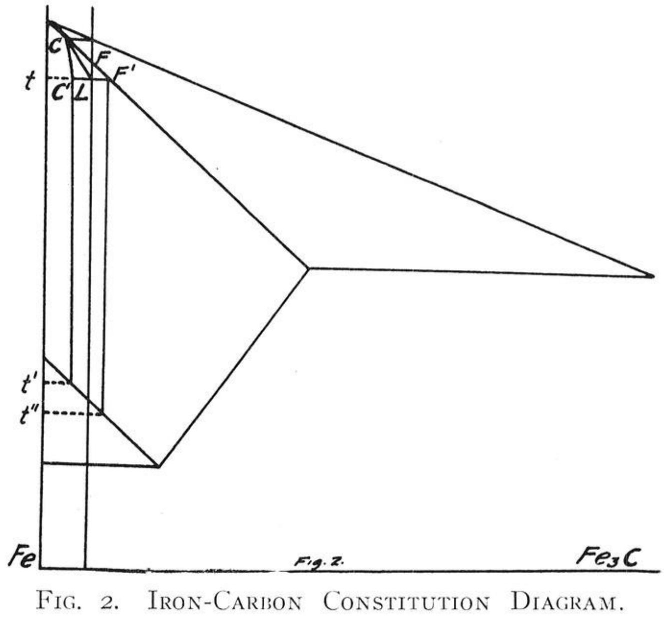
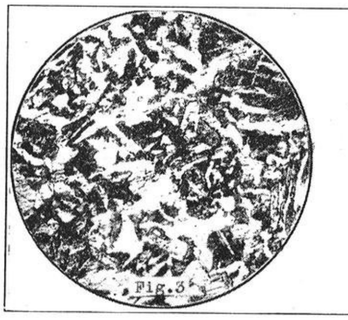


Fig. 2. Iron-Carbon Constitution Diagram.

completely molten at temperature t, on cooling to t' starts to separate out crystals of composition C. On cooling, the composition of the solid separating out follows the solidus line CF, so that at temperature t'' the separating solid is of composition N. Thus the nucleus, of composition C, is the center of a crystal consisting of layers of XZ solid solution, ever becoming richer in Z. Now, should diffusion take place with infinite rapidity from the outer region of higher Z concentration toward the center, the difference in concentration between succeeding layers will disappear, and the line CF will at all times represent the composition of the



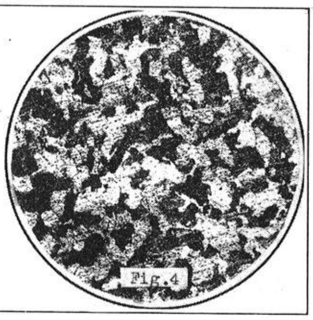


FIG. 3. .3% CARBON STEEL AS CAST. x 100.

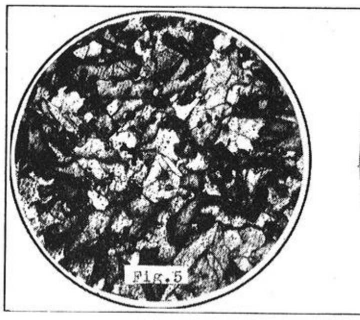
FIG. 4. .3% CARBON STEEL OIL QUENCHED AFTER HEATING 1 HOUR AT 825 C. x100.

entire solid portion. When t''' is reached, the composition of the solid separating coincides with the alloy composition, and the entire mass is solid.

Diffusion in a solid actually takes place, however, far to slowly to have the above ideal condition even approached in practice.

Diffusion acts just rapidly enough so that the nucleus of composition C becomes slowly enriched in Z, its composition following the line CK as the temperature falls. CF at any time represents at any temperature only the composition of the surface of the crystal. Line CL follows the average composition of the crystal, and, as the average composition of solid separating out reaches the alloy composition, final solidification occurs at temperature t''''. The mass then consists of crystals whose internal composition varies from composition C' at the nucleus to F' at the periphery.

Throughout the range of steel composition and above critical temperatures, the iron-carbon diagram is of the solid solution type, in which cooling occurs as above described. As a result the austenitic crystals making



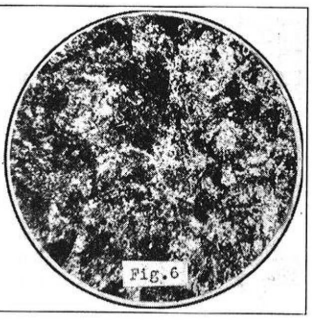


FIG. 5. .3% CARBON STEEL HELD 4 HOURS AT 900 C AND SLOWLY COOLED. x100

FIG. 6. .3% CARBON STEEL HELD 4 HOURS AT 900 C, SLOWLY COOLED TO 825 C AND OIL QUENCHED. x100.

up the mass vary individually in composition from a low carbon nucleus to a periphery high in carbon.

The importance of this fact lies in the resulting effect on the manner of separation of the ferrite as the temperature descends through the critical range.

Reference to the iron-carbon constitution diagram, (fig. 2) shows that through the upper range of primary crystallization a condition occurs just as explained in detail regarding the solid solution alloy XZ. As a result, at temperature t the austenite consists of crystals having a low carbon nucleus of composition C' and a higher carbon periphery of composition F'. At an ordinary rate of cooling, diffusion has time to lessen this difference of composition but very little, so that the low carbon nucleus reaches the temperature t' at which ferrite starts to separate out some time before the periphery reaches the temperature of ferrite separation (t''). Thus the nucleus of primary crystal determines the nucleus of a ferrite crystal, and the ferrite congregates around a predetermined number of centers. The result is that ferrite accumulates in masses which touch in many places and form a ferrite network.

Considering a hypothetical case, assume now that the austenite is perfectly homogeneous. The temperature of

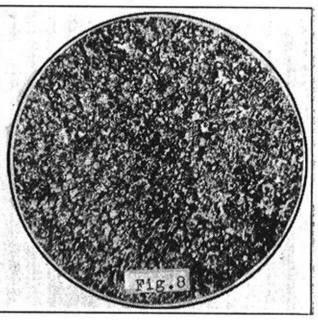


FIG. 7. .3% CARBON STEEL HELD 6 HOURS AT 950 C AND SLOWLY COOLED. x100

FIG. 8. .3% CARBON STEEL HELD 6 HOURS AT 950 C COOLED SLOWLY TO 825 C, AND OIL QUENCHED. x100.

first ferrite separation is then reached by the entire mass at the same instant. A multitude of nuclei then form throughout the mass, and in the resulting structure, tiny ferrite crystals will be uniformly distributed. Steel of such structure has, in the highest degree, the qualities of strength, ductility, and shock resistance.

Although a perfectly homogeneous austenite can never be completely realized in practice, such a close approximation may be obtained as to produce in cast steels a structure similar to that found in forgings. The necessary treatment consists of subjecting the steel to a temperature considerably above the critical range for a time long enough to permit the process of diffusion approximately to equalize the composition. The steel should then be cooled slowly to a temperature just above the critical range. A rapid cooling through the critical range then supplements the effect of the homo-

(Continued on page 95)

OCCUPATIONAL DISEASES IN THE CHEMICAL INDUSTRY

WILLIAM E. OUWENEEL

Junior Chemical

The field of chemical engineering embraces the most dangerous and unhealthful occupations known to industry. The reason for it is quite apparent. An important phase of chemical engineering may be said to be the commercial application of chemical reactions, and only such materials as are chemically active can be subjected to a chemical process. High chemical reactivity, then, characterizes much of the material used, and there is no reason to believe that these same substances should not be highly active within the human body where we find many conditions favorable to chemical action. We find in the chemical industry not only the usual hazards of dust, poor lighting, insanitary conditions, and lack of safety devices, but also the added hazard of chemically active substances.

Necessity for Preventive Measures

The question might well be asked why we, as engineers, should bother ourselves with the quesstion of occupational diseases, when, even though men working under us are subject to those diseases, we, by virtue of our positions, are not. There are two reasons, the ethical one and the commercial one. To one who has studied the field of occupational diseases even to a limited extent, the ethical reason outshines the commercial one. Men may, because of the nature of their occupation, contract incurable diseases or diseases which become incurable when they have developed beyond a certain stage. Men who needs must work in these unhealthful occupations are never comfortably fixed in life and seldom have enough money laid aside to support them in case of permanent disability. If they had, there would be no need of their subjecting themselves to further poisoning and discomfort. Most of them have families to support, and in such cases, when the father becomes incapacitated, the children are drawn from school and put to work and so are deprived of a normal outlook upon life. Aside from the thought of the misery and agony which such a case produces in the home, we should be led to know something of occupational diseases because of our peculiar ability to understand them and aid, through that knowledge in making the world a more pleasant place to live in.

The commercial reason for acquainting ourselves with occupational diseases is embodied in the labor policies of many of our large corporations, which put satisfied, steady labor above cheaply paid labor, believing that the former is the more profitable. Satisfied labor does better work, makes less waste, and reduces the expense of labor turnover. Can a man who has contracted an occupational disease be satisfied in that occupation? An unhealthy man can hardly be satisfied in any occupation, much less in the one which has caused his ill health. A firm with a well-planned labor policy will try to reduce its occupational disease to a minimum. Unless it does it will have difficulty getting labor at any wage when times are good. When times are poor, it will have help only at the expense of a large labor turnover. Healthy, satisfied, steady labor is most profitable.

In looking over a list of occupational diseases, one will note that many common diseases are classed as occupational diseases. A disease may be called an occupational one if persons are especially susceptible to it because of the nature of their occupation. It is the origin, not the nature, of a disease that determines whether or not it is an occupational one.

Broadly speaking, exposure to any chemical compound is likely to be injurious to the health, especially if it gives rise to dust fumes or gas, and there is no part of the human body which is not subject to some occupational disease.

The Dust Hazard

The hazard which is most common, and not confined to the chemical industry, is that of inert dust, which acts wholly upon the respiratory system, its action being to cause physical obstruction or an irritation due to the gritty nature of the dust. Glass dust, fine sand, or other mineral substances may lodge in the mucous tissues of the lungs, producing inflammation, lowering the resistance of the body, and making the lungs fertile for bacterial growth. Limestone workers are especially free from tuberculosis, a condition which has been explained upon the theory that the limestone is dissolved in the body fluids, thus freeing carbon dioxide. Coal miners have been reported to be surprisingly free from tuberculosis.

Irritant dusts as a rule do not produce chronic diseases, although irritant chemicals in general may render parts of the body susceptible to cancer. Irritant dusts, besides their action upon the respiratory system, produce dermatitis, or inflammation of the skin, which often assumes the form of a rash. Chief among these dusts are the intermediates used in the manufacture of dyes and explosives. Dermatitis is evidenced by the skin becoming red or pink, accompanied by severe itching and possible puffing up. It is induced especially by hot weather and sweating, attacking the tender parts of the body and those against which clothing rubs. Individual immunity plays a large part in resisting these dusts. Dark skinned people are immune to many forms, while the light and ruddy skinned type are especially susceptible.

Many dusts, however, are poisonous. Lead and arsenic compounds have long been popularly known as poisons. Lead and cadmium have been found in the kidneys of lead workers suffering from kidney diseases. "Chrome sores" may be caused by dust containing chromium compounds getting into open cuts in the skin. Unless treated immediately and continually, ulcers are formed which grow outwards, forming large sores. Dinitrobenzene may cause severe dermatitis.

Harmful Gases

Gases affect the body only through the respiratory system. The most common of the irritant gases are sulphur dioxide, chlorine, and nitrous fumes. Most of the poisonous gases are so disagreeable that a person will not expose himself to a strong attack of the gas, but he may weaken his body by constant exposure to small amounts. Nitrous fumes as a rule are not so offensive as the others, and men are often severely attacked without their knowledge. Cases are on record in which men have died within a few days after having suffered a severe attack without their knowledge of it. The gases listed above have an irritating action only and make the lungs especially susceptible to pneumonia. The fact that during the war men employed in the manufacture of war gases were surprisingly immune to attacks of flu, led men to investigate the possible prophylactic action of small amounts of these gases. An investigation by the American Chemical Society showed that the immunity was enjoyed to a large extent in most of the plants making war gases, but that there were a few exceptions which prevented them from making any definite conclusions.

Several gases are poisonous because of their action upon the blood. Carbon monoxide and hydrocyanic acid have a greater affinity for the haemogoblin of the red corpuscles than has oxygen, thus preventing the blood from functioning normally. Death in such a case is due to an insufficiency of oxygen.

Poisonous Liquids

The liquids which have a poisonous effect are largely the amido and nitro derivatives of coal-tar products, aniline and nitrobenzene being the simplest ones. They may enter the body as vapors through the lungs, or they may be absorbed directly through the skin due to their solubility in the fats of the body. Their main action is the destruction of the corpuscles of the blood, producing a condition known as cyanosis. Because the blood has been depleted of red corpuscles, persons suffering from cyanosis have a blue or gray appearance. In one severe case a man had a blue-black color. Cyanosis is accompanied by constipation and headache. It affects one only temporarily, and even in the severe case mentioned above the man returned to work after two weeks. Most cases of aniline poisoning are due to the laborer's negligence. If a laborer keeps his clothing free from aniline or similar substances he is not likely to be affected. Phenol may cause dizziness, delirium, and Bright's disease. Wood alcohol may be absorbed as vapors or through the skin and produce effects which are now well known. Carbon tetrachloride and tetrachlorethylene may produce toxic jaundice.

The higher derivatives of the coal-tar products, such as dinitrobenzene and trinitrotoluene, have a more powerful effect. Besides the usual effects of aniline poisoning, degeneration of the cells of the kidneys and liver is produced, making one thus attacked subject to Bright's disease and to toxic jaundice.

Prevention of Disease

The prevention of occupational diseases is largely a matter of ventilation, sanitation, and education.

Since dust and fumes are found in so many kinds of plants, proper ventilation is seen to be of wide necessity. This implies not only the use of windows and ventilators but of forced drafts to carry dust and gases to places where they will not cause discomfort.

Sanitation and personal hygiene play possibly the largest part in the prevention of occupational diseases. It has been pointed out that much of the disease is due to the contact of chemicals with the skin. This of course can be mitigated by frequent bathing and the changing of clothes. Modern chemical plants have shower baths which the men are required to use each evening before leaving work. Many plants insist on the men's having a complete change of clothing at work, which is washed as often as necessary. Men are furnished in some cases with complete toilet kits including a toothbrush and a fingernail brush which they are urged to use several times each day and especially before leaving work. Special clothing, aprons, gloves, goggles and wooden soled shoes are often furnished. Sanitary toliet and drinking facilities should be supplied. Chemical machinery should be constructed to prevent leakage and spillage. Floors should be flushed with water daily if possible. Materials should be kept in well covered containers. Ventilator exhausts discharging dust should be connected with bag filters or other dust precipitators. Fumes should be discharged at a height such that they will not cause discomfort.

The average laborer in the chemical industries has a low standard of personal hygiene. If he is inexperienced in work in a chemical plant, he will not subscribe immediately to the program outlined briefly above. Possibly he will think himself hard and above the necessity of observing precautions. Such men as a rule are poor risks. Sooner or later they will suffer an accident merely because of their inattention to advice. The use of the equipment listed above helps everyone concerned. It helps the employer to keep a steady, satisfied, healthy force on the job; it helps the laborer to retain his health and to enjoy personal comfort. The use of the bathing facilities not only keeps him healthy, but aids him in enjoying his rest at home and his sleep during the night. Much ordinary disease among working men is due to their ignorance of hygiene. In some occupations men suffer from a form of rash which is due to the unusually favorable conditions furnished the germs on the surface of the skin to start an infection. This is entirely prevented by frequent bathing. Many

(Concluded on page 95)

A NOVEL HEATING PLANT

By John C. White

State Power Plant Engineer

The Child Welfare Bureau of the State Board of Health operates a clinic car in connection with its work in the rural districts where facilities for the examination of children are limited. The car was built under

Fig. 1. The Child Welfare Car Unlimbered for Action. *The car is fully equipped with a hot water heating plant, lavatory and running water, and electric lights.*

the general direction of Mrs. H. H. Morgan, Director of the Bureau, and the mechanical equipment was designed and installed by the State Department of Engineering.

This equipment consists of a hot water heating plant, a lavatory and running water, electric lighting, folding steps for the front entrance, and several other minor details.

Figure 1 shows the general appearance of the car as unlimbered for action. Entrance is at the front and exit by the rear steps. A hand rail, not shown in the cut, is provided for the rear steps. The car is fully equipped for the medical examination of children of pre-school age and it carries a physician and nurse in addition to the driver.

The body of the car is 6 feet wide, 6 feet 4 inches high, and 12 feet long. The working length is increased 3 feet by the folding doors at the rear. It is mounted on a General Motors Company 1½ ton truck chassis.

The heating plant consists of a vertical steel bailer, 8 inches diameter by 8 inches high, with 64 ½-inch O. D. seamless steel tubes, welded in place and giving a total heating surface of about 5.5 square feet, a 3-unit Bunsen burner, two wall type radiators of 15 square feet and one of 10 square feet, an expansion tank and the necessary piping, fuel supply tanks and appurtenances. The fuel is gasoline.

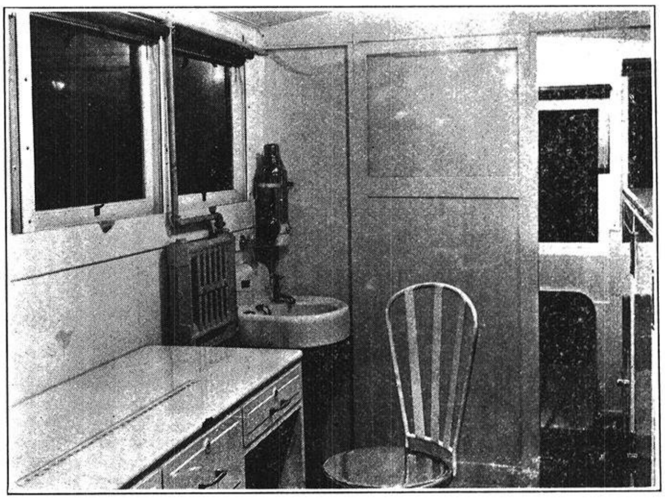


Fig. 5. An Interior View. *The heating system involves no sacrifice of space in the car.*

No working space in the car is sacrificed to heating equipment other than the radiators and their necessary piping. The expansion tank is overhead and the boiler, burner, and fuel tanks are beneath the floor.

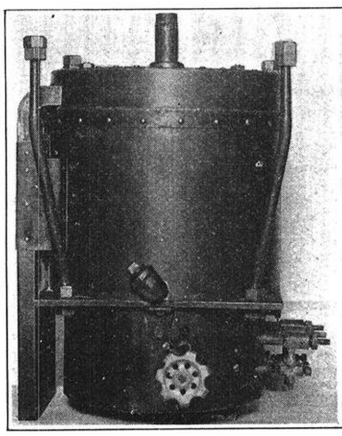


Fig. 2. Side View of Boiler and Burner.

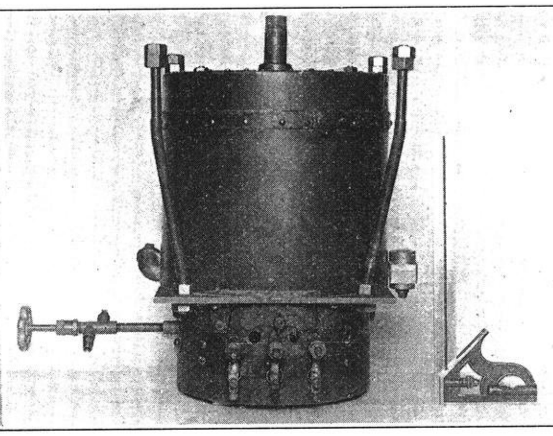


Fig. 3. Front View of Boiler and Burner.

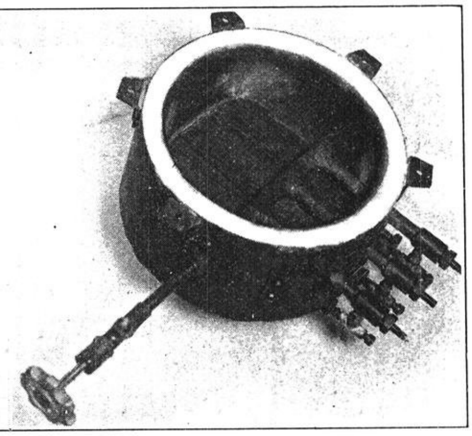


Fig. 4. Interior View of Burner.

Hot water was chosen because of its better control of temperatures and consequent economy, and the Bunsen type burner because its blast feature eliminated the

(Concluded on page 94)

A MILLION VOLT EXPERIMENTAL OUTFIT

BY PARRY H. MOON, e '22,

Cadet, Westinghouse Electric & Manufacturing Co.

When the California Institute of Technology decided to purchase transformers for the production of 1,000,000 volts, it considered several possible methods. It was feasible to get a single transformer of very high voltage such as the one in operation in the Westinghouse laboratories at Trafford City, Pennsylvania; two 500,000-volt units could be connected in series as in the General Electric laboratory at Pittsfield, Massachusetts; or a larger number of transformers of correspondingly lower voltage might be used.

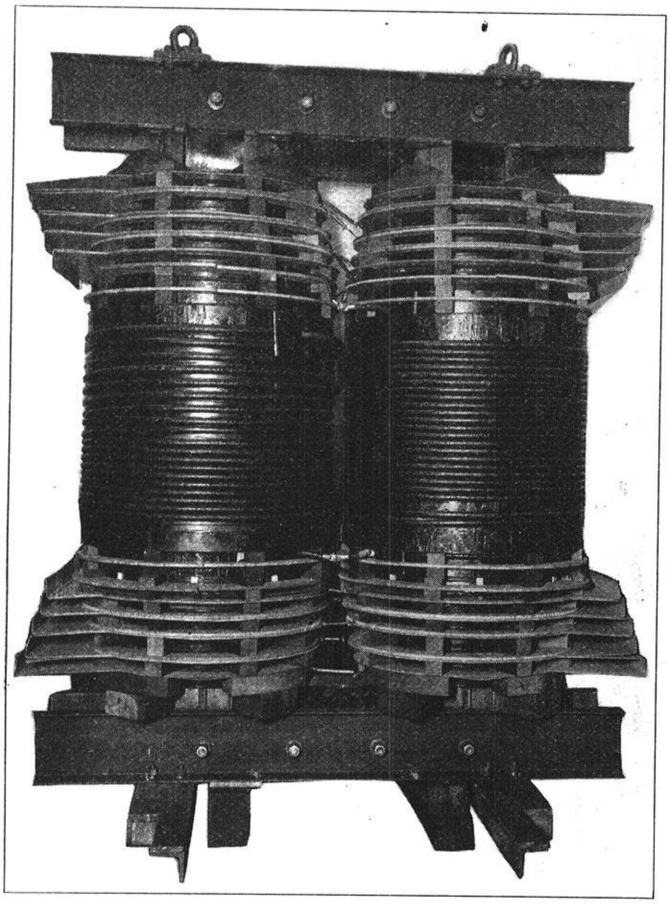


FIG. 1. HIGH VOLTAGE TRANSFORMERS. *The core is silicon steel, the secondary consists of sixteen concentric micarta tubes each wound with a single layer of wire, and the end portions are wound with 7000-volt cable.*

The Institute decided to use a set of four 250,000-volt units, the greater cost and complexity of this arrangement being more than balanced by the greater flexibility. These transformers are now in the last stages of construction in the East Pittsburgh shops of the Westinghouse Electric and Manufacturing Company.

By the use of four units a considerable range of experimental work can be done that would be impossible with a lesser number. A cascade connection will be used for 1,000,000 volts, a single-phase transmission line can be run at 500,000 volts, by using two transformers at each end, and a three-phase open-delta connection is useful for 250,000-volt transmission. While transformers of higher voltage are quite common, the uses to which these units will be put necessitates some rather unusual features.

Fig.2 shows a diagram of connections for 1,000,000-volt operation. Four duplicate transformers are used, each rated at 250 kv-a., 3000 or 6000 volts primary, 250,000 volts secondary. The entire set is rated at 1000 kv-a. The primary of the first transformer is supplied at either 3000 or 6000 volts, induction regulators being used to vary the voltages from these values as desired. A tap is brought out 3000 volts from the high voltage end of the secondary, and this upper section of the winding supplies the primary of the second transformer.* The third and fourth are supplied similarly, so that a million volts is obtained from the last terminal.

It will be noted that the lower end of the first secondary is at ground potential while the second transformer case is 250,000 volts above ground, the third 500,000 volts, and the fourth 750,000 volts. Thus

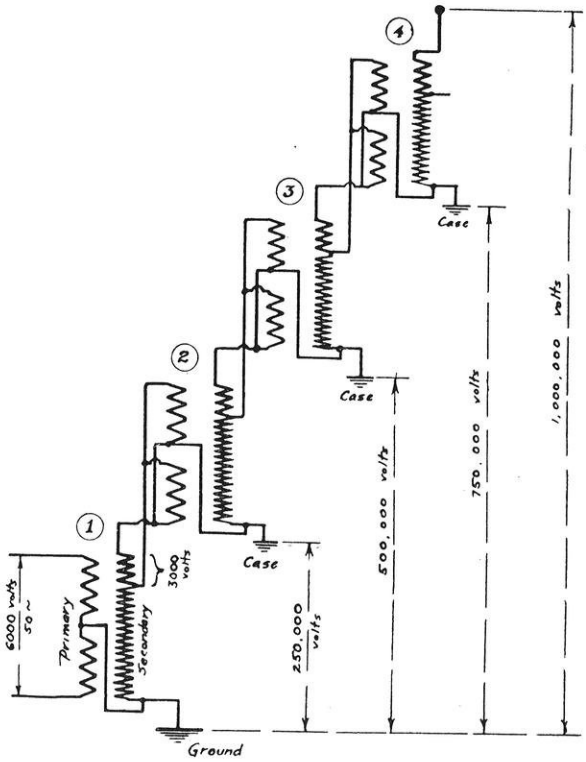


FIG. 2. DIAGRAM OF CONNECTIONS FOR 1,000,000-VOLT TRANSMISSION. *Four duplicate transformers are used, each rated at 250 kv-a., 3000 or 6000 volts primary, 250,000 volts secondary.*

*It was, of course, impossible to supply the second transformer directly from the line since it is at a potential of 250,000 volts above ground.

(Concluded on page 95)

THE HYDRAULIC LABORATORY OF THE UNIVERSITY OF WISCONSIN

By Charles I. Corp,

Professor of Hydraulic and Sanitary Engineering

In 1904 and 1905 at the time the Hydraulic Laboratory of the University of Wisconsin was constructed, outside of the laboratories at Cornell University, Worcester Polytechnic Institute, and, possibly, the University of Illinois, the facilities for experimental hydraulic work at the various institutions was quite meager. Since its construction 18 years ago the Hydraulic Laboratory at Wisconsin has probably been the outstanding laboratory equipped, as it is, for problems involving low head work and with machinery of a size comparable to commercial conditions. From time to time instructors from a number of other institutions have taken advantage of the opportunity offered by its equipment and research facilities. Others have inspected the laboratory in connection with the development of laboratories at their institutions. Because the writer has so frequently been asked to describe the laboratory and its equipment and to suggest the fundamental principles in developing a laboratory he has come to believe that a description of the laboratory would be of general interest.

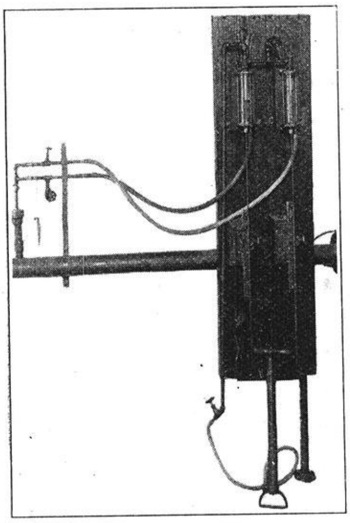


Fig. 1. Pitot Tube and Gage. *This is a special gage, developed in this laboratory, for measuring small differences in head. Modified hook gages are used to obtain the water level in the enlarged glass tubes.*

Laboratory Serves Two-Fold Purpose

The purpose of the laboratory is two-fold: To give instruction and to conduct investigations in the hydraulic field. The instructional work is of two types,—that which is devoted to the fundamental instruction of students in the principles of hydraulics, and that intended to afford opportunity for more detailed work for students, particularly interested in hydraulic problems. In the first type of instruction students experiment with the more simple apparatus, and are given laboratory demonstrations to illustrate principles. For the second class advanced courses in machine testing, specialized problems and thesis work are offered.

Results of research investigations are published from time to time in the form of articles or papers and as bulletins of the Engineering Experiment Station.

Features of Laboratory Design

In designing a laboratory certain special features need to be incorporated if it is to serve its purpose effectively.

A storage reservoir from which to draw and return the water that is used is necessary unless a natural reservoir is available such as the Wisconsin laboratory has in Lake Mendota. The capacity and surface area of a reservoir need to be such that the change in level will be limited when the experimental apparatus is filled or emptied.

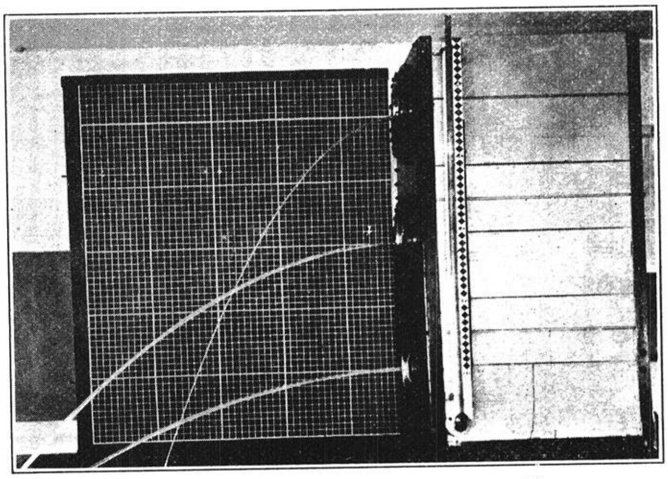


Fig. 2. A Lecture Experiment to Substantiate Torrecelli's Theorem. *Readings are taken while the water is running, and the students are required to verify the theorem from the data thus secured.*

The building should be arranged with several dif-

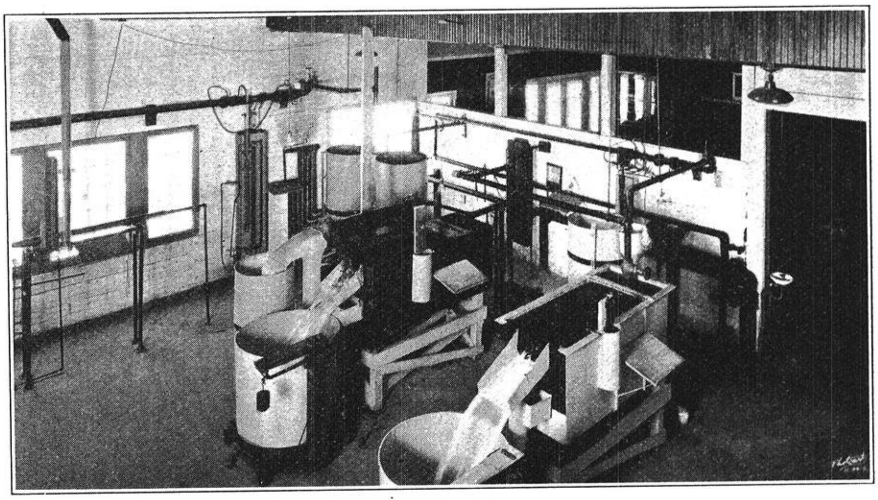


Fig. 3. Apparatus for Routine Instruction. *Students work in pairs, but each man obtains an independent set of data. Two hours per experiment are spent in the laboratory and two hours in the computing room.*

ferent elevations. This will permit the experimental apparatus, measuring tanks, waste channels and the storage reservoir to be at successively lower levels so that water may flow by gravity through the system.

A number of independent sources of water supply are also desirable in order that experiments may be conducted simultaneously without interfering with one another. These sources may be pumps, elevated reservoirs, or small tanks or pipes with automatic water level control. Piping, head and waste channels, and measuring devices should be so arranged as to give flexibility and independence to the work. It goes without saying that there should be an adequate amount of small equipment such as hook gages, scales, weirs, orifices, and meters. It is also desirable that facilities should be provided for measuring the largest quantity of water which the laboratory is equipped to use in any experiment. One of the features most often overlooked is storage space for equipment not in use such as tanks and piping.

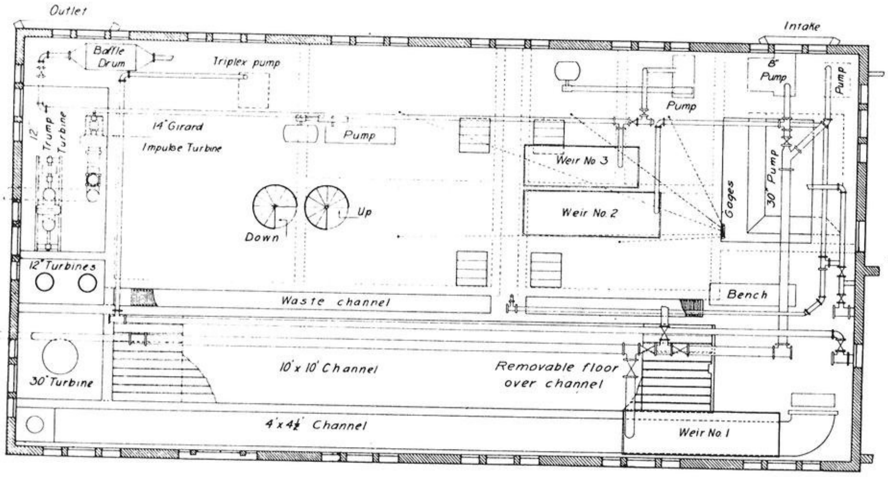


FIG. 4. FIRST FLOOR PLAN. *This floor contains the larger equipment used in advanced work and research problems. The dotted lines indicate channels and measuring basins in the basement.*

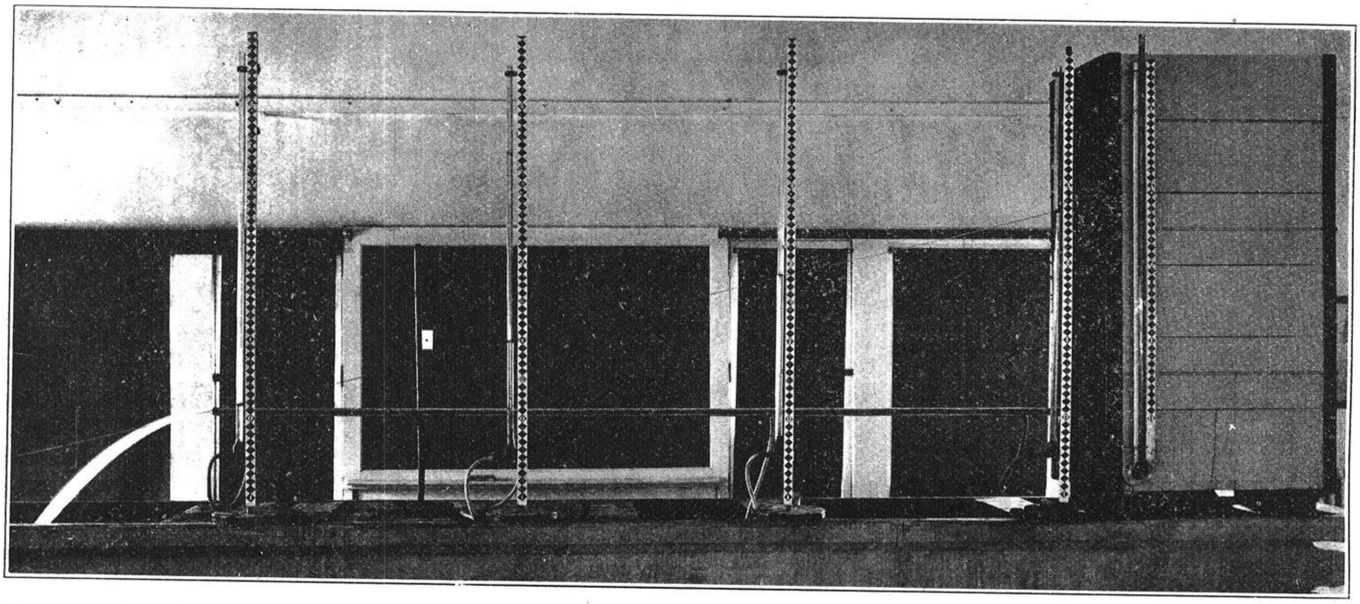


FIG. 5. AN EXPERIMENT TO DEMONSTRATE ENTRANCE LOSS AND PIPE FRICTION. *Students are required to take readings and determine the friction factor and coefficient of velocity at entrance.*

The Wisconsin Laboratory

The Hydraulic Laboratory of the University of Wisconsin is situated on the south shore of Lake Mendota at the base of a bluff, which rises abruptly immediately in front of the building. Adjoining the laboratory building on the east is the university pumping plant and to the west is space for future expansion. Fig. 7 shows the general arrangement.

The building has three floors and a basement. The upper or third floor extends over two-thirds of the building and is divided into a large computing room and space for the computing work of thesis students and research men.

The main lecture room and offices for the teaching staff are on the second floor. On this floor, also, is the laboratory equipment which is used by the students parallel with their study of the theoretical course. To have this selected equipment adjacent to the class room is a decided advantage.

On the first floor (Fig. 4) is the larger equipment which is used mainly for advanced work, special problems, and for thesis and research investigations. This equipment has, however, a very distinct function in acquainting the elementary students with hydraulic machinery and awakening their interest in several things about which they may study in a very abstract way. In the class and lecture room a more or less studied effort is made to incite student interest in this equipment. One plan is the assignment of problems which require examination of the machines for solution. The basement has only one small room, the space being mostly occupied by concrete measuring basins, a large pump pit, and channels for conducting water. Across the west end of the basement is an outlet channel which is arranged to receive the discharge from any of the main channels or turbine water wheel pits. It is fitted with a ten-foot suppressed weir which makes possible the measurement of water from any pit or channel before it is returned to the storage basin—in this case, Lake Mendota.

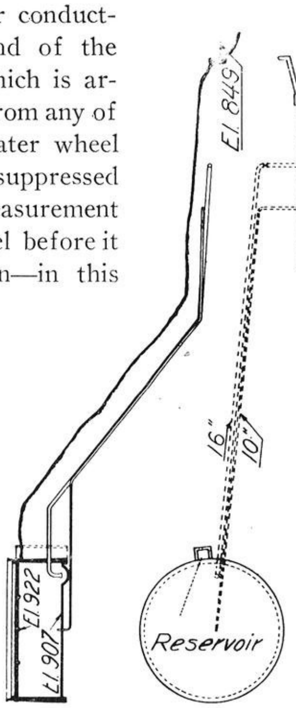
The Water Supply

The laboratory has three main sources of water supply: First, its own pumps, the largest one of which is a 30-inch diameter centrifugal pump with a capacity of 30,000 gallons per minute; second, the University pumping plant which furnishes water under 85 pounds pressure and up to 1500 gallons per minute; third, the laboratory's reservoir, 220,000 gallons capacity, which is located on the bluff 60 feet above the first floor of the laboratory.

Equipment

Fig. 6 shows the general arrangement of the second floor. The lecture room is equipped with apparatus for demonstrating experimentally the different principles of hydraulics. Students are assembled here for a weekly demonstration lecture. The visual picture presented by the experiment clarifies the classroom discussion. As examples of the experiments performed Fig. 2 and 5 are given.

Figure 2 shows an experiment in which a stream from an orifice is passing in front of a cross-sectioned board. By comparing the velocity of the stream as shown from readings on the cross-sectioned board and that calculated from the observed head of water on the orifice, the student is brought to see the correctness of Torrecelli's Theorem, namely the velocity of a stream issuing from an opening in a tank is equal to $\sqrt{2gh}$.



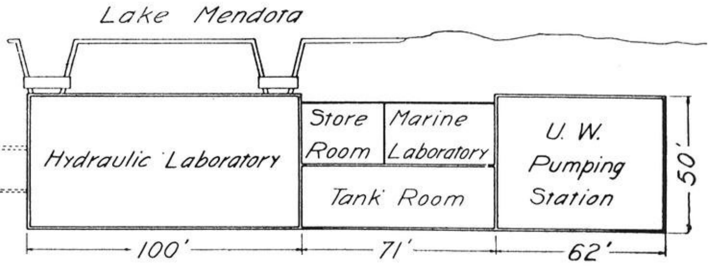


FIG. 7. GENERAL PLAN OF THE HYDRAULIC LABORATORY OF THE UNIVERSITY OF WISCONSIN. *The laboratory is on the shore of Lake Mendota at the foot of a 60-ft. bluff upon which is situated a 220,000 gallon reservoir.*

Likewise the apparatus shown in Figure 5 is used to explain the problem of pipe losses.

The laboratory equipment before mentioned, on the second floor, consists of head, velocity, and flow measuring apparatus. In order to avoid laboratory work done "by rote" or in a perfunctory way, and to acquaint the student with varied methods, the different set ups are fitted with scales, gages and water measuring devices of various types. Fig. 3 is a photograph of a part of this equipment. Fig. 1 shows one of the pitot tubes and its gage.

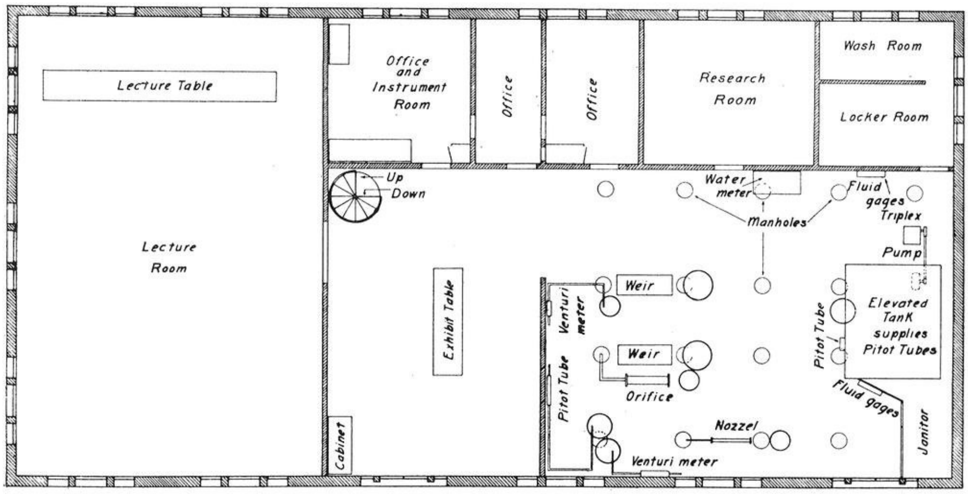


FIG 6. SECOND FLOOR PLAN. *The main lecture room and the offices are on this floor, which also contains the apparatus used in routine instruction.*

The arrangement of the equipment on the first floor is shown in Fig. 4. Weir boxes No. 2 and No. 3 are placed so that they may be discharged either into a waste channel or into the calibrated basins immediately below them. Weir box No. 1 serves the 4x4½ ft. channel beneath it. This channel is used for submerged weir, taintor gate, channel, and other experiments. The turbines, both open pit and encased, are arranged along the west end of the first floor over the outlet channel. Most of the apparatus on this floor is not permanently located but is shifted from year to year depending upon the investigations in progress.

At present the space is well crowded with work on the following problems:

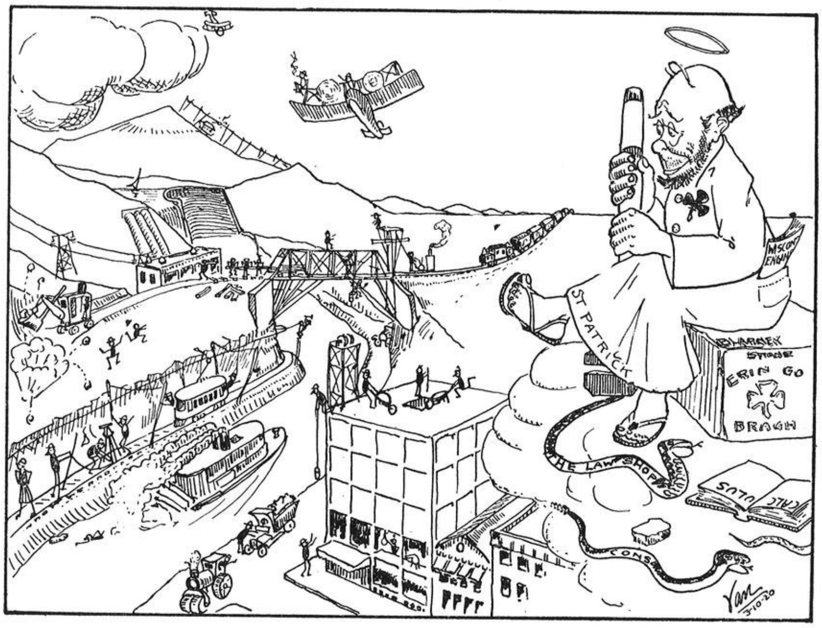
Sudden change in section in open channels; bends of different radii in open channels; discharge from a weir

(Concluded on page 94)

EDITORIALS

ST. PATRICK'S DAY CELEBRATION One day out of each year is dedicated exclusively to the engineering student,—the seventeenth of March, St. Patrick's Day. It is a day of rejoicing and celebration in engineering schools all over this land of ours.

The ENGINEERS' PARADE is a feature of the Wisconsin celebration. Without doubt the 1923 parade will surpass those of former years. Its success will depend, of course, upon the energy of the committee that manages the affair, and upon the hearty co-operation of all engineering students.



His Boys

It's time to begin to plan that stunt you intend to put on this year. Put the think gear into high and show some speed. There will be a chance for everyone to help make the parade go big; if you don't think of a stunt yourself, help out the fellow who has one in mind.

Athletic contests show up the quitter; but quitting is not confined to the athletic field. There is such a thing as a mental quitter, and he is just as yellow as his athletic prototype. He lies down and takes the count if thrown into the ring with a tough problem; his feet grow cold and his liver turns to water in the face of a quiz; and he's licked before he starts in any event that requires original thinking.

THE WISCONSIN ENGINEER Whosoever holdeth a unique position will probably be misunderstood. The WISCONSIN ENGINEER holds a position among campus publications that is believed to be unique, and it has lately been borne in upon us that The ENGINEER and those responsible for it are misunderstood. Verily it is a dire thing to be misunderstood, and so we are lifting up our voices in explanation.

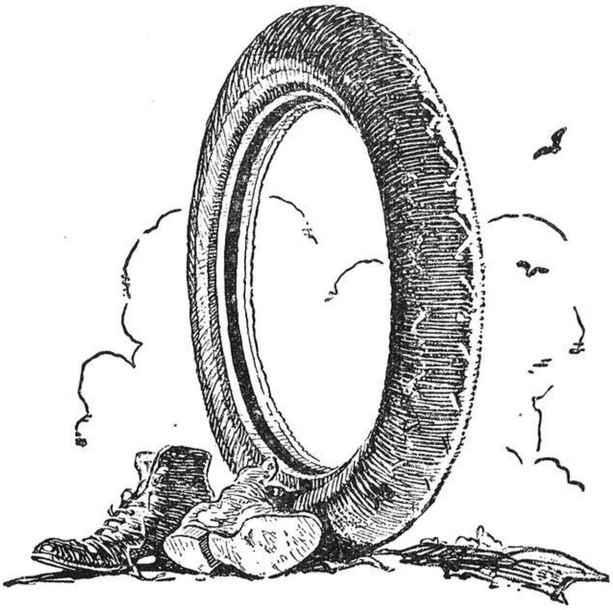
Wherein lies our uniqueness? In just this: The magazine is being conducted for the benefit only of the College of Engineering and the University of Wisconsin; it is not anybody's private graft.

It is a hard thing to realize, in this age of selfish materialism, that a group of young fellows will undertake such a responsibility as is involved in publishing a monthly magazine without the sordid incentive of monetary remuneration for their services. It is so hard to realize that probably we will not be able to convince everybody that such is the fact. Nevertheless it is the fact.

There are no salaries, no commissions on advertising or subscriptions, no splitting of profits in connection with our business. The staff goes ahead with its job without the prospect of any reward except the pleasure of creating something and of advancing the interests of the university.

What do we do with all our earnings? Well, first of all we have our bills to pay, and they run about $500 a month. That is a tidy sum to have to raise eight times a year. Nevertheless, thanks to vigorous managers and assistants, we have been able to pay expenses nearly every month, and for the past ten years we have had a small profit annually. By the end of this year we will have accumulated sufficient working capital to enable us to discount our bills promptly and maintain our business credit in excellent condition. Beyond that we do not care to accumulate. In the future we must find ways of using any possible profits to the benefit of the magazine and the college.

This magazine is being published purely and solely in the interest of Wisconsin engineers, whether faculty, students, or alumni. No one need withhold support because of the suspicion that his contribution—whether literary or monetary—is sacrificed to private gain. So far as lies within our power, each contribution shall redound to the honor and glory of the college.



THE KLAN Rumor has it that Madison harbors 1500 members of the so-called Invisible Empire, and vague stories are afloat of the sighting of white robes and the fiery cross on Picnic Point. The rumors may or may not have foundation in fact. In either case it seems an appropriate time to call attention to a few fundamentals to be considered before affiliating with such an organization.

No one will quarrel with the ceremonies the klansmen use to impress novitiates, and no one will quarrel seriously with any restrictions of race or creed that may be placed upon membership. Those things are unimportant. The quarrel with the Klan arises from the attempts it is alleged to have made in various parts of the country to regulate the personal conduct of people who are not klansmen. When men and women are taken from their homes and whipped, tarred and feathered, and even murdered by people who set themselves up as judges and executioners without proper legal authority, a situation is created which is full of danger for every member of the community. Absolutely no one is safe if the protection of the law is removed. A personal enemy may conspire to bring the mob down upon one at any moment. History is full of such instances.

Aspersion has been cast upon the motives of those who launched this revival of the Klu Klux Klan. The taint of commercialism is upon it at present. Nevertheless, it is quite possible—even probable—that the revivers were inspired by high purpose. But high ideals cannot be maintained if the Klan makes a practice of taking extra-legal action. The original Klan, which is said to have been created by idealistic patriots of the South who were on fire with the injustice of a carpet bag government, quickly was seized upon by those who had neither idealism nor patriotism and who used the Klan only as a cover for their wicked and violent deeds. Read "A Fool's Errand" if you would know what the Klan became in those Reconstruction days. There you will find recorded deeds as brutal and cold blooded as the throat cuttings of Herrin.

Such organizations as the Klan are apt to be composed of impulsive, hot-headed, intolerant, and ignorant (though not necessarily unintelligent) people. It is impossible for moderate leaders to maintain control of a mob of such people bent upon an illegal errand; discipline is not sufficiently rigid in a mob. The most radical leaders will prevail in such a case. This was well illustrated at Herrin where the original leader of the mob was quickly deposed, once the prisoners were in hand, and men of blood took the reins. It was illustrated on a larger scale in the French revolution where power went quickly from the moderate revolutionists to the more radical until it reached the hands of the most blood-thirsty men in the country. It was illustrated again in Russia where Kerensky, the moderate, was overthrown by Lenin who was willing to go to any lengths to carry out his plans.

The Klan as a social organization might add to the gaiety of the nation; but as the arbiter of our daily life it should not and will not be tolerated.

ALUMNI NOTES

CIVIL

Charles F. Loweth, CE '15 (hon) Chief Engineer of the C., M. & St. P. R. R., has been elected president of the A. S. C. E. He is a graduate of Oberlin College.

Jerry Donohue, c '07, who is in consulting practice in Sheboygan, is president of the Engineering Society of Wisconsin which holds its annual convention at the College of Engineering on February 22 and 23. "Jerry" has made a most energetic and enthusiastic president and will turn over to his successor a vigorous organization.

JERRY DONOHUE

Perry F. Brown, c '97, is consulting engineer at Fresno, Calif. Business address: Box 484.

Michael T. Hayes, c '08, is grading and road building contractor. Business address: 634 Rookery Bldg., Chicago.

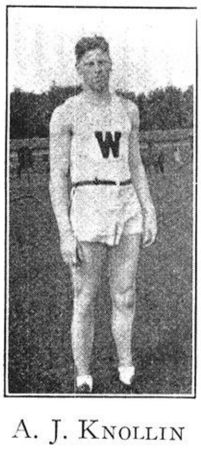
Elmer A. Jacob, c '13, is engineer for the Provo Reservoir Company of Provo, Utah. Residence: 258 N. 2 E. St.

William N. Jones, c '05, C. E. '10, is general superintendent for D. D. Thomas & Son, general contractors, Memphis, Tenn.

L. H. Kessler, c '22, was married to Miss Elizabeth M. Hill, at Chicago, on November 25, 1922.

Albert J. Knollin, c '22, was killed in a gasoline engine accident on February 10, at Loma Vista ranch, Bethel, Kansas. The ranch is owned by his father and Knollin has been working there since leaving school last spring. No details of the accident are available at this time.

Knollin was prominent in his class. He was a hurdler of stellar ability and captained the track team in 1922. His scholarship was much above the average; he was popular. His death is deeply regretted by his many college friends.



A. J. KNOLLIN

James R. Price, c '22, who has been with the Menominee and Marinette Light and Traction Company, on Feb. 1 accepted a position on the engineering staff of the Sewage Commission of Milwaukee. Address: 699 Maryland Ave., Milwaukee.

Robert M. Smith, c '13, who has been assistant city engineer at Kenosha, Wisconsin, has recently been made city engineer.

Walter C. Thiel, c '22, who is assistant city engineer at Minot, N. Dak., writes that he has been working on a drawing of a new city map, as well as the summarizing of a report showing the construction activities of that city for the year 1922.

William H. Wetzler, c '06, C. E. '10, is chief draftsman for the Sinclair Refining Co. in the Chicago office. Residence: 144 Judson Ave., Highland Park, Ill.

Edward N. Whitney, c '13, who has been instructing in roads and pavements and city planning, resigned in February in order to take a position with Mead and Seastone, of Madison.

Karl L. Zander, c '23, who has just completed his requirements for a degree in civil engineering, will be on the engineering staff of the city engineer at Kenosha.

CHEMICALS

Robert W. Cretney, ch '21, has been transferred from the general offices of the Southern Illinois Gas Company, at Du Quoin, Illinois, to the southern district office at Murphysboro, Illinois. Address: 112 South Eleventh Street, Murphysboro.

Edmund C. Haag, ch. '11, is chief chemist with the Ruber-oid Co. of Joliet, Ill. Residence: 415 Western Ave., Joliet, Ill.

W. R. Kellett, ch. '22, is night superintendent at the Atlas Mill of the Kimberley Clark Paper Company, at Neenah, Wis.

Owen J. Pritchard, ch '17, is assistant superintendent of The Milwaukee Coke & Gas Co. Residence: 788 52nd St., Milwaukee.

Carl J. Anderson, e '21, is an engineer in the R. S. dept., of T. M. E. R. & L. Co., of Milwaukee, Wisconsin. Address: 546 First Avenue.

Edwin L. Andrew, e '16, has been appointed assistant to the manager of the Publicity Department of the Westinghouse Electric and Manufacturing Company, at East Pittsburg, Pa. While he was in college Andrew was on the staff of the WISCONSIN ENGINEER, being circulation manager in 1913-14, editor in 1914-15, and manager n 1915-16. He was one of the few men who have filled both the editor's and manager's positions. His college activities developed an interest in advertising which influenced him after he was graduated and had entered upon an apprenticeship course with the Westinghouse Company. When the course was completed he turned to publicity work with the company and has followed that line ever since. In his opinion engineering training has been of distinct value to him in advertising work.

EDWIN L. ANDREW

Carl W. Borecky, e '11, is accountant with the Toledo Edison Co. of Toledo, Ohio. Residence: 247 Michigan St.

E. von Geltch, e '11, is engineer with the Wisconsin Railroad Commission with headquarters in Madison. Residence: 1621 Jefferson Street.

Ray S. Hardin, e '15, electrical engineer with the Birtman Electric Company of Chicago. Residence: 2201 Forestview Road, Evanston, Ill.

Frank W. Johns, E. E. '13, is with the A. T. & T. Co. Business address: 420 3rd Ave., Minneapolis, Minn.

C. A. Jones, e '09, is manager of the Art Aseptible Furniture Company. Business address: 6700 Vernon Place, St. Louis, Mo.

Frank E. Kruesi, e '08, is manager of the Seattle office of Frazar & Co. of New York City. Residence: 1160 18th Ave., North, Seattle, Wash.

E. S. Moles, e '05, is toll fundamental plan engineer with the Pacific Telephone & Telegraph Co., at San Francisco. Residence: 854 Neilson St., Berkeley, Calif.

Parry H. Moon, e '22, visited the University recently, as a representative of the Westinghouse Company, interviewing senior electricals and mechanicals preparatory to hiring them for work with the Westinghouse Company.

Gail W. Palmer, e '22, who has been research assistant with the Agricultural Engineering Department of the University, has joined the operating research department of the T. M. E. R. & L. Co., at Milwaukee, Wis. Address: 506½ Wauwatosa Ave., Wauwatosa, Wis.

Arthur A. Pergande, e '10, is assistant manager of the Central Falls Mazda Lamp Division of the General Electric Company. Residence: 48 Makin St., Pawtucket, R. I.

Walter Schneider, e '10, is valuation engineer for the Ohio Bell Telephone Co., Cleveland.

J. S. Strong, ex-e '21, was married to Miss Mary Drake of Decatur, Illinois. Strong is an instructor in electrical engineering.

MECHANICALS

John M. Barr, m '99, is general manager for the Louis Allis Company of Milwaukee. Address: 375 Royall Place.

Clark C. Boardman, m '10, has resigned, effective Feb. 1, as assistant general manager of the Southern Illinois Gas Company to become general manager of a carbon black plant in Louisiana for the Thermomotic Products Company.

Claude Campbell, m '22, was married to Miss Irma Butler of Madison.

Edward P. Langworthy, m '13, is plant manager for the American Radiator Company at Buffalo, N. Y. Home address: 52 Euclid Ave., Kenmore, N. Y.

H. A. Phillips, m '22, who has been with the Wm. Baker Organization, has recently joined the forces of Westerlin and Campbell, distributors for the York Manufacturing Company, of York, Pa., manufacturers of refrigerating machinery. Address, 2214 Orrington Ave., Evanston, Ill.

Bert Puerner, m '20, is a sales engineer in the Crushing and Cement Department of the Allis Chalmers Company, at Milwaukee.

Paul A. Royer, m '21, is development engineer for the Joslyn Mfg. & Supply Co. Business address: 37th & S. Morgan Sts., Chicago.

W. H. Steimke, m '15, is manager of the Full-Crawler Co., a department of Geo. H. Smith Steel Casting Co., of Milwaukee. He is also partner in the firm of Jett & Steimke, engineers. Business address: 420 M. & M. Bank Bldg.

Edward B. Williams, m '19, is sales engineer with the Bucyrus Steam Shovel Co. Business address: 30 Church St., New York City.

MINERS

W. A. Emanuel, min '20, is chemist with the Anaconda Copper Mining Co. Residence: 305 W. 3rd St., Anaconda, Mont.

W. V. Dargan, min '15, is metallurgist for the Utah Con. Mining Co. Address: Box 419, Tooele, Utah.

Harold L. Rau, min '16, is petroleum geologist with the Carter Oil Company of Tulsa, Okla. Address: Box 2045.

E. O. Werba, min '19, is assistant manager of the Grand Rapids Gas Light Company, Grand Rapids, Mich.

BIRTHS

To Mr. and Mrs. Eugene Noyes, 844 Wall Street, Akron, Ohio, a son, John Ham, December 12. Noyes is a '13 civil.

To Mr. and Mrs. Lloyd Call, Chicago, Ill., a daughter, Betty Jane. Call is an '18 electrical.

THE HOOVER DWELLING HOUSE CODE

The methods and practices now in use in the design and construction of dwelling houses are the result of blindly following tradition and past custom. There seems to be no other reason for the thickness of masonry walls used for ordinary one and two-story dwellings than a survival of the belief that such walls should act to a large extent as parts of a fort.

Engineers and architects have doubtless previously made the simple computations necessary to show that the actual loads coming upon the walls of the ordinary one or two-story house are ridiculously small and are, in fact, only a small percentage of the working loads which engineers long have used in the design of large and important bridges and buildings.

The Recommended Minimum Requirements for Small Dwelling Construction, which resulted from the appointment of a Building Code Committee by Secretary of Commerce Herbert Hoover, removes many of the unnecessary limitations which the common practice in house construction seemed to require and for which the home owner has to pay. Instead of 12-inch brick walls for two-story buildings, a thickness of 8 inches is permitted.

The use of concrete, both plain and reinforced, is provided for in the code, and recognition of the strong monolithic character of this structural material is given by allowing exterior walls to be 6 inches thick. The thickness of walls of hollow building tile and hollow concrete block is also placed more clearly on a basis of the actual strength of these walls than on arbitrary requirements. Walls of hollow building tile or hollow concrete block 8 inches thick are allowed for the uppermost 20 feet of buildings limited to 30 feet high.

The use of reinforced concrete is placed on the same general basis as large buildings and bridges, examples of which have become so numerous and well known. Dwellings of this type may be designed in accordance with the well recognized principles of reinforced concrete design to withstand the loads to which they will be subjected. However certain requirements are provided which are based on the practical work of getting the concrete into the forms. Double walls of concrete, providing an insulating air space, may be constructed with a 16-inch net thickness of concrete cast in place. The use of large precast units, each of which may be one story high and form an entire one-story wall of one side of the house, is permitted. Concrete houses provided with a reinforced concrete framework similar to that used in large buildings but with enclosing and partition walls of concrete plastered on metal lath are permitted in this code. The new methods of construction give promise of developing firesafe types and low costs.

CAMPUS NOTES

EARL L. CALDWELL

After the debacle of examinations, we ask in a small, weak voice, "Are you there, Cuthbert?"

Roll call on the staff of the ENGINEER is like roll call after the battle; the faculty tore great holes in our line this time.

Two of our faculty members have recently announced their marriages: Mr. L. H. Kessler, c '22 and instructor in hydraulics, was married to Elizabeth M. Hill on November 25. Mr. J. S. Strong, e '21 and instructor in electrical engineering, was married to Mary Drake of Decatur, Illinois.

Dean Turneaure returned about the end of January from a trip to Hawaii. Hawaii, you know, is famous for two things: A volcano and a beach. The Dean says he saw both, and several matters of engineering interest besides. We hope to induce him to present some of the interesting phases of his trip to the readers of the ENGINEER.

WE ACCEPT THE CORRECTION, UNCLE IKE

The following communication may (or may not) add to the existing fund of information about the geology of Devil's Lake. There seems to be something fishy about it.

> Re that article in the last Engr. about "Uncle Ike" who hauls baggage at Devils Lake,—You got that all wrong. It wasn't his grandfather, it was his dad that saw the glacier. This is the way it happened—
>
> "There was a river flowing around a hill. One winter the river froze especially hard. In the spring instead of thawing the river just flowed on and took the hill with it."
>
> But, anyway, lots of strange things happen at Devils Lake. (How about it, you summer camp civils?) Last spring, for instance, we had such a heavy fog that the fish swam up and ate the buds off the apple trees. (For Gawd's sake, don't pull that one about crab-apples, or I'll turn turtle.)
>
> Some of the poor fish didn't get back before the sun came out. Two days later I found a predatory bass which had treed a rattlesnake up a triangulation station on the Lake Bluff. (No, Louie Schmidt isn't the kind of Lake Bluff I mean.)
>
> THIEMANN, e '25.

GO TO THE HEAD OF THE CLASS

RANDALL SCHOOL TEACHER—Seidlitz de Puyster, can you explain the meaning of the word signify?

SEIDLITZ—Yes, ma'am. That's the bunch of roughnecks that lives up on the Heights.

Well, Bill, I hear you got kicked out. That's bad.
Not so bad; they let me stay
That's good.
Not so good; they put me on probation.
That's bad.
Not so bad; they reduced my schedule.
That's good.
Not so good; I have to average "fair" at mid-semester.
That's bad,
Bad? Hell, it's *impossible*.

Can you raise $x^{3/2}$ quickly on your old stick? If you are one of the chaps who cubes x and then takes the square root, you are the chap who should read this. In the first place;

$$x^{3/2} = x^{2/2} \times x^{1/2} = x\sqrt{x}$$

Set the index to x on the fourth floor, technically known as the A scale. In the basement, the D scale, you will find the $\sqrt{x}$ directly below x on the A scale. Push the sliding storm window over the C scale until you have multiplied $\sqrt{x}$ by x. The product on the D scale is the elusive and much sought $x^{3/2}$. And don't forget, brother, that this is good for x to any odd half power.

It is surprising, though, how many fellows are still in the primary class with the old stick. Take the inverse scale, for instance—the one in red. A lot of fellows evidently think the red figures mean danger—but they don't, brother—they mean speed. If you use the inverse scale, you can reduce your nightly mileage to 10 miles instead of 20 miles, and more answers per cubic foot of profanity. Take down that little instruction book you got with the stick and buck a bit on it! It'll pay you handsomely. Just think, I met a chap yesterday who couldn't read logs to the base e on his log-log stick! That's like owning a Stutz, and never going over 20 miles per hour! Value in any machine is rated by its *maximum* production. Know your stick!

ON THE S. E. SPECIAL, OR, TURNED OUT IS RIGHT

TALKATIVE STRANGER (to student who is homeward bound)—You got on at Madison, didn't you? Student at the University, I suppose?

DISCONSOLATE STUDE—I was.

T. S.—You mean that you are through at the University?

D. S.—I'm through.

T. S.—It's a great institution, isn't it? It turns out some great men—some remarkable men.

D. S. (*Bursting into tears*)—Mister, that's the first bit of sympathy I've had in a week.

NOW YOU KNOW WHOM TO BLAME

F. Haber's book, "Thermodynamics of Technical Gas Reactions," bears the following dedication:

"To my dear wife, Clara Haber, Ph. D., in gratitude for her *silent* co-operation."

Likewise, Sidney A. Reeve's "Thermodynamics of Heat Engines" is dedicated

"To my wife, to whose devotion and aid (although she
doesn't know entropy from carbonic acid)
the existence of this book is due,
it is dedicated."

Professor Leonard Smith spoke on "Housing and Its Relation to City Planning" at a conference held at Lafayette, Ind., on February 15.

Never mind, old side kick, even if that Ex you thought you had landed at mid-semester did go sour on you and turn into a Poor; here's a philosophy that will temper your disappointment. We grab it from "Personal Efficiency" of the La Salle Extension University.

"Never mind the losing—think of how you ran;
Smile and shut your teeth, lad; take it like a man.
Not the winning counts, lad; but the playing fair;
Not the losing shames, lad; but the weak despair.
So when failure stuns you, don't forget your plan;
Smile and shut your teeth, lad; take it like a man."

Once more we have a girl engineering student, Grace Heimbaugh of Superior, who is taking work in the civil engineering department. The first hundred points are the hardest, dear. We wish you luck.

CO-OPERATION BETWEEN CONTRACTOR AND ENGINEER

That the best construction results where engineer and contractor work harmoniously was emphasized by W. R. Neel, State Highway Engineer of Georgia, in a paper presented before the Southern District of the Asphalt Association.

The following is an abstract of his remarks:

This is a subject often under discussion by all of the parties concerned. The engineer has his interpretation of the word co-operation, the contractor his and the owner his; but isn't it a fact that each one's idea about just what this word means is a little different? This reminds me of a story told me by a friend. He relates that soon after marrying, wishing to avoid mistakes commonly made by married people, he decided it would be a good idea to have a frank discussion with his wife in order that they arrive at a plain understanding of their relations. After a brief discussion, mostly carried on by him, they agreed that, as he was the man, all weighty matters would be decided by him; everything else would be decided by the wife. He relates that after several years of married life nothing of a real serious nature had come up for decision; his wife had decided everything.

In regard to the subject under discussion: Most specifications frankly place upon the engineer all of the decisions in the carrying out of a contract. It is my belief, however, that the engineer has, generally speaking, fully realized that this authority is not given him to abuse. Fairness to both the owner and the contractor should be the goal for which the engineer strives.

My experience in life has been that almost every one wishes to be fair according to his own lights; but I must admit that I have met some people with very dim lights. My experience has also led me to believe that, generally, misunderstandings are brought about by the ignorance of someone connected with the undertaking.

Frequently contractors submit bids without either a thorough knowledge of the specifications or of the site where the work is to be executed. Frequently misunderstandings arise, due to the fact, that the engineer is either unfamiliar with the terms of the contract and the specifications, or he is so inexperienced that he is not capable of properly interpreting same.

The first lesson to be learned by the engineer is that he is not only representing the owner, but that he is also representing the contractor. Fairness to these parties is the engineer's job. First, it must be recognized that the owner or beneficiary should pay the full cost agreed upon for the improvement. Second, the contractor effecting the improvement should receive a fair compensation for his efforts, insofar as the limitations of the contract will permit. It should be the desire of the engineer so to assist the contractor that, after the proper execution of the work, a maximum profit can be made. It should be the desire of the contractors so to perform his work that nothing, either in the spirit or the letter of the contract, remains to be done toward securing for the owner a satisfactory job. With both the engineer and the contractor entering into their work with this spirit, true co-operation may be expected.

The laws frequently prevent the very thing for which they are written. They frequently prevent the awarding of the contracts to the best bidder; frequently there are written upon the statute books maximum salaries to be paid engineers, thus preventing the state or county from securing the best engineering service. Often you find a resident engineer or a division engineer in charge of a great many construction jobs and clothed with full authority, who may or may not be competent and who frequently is paid less money than the foreman of the construction gang.

Contractors are always on the lookout for good men and good men are always on the lookout for a means of bettering their positions in life; therefore, it is imperative not only from the interests of the owner but, also, from that of the contractor that adequate salaries be allowed in order to secure and hold competent, exper-

(*Concluded on page 96*)

ATHLETICS

WANTED: A FOOTBALL COACH

Did you ever see a woman buy,—that is, *try* to buy, a hat? If you have, perhaps you will appreciate what the Athletic Council is going through in an endeavor to get a new football coach. Some forty coaches throughout the country aspire to fill the boots left vacant by the resignation of John Richards. Tom Jones is now busy eliminating thirty-nine of those forty, leaving *one* who will satisfy students, alumni, faculty, the Chicago Tribune, and Roundy, and also win the 1923 conference championship. Several good men have already been here for interviews.

"Hod" Ofstie

"Hod" Ofstie, civil engineer, all-Western end on our 1912 championship eleven, and now coaching at the Mississippi A. and M. College, has been considered. Jack Ryan, Marquette mentor, also looms up as a possibility. Amid much hurrah, a Madison paper recently got out a 9 a. m. extra announcing that Little, Yost's assistant at Michigan, had accepted the job. The scoop proved about as fallacious as dollar oil stock; Little had merely wired Coach Jones in regard to the hockey games at Madison. Who'll be the next coach? Who'll be the next president?

PLUMBERS PERFORM IN TRACK MEET

The rest of the school is prone to look upon the engineer as a duffer good for little else than plumbing a rod or turning a wrench, but within the ranks of the civils alone are enough star performers on field and track to beat the varsity. In the interclass meet held in the annex, Saturday afternoon, January 2th, the juniors came out on top with 41½ points, followed by the sophs with 37 points. Brown Donohue, junior civil, won eight points single handed (or single-footed, if you will). He placed first in the high jump and second in the shot. This was the largest single score of the afternoon. Schneider, exponent of the Venturi meter and the suppressed weir, broke the mile tape four minutes and thirty-nine seconds after the starter's gun sent the amateur Mercurys on their way. Tschudy, slip-stick paragon and mass curve expert, saved the seniors from utter disgrace by winning the two-mile run in 10:18 5/10; this little act gave the school ancients five of their 8½ total score. "Bill" Hamman, who got lots of practice flying over the handle bars of his motorcycle covered 20′ 5″ for first in the broad jump. Bill also placed third in the pole vault. E. A. Schmidt, also a C. E., won second in the pole-vault. If the varsity didn't need this bunch of point-getters, the old Nelson trophy might once again grace our front hall; but cheerio, a winning varsity team is better than all the statuary in the Art Museum.

WISCONSIN'S LATEST SPORT—HOCKEY

The lower campus, scene of as many and as varied activities as the Orpheum footlights, is now being used for hockey. A large, boarded-in rink has been constructed, and here the hockey team, representatives of Wisconsin's latest inter-collegiate sport, practice and play, fall and fight over an unassuming, black puck. Under the tutelage of Coach Viner the team is developing slowly, but surely. After losing all of last year's games and three this year, the Cardinal pucksters beat the fast Michigan aggregation 1-0 in the second of a two-game series here at Madison.

JANUARY 12—RED LETTER DAY

January 12 saw two Wisconsin teams emerge victorious from their respective frays. While Joe Steinhauer's speedy swimmers took Indiana into camp 38 to 30, Coach Hitchcock'c Samsons and Goliaths tumbled and roughed up the Northwestern strong men, winning five of seven bouts.

The swimming team has been much handicapped because of the building of the new pool, but they showed up well for the opening of the season. Engineers swimming with the team are Czerwonky, back and breast strokes, and Norm Koch, fancy diving. Ewald, another plumber, is on the relay team.

BADGERS LOSE BASEBALL STARS

Every collegiate sport writer at some time or other tells of a certain gruesome something called the ineligibility jinx. This hoodoo, it seems, plays havoc with many a budding championship team. Recently four baseball men, the nucleus of Lowman's 1923 nine, went by the boards. Unable to refute summer baseball charges, George Ruediger, captain and crack third baseman; Hoffman, star twirler, and Montgomery and Bruemmer have been scratched from the spring line up. This is a blow to Cardinal baseball hopes, but where there's life there's hope, and no one, especially fussy landladies and nervous profs, can say that there isn't life at this institution. With the opening of the new semester, indoor work has begun in earnest; a spring training trip is planned for the week of spring vacation in April. The teams will play a series of games with Mississippi, Mississippi A. and M., and the University of Alabama.

INTER-UNION QUARREL HAMPERS CONSTRUCTION

A great deal of trouble and embarrassing delay was experienced in getting telephone service for the Ruskin Apartments in Pittsburgh. The electricians' union, which does not recognize the linemen's and telephone workers' union, has a ruling that wherever conduit is installed in a building the pulling of the wires, as well as the installation of the conduit, must be done by the building electricians, regardless of the purpose which the wire serves. They refused to complete the other electrical work on the building unless they were allowed to pull telephone wires to every outlet. The telephone company would not permit the building electricians to pull their wires, so telephone wire had to be bought by the job and pulled in by the building electricians.

The telephone company refused to use any wire except their own material, pulled by their own men, and refused to come on the job until all the wire previously pulled in had been removed. Since any attempt to remove it would have caused the building electricians to strike, the telephone men could not start until all the other electrical work was finished and the electricians discharged. The wires disappeared from the conduit over night and installation of telephones was begun the following day. The electricians threatened to cause the few remaining union men in the job to strike, but the building was so nearly completed that is was possible to finish up before they could take any action. The electricians declare they were tricked, and claim that they will not allow any more buildings to be wired by union men unless the telephone contract calls for the pulling of telephone wires by union electricians.

A NOVEL HEATING PLANT

(Concluded from page 81)

necessity of a chimney or flue, the gases being discharged downward.

Figures 2, 3, and 4 show respectively side and front views of the boiler and burner assembled, and an interior view of the burner after it had been in trial service for a short period. The boiler and smoke hood are insulated with 1 inch thickness of 85% magnesia and jacketed. The burner is lined with a mixture of long fiber asbestos and high temperature cement. Figure 6 shows the mounting of the boiler just back of the left rear wheel of the truck. The acetylene gas tank is used to generate the first unit in firing up. The other units may be turned on at will after the first one has been fired long enough to become thoroughly heated. The fuel tank is located near the front of the car safely away from the boiler. All parts are encased in steel boxes to protect them from wheel splash, rain, and tampering.

In firing up, the boiler and heating system should first be filled with water by means of the hand pump, the handle of which is shown at the upper right of the boiler in Figure 6. The fuel tank should be filled with gasoline and an air pressure of 30 to 40 pounds be built up in the air tank. The air valve may then be opened admitting air pressure to the gasoline tank. The acetylene torch may next be applied to the exposed end of the first nozzle and when it is well heated, the torch should be inserted in the small hole just above the first and second nozzles, (shown in figure 3), and the gasoline be turned on. After ignition takes place in the burner the torch should be held on the exposed nozzle again for a few moments until the burner has generated enough heat to sustain its action. With one unit of the burner in operation the temperature of the water will become stable at about 120° to 130° Fahrenheit. With two units it will rise to 160° to 170° degrees. With three units it will rise to 200° to 210°.

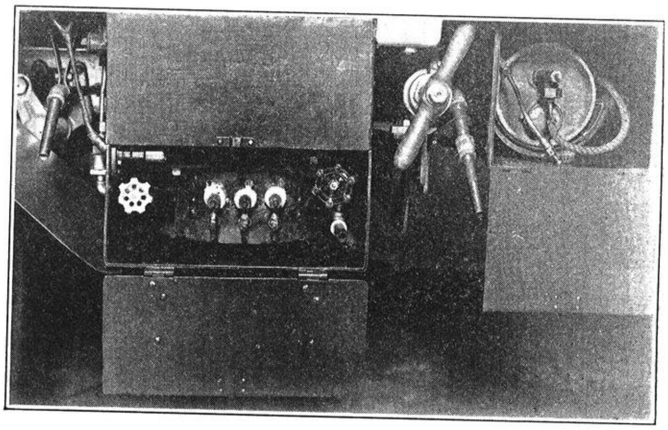


FIG. 6. A CLOSE-UP OF THE HEATING PLANT IN PLACE. *The acetylene torch used to ignite the burners is seen in the upper right hand corner. The handle of the water pump is between the acetylene tank and the burner.*

The car has been in successful use for one season, April to December 1, 1922. Each unit of the burner will consume from 5 to 6 quarts of gasoline per day of 24 hours. The car is not in use during the three or four months of severe weather and two units are generally sufficient. Complete detailed drawings are on file in the State Department of Engineering and full information will be furnished to anyone interested.

THE HYDRAULIC LABORATORY

(Concluded from page 85)

on the side of a flowing channel; loss of head due to reverse bends in pipes; loss of head due to sudden enlargement in pipe; loss of head due to gradual enlargement in pipe; coefficient determinations of special orifices; and the calibration of a special venturi meter to be used in an air-lift plant test.

The instructional work of the department includes hydrology, water-supply, water power, sewerage, sewage disposal, drainage, irrigation, hydraulic machinery, and hydraulic design. Only that part which has to do with the instruction in theoretical hydraulics, laboratory, and research work is conducted in the laboratory building.

BETTER LIGHTING NEEDED IN INDUSTRIAL PLANTS.

In a paper read before the Illuminating Engineering Society, February, 1920, entitled, "A Survey of Industrial Lighting in Fifteen States," R. O. Eastman submitted some very interesting data regarding the lighting conditions in industrial institutions. The survey comprises some 446 institutions, in which lighting was considered by 55.4% as being vitally important, and by 31.6% as being moderately important, and by 13% as being of little importance. Practically 58% considered that lighting was as important as power in the operation of the plant, and a small proportion would give more attention to lighting than to anything else.

In considering the present condition of lighting as found in the various plants, only 9% ranked as excellent, about 1/3 ranked as good, 29% fair, 18.8% poor, 3.5% very poor, and 7.8% partly good and partly poor. It was found that the lighting in the offices was far superior to that in the shops; 19% being excellent, 36% good, 31% fair, and only 13% poor and none very poor.

On consulting the executives regarding what factors were most important in considering lighting, the following facts were revealed: Increase of production 79.4%, decrease of spoilage 71.1%, prevention of accidents 59.5%, improvement of good discipline 51.2%, and improvement of hygienic conditions 41.4%. Manufacturers who have good lighting appreciated its value largely from the standpoint of its stimulating effect upon output.

There is no question that any intelligent man who carefully considers the necessity for good lighting in an industrial plant, will agree that it is impossible for a person to do as good work, either in quality or quantity, in poor light as in good light, but yet the result of a careful analysis discloses the fact that only about 40% of industrial plants are furnishing good light to their workers and 60% are operating under poor lighting. It is hard to understand why such a proportion of concerns can be satisfied with a condition which is universally admitted to be a curtailer of efficiency and a prolific causer of accidents. The principal cause of this condition is that those in charge of such establishments have not given the attention to lighting that it demands. They do not know what constitutes good lighting, and in their absorbing interest of other factors of production have overlooked a vital one.

Every safety official should deeply interest himself in the lighting of his plant and insist upon good lighting as much as good goggles, good guards and other necessary accident prevention equipment. Every production manager should insist upon good lighting because the efficiency of the working force is increased by the condition of the lighting furnished. The plant physician should examine the lighting, for eye strain and eye fatigue are directly affected by poor lighting, as is the hygienic condition. Well lighted plants are invariably cleaner than poor lighted places. Plants equipped with Factrolite Glass in all windows are well lighted.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

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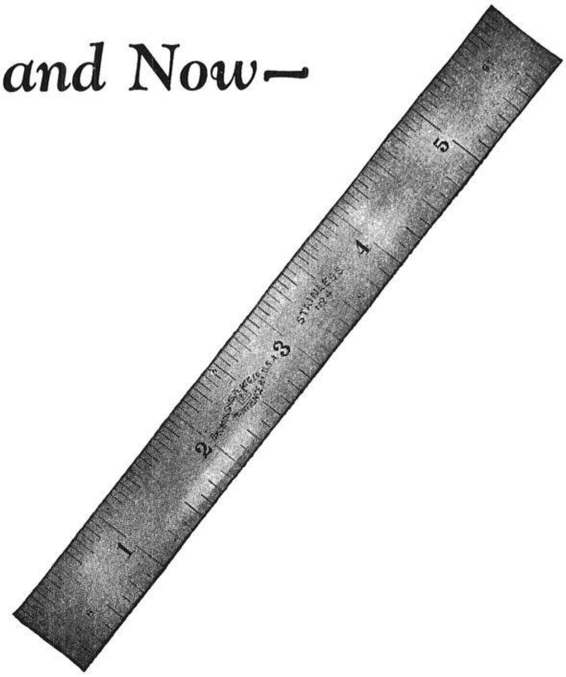

A MILLION VOLT OUTFIT

(Concluded from page 82)

transformers 2, 3, and 4 must be well insulated from the ground. Because of the dry climate of Pasadena, it is expected that treated wood will be feasible for this purpose, the transformers being merely set on wooden platforms. The maximum voltage between primary and secondary or secondary and tank is, however, only 250,000 volts, which makes possobile a comparatively small amount of insulation in the transformers themselves.

In order to supply 1000 kv-a. on the secondary of the group, the primary of the first transformer must be able to handle the entire amount. The upper part of the secondary (as well as the primary of the second unit) must be capable of handling 750 kv-a., while the fourth unit need have a capacity of only 250 kv-a. However, each primary is designed for 1000 kv-a., the upper section of each secondary for 750 kv-a., and the lower section for 250 kv-a. in order to make the apparatus interchangeable. This again makes a larger and more expensive construction, but one which allows any kind of connection.

The complete transformers are oil-insulated and self-cooled. The 247,000 and 250,000-volt leads are brought out through one large condenser bushing on each transformer, one lead being the copper tube on which the layers of tinfoil and paper are originally wrapped in forming the bushing and the other being a strap conductor passing up through the center of the tube and insulated from it.

Fig. 1 gives an idea of the construction of these transformers. The core is built up of silicon steel in a cruciform section. In transformers for such high voltage, the ordinary pancake coils are replaced by heavy micarta tubes, each wound with a single layer of wire. The tubes immediately around the core contain the primary winding. The mid-point is grounded to the iron. The next set of tubes constitute the beginning of the secondary. One end of the wire on the first tube is grounded and the other end passes across to the corresponding winding on the other leg. The same construction is used throughout the secondary, the cylinders being concentrically placed and the consecutive sections of the winding being first on one leg and then on the other. In this way, there is a comparatively small voltage across any two layers, and corresponding layers on the two legs are at approximately the same potential. Sixteen concentric cylinders are used for the secondary, and contain a total of 10,000 turns of wire for each transformer.

An interesting feature is the extra insulation used between turns on the high voltage end. A large part of the secondary winding consists of enameled, quadruple cotton-covered wire, but the end portions are wound with 7000-volt cable which is gradually increased in spacing until, at the high-voltage end, the turns are about two inches apart. This extra insulation makes the outfit immune to impulses of steep wave front which may be encountered in the work with experimental transmission lines.

Another feature is the static shield around the outer winding. (Not shown in Fig. 1.) A sheet of steel is bent half way around the outside of each leg and is connected directly to the high voltage lead. When a surge enters the transformer, it immediately spreads out over the shield and thus distributes the stress electrostatically over the entire first layer. Without shields, such an impulse might produce dangerously high potentials across the end turns.

The California Institute of Technology will be one of the first schools to have available a million volts for experimental purposes. It will be interesting to note the differences and the similarities between this and other outfits which may be built in the future.

OCCUPATIONAL DISEASES

(Concluded from page 80)

workmen have the habit of carrying an open package of tobacco in their hip-pockets. This offers an excellent receptacle for dust, and when the man takes his chew he puts into his mouth not only the dust which has fallen into the package but also whatever may be on his hand. Some men find discomfort in wearing goggles or respirators, but every man who disregards these safety devices suffers sooner or later, usually sooner. Safety First should be the eternal slogan in a chemical plant.

Many of the large corporations have a medical staff which includes at least one doctor. The doctor is a full-time man and makes a study of the conditions peculiar to his plant. In at least one plant in this country, applicants for employment are given a physical examination. This examination has eliminated nine per cent of the applicants. Timely medical attention will often save time and money for both workman and employer.

The Engineer's Duty

The engineer's special ability in regard to occupational disease is to see both the employer's and the laborer's viewpoint, and to transmit the ideas of one group to the other. He should inspire in both a confidence which is strengthened as time passes and proves that his interpretation and judgment have been fair and practicable.

STEEL CASTINGS TOUGH AS FORGINGS

(Concluded from page 78)

geneity treatment in bringing about the dispersion of the ferrite. Quenching leaves the metal in a state of internal strain and a reheating or "drawing" is necessary to eliminate this. The structure of the eutectoid matrix is a function of the temperature at which this final operation is carried on, and, in order that the eutectoid may consist of sorbite (unresolved pearlite), the "drawing" should be at a temperature of 550° C.

Fig. 3 reproduces at 100 diameter magnification the miscrostructure of steel of .3 per cent carbon content. The ferrite (light) is agglomerated in large crystals forming a practically continuous network. As ferrite has a tensile strength of only 36,000 lb. per square inch, it is no wonder that such steel has inferior qualities. The properties of a .3 per cent carbon streel in such condition are about as follows:

Tensile strength	65,000 lb. per sq. in.
Elastic limit	35,000 lb. per sq. in.
Elongation	12 per cent
Reduction of area	5 per cent

The impact test, the importance of which is generally underestimated, shows very low shock resistance for such a steel.

An ordinary method of heat treatment in the steel foundry is simply to heat the castings to a temperature slightly above the critical range, and allow them to cool slowly. It is a common belief that such treatment reduces the grain size and is of considerable benefit. The austenite from which the second separation of ferrite takes place is substantially unaltered from its original condition, and it is hard to see why this treatment should be of material benefit, aside from a tendency to lessen internal strains incurred during first cooling. Even when the steel is quenched in oil after such treatment, there is but little alteration of the original ferrite network. Fig. 4, which shows the microstructure of a steel so treated, brings out the truth of this statement. Average figures for a steel subjected to such treatment follow:

Tensile strength	67,000 lb. per sq. in.
Elastic limit	38,000 lb. per sq. in.
Elongation	15 per cent
Reduction of area	10 per cent

The impact resistance is also slightly increased.

It becomes evident that ordinary treatment does not give to cast steel properties comparable to those of good forged steels, and in the large interlocking grains of ferrite can be seen the reason.

The remaining micrographs show the striking structural changes brought about as a result of obtaining homogeneity in the autenite.

Figures 5 and 6 picture the results of a preliminary treatment which has been only partially effective. In both cases the steel was held for five hours at 900° C. The specimen in Figure 5 was furnace cooled, enough power having been left on so that the descent through the critical range required two hours. The ferrite grains are still rather large, but the result of the treatment is seen in their independence and random placing. The specimen shown in Figure 6 was oil quenched through the critical range. The grain size is well reduced, but the effect of insufficient homogeneity in the austenite is still to be seen in the tendency of the ferrite to localize in distinct areas.

Figures 7 and 8 picture the effects of a homogeneity treatment as stringent as would be expedient in practice. Both specimens were heated seven hours at 950° C. Specimen 7 was slowly cooled, and, although the ferrite thus had opportunity to dispose itself at will, it is found to be well distributed and the grains are reduced in size and independent. Figure 8 shows the effect of quenching in oil after a sufficient preliminary treatment. All traces of continuity in the ferrite have disappeared and the grain size is minute. The structure corresponds to that of the best forged steels. In testing cast steels of similar carbon content, Giolliti showed the following properties to be obtainable with such methods of treatment.

Tensile strength	90,000 lb. per sq. in.
Elastic limit	63,000 lb. per sq. in.
Elongation	24 per cent
Reduction of area	40 per cent

He also obtained a tensile impact resistance of 135 kg-m as compared to 132 kg-m in a properly treated forging of the same carbon content.

The steel foundry is in no way limited to the use of plain carbon steels in making castings. Alloying elements can be used with as great beneficial effects as in forgings. An alloy with from two to three per cent nickel, properly heat treated, shows properties about the same as a forged nickel steel. The same general considerations apply in the heat treatment of nickel steel as in the heat treatment of plain carbon steel. The effect of the alloying element is two-fold: In solution in the ferrite it strengthens that element; it also tends to increase the number of ferrite nuclei appearing as the metal, on cooling, reaches the critical range.

CO-OPERATION BETWEEN CONTRACTOR AND ENGINEER

(Concluded from page 92)

ienced engineers. Not only is this true of the engineer but it is true also of the contractor. A well equipped contractor receiving a fair compensation for his work, with an experienced engineer—and generally this means an engineer receiving a fair salary—in charge of the work means a smooth running, harmonious job where real co-operation and satisfactory results to the owner may be expected. On the contrary a poorly equipped contractor who has submitted a bid which will not allow of a first class job with a fair margin of profit, means contentions, and either the slighting of the job or calling on the bondsman; and this always means delay and, ultimately, a poorly finished job and a dissatisfied public.

The inspectors and the resident engineer are supposed to be able to enforce the carrying out of plans and specifications and secure the same result regardless of what class of contractor is doing the work. Yet, anyone at all familiar with construction knows how utterly impossible this is. To obtain first class results, experienced, well equipped contractors and competent, experienced engineers co-operating to the best interests of the owner are absolutely necessary. Now, how can this be accomplished? In my opinion, the only practical way is for the engineer to reject all work not coming up to the plans and specifications.

—W. R. Neel.