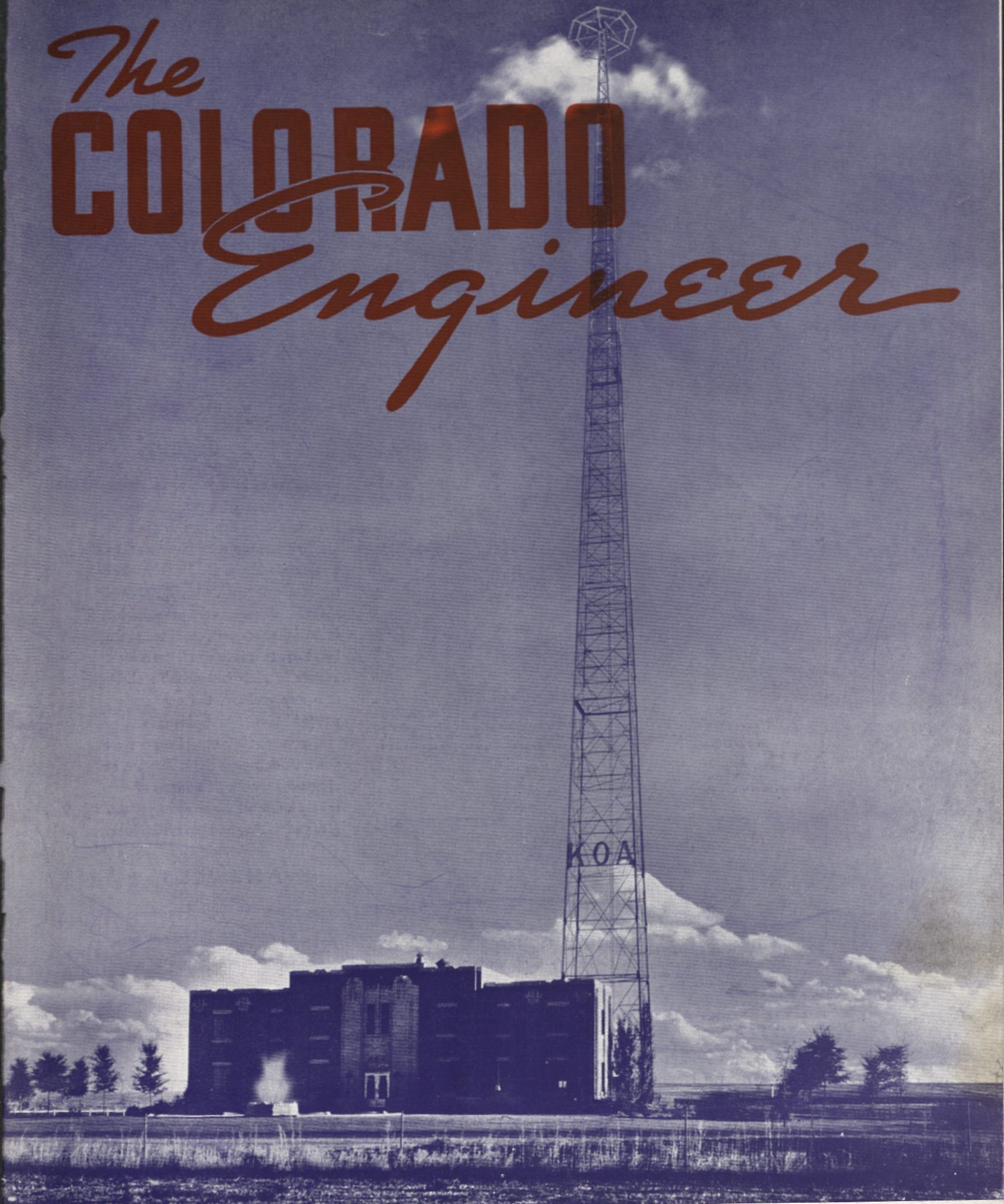


The **COLORADO** *Engineer*



UNIVERSITY OF COLORADO • MAY 1941

What do you know about Electricity?

No. 2 of a Series of Modern Engineering Tests!



THE OSCILLOGRAPH

The Westinghouse cathode-ray oscillograph makes written records of electrical events occurring in as short a time as:

1. One second
2. One cycle of a 60 cycle per second wave
3. One-thousandth of a second
4. One-millionth of a second.



LIGHTNING ARRESTERS

Lightning is a constant threat to transmission lines. Westinghouse has constructed lightning arresters that protect the highest voltage carried, which is:

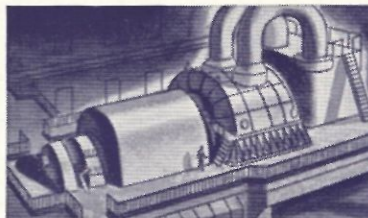
1. 33,000 volts
2. 66,000 volts
3. 220,000 volts
4. 287,000 volts



DEEP OIL WELL DRILLING

Great depth is being attained with electric rigs using Westinghouse equipment. To date, holes have been drilled as deep as:

1. 1200 feet
2. 4300 feet
3. Two and one-half miles
4. Six and one-third miles.



STEAM-TURBINE GENERATOR

Installed in Philadelphia is the largest single-shaft steam-turbine generator ever constructed. It was built by Westinghouse and can develop:

1. 17,500 kw
2. 72,500 kw
3. 165,000 kw
4. 850,000 kw



SEADROME CONTACT LIGHT

The Seadrome Contact Light, developed by Westinghouse to facilitate night landing of sea-planes, is turned on and off by:

1. A man in a launch
2. An electric eye
3. Radio signals from shore
4. A submerged cable.



DE-ION PRINCIPLE

As pioneered in 1928 by Dr. Joseph Slepian, Westinghouse Research Engineer, the De-ion principle is concerned with:

1. Faster, more efficient extinction of electric arcs
2. A new method of charging for electric power
3. The theory of magnetism
4. Harnessing the power of the atom.

Let's Try It Again!

Regardless of how you came out on the last series of questions, here's another chance for you to see how familiar you are with important developments in the field of electrical engineering.

Optional answers are provided for each of the six questions listed at the left. Your task is to check the correct answer in each instance. To eliminate any peeking, the answers are printed below, upside down.

If you get four out of six correct you'll be doing all right. Five out of six passes you with honors. If you should know all the answers you can give yourself a good pat on the back.

★ ANSWERS ★

1. Ans. The De-ion Principle
3. Ans. Seadrome Contact Light
3. Ans. Steam-Turbine Generator
3. Ans. Deep Oil Well Drilling
4. Ans. Lightning Arresters
4. Ans. The Oscillograph



Westinghouse

*"The name that means
everything in electricity"*

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The COLORADO Engineer

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CIRCULATION 2,000

MAY, 1941

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Contents

PAGE

Cover — KOA Transmitting Station, Denver — <i>Courtesy KOA</i>	
Frontispiece	98
Our Responsibility	99
<i>Editorial</i>	
Fibrous Glass as an Insulator	100
<i>By Herbert W. Conn</i>	
The Business Side of Engineering	104
<i>By Miss Elsie Eaves</i>	
Corrosion in Structural Steel	106
<i>By George J. Nelson</i>	
Life Insurance	108
<i>By Mr. A. R. Stevenson</i>	
Behind the Scenes	110
<i>By Morton David, Jr.</i>	
News Briefs	112
<i>By August Etcheverry</i>	
On Our Campus	114
<i>By Lawrence Brown</i>	
With Our Alumni	118
<i>By Walter Shaw</i>	
Oil Can	128
<i>By Douglas Brauner</i>	

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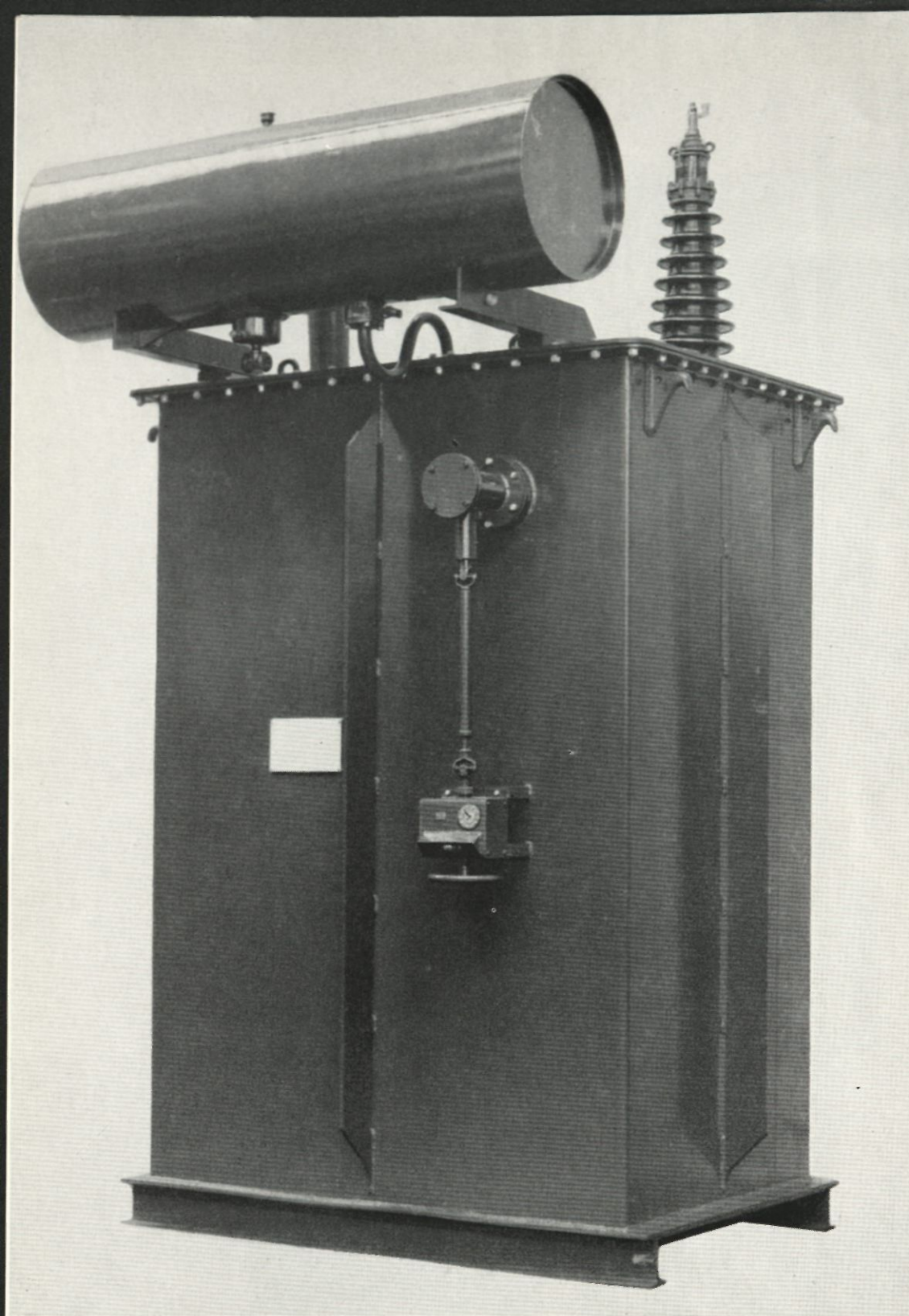
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Courtesy Public Service Company of Colorado.

Lightning is a Lesser Problem

THE PETERSEN COIL is a carefully tuned iron cored reactor which is used for the protection of High Voltage Transmission lines against damage due to lightning by quenching the power arc which follows the lightning stroke without causing power outage. Doctor W. W. Lewis, the Transmission Engineer in the Central Station Department of the General Electric Company, developed the coil for use on American power systems. Dr. Lewis obtained his Bachelor of Science degree in electrical engineering in 1907, his Electrical Engineering degree in 1923, and his Doctor of Science degree in 1936. He received all of his degrees at the University of Colorado.

Our Responsibility

THE FOREIGN SITUATION hits far closer to home than most of us think. An indication of the truth of this statement is the fact that German, as a scientific language for technical students, is rapidly being dropped from the curricula of technical schools. Why should this be so? The explanation is simple; due to the combined effects of "liquidation" and of state-directed activity for the engineering geniuses of the old countries, foreign engineers no longer dominate the field of purely technical research. The super-minds of old, those whose greater capacities for analysis and research caused them to be brilliant torches leading the rest of us along the right paths, are no longer able to pursue the studies and research for which they were suited. Unless engineering progress is to be plunged into the darkness of ignorance, it is necessary that this torch be carried by those who are not forced to devote their minds entirely towards selfish, nationalistic advancements.

The logical place to look for these men is here in the United States. Our engineers are already in the fore because of their *practical* ability, but can we offer a group of men who are able to carry on the analytical side of research? A little thought will show that this is not too probable at the present time. The American engineer, because of a super-abundance of raw materials, depends largely upon a generous factor of safety and upon laboratory-developed, empirical formulae to carry him through the fine details of his work rather than to take the trouble to develop accurate formulae for each case. Perhaps this apparent mental laziness is due to the lack of the mental prod of necessity—perhaps it is truly mental laziness. At any rate it is now up to us to develop a class of high grade, technical men who will be the analytical geniuses of the future. This group of men can no longer be content with an "approximation," but must relentlessly carry a problem to its basic fundamentals in order to determine the why and wherefore of each failure and of each success.

These men will not, nor cannot spring into being overnight! It is up to the faculty and students, and the faculty-to-be of our technical schools to develop them. The technical student must no longer be content to solve problems by simply following the procedure of a parallel text-book problem, but must develop the ability to think through and understand all the aspects of each problem. In this respect, the faculty have a definite responsibility. They must no longer baby the student and lead him through his problems, but must teach him to dig in and find the answer not by copy-work, but by a process of real THINKING.—Wilson.

Fibrous Glass As An Insulator

GLASS has been an important material in the electrical industry ever since the beginning of the industry. In fact, second only to amber, it may be classified as the oldest material associated with the phenomenon of electricity, one thousand B.C. Thales performed experiments with charged glass and amber rods, noting how they attracted light objects. Glass was put to its first practical electrical use in the Leyden jar in 1746, and since then it has assumed a permanent place in lamp bulbs and vacuum tubes. Glass insulators have long been used on low voltage power and communications lines.

As an insulator glass has ideal electric properties. Its dielectric strength and resistivity are both extremely high. In addition, its mechanical strength, its resistance to heat and to chemical agents, would make it the perfect insulator if it were not for one disadvantage. Glass in the ordinary state is not flexible. Under shearing stresses it is exceedingly brittle. From this fact glass gets its reputation for being fragile, even though its tensile strength is comparable with the best grades of steel. Hence solid glass insulation is difficult to apply to a variety of uses.

In 1859 it was suggested that glass fibers, woven into tape or fabric, would make glass insulation more practical. Until the last few years, however, no one actually investigated the possibilities of insulating with spun glass. But now that several of the United States glass companies are producing fibrous-glass products commercially, a large amount of experimentation has been carried on. Insulation tape, woven from glass yarn, has been found to have all the good characteristics of solid glass, and few of the bad. It is pleasing in appearance, having a close resemblance to silk or rayon. It has all of the insulating properties possessed by glass in its usual state. It does not deteriorate at high temperatures, nor under the influence of chemical agents or moisture. It will not burn, and its tensile strength, hardness, and elasticity are all excellent. It can be impregnated with insulating resins or varnishes to keep air and moisture out of the spaces between the fibers. And most important, because of the extreme fineness of the fibers, it has the flexibility of silk.

At present glass-insulated coils are being used to some extent on motors, generators, and transformers. Glass-insulated cables for house wiring are beginning to be used. The superior heat-resisting properties of glass, as compared with cotton, promise to revolutionize the size, weight, and ratings of various types of electrical apparatus.

Before we consider the properties and applications of fibrous glass insulation in detail, let us find out more about this type of glass. Glass fibers have been produced by glass blowers for centuries. In the thirteenth century the Venetians used them

by Herbert W. Conn, e. '41.

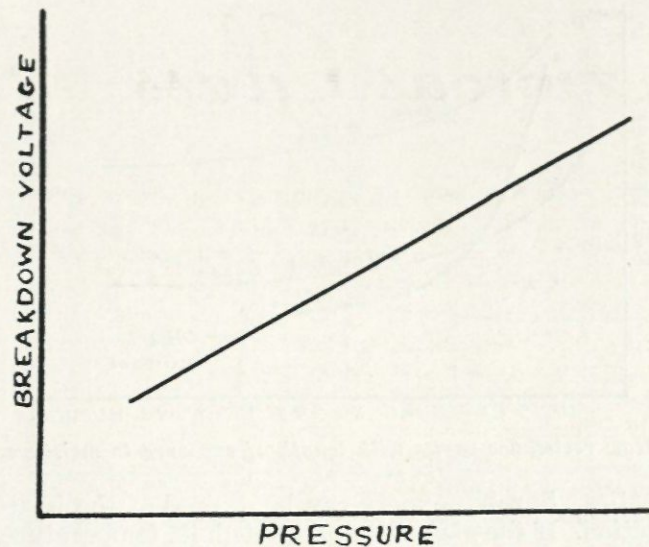
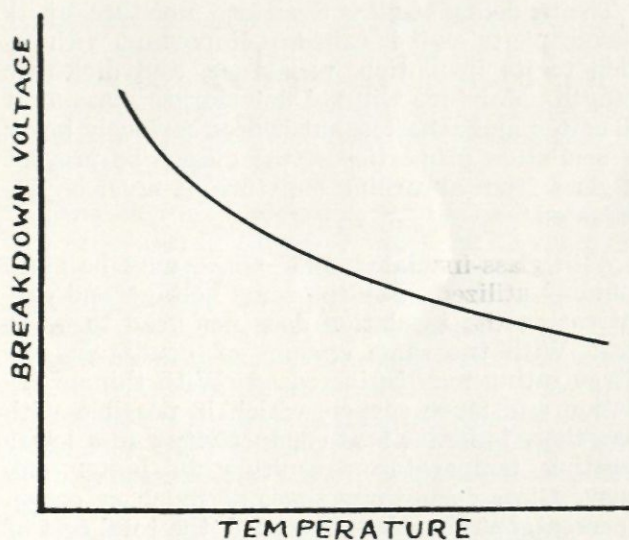
★ The new development in glass—fibrous glass—promises to replace all kinds of flexible electric insulation used in the engineering industry. In this article Mr. Conn discusses the features and advantages of spun glass insulation as compared with other insulating materials.

for decorating their glassware. The Venetian technique of producing the fibers was more interesting than efficient. The blower would heat a small lump of glass to the plastic state. Then his apprentice approached, seized a corner of the lump with a pair of tongs, and ran away as fast as he could. It wasn't long, however, until they discovered that the fiber could be pulled out more efficiently by a swiftly rotating drum. But the fiber was still costly, and was used only for expensive novelties.

At present two types of fibrous glass are being produced in this country. One is called "staple," and is made up of short lengths of individual fiber, eight to fifteen inches long. It has a fuzzy texture and holds impregnating compounds well. The other type is called "continuous," since the individual fibers are continuous throughout the length of the yarn. It is stronger and more expensive than the "staple" product, and in addition it is smoother and better appearing.

For the manufacture of both products a special glass is used. This glass is moulded into marbles three-fourths of an inch in diameter, that are rigidly inspected for air bubbles and imperfections. The satisfactory marbles are fed into small electric furnaces the size of a cigar box, where the glass melts at a temperature of 2400 degrees Fahrenheit. The molten glass flows by gravity through a row of fine holes in a precious metal die forming the bottom of the tank. To form the "staple" product, the fibers thus formed are pulled out by a jet of steam onto a revolving drum. From the drum the fibers are removed in narrow strips, one-eighth to one-quarter of an inch in width, called the "sliver." The sliver is twisted together to form yarn. The yarn may then be woven into cloth or tape.

When the "continuous" form is being made, the streams of glass that flow through the holes in the furnace—102 in all—are gathered together and pulled onto a revolving spindle. Lubricating oil is added to the fibers in this process so that they will



Curves showing the change in dielectric strength of glass insulation with temperature and pressure.

slide over each other easily when twisted. The individual fibers are about 0.0002 inches in diameter, or one-twentieth the thickness of a human hair. The fibers are pulled out by the spindle at a speed exceeding sixty miles per hour. One pound of glass will produce a strand of 102 fibers 90,000 yards long. These strands are now ready to be twisted into a fine yarn, from which glass cloth, tape, braid, and sleeving may be manufactured.

Tapes are manufactured with a thickness as low as 0.005 inches, and glass cloth with a thickness as small as 0.003 inches. Matting on which glass fibers are held by a bonding agent, and papers containing various percentages of glass fibers are now on the market. A wide variety in the chemical composition and subsequent heat and chemical treatment of the glass is possible, so that various properties may be obtained.

The characteristics of fibrous glass insulation depend somewhat upon whether the fabric is impregnated or not. Glass responds well to some sort of compounding treatment. If the spaces between the fibers are not filled with an impregnating compound, the dielectric strength of the glass is reduced to approximately that of an air-gap of corresponding thickness, or about 80 volts per mil. Solid glass, in contrast, has a break-down voltage strength of 3000 volts per mil. Also moisture can enter between the fibers and reduce the leakage resistance of the insulator. The chief disadvantage, however, in using a varnish, resin, or gum as a filler is that these substances are organic, and they deteriorate at a much lower temperature than glass. Hence one advantage of glass over organic insulators is lost. The ideal insulator would be fibrous glass impregnated with an inorganic resin, if such a thing existed. Semi-inorganic resins have been developed which can withstand a temperature of 300 degrees Centigrade, whereas all organic materials lose their mechanical strength and start deteriorating below 200 degrees.

The following properties are important in an

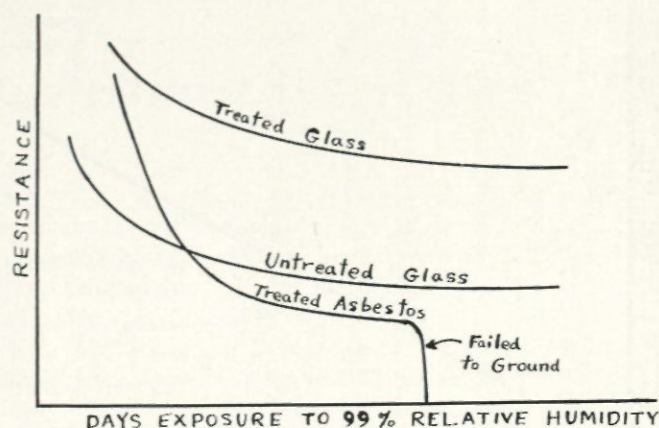
insulating material, and will be taken up one by one in connection with fibrous glass: dielectric strength, insulation resistance, resistance to high temperatures, thermal conductivity, mechanical strength, resistance to attack by chemical agents, tendency to absorb moisture, and space factor.

As has been stated, the dielectric strength of unimpregnated glass is rather low, somewhat less than that of cotton. However, it has twice the breakdown strength of the same thickness of asbestos. When impregnated, glass is about equal to cotton in this respect. As the temperature is raised, the dielectric strength of glass, although decreasing, improves with respect to that of other insulators. The dielectric strength of glass increases linearly with increasing gas pressure. The density of the glass has little effect on the breakdown point. A higher a-c voltage than d-c is required to puncture the glass.

The insulation resistance of glass is between 10^{16} and 10^{13} ohm-centimeters. Impregnated glass has higher resistivity than the untreated variety, because the impregnants keep out moisture which lowers the resistance. Glass can absorb moisture between its fibers, but the fibers themselves will not absorb moisture any more readily than window glass. Treated asbestos, on the other hand, has no space for moisture between its fibers, so that, in that case, it must be the fibers themselves that take in the moisture.

Insulation resistance decreases with increasing temperature in such a manner that if the logarithm or the resistivity is plotted against the reciprocal of the absolute temperature, a straight line results.

The next point, the resistance of the glass to high temperature, is what lifts glass out of the class of all organic insulators. Unimpregnated glass may be heated to its yield point, between 500 and 700 degrees Centigrade, before it loses any of its electrical or mechanical properties. Before this temperature is reached, if the coil in question has an iron core, the core will lose its magnetic prop-



How resistance varies with length of exposure to moisture.

erties. Surely no more can be desired of the insulation. If the glass is impregnated, its temperature limit will be fixed by the impregnant. Some of the oil used in the manufacture of the fibers remains on the glass, and gives trouble by oxidizing at high temperatures. It can be removed by heating the glass to 450 degrees Centigrade, or by washing the glass in an alkaline soap. The latter method is preferable, because the heat-treatment causes the glass fibers to become brittle.

Formerly, asbestos was the only flexible insulator resistant to heat. Motors wound with asbestos insulation are large and heavy. When glass tape is used, the size and weight are materially decreased. Since the coils can run hotter without injury to the insulation, some copper may be saved, too.

The heat conductivity of glass is considerably higher than that of cotton, wool, or asbestos. Thus, coils carrying the same amount of current, when insulated with glass, will run cooler than those insulated with an organic material, since heat is dissipated more quickly through the glass.

Glass fibers are remarkably strong in tension. The ultimate strength of very fine diameter fibers is in the neighborhood of one million pounds per square inch. This compares with 330,000 pounds per square inch for steel piano wire. Since glass is stronger than either asbestos or cotton, it can be used thinner, with a saving in space and weight. In rotor windings where the electrical and mechanical forces on the coils are great, glass insulation is very useful. However, glass is still glass, and it is weak in shear. When glass fabric rubs on sharp edges, some of the fibers break, weakening the whole material. This may be prevented by treating with varnish or oil, after which the glass is practically impervious to wear and vibration.

Ordinary glass will withstand the actions of organic solvents, oil, and all acids except hydrofluoric. An alkali-free glass has been devised which is impervious to most alkaline reagents. Glass will not oxidize or carbonize. It will not rot or mildew. Hence glass insulation is ideal in a corrosive atmosphere, such as exists in power and chemical plants.

The tendency of glass to absorb moisture, or its hygroscopicity as it is called, is important with relation to its insulation, resistance, and dielectric strength. Moisture will not deteriorate glass as it will cotton and asbestos, but it does seriously lower the insulation properties of the glass. To prevent the glass from absorbing moisture, it must be impregnated.

With glass-insulated coils, space may be more profitably utilized. For the same voltage and current rating the insulation does not need to be so thick. With the same amount of insulation, the voltage rating may be increased. With thinner insulation and more copper, which is possible with glass, there is better heat conductivity and a lower operating temperature, resulting in better efficiency. Glass costs three times as much as cotton at present, but since less is needed, the total cost of glass is only a little greater.

Last year glass-insulated motors were being made by at least twenty-five manufacturers. In addition to having high mechanical strength and resistance to temperature and corrosion, glass-wound coils for motors can be bent and formed easily, and have a good space factor. In installations where heavy overloads are common, glass insulation is very satisfactory. In all forms of railway motors, such as street cars, coal mine locomotives, and Diesel-electrics, weight must be kept at a minimum, and high temperatures are experienced, both from overload and from location. Hence glass-wound coils are being used. A 7.5 horsepower glass-insulated motor is one-third smaller and 90 pounds lighter than the usual type. Its coils get approximately 14 degrees Centigrade hotter, without danger of excess heat.

Glass is being used for stator windings up to 16,500 KVA, requiring 5,600 pounds of wire and insulation. For insulating the slots of these machines to ground, mica splittings fastened to glass cloth are used. The mica improves the dielectric strength of the unimpregnated glass. The end windings of the coils are bound with glass tape, interspersed with layers of mica. The higher the voltage of the machine, the more mica is used. The whole coil is then wound with glass tape.

For field windings, the strength of glass makes it especially suitable. Glass tape around the field-coil end windings holds them in place at high rotor speeds. The field slot lining is reduced in thickness, making a shorter heat path from the copper to the iron, in which the heat is dissipated.

A new coaxial transmission line has been developed, using a braided glass spiral winding to separate the inner conductor from the outer. The usual cables with ceramic spacing insulators are expensive, inflexible, and difficult to make in small sizes. Most flexible insulators, such as rubber, cotton, or cellulose, have such high power factors that the dielectric losses are too large. Glass has been used successfully on a one-fourth inch cable, to make a line so flexible that it can be wound on small

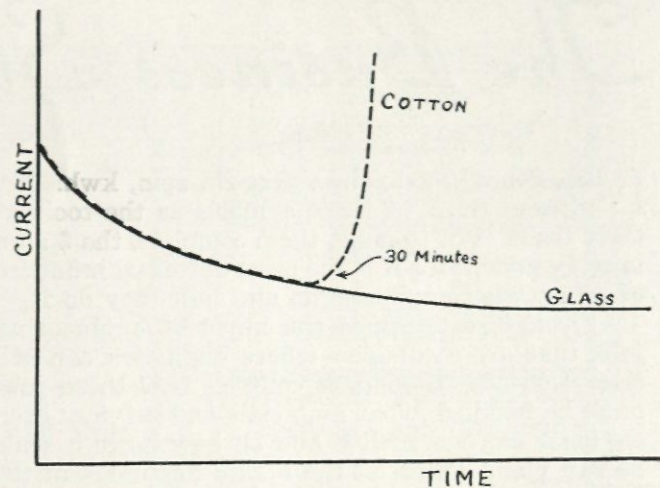
spools, run through conduits, and bent double without shorting the conductors. The power losses are low, and its d-c resistance is well over 50 megohms per 500-foot length of cable. Larger cables, which would have even smaller power losses, are now being tried.

Another use for glass is the insulation of magnet wire. Parallel glass threads are mounted on a cotton wrapping, and the whole thing is impregnated with heat-resisting varnish. Among the advantages claimed for this insulation are better electrical and mechanical properties; a better space factor; adaptability to smaller wire sizes; more permanence; it has a lower maintenance cost; resistance to higher temperatures; immunity to oils, acids, and corrosive vapors; and its non-absorbence of moisture. Glass threads wind smoothly onto wire, and tend to spread evenly. Automatic winding machines may be used to advantage. Glass fibers bend around a smaller radius without breaking than most forms of felted insulation now used. Glass insulation has been satisfactorily used on as small as number 40 wire.

In the field of radio, glass insulation is being used on choke coils. With an impregnant that makes it resistant to corona and moisture, the allowable temperature limits are much higher than in corresponding cotton-insulated coils. One notable test was run on two similar coils, one insulated with glass, the other with cotton. A high sixty-cycle voltage was connected across each of them so that they were both heated to a high temperature. A record was kept of the current in each. At first both currents decreased along the same curve, due to the coil resistance increasing with temperature. But at the end of 30 minutes, the current in the cotton-wrapped coil suddenly jumped up. Its insulation had failed. But in the other coil, there was no sign of failure at the end of 29 hours, although by this time the impregnant was completely burned out of the glass. The significance of this test is that similar results would be obtained at lower temperature when the time is measured in months instead of minutes.

A radio-frequency plate choke, insulated with glass, designed for the same radio-frequency power dissipation, the same frequency range, and the same d-c plate current as a cotton-wound coil, compared as follows: weight 25 per cent, diameter 67 per cent, and length 43 per cent of the cotton-insulated coil. A glass-wound transformer in an aircraft radio power unit decreased the weight of the transformer by 30 per cent. There was no sacrifice in the efficiency, and the life expectancy was increased 100 per cent. In general, glass-insulated coils raise the operating voltage over a given frequency range, or extend the frequency range for a fixed radio-frequency voltage. The permissible d-c plate current is raised, and coils of smaller dimensions are made available for higher voltages.

Glass windings that deliver double amperage are being used on welding generators. Glass is replacing asbestos as insulation for electric stoves



Resistance to temperature of cotton and glass insulation.

and flatirons. Appliance lead wires for kitchen electrical gadgets are now on the market, with fabricated glass a major part of the insulation. In all types of apparatus where overloads and extreme service conditions are encountered, glass insulation is finding a use.

And so glass, one of the oldest artificial materials devised by man, has found a new use. It is not, by any means, a cure-all for insulation problems, but it has advantages which make it definitely worth the consideration of a designer. Its resistance to high temperatures and corrosives and its mechanical strength are properties that will cause glass to assume a larger and larger place in the manufacture of electrical apparatus. Glass insulation that is now in use is being carefully watched, and it is being studied in the laboratories of numerous companies. As new properties are discovered, and as problems of design created by the new material are being worked out, more and more will glass become a vital factor in the electrical industry.

A three-horsepower electric motor, developed for aircraft, weighs less than twelve pounds as compared with 150 pounds for an ordinary three-horsepower motor.

Rubber can be given the property of conducting electricity without affecting its other normal qualities. Degree of conductivity can be varied in all types of rubber except the extremely soft rubber.
—*Product Engineering*.

Paint experts say that an object may appear heavier in weight if painted red or orange, lighter in weight if colored blue or yellow.—*Science Digest*.

The world's record for house painting was broken at Omaha when 110 workmen painted a house in four minutes and fourteen seconds.

A road across Italian North Africa has one straight stretch 400 miles long without a sharp curve.—*Scientific American*.

The Business Side of Engineering

LBS./SQ. IN., gal./min., acre-ft., rpm, kwh. Engineers think of these symbols as the tools of their trade. But to make them complete, the \$ sign must be added; for it is the most universal influence of all on what engineers do and how they do it.

First, it determines the kinds of engineering jobs that are available—where engineers can sell their services. Second, it controls how those jobs must be handled, what materials and services each engineer can work with and on how large a scale he can plan. Third, as the \$ sign fluctuates in the buying power it stands for, engineers can time their work to take maximum advantage of the trend in costs and prices, to speed up buying in a rising market, to hold it back in a period of declining prices.

The engineer a buyer and a seller? Yes, he is as concerned with market conditions as any business man. There is a market for civil engineering services only when living standards are to be raised, production facilities are to be increased or community or national safety is to be protected. In our economy, before engineering services can be used, national thrift must be practiced to produce savings for investment in capital improvements. When capital investment, either by private individuals or organizations or by public bodies and government, dries up, engineering jobs dry up too.

Once the test of the economic soundness for a proposed engineering improvement was "Will it pay?" and that meant "Will it pay in \$'s returned to the owner?" "Will it save enough money in future operation to justify the initial outlay?" During the depression of the 1930's and now in the defense efforts of 1941 a different conception of "Will it pay?" has come out of the setback suffered by our economic system. This new conception, "Will it pay in social gains?" is now a parallel test to "Will it pay in monetary returns?"

Civil engineering and its partner, construction, are the advance guard of social as well as business progress. They provide the shelter and housing for business and living, the ways and terminal service facilities for all form of transportation and this includes pipes for transporting water, oil and gas as well as the canals, harbor structures, railroad way and structures, highways, airports. They raise standards of safety through sanitation in community water supplies and sewage and waste disposal. Many of these civil engineering construction works represent both social and financial gains. Now civil engineers are busier than they have ever been before in history rushing through production facilities, not for \$'s returned to entrepreneurs, but for the production of armament, ammunition, aircraft and ships and for military housing, shelter, transportation, terminal, and sanitary facilities, for the common good.

Until 1930, American civil engineers had never experienced selling their services in a "buyers' mar-

by Miss Elsie Eaves, c. '20

★ The engineer of today cannot be content with simply a technical knowledge of his profession. He must also have a good understanding of the economic side of his profession, because the \$ sign is an important influence on his work. In this article, Miss Eaves, who is the manager of The Business News Department of The Engineering News-Record, discusses the various economic aspects of the engineering field.

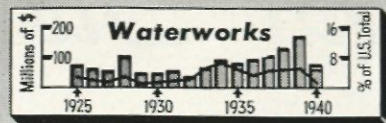
ket" of job scarcity. Now, after ten years of rigorous practice in keeping their skills and abilities occupied in a slim market they are again in a "sellers' market" of engineering scarcity due to the emergency speed-up of defense work. But after this emergency, what? It behooves level-headed engineers to consider thoughtfully the economic significance of their profession and help economists, business men and government officials solve today's most baffling problem, smoothing out the ups and downs of the business curve. The National Resources Planning Board is asking Congress for \$2,000,000,000 to prevent a sharp letdown in construction work after the emergency defense program eases up, but this is a palliative, not a cure.

As private capital investment has declined since 1929 there has been a rise in capital investment by public ownership. Which is the cause? And which the effect? Engineers should understand this, or the conditions that cause it. The present trend represents a socializing of their profession. Is this good or is it bad? Can engineers themselves do anything about it?

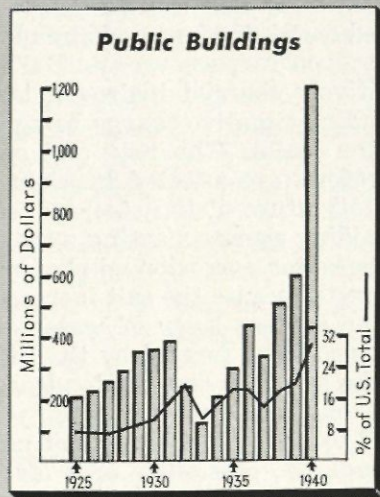
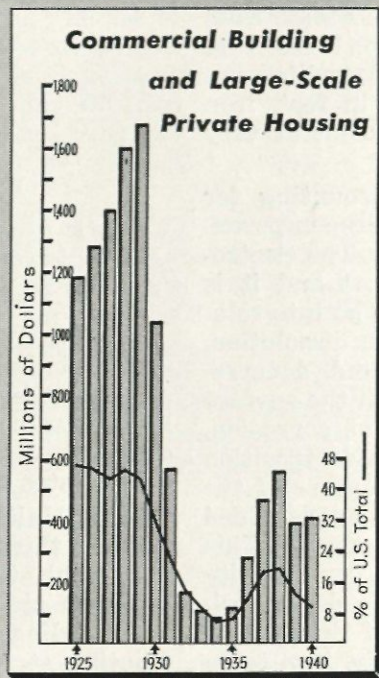
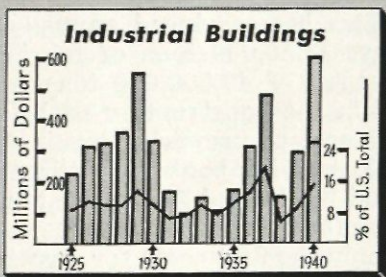
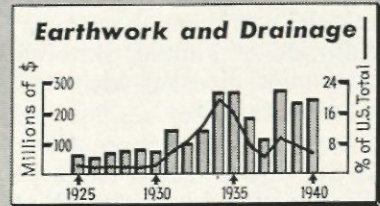
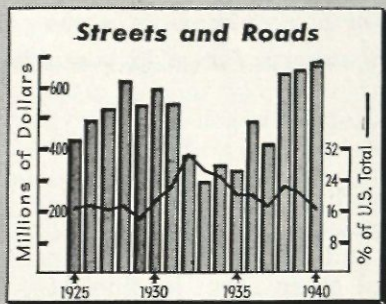
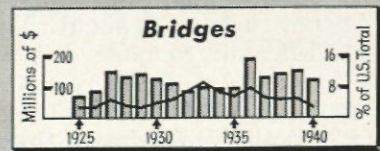
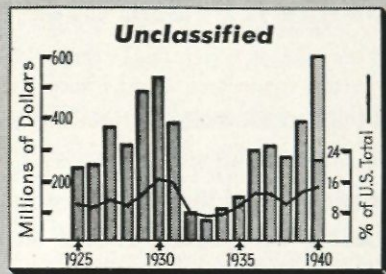
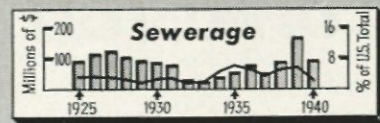
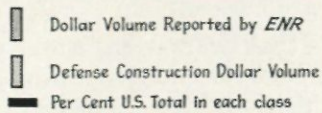
Capital investment not only varies in amount from year to year but varies in the usage to which it is put—in the types of structures it pays for. A few civil engineers can settle down comfortably in one job on one kind of work and stay there year in and year out, but not many. Most engineers not only can, but must, apply their knowledge of fundamental principles to many classes of engineering problems and constantly extend and round out that knowledge to meet the new demands on new jobs. A measure of the principal kinds of engineering jobs available and of how their frequency varies each year is given in the charts in which *Engineering News-Record* reports construction expenditures

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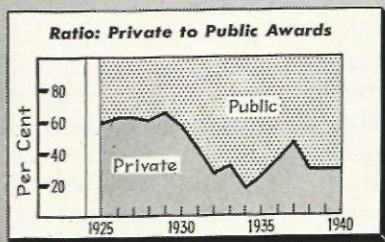
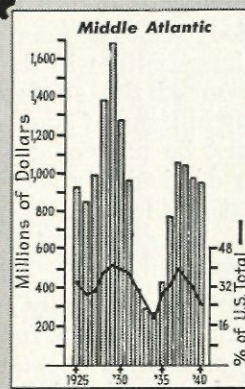
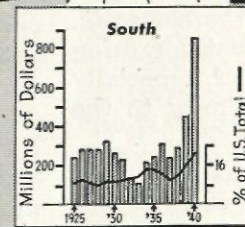
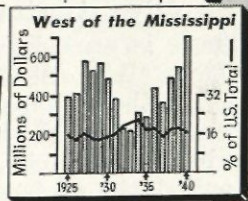
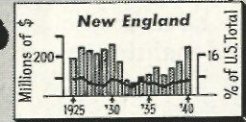
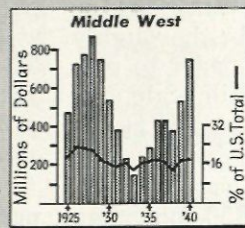
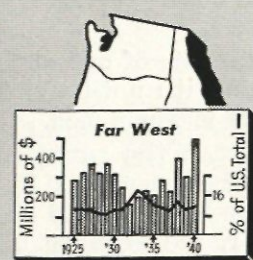
6. CLASSES AND LOCATION OF CONSTRUCTION REPORTED BY ENR



TRENDS BY CLASS



TRENDS BY LOCATION



ENR Business News

Corrosion in Structural Steel

RUST was once so obvious and simple that everybody understood it. Now it seems that no one knows how rust comes about. The chemist long ago analyzed it and pronounced it a hydrated oxide of iron. Since the atmosphere contains an abundance of free oxygen and water, what is more natural and reasonable than to suppose that these components of the air combine directly with the iron? Growing chemical knowledge, however, has discredited the explanation of simple combination: in fact, iron cannot unite directly with oxygen except at very high temperature.

There are now three theories accounting for rust; the carbonic-acid theory, the hydrogen peroxide theory, and the electrolytic theory. The electrolytic theory has the strongest support and it is based on the tendency of any metal to go into solution, even in pure water. During the dissolution, positively charged hydrogen is released, a corresponding negative charge being left on the surface of the metal. The rate and extent of corrosion, therefore, are affected by changes in composition and structure of the steel or by the nature of the corroding elements acting upon it. If salt is added to the water, corrosion will become more rapid. This happens because the salt increases the conductivity of the surface layer of water and the decomposition products, formed by the action of the current on the salt, increase the tendency of the iron to go into solution, where it is readily oxidized and hydrolyzed to rust. The purpose of painting metals is to exclude the possibility of a layer of water on the surface of the metal. The metal must be thoroughly cleaned before the paint is applied in order to prevent scaling because of dust or loose mill scale.

In the past several years, many notable structures have been completed. We must consider the cost of maintenance of such structures as the White-stone Bridge in New York City, a 2300-foot span suspension bridge, fifth longest in the world; Meeker Avenue Viaduct in New York City, 6400 feet of steel and concrete; the Housatonic River Bridge in Connecticut, noted for its use of open steel grating floor; and the many Mississippi River bridges. The largest item in the maintenance cost is the protection of the surface from corrosion. There are many billions of square feet of steel surface which must be protected from the elements. The protection of steel surfaces against corrosion presents a great problem to the engineer, especially along the coasts because of the proximity to the action of salt water.

The problem is not usually so great for structural steel in buildings as it is for bridges and other outside structures, since the steel in buildings is usually protected by coating for fireproofing, or it is inside where it is not exposed to rain and snow and where the temperature is reasonably constant. How-

by George J. Nelson, c. '41

★ One of the structural engineer's greatest foes is corrosion of steel surfaces. It is a major problem of the modern engineer to plan a successful attack on this dreaded enemy. Mr. Nelson shows some of the requirements for the protection of structural steel in this article.

ever, in buildings such as steel mills, the structural steel must be protected from gases and fumes released by furnaces and forges. In roundhouses, because of smoke and gases from locomotives, steel deteriorates rapidly if it is not properly protected.

The United States has produced annually for the last thirty years 1,650,000 tons of fabricated structural steel, a total of 49,500,000 tons which has been absorbed in the construction of bridges and buildings. The cost of properly cleaning and painting structural steel is about ten dollars per ton. This means that the United States must spend \$16,500,000 per year for the protection of new steel produced. This is only the first cost; for structural steel must be repainted about every seven years. Therefore, from this date, and increasing every year, \$50,000,000 must be expended yearly for the proper protection and maintenance of structural steel.

The problem of corrosion is one of our greatest problems and it must be dealt with until a strictly non-corrosive structural steel is furnished.

There is an old adage, "save the surface and you save all." All that seems necessary in the saving of the surface is the application of one or two coats of paint. However, the problem is far from being as simple as this. Before the paint can be applied, the surface must be thoroughly cleaned and dried. There are four methods employed in the cleaning of structural steel: the wire brush method, the pickling method, the flame-cleaning method, and the sandblast method.

Cleaning with wire brushes may be done either by hand or with power brushes, and it includes the use of a scraper and a chipping hammer. This method is rather expensive and is used most extensively in spot-painting where only isolated places must be painted. Another disadvantage of this method is that it is impossible to brush and scrape steel hard enough to thoroughly clean the surface.

The pickling method is used in cleaning metal which is to be electroplated or enameled. The steel is treated with a dilute acid. This method can be used only on members having a large area per ton of metal such as open floor grating or light lattice work.

Flame-cleaning as a method of preparing the surface for painting has been developed in the past year and a half and it is being used at present at the Golden Gate Bridge. In this area there are frequent salt fogs and high winds which cause the members of the structure to become damp so that the paint will not cling to the surface. The use of the flame-cleaning method insures a dry surface for painting. The flame used is the Oxy-acetylene flame which has been used for a number of year in fusion welding, but the apparatus used for applying the flame is entirely different from fusion welding equipment.

The requirements for flame-cleaning are: (1) that the equipment be operated under conditions of high efficiency of heat transfer; (2) that the heads be well protected against wear; and (3) that the equipment be light and easy to handle so that the operator will not tire too quickly. Flame-cleaning of structural steel requires intense high temperature flames which are traversed over the surface so that the surface scale is heated quickly, thus being caused to expand and to free itself from the underlying steel before the steel is warm enough to expand appreciably. This operation is followed by a thorough wire brushing, which breaks away any partially freed scale, dirt, or rust and removes it from the surface. The heat of the flame also warms the steel and drives moisture from the surface and from the crevices between the assembled parts.

The apparatus for flame-cleaning consists of a torch like a squeegee, about six inches long, from which jets of gas issue through openings spaced about one-fourth of an inch apart. Skid bars are placed on each end of the torch, so that when the flame is applied to the steel, the jet openings are held the required distance from the steel.

The use of the flame-cleaning method on such structures as the Golden Gate Bridge does not present as many difficulties as it does on a smaller structure. The members of the Golden Gate Bridge are so massive that a man can climb up inside of a post and work inside the chord members. On a small bridge there are many corners and crevices per ton which are inaccessible because of their small size.

After the flame-cleaning method has been applied, the steel must be gone over with a wire brush and then with a duster before it can be painted. This method has the advantage over sandblasting in that the painters can follow very closely the cleaning, while in sandblasting the painters cannot paint adjacent to the cleaning operation because of flying sand.

Undoubtedly the most widely used method of structural steel surface cleaning is sandblasting which consists of spraying sand, under high pres-

sure, upon the surface. A typical specification for the cleaning of steel follows: "All surfaces of the metal which are to be painted shall be sandblasted to remove all rust, scale, dirt, old paint, concrete, and all other substances. The sandblasting is continued until the surfaces are bright and resemble frosted silver. The removal of heavy rust, dirt, scale, or concrete shall be accompanied by the use of metal brushes, chisels, hammers, or other effective means. Oil and grease shall be removed by the use of gasoline and benzine.

"A compressor of sufficient capacity shall be used for the operation of the sand drum. The compressor shall maintain a minimum air pressure of ninety pounds per square inch at the drum, using a five-sixteenth nozzle. A sand dryer of sufficient capacity to insure dry sand shall be used.

"The sandblasting and painting operation shall be carried on in such a manner that the elapsed time between the sandblasting and the application of the first coat of paint will not be more than forty-eight hours. The work shall be carried on in such a manner that sand and dust from the sandblasting operation will not come in contact with freshly applied paint."

Sand is an expensive material in sandblasting. It must be perfectly dry in order to insure a good job since wet sand will clog the pipes, hose, and nozzle. It must be screened in order to remove all the dust and large particles. If the sand contains dust, the operator, being unable to see, will not get any work done. In addition to this, the dust will not have any abrasive effect. Consequently a large amount of sand will have to be used for a small amount of finished work. Another disadvantage of sandblasting is that the sand usually cannot be recovered since, during the process, it is rather widely scattered.

No matter what method is used in cleaning the surface of steel, a small amount of hand work is necessary. Concrete can be cleaned from steel only by chipping and scraping. Oil or grease must be removed with gasoline.

Structural steel may be cleaned either in the shop before it is delivered to the job or after it has been placed in the structure. Also the first coat of paint may be applied in the shop. There are several advantages in cleaning and painting in the shop, but there are also some disadvantages. Some of the advantages are: that the steel is on the ground, so that it is not necessary to build rigging in order to make the members accessible to the workmen; cranes and hoists are available for handling the members, making it possible to place them so that they can be easily painted; and the members may be conveniently inspected in the shop. The chief disadvantage to shop painting is that steel when first rolled has a large amount of mill scale which is not easily removable until the steel has been exposed to the weather for some time; this mill scale will remain a seemingly integral part of the steel until the member is placed in the structure and slightly deflected at which time the scale will drop

(Continued on page 126)

Life Insurance

LIFE INSURANCE is essential to the American standard of living. It is a means of protection for dependents of the insured in the event of his death or gives the insured financial security in his old age. If a man buys life insurance he is not guaranteed a longer life than the man who does not own life insurance, but the dependents of the insured are guaranteed, in some measure at least, the continued economic value of the insured after his death. When a man dies there is the economic loss to his family, or to his business, or to those dependent upon him for the money that he did not live to earn. When a man outlives his earning capacity—and the tendency today with corporate business is to retire men at younger and younger ages—he must have an income from some source to replace that lost because he is no longer on a payroll. Life insurance of the right kind and amount will compensate for these losses.

In the United States at the end of 1940, there were more than 65,000,000 life insurance policy holders; or approximately one out of every two of the country's entire population owns life insurance. The people of the United States comprise less than 7% of the world's population but they own more than 70% of the world's life insurance. Life insurance in force at the end of 1940 reached the all-time high of \$117,500,000,000 or nearly \$1,000 for every man, woman, and child.

An amount of \$2,700,000,000 was paid to policy holders and their beneficiaries in 1940. Of this amount, living policy holders, men and women who had consistently saved by making small premium payments out of earnings, received \$1,700,000,000. Also, \$1,000,000,000 went to beneficiaries of the insured as partial replacement of the money the insured did not live to earn.

Many men eligible for the draft are wondering if the Government will pay premiums on their life

by Mr. A. R. Stevenson

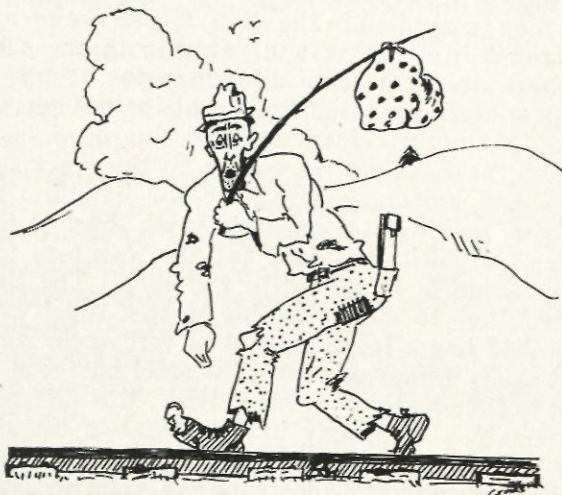
★ This excellent article was prepared by Mr. A. R. Stevenson, of the New England Mutual Life Insurance Company, especially for the senior engineers who have little or no knowledge of life insurance or of its value either as protection or as an investment.

insurance; and if so, what action should be taken to see that this is done. On October 17, 1940, the Soldiers and Sailors Relief Act was approved. This Federal law provides that the United States Government will advance premiums on private life insurance protection up to a total face amount of \$5,000 to men who enter military or naval service. The policy, or policies, must have been purchased and at least one premium paid prior to October 17, 1940, or purchased not less than 30 days prior to the entry of the insured into military or naval service, and at least one premium paid by the insured. It is understood that as little as one monthly premium will be construed as "one premium." Premiums advanced by the government are not to be deducted from the insured's regular pay check.

Life insurance has two basic functions. The first is to provide money for surviving dependents of the insured, if he dies too soon; the second is to provide money for the insured, if he lives long enough. By means of life insurance, money is purchased on the installment plan for future delivery.

There are two principle types of life insurance, temporary and permanent. Temporary insurance, more commonly called Term insurance, is life insurance covering a definite risk for a limited time only. This type of protection is designed for use during periods of unusual financial risks and is generally written for a limited period of 5, 10, or 15 years. If death of the insured does not occur during the term of the policy, the insured has no further protection, neither has he created any savings, or cash value, as would have been the case had he purchased some form of permanent insurance in the beginning. Premium payments required to provide Term insurance are less than premium payments for any form of permanent insurance, but the net cost of an equal amount of permanent protection is less because Term insurance has no cash value to credit back against premiums paid.

All types of life insurance policies, other than Term, come under the general classification of



"I forgot to pay my annuity premiums."

Permanent insurance. The five most popular forms of Permanent insurance are: Ordinary Life, Limited Payment Life, Endowment Insurance, Retirement Income Insurance, and Annuities.

Ordinary Life insurance, sometimes called Whole or Straight Life, is payable at the death of the insured. Premium rates for Ordinary Life are computed on the assumption that premiums will be paid during the whole life of the insured. Ordinary Life will become fully paid up if all dividends are allowed to remain with the company to accumulate at compound interest. All Ordinary Life policies will mature as endowments even though dividends are not allowed to remain with the company if the insured lives to the age of 96. Ordinary Life insurance requires slightly higher premiums than Term insurance, but the premiums remain the same, year after year, part of the premiums being used to build up an increasing cash or loan value, which Term insurance does not have.

Ordinary Life insurance is the basis from which other forms of permanent insurance are derived. Actually there is no difference between Ordinary Life, Limited Payment Life, and Endowment insurance, except in the amount of premium payments required, the cash or loan values produced, and the effect that the different cash values have on other non-forfeiture provisions. Ordinary Life is issued in greater volume than any other type. In many companies from 35% to 40% of the total of insurance in force is on the Ordinary Life basis. This form of insurance gives the maximum of protection for the minimum of premium outlay and is well suited to the needs of the young man just starting his insurance estate.

A word of caution is advisable, because not all insurance companies guarantee the insured the right to change from one form of insurance to another as his needs change. If a young man buys Ordinary Life, or any other form, he should take care to see that his policy will permit him to change to some other form, possibly from primarily protection to mostly investment if and when his affairs justify.

Limited Payment is insurance against death at any time, but with premiums payable for a limited number of years only, 5, 10, 15, 20, 25, or 30 years; or with premium payments ceasing at some stated age as 60, 65, or 70 years. Otherwise, Limited Payment is the same as Ordinary Life except that cash and loan values of Limited Payment are greater.

Endowment Insurance is basically Ordinary Life with premium payments the next step higher than premiums for Limited Payment. Frequently purchasers of insurance want a definite sum of money at a specified future time, but with the absolute certainty of providing the required amount of money should they die before the stated time arrives. Endowment insurance will meet these requirements. This form of insurance is usually written for the same specified number of years as is Limited Payment and differs from Limited Pay-

ment in that if the insured is living at the end of the specified number of years the cash value of the Endowment Insurance will have increased to equal the face value of the policy.

Retirement Income insurance is the next step higher in premium payment than Endowment insurance. Retirement Income is nearly always written to provide the insured \$10 a month for life after some predetermined age for each \$1000 of life insurance protection afforded by the policy from date of issue to the retirement age selected. With rare exceptions the cash value, if equal to or greater than \$1000, of any form of life insurance, whether Ordinary Life, Limited Payment Life, or Endowment, can be converted into a monthly life income for the insured.

Annuities are, in effect, Retirement Income insurance with the life insurance protection eliminated. Annuity policies are primarily for saving or investment purposes and to guarantee the annuitant old-age financial independence. There are two main types of annuities; those for which the purchaser makes regular annual premium deposits from date of issue to some stated age, and the single premium type of annuity.

If the purchaser of an annual premium annuity dies before reaching the designated retirement age, his beneficiaries are guaranteed the return of his premium deposits or the cash value of the annuity, whichever is greater. The single premium annuity is usually purchased by persons of mature age who have accumulated a large sum of money and are seeking lifetime security in the form of a guaranteed monthly life income.

Annuities are issued on a Refund and Non-Refund basis. In the Refund Annuities, if the annuitant does not live long enough to receive, in monthly payments, a total equal to the cash value or original purchase price, the company will continue paying to a named beneficiary until the cash or full purchase price has been returned. The monthly payment to the Annuitant from a Non-Refund annuity is greater than from a Refund annuity but the payment from a Non-Refund annuity ceases regardless of the date of death of the Annuitant.

Most, but not all, life insurance companies will add two special protection features to the policies they issue. These are the Waiver of Premium and Double Indemnity clauses.

The Waiver of Premium clause specifies that, if the policy holder becomes totally and permanently disabled by disease or accident, after at least six months of total disability the life insurance company will pay all premiums that may become due as long as the insured remains totally disabled. To make this clause effective the impairment causing total disability must occur before the insured attains a certain age, usually limited by life insurance companies to 60 or 65 years.

The Double Indemnity feature provides that

(Continued on page 125)

Behind the Scenes

Warren Mallory — Editor

Warren Mallory, editor of the *Colorado Engineer*, was born in Boulder on Armistice Day in 1919. He attended both grade and high school here in Boulder. While he was in grade school he took up amateur radio, and became the youngest licensed operator in the state at thirteen. He has talked to 103 foreign countries over his station, W9PGS. This hobby was partly responsible for his decision to take up electrical engineering. Warren has worked on the *Engineer* staff for two and one-half years, having been News Briefs editor, Campus News editor, and editor. In line with his hobby he has been president of the Radio Club and chairman of the Hamfest for Engineers' Day. He is a member of Tau Beta Pi, Eta Kappa Nu, Sigma Tau, Sumalia, and the A.I.E.E. He is affiliated with Sigma Phi Epsilon social fraternity. As proof of his mental ability, he has maintained a 2.3 average for four years and has managed to get Eleanor Hall to believe him long enough to become engaged to him. Upon graduation Warren is going to work for the Magnolia Petroleum Company in Texas, doing seismographic work.

Ted Kuntz — New Editor

Ted Kuntz, new editor of the *Colorado Engineer*, was born in Ottumwa, Iowa, July 7, 1921. He attended the first seven grades in Denver, Colorado, and then moved to Terre Haute, Indiana, where he attended the eighth and ninth grades. Forsaking the corn belt for the mountains, he moved back to Denver. There he went to high school and graduated from South Denver High. Having aspired to be an engineer for as long as he could remember, Ted, upon entering the University, de-

by Morton David, Jr. ch. '42

★ The task of producing the *Colorado Engineer* four times a year is not an easy one. The staff members who accomplish this feat expend a lot of hard work and receive little in return. In this article we present the senior staff members who have done such an excellent job this year and also the new editor and business manager for next year.

Photos by David Boyd

cided to follow in his father's footsteps and took up civil engineering. Ted has been on the *Engineer* staff for three years, as a staff assistant, as Campus News editor, as News Briefs editor, and now editor for next year. Ted is affiliated with Sigma Phi Epsilon social fraternity and is a member of A.S.C.E.

Harold Cook — Business Manager

If such a person as an indispensable man does exist, that appellation may well be applied to Harold Cook, Business Manager of the *Colorado Engineer*. Born in Denver, Harold attended West High School, where he was a member of the National Honor Society and was high man in scholarship. He planned to enter Carnegie Tech, but luckily his parents thought that it was too far from Denver. Harold started on the *Engineer* staff as a freshman.



Warren Mallory



Ted Kuntz



Harold Cook



Eugene Light

His junior year he was Boulder advertising manager, and this year, of course, business manager. During his four years at college he has become a member of Tau Beta Pi, Sigma Tau, Pi Mu Epsilon, and Pi Tau Sigma honoraries and Phi Sigma Delta social fraternity, of which he is president. He is also president of the Interfraternity Council and is a member of the A.S.U.C. Commission. When Harold graduates this June, he will not be finished with school, however, as he is going to attend either Purdue University or N.Y.U. for three months at the Government's expense. Following the completion of this course, he will become a Second Lieutenant in the engineering division of the U.S. Army Air Corps.

Eugene Light — *New Business Manager*

The future directing hand behind the business staff of the *Colorado Engineer* will be that of Eugene Light, business manager for next year. No stranger to the *Engineer* staff, Gene is well known to most students for his outstanding scholastic achievements and genial, direct manner. Two years ago Gene joined the *Engineer* staff, and his rapid rise is good measure of his ability. Last year he was Boulder advertising manager. A native of Nebraska, Gene left the Cornhusker state for Colorado University, although offered scholarships at other schools. His 2.7 average, his active participation in intra-mural athletics, and his membership in Pi Mu Epsilon, Sigma Tau, and Eta Kappa Nu attest that Gene's choice has been a happy one. This is his junior year in electrical engineering. Summertime for Gene means entertaining tourists and filling gas tanks in Idaho Springs.

Don Littlejohn

Don Littlejohn, assistant editor, has roamed the campus for four years endeavoring to discover the many mysteries of women and electricity—with notable success in at least one of the fields. After graduating, Don is accepting a position in Texas with the Magnolia Petroleum Co., doing seismographic or gravity meter work. While in school, he has participated in many branches of student activity, being a member of Tau Beta Pi, Sigma Tau, and former president of Eta Kappa Nu, in addition to his work on the staff of the *Colorado Engineer*. "D. A."—always ready to lend a helping hand—has served on the Applefest and Engineers' Day committees, and was "star" ticket salesman for the Engineers' Ball.



Don Littlejohn

Stan Fitzmorris

Stan Fitzmorris, ("S.R.") is the other half of the Littlejohn-Fitzmorris combination which has caused so many feminine hearts to flutter. In addition to maintaining a 2.85 average, he has worked as assistant editor of the *Colorado Engineer* and is a prominent member of many engineering organizations. Stan is vice-president of Tau Beta Pi, former vice-president of Eta Kappa Nu, a member of Sigma Tau, Pi Mu Epsilon, A.I.E.E., and the Radio Club. "S.R." has always had an interest in radio and he holds a first-class, commercial, radio operator's license as well as having been an active amateur radio operator. Upon graduation, he is going to work for the General Electric Co., in Schenectady, New York.



Stan Fitzmorris

Earl Harter

Earl Harter, assistant editor of the *Colorado Engineer*, came to the University of Colorado from Denver's East High. As he is fond of automobiles, shop work, and mechanics in general, it is surprising that he did not enter the field of mechanical engineering. However, Earl became an "electrical." Upon graduation this spring he will work for Westinghouse at East Pittsburgh. Besides his work for the *Colorado Engineer*, Earl belongs to the A.I.E.E. and is house manager of Alpha Sigma Phi social fraternity.



Earl Harter

John Wilson

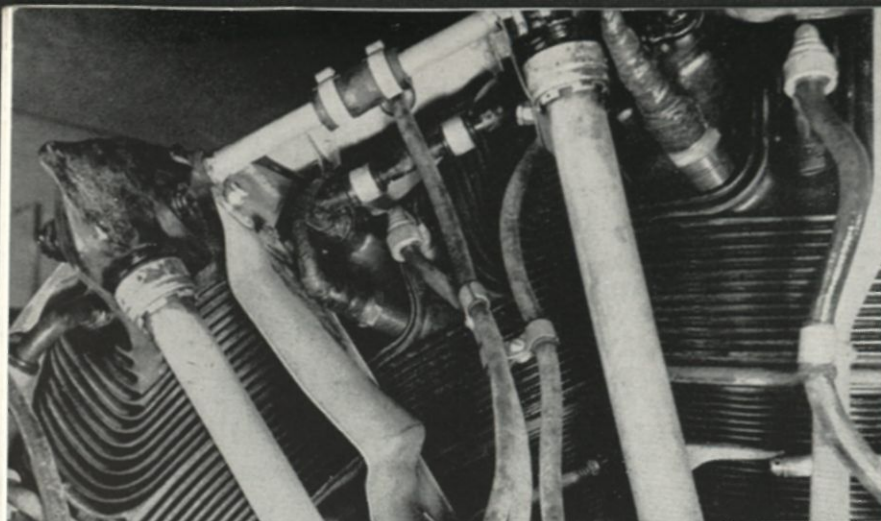
John Wilson, whose home is in Denver, has been an active member of the present graduating class of engineers. In addition to his work on the *Colorado Engineer* staff, as staff assistant and assistant editor, John has had many scholastic and social activities. Among his scholastic activities are membership in Tau Beta Pi, Eta Kappa Nu, Pi Mu Epsilon, and Sigma Tau fraternities and secretary of the A.I.E.E. As a member of the Viking club and president of the Newman Club, John has also had a busy social life. Upon graduation this spring John will leave for Schenectady, New York, where he has a position with the General Electric Company.



John Wilson

(Continued on page 122)

by August Et



Courtesy United Airlines.

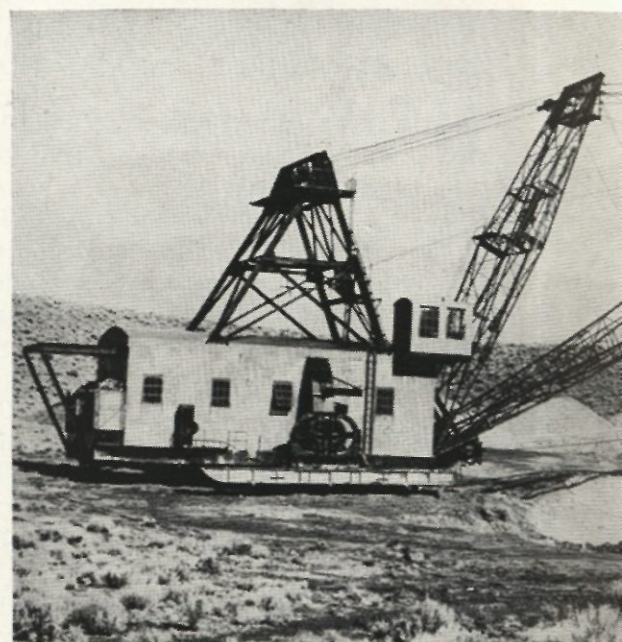
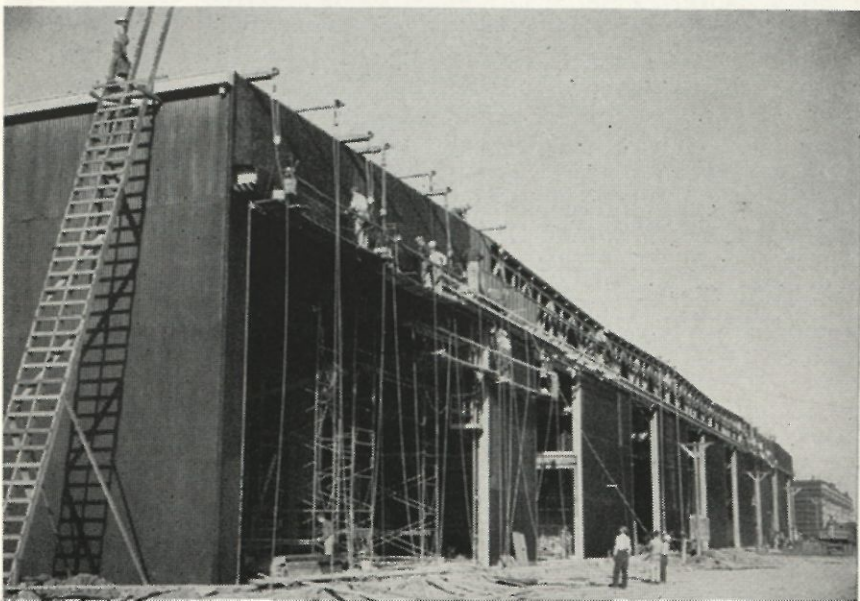
DETONATION INDICATOR

Above is a picture of the detonation indicator, a part of the equipment used by N. N. Stoffle, a graduate of the engineering school at the University of Colorado, in a recently completed study of the effect of various fuels, injection carburetors, and different types of spark plugs on the performance of airplane engines. The detonation indicator is installed directly onto the motor. The equipment used in the tests of the commercial fuels, laboratory fuels, and carburetors consisted of a torquemeter, thermocouples, detonation indicators, fuel flow meters, airflow manometers, tachometers, exhaust gas analyzer, and a special movie camera to photograph power conditions and to record individual cylinder pressures as shown by a cathode ray oscillograph. Covering a period of four months, the tests were made under actual operating conditions and were conducted by United Airlines in conjunction with Standard Oil of California.

DOUGLAS "BLACKOUT" PLANT

This building is one of the twelve members of the new "blackout" plant being constructed by the Douglas Aircraft Company at Long Beach, California. The plant will be colored to blend with the landscape and surroundings and will be windowless, air-conditioned, and fireproof. The power plant and essential materials will be placed in subterranean vaults for safe-guarding. Covering a tract of 200 acres, the plant will provide 1,400,000 square feet of working area. Some units of the plant will swing into action far ahead of the estimated schedule. Eventually the plant will employ 16,000 workers, and will operate 24 hours a day producing attack bombers and military transports.

Courtesy "Steel"



"ELECTRIC MINER"

Taking 19 tons of sand and gravel at one 24-hour day this new apparatus moves more "dirt" than 1,000 hand miners of olden times. The machine consists of two operations: the giant dredge extracts sand and gravel from the riverbed and hauls it to the recovery plant. With powerful streams of water, the large pieces of gold are recovered as an amalgam with mercury. While most of the work in the recovery plant

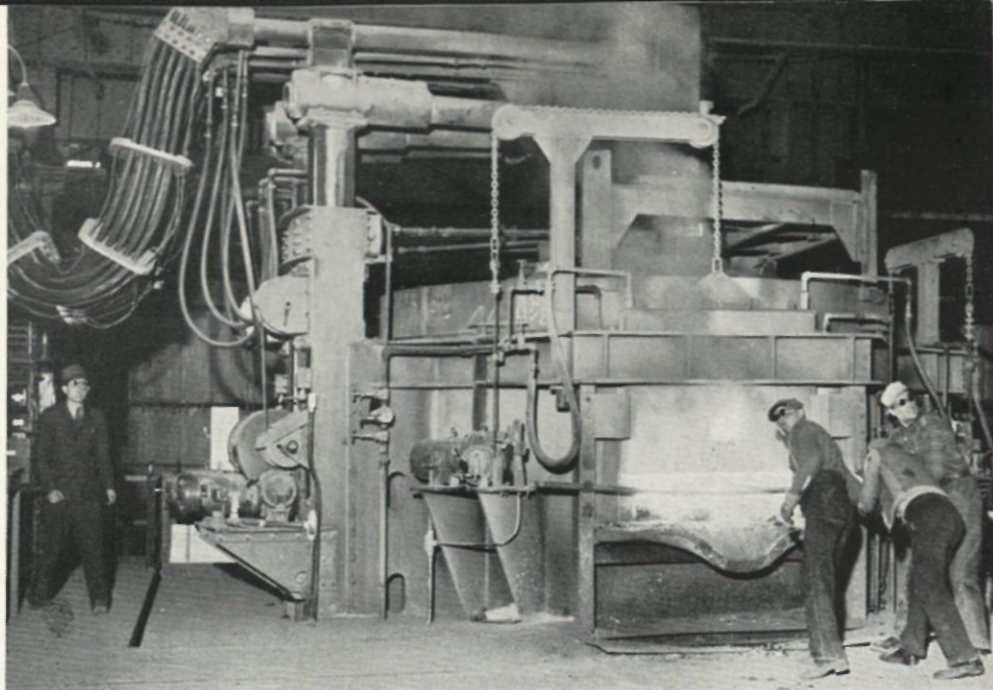
Briefs

cheverry, ch, '43



Courtesy "Scientific American"

one bite, the "electric miner" is being used to in the region of historic Dayton, Nevada. In es 40,000,000 pounds of gravel — more "pay es could turn out in a week. Electrical mining ge, shown in the picture, scoops up the gravel t: at the recovery plant the material is washed pieces of gravel are crushed, and the gold is The miner is operated by a crew of six men nt is done by 24 motors.



Courtesy "Steel"

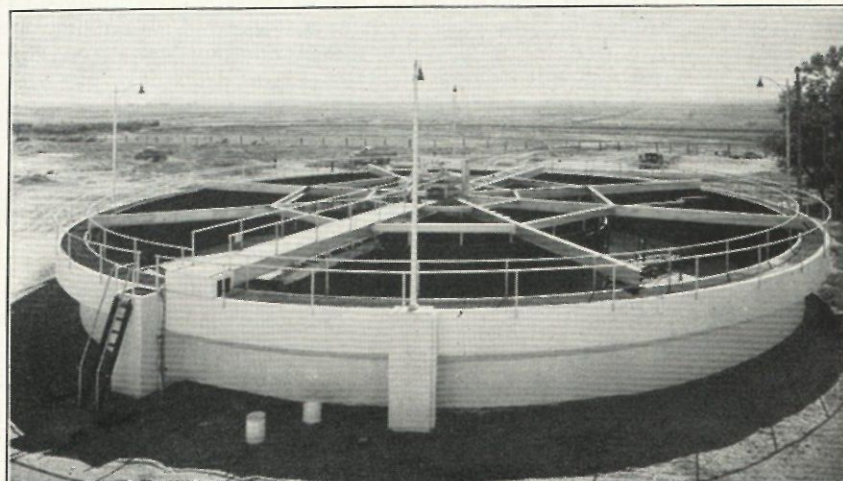
ELECTRIC STEEL FURNACE

This electric steel-making furnace, costing several hundred thousand dollars, is the first installed in the Youngstown district and is part of the \$1,000,000 expansion program of the Sharon Steel Corporation. Recently put into operation, it was built and installed in record time after the ground was cleared. A twenty-ton unit, it has a capacity of about 3,000 tons a month of alloy, stainless and high carbon steel. The Sharon Steel Corporation plans to use this furnace in its program of development in the high-grade steel field.

"CLARIFLOCCULATOR"

This 9MGD "clariflocculator" is a combination of a flocculator and a clarifier and is used in the treatment of sewerage at the Bakersfield, California, plant. One hundred feet in diameter, the unit employs a mechanical flocculation chamber at the central part and promotes uniformly distributed flow and minimum short-circuiting in the annular clarification section. In this manner a larger rate of flow of material is obtained with a consequential decrease in cost. During 1940 a number of these units were put into operation for use with or without chemicals, depending upon conditions.

Courtesy "Water Works & Sewerage"



On Our Campus —

Engineers' Day

An array of newly painted and polished equipment, supplemented by a host of student projects and outside exhibits, will compete at this year's two-day Engineers' Day to attract attention and praise to electrical, mechanical, civil, and chemical engineering departments. Visiting engineers and engineering students, as well as high school students from throughout the region, will inspect the laboratories and attend the many special events scheduled for May 23 and 24.

Engineers' Day will be earmarked by few important changes, following a procedure somewhat as in the past. Instead of the usual Wednesday afternoon and evening celebration, the engineers will extend a Friday afternoon and evening performance into Saturday in order that high school students attending the annual high school track meet on Saturday, May 24, may get a glimpse of the engineering student in action. Although the plan of having a general convocation of engineering students has been abandoned for several years, it will be revived this year, the convocation being held in the University theatre. An indefinite program for the convocation will schedule either a well-known outside speaker or a number of student papers on engineering topics.

Softball will be king on Friday afternoon as senior engineering diamond stars meet an engineering faculty nine in the annual senior-faculty contest. Preceding the open house at the laboratories, a dinner will be held for visiting engineers and the University engineering faculty. The laboratories will be open on Friday evening and again on Saturday morning, probably closing about midday.

Radio amateurs from throughout the state will convene for the annual hamfest held Saturday afternoon and evening. The hamfest this year will be marked by a number of special demonstrations in addition to the usual hidden transmitter hunt and evening get-together on Flagstaff mountain. Following registration, the "hams" will be treated to a number of student demonstrations. A talk by an outstanding radio technician is planned. Later in the afternoon the radio enthusiasts will attempt to locate two hidden transmitters in the mountains near Boulder. Hiding transmitter W9IVT will be Warren Andrew; while to make the search doubly difficult, Hurlburt Anderson will send signals from a concealed 9HIR. The radiomen will gather atop Flagstaff in the evening to participate in a picnic supper and prize drawings. The versatile transmitter finder will receive an award.

Of especial interest in the electrical laboratories will be the new million volt surge generator, a gift of the General Electric Company, installation of

by Lawrence Brown, e, '42

which has recently been completed. A sidelight on the generator which will be demonstrated in the electrical laboratories is the oscillograph used for observations of the surge effects. All of the electrical laboratory equipment will be in operation, and electrical engineering students will be on hand to explain volt and ampere intricacies to the visitors.

Outstanding automotive and aeronautical exhibits and demonstrations will attract visitors to the mechanical engineering laboratories. Work is being rushed at the present time on the experimental wind tunnel, designed by Prof. Norman A. Parker, in order that the tunnel may be placed in operation on Engineers' Day. A second featured display will be the series of historical aeronautical engines accumulated by the mechanical department over a long period of years. Engines ranging from the antiquated 1914 types to the latest models will be shown. The 400 H.P. Liberty test engine and the 450 H.P. Pratt-Whitney engine in the observation plane will be in operation.

In the civil engineering laboratory a large relief model of the Colorado Big Thompson water diversion project will be a chief attraction. A model of a water filtration plant similar to that incorporated in the Denver city water system will be explained. A third item consists of a series of animated units showing a steel mill in operation. Civil engineers will load concrete and steel specimens to failure in the materials testing laboratory, explaining the value of tests made on these materials.

The exhibits presented by the architectural engineers will center for the most part around student work. Various satisfactory solutions to original design problems will be shown, as well as student solutions of home building problems. There will be many examples of the type of work that is being done in freehand drawing classes.

Several recently completed chemical units will be in operation in the chemical engineering laboratory. Among these projects, designed and constructed by students, will be the new low temperature coke oven, where the making of smokeless fuel and the utilization of farm waste products is achieved. Students will demonstrate the functioning of the many complex units by making salt in the evaporating unit, purifying acetone solvent in the distilling unit, and drying chalk compounds in the drying unit. Fluid flow, heat transfer, and centrifuge apparatus will be in operation. These units will be supplemented by a mixing and agitation device, an absorption unit, and a filtration system.

Tests will be made on petroleum products and fuels in the oil and fuel laboratory.

Leslie Clayton is head of the Engineers' Day committee and Dr. Carl W. Borgmann acts as faculty adviser. Committee members appointed by the Combined Engineers are Fred Kelsall and Lee Alden, civil engineering; Donald Littlejohn and Robert Fleming, electrical engineering; Chalmers Loughridge and Sheridan Crooks, chemical engineering, and Stanley Proffitt and Lloyd Gardner from the mechanical engineering department.

More Jobs

All indications point to 1941 as a banner year for technical graduates. Defense expansion and generally good business conditions have opened footholds for graduates in every department.

Eighteen seniors in the civil engineering department have accepted positions following their graduation in June. Seniors and their jobs are as follows: Robert E. Boner, Walter R. Hogue, Nat Sachter, and Samuel Tamminga—Giffels and Vallet of Detroit; J. Douglas Brawner—graduate work at M. I. T.; Douglas Case—American Rolling Mill Company; Leslie Clayton—American Bridge Company at Ambridge, Pennsylvania; Joseph W. Fountain—American Bridge Company at Gary, Indiana; Fred Kelsall—American Bridge Company at Trenton, New Jersey; Woodrow Erickson—Public Service Company of Colorado; Daniel J. McQuaid—Denver Water Board; Oscar B. Jacobson—Standard Oil Company of Indiana; John S. Marshall and Jesse J. Simmons—Colorado State Highway Department; George H. Morgan—work with his father at Ladysmith, Wisconsin; Roy M. Ruddell and Thomas W. Ten Eyck—United States Navy; Howard F. Smith—Bureau of Reclamation.

Professor W. C. DuVall, head of the electrical engineering department, indicated that by mid-April 87% of the seniors in this department had definitely accepted positions following commencement. Jobs not previously reported include: John M. Firth—Sperry Corporation; Warren M. Mallory and Donald A. Littlejohn—Magnolia Petroleum Company; Werth Hage—Commonwealth Edison Company, Chicago, Illinois; Marcus Leh—Public Service Company of Colorado; James Slater—Colorado Fuel and Iron Company, Pueblo, Colorado; John Hester—United States Army; Willey M. Gue—Westinghouse Electric and Manufacturing Company.

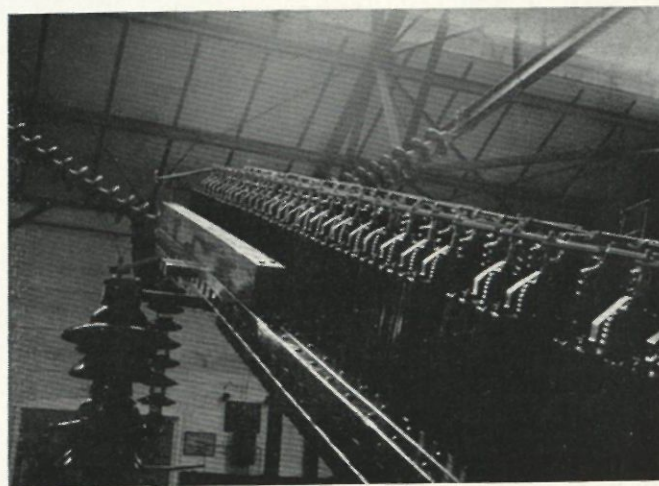
Twenty-five men in the chemical engineering department have definitely accepted positions following commencement. Graduating men and their jobs are: Henry R. Benson—Du Pont; Arthur E. Brainerd—Dow Chemical Company; Lyle Bray—Phillips Petroleum Company; Elvin E. Bushnell—Studebaker Corporation; Robert B. Chamberlin—assistantship, University of Minnesota; Earl W. Devalon—Procter and Gamble; John Fleming—U. S. Rubber Company; Hugh S. Graham—assist-

antship, M. I. T.; A. Tom Gurmataakis—U. S. Rubber Company; William B. Harris—National Aniline and Chemical Company; Hal M. Harrison and Paul H. Wilson—Chrysler Corporation; Joseph T. Hobbs, Jr.—Aluminum Research Laboratories; William E. Jordan—The Texas Company; Harold Lawler—Hercules Powder Company; Chalmers A. Loughridge—Atlas Powder Company; Edwin McCrillis and William E. Showalter—General Chemical Company; Elmer D. Scherrer, Paul E. Werner, and Harry L. Youngkin—American Rolling Mills Corporation; Charles N. Stone—The Texas Company; C. Robert Towse—American Smelting and Refining Company; David M. Boyd—The Barrett Company; William E. Williams—National Carbon Company.

Senior mechanical engineers who will claim jobs this summer include: Jack E. Barth and Richard B. Snodgrass—Boeing; Willard W. Brockway and Byron L. Whitney—Du Pont; Donald E. Clark, Harold V. Cook, Bernard B. Levitt—Army Air Corps; Jay E. Combs and Elijah R. Wagner—Carnegie Illinois Steel; Charles J. Elzi—Giffels and Vallet; Charles M. George and Orrin E. Watson—Wright Aeronautical Corporation; Henry R. Nash—Lockheed; Ralph E. Porterfield—Stearman Aircraft Corporation; Melvin R. Schuster—Aluminum Company of America; Deane Valentine—Colorado Fuel and Iron Company.

New Surge Generator for Electrical Engineering Laboratory

A million-volt lightning or surge generator is now being assembled in the Electrical Engineering Laboratories. The new unit, a recent gift of the General Electric Company, includes about 6 tons of apparatus, arranged on a platform 18 feet in length, 8 feet wide, and reaches to a height of about 10 feet. On the platform are mounted 80 capacitors arranged in banks of 2 each, there being 40 such



E. E. Laboratory's New Million Volt Surge Generator

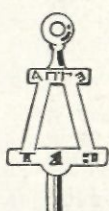
banks. These banks are connected in parallel for charging at 25,000 volts. The lightning discharge is obtained by discharging the 40 banks of condensers in series, giving 1,000,000 volts between the high voltage terminals and ground. A 25 kva, 25,000 volt 60-cycle transformer, and a Kenotron are used to provide the direct current for charging the capacitor units.

The generator will be used for student instruction, and investigation of the behavior of electrical apparatus and insulation when subjected to lightning strokes at high altitudes, a matter of considerable importance to electrical engineers engaged in high voltage power transmission work in mountainous regions.

Mrs. White Leaves

Mrs. John White, secretary to Dean Evans, has resigned her position to accompany her husband to Bridgeport, Connecticut, where he will be employed by the Remington Arms Company. Her pleasant face, eagerness to be of service, and uncanny ability to remember students' names has been an institution in the engine school for more than ten years; and her going is a loss that can never be quite replaced. Mr. and Mrs. White hope to return to Colorado in about five months. Miss Norma Mitchell is Dean Evan's new secretary.

Tau Beta Pi



At the meeting held on the evening of April 15, Colorado Beta chapter of Tau Beta Pi elected new officers. Carrying the torch for next year will be Everett Gilbert, president; Ben Griffith, vice-president; Jack Sanders, recording secretary; Sheridan Crooks, corresponding secretary; Mr. Arthur J. McNair, cataloguer; and Professor Wayne S. Beattie, treasurer. Retiring student officers are Berlin Boyd, president; Stanley Fitzmorris, vice-president; Elmer Scherrer, recording secretary; and J. Robert Rosenkrans, corresponding secretary. Professor Frank A. Easton was elected to the Advisory Board of Tau Beta Pi. He replaces Professor Charles A. Hutchinson, who has completed a four-year term.

An initiation banquet was held in Memorial Student Union Building April 1. Essays written by the pledges were read. A prize is to be awarded to the writer of the best pledge essay.

Sigma Tau



Sigma Tau held installation on Tuesday, March 25, for the following officers: Gordon Hungerford, president; Robert Fleming, vice-president; Richard Kellogg, treasurer; Lloyd Gardner, secretary; and Ben Griffith, historian.

Sigma Tau met Thursday, April 17, to choose its pledges. Eight senior men and twelve junior men were chosen. The

senior pledges were: Russell Schlosser, Orrin Watson, Joseph Hobbs, Earl Harter, Bernard Levitt, Frank Priest, Richard Snodgrass, and Chalmers Loughridge. New juniors are: Sheridan Crooks, Robert Cunningham, Roger Fricke, Victor Miller, Jack Sanders, Lawrence Brown, Elbert Michael, James Davis, Eugene Light, Robert Ramsey, Jesse Wilson, and Lee Alden.

Eta Kappa Nu



Eta Kappa Nu, honorary electrical engineering fraternity, elected new officers late in the winter quarter. New leaders are J. Victor Miller, president; Robert Cunningham, vice-president; and Ray Robertson, treasurer.

New members were pledged April 2. Eta Kappa Nu collaborated with Pi Tau Sigma in entertaining pledges of both societies at Canon Park. Pledged to Eta Kappa Nu were Jack Allen, Ray Allen, Martin Buffo, Robert Emigh, Eugene Light, Jack Sanders, Herbert Schweizer, Walter Stroh, Bill Ward, and Mr. V. O. Long. Their pledge activities included carrying motor armatures, switches, and coils of wire about the campus, and finding the capacities of these parts. An initiation banquet was held April 24. Informal speeches by the pledges were featured.

At the meeting of April 16, the petition of Georgia School of Technology for establishment of a chapter was approved. Plans were made for an Engineers' Day exhibit sponsored by Eta Kappa Nu.

Response to the Eta Kappa Nu annual job survey has been very satisfactory. More than fifteen replies have been received from utilities and manufacturing companies, many of them favorable. These letters are open to all engineering students, and may be seen in Professor McCormick's office.

Pi Tau Sigma



Pi Tau Sigma, honorary mechanical engineering fraternity, met recently to elect new officers. Joe Byrne will lead the fraternity next year. Ben Griffith is the new vice-president, and other officers are Lloyd Gardner, recording secretary; Richard Kellogg, Corresponding secretary; and Robert Brace, treasurer. Installation was held about May first.

April 9, Pi Tau Sigma met to elect new members. Pledges were Bruce Van Druff, Walter Shaw, Louis DiPastena, Lee Hall, George Fager, Jesse Wilson, Earl Donnen, and Lewis Crumley. Pi Tau Sigma and Eta Kappa Nu celebrated the occasion at Canon Park with their pledges. An initiation banquet was held honoring the new members.

(Continued on page 120)

How you get late newsso early



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research or utilize telephone equipment, or both.

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With Our Alumni —

1910

ERNEST C. ALLEN, m, and his family spent a few days in Boulder recently visiting Mr. Allen's mother. Mr. Allen is working with the steam turbine engineering department of Allis-Chalmers Manufacturing Company at Milwaukee, Wisconsin.

1919

KING BURGHARDT, c, who has been bridge designer for Colorado State Highways for the past six years, has taken a position as structural designer with Smith, Hinchman, and Grylls, Inc., consulting engineers and architects on the Denver munitions plant.

1921

CLARENCE H. CAUGHEY, m, has been made chief engineer of the Cardox Safety Corporation, Chicago, Illinois.

1926

GALEN G. CARTWRIGHT, e, has been promoted to assistant manager of advertising of the Goodyear Tire and Rubber Company.

1928

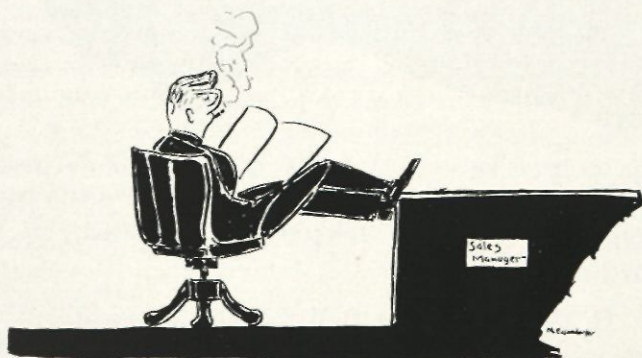
ROBERT HINMAN, c, is secretary and manager of the Hinman Brothers Construction Company, Denver, Colorado.

W. C. ROYAL, e, is doing design work on telephone toll cables at the Point Breeze Laboratory of the Bell Telephone Laboratories, Inc.

1929

H. LUTHER INTEMANN, arch, is employed as an estimating engineer on the Panama Canal at Balboa Heights, Canal Zone.

TERRY J. OWENS, c, is district manager of the Works Project Administration in Pueblo, Colorado.



1930

HARRY DEINES, m, has been appointed manager of advertising and sales promotion for the General Electric radio and television department, Bridgeport, Connecticut.

FRANK HORN, e, is in the design department of Western Electric Company at Baltimore, Maryland.

by Walter Shaw, m, '42

1932

LIEUTENANT L. J. BRUNTON, m, is now serving the war department at the First National Bank Building, Chicago, Illinois.

HUGH E. RICHMOND, ch, has been appointed special assistant to Emile F. du Pont, director of the nylon division of the du Pont company.

1935

J. RANDALL NUSSBAUM, c, recently accepted a position with the United States Bureau of Reclamation at Rapid City, South Dakota.

KARL WIEGER, arch, is employed by the Public Works Department of the Eleventh Naval District, San Diego, California, as inspector of construction.

1936

GILBERT BROWN, c, recently accepted a permanent government position as design engineer with the naval department at Mare Island, California.

1937

WILLIAM H. BURGER, m, is employed with the Kimberly-Clark Corporation at Neenah, Wisconsin. He is working in the heating and ventilating department.

BOB RATHBURN, arch, is now employed by J. T. Parmer of Chicago, as a draftsman.

CLEMONS ROARK, m, had his opinions on the decentralization of industry quoted to some length in a recent article appearing in McCall Magazine. Mr. Roark is executive director of the Housing Authority in Beaver County, Pennsylvania, the fourth largest industrial area of the United States.

GORDON WOOLCOTT, m, is instructing in the mechanical engineering department at the University of Wyoming.

1938

TOM BOAK, c, is employed by the Bethlehem Steel Company, Inc. He is specializing in Alloy Steels.

JACK FREEMAN, m, finds tool design work most interesting at the Boeing Aircraft plant in Seattle, Washington.

JOHN C. HAYES, e, who has taken the defense training course, "The Airplane and Its Engine," has gone to work for Lockheed Aircraft Corporation in Burbank, California.

ROBERT M. MAINS, c, is now teaching in the Missouri School of Mines and Metallurgy, at Rolla, Missouri.

ELMER L. MAUL, e, has accepted a position as navy flying cadet at Oakland, California.

ROBERT W. MILLENSIGER, c, recently became associated with the Johns-Manville Company in Denver.

CARL MOORE, m, has obtained his Master of Science degree at California Institute of Technology.

ROBERT SHAFFER, c, is now employed by Leeds, Hill, Barnard, and Jewett at Los Angeles, California.

1939

GEORGE H. ANDERSON, e, is keeping KOA's transmitter on the air in Denver.

WILLIAM DUTTON, e, who is employed by Allis-Chalmers has been sent to Marysville, Tennessee, where he is doing government work with the Alco Company of America.

ARTHUR FATTOR, ch, is now working in the gas engineering department of the Public Service Company of Colorado in Denver.

WILLIAM F. FRANK, c, is now a Second Lieutenant in the Marine Corps at San Diego, California.

PAUL H. JOHNSON, e, is working for the Public Service Company of Colorado in the Denver electrical engineering department.

FRED MACDONALD, e, is now with the Gates Rubber Company in Denver.

CHARLES MURRAY, e, is working for the U. S. Bureau of Reclamation in Denver.



RAY ORTEZ, c, is working for H. E. Beysten Corporation at Detroit, Michigan. He is in the drafting and designing department.

DICK TREMMEL, m, who has been working for Proctor and Gamble, has recently accepted a position with Lockheed Aircraft Corporation at Burbank, California.

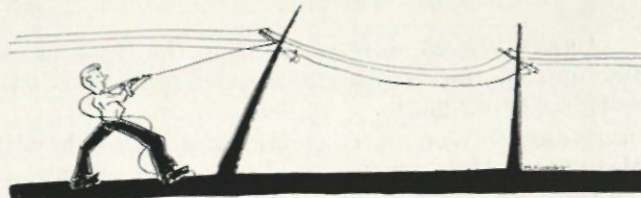
ARTHUR F. WEERS, e, is with the Public Service Company of Colorado in Denver.

1940

IVAN BLOSSER, ch, is working in the analysis laboratories of the Rustless Iron and Steel Company, at Baltimore, Maryland.

FLOYD BUSCH, e, is working for the General Electric Company at Lynn, Massachusetts.

CHARLES CARPENTER, m, and EATON DRAPER, m, are enjoying their work with the Wright Aeronautical Corporation at Paterson, New Jersey. Out of a class of 131 men Mr. Carpenter and Mr. Draper both rank in the upper five per cent.



ROBERT L. CARBREY, e, who recently married Miss Alma Marts of Denver, is now working for Western Electric Company at Baltimore, Maryland. Mr. CarbreY has been assigned to cable development work for the Bell Telephone Laboratories.

HAROLD L. CRISPELL, e, is Engineer in Charge of Frequency Measurements for the Hollywood office of the Commercial Radio Equipment Company.

TOM DALBY, arch, is employed by the Bethlehem Steel Company, Inc., at Bethlehem, Pennsylvania.

JENNINGS R. DAVID, e, is taking post graduate work at the University of Pennsylvania.

JOHN T. FALLON, m, has enrolled in the graduate student course at the Westinghouse Electric and Manufacturing Company, where he is taking a combined sales and engineering course in preparation to entering the sales engineering department.

JOHN IMMELL, m, is working with the Wright Aeronautical Corporation in Paterson, New Jersey.

GEORGE LOVERING, m, is at Purdue, where he is taking the Army Air Corps Engineering Squadron officer's training course.

ALBERT LUSIC, e, after several months with Amalgamated Sugar in Twin Falls, Idaho, has accepted a position with the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pennsylvania.

GORDON MESSMER, e, has been doing some work on inductive interference from power lines to telephone lines for the Rural Electrification Administration in Southern Maryland.

ROBERT E. SCHERRER, c, is working for a degree in Engineering Mechanics at Stanford University.

WALTER B. SCOTT, m, is navy aircraft inspector at the U. S. Navy Yards, Philadelphia, Pennsylvania.

WILLIAM SHEPARD, e, is working at the Fort Wayne, Indiana, plant of General Electric Company.

SAM STAHLEY, m, is employed as junior instructor of aviation mechanics at the Air Corps Institute, Scott Field, Illinois.

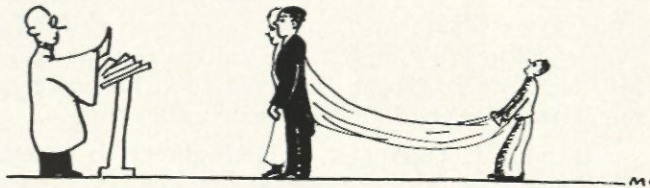
CLYDE SWETT, e, is working for the Civil Aeronautics Board at Hampton, Virginia.

ROBERT TSCHANNEN, e, is doing antenna measurement work for the Commercial Radio Equipment Company in Kansas City, Missouri.

VINCENT VALLERO, m, is at New York University, where he is enrolled as a student in the Army Air Corps Engineering Squadron officer's training course.

PLATT WICKS, e, is working in the Switchgear division of the Westinghouse Company in Pittsburgh, Pennsylvania.

WARREN WOODIS, c, is taking a new job with the Navy Department of Docks and Yards in Seattle, Washington.



MARRIAGES

1937

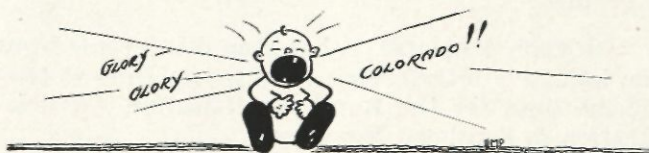
William E. Bower, c, and Miss Ann Mollin were married at St. Thomas Episcopal Church, in Denver on March 16. Their home will be in Charleston, South Carolina, where Mr. Bower is an ensign in the civil engineering corps of the U. S. Navy.

Robert K. Lootens, m, was married March 19, 1941, to Miss Alberta A. Snow. Mr. Lootens is an engineer with the Navy Department in Washington, D. C.

1940

Wilfred H. DeVore, arch, and Miss Aleon Belle Cook were married in January at the Wesley Chapel, Detroit, Michigan.

James M. Lane, ch, and Miss Marjorie Bee Bartow were married at Cheyenne, Wyoming. They are now living in Denver.



BIRTHS

Marian Barnes Taylor, arch, and Wade Hampton Taylor, Jr., e, Engineers Incorporated, announce that on March 11, 1941, Wade Hampton Taylor III was received into partnership. The firm will henceforth be known as Taylor, Taylor, and Taylor Co., unLtd. Marian Taylor, to date manager of the Construction Department, will now have complete charge of the brand new Heir-Conditioning Department. Wade Taylor will manage the Procurement and Transportation Departments, specializing in the Regular Delivery of Bacon. The New Member will devote all attention to Design (on diapers) and tests of Nursery Acoustics.

ON OUR CAMPUS

(Continued from page 116)

Alpha Chi Sigma



Alpha Chi Sigma initiated twelve men April 19 at a banquet. New members are Alan Coburn, Joseph Choun, Dick Dawson, Rex Ellington, Eugene Negro, Robert Ramsey, and John Williams, engineers. Minor Coon, Dale Griffin, Dale Rector, Vernon Lockard and Martin Biscoff were also pledged to Alpha Chi Sigma. Dean Oliver C. Lester presented his ideas on student life in an address entitled "Observations of the Dean." Pledge activities of these men included rejuvenating the mineral displays in the Chemistry Building.

On April 23, Alpha Chi Sigma elected new officers. The new president is John Hopkins. Don Walsh is vice-president; Victor Kalcevic, reporter; Rex Ellington, recorder; Dick Dawson, treasurer; Dr. H. B. Van Valkenburgh, alumni secretary; and Lawrence Farrell, master of ceremonies.

Chi Epsilon



The first meeting of Chi Epsilon this quarter was a dinner meeting on March 26 at which Mr. James B. Kenney, managing director of the Colorado Association of Highway Contractors, was guest of honor. Mr. Kenney addressed the student chapter of American Society of Civil Engineers later in the evening.

On April 8, Chi Epsilon elected the following new officers: Charles Dwyer, president; Douglas Wood, vice-president; Nolan Williams, secretary; and William R. Wright, treasurer. The first official action of the new president was to appoint a committee to work on plans for a Dutch lunch.

In the meeting of April 15, Chi Epsilon elected new members. Pledges were tapped at the A.S.C.E. meeting April 16. New members are Howard Smith, senior; and Robert Settergren and Allen Ziegemeier, juniors. A buffet lunch and initiation will be held for the new men in the latter part of this quarter.

American Institute of Electrical Engineers



The local student A. I. E. E. branch presented an outstanding program Tuesday, February 25. The program was given in the Boulder High School auditorium, and featured a demonstration on "The Artificial Creation of Speech," conducted by Dr. J. L. Perrine, assistant vice-president of the American Telephone and Telegraph Company.

A. I. E. E. convened April 9 to elect new officers. Chairman for next year is Robert G. Fleming. John T. Allen is vice-chairman; and other officers are Robert W. York, secretary; and C. Robert Emigh, treasurer. Following the election, Wilbur C. Brown presented a paper entitled, "Application of the

Amplidyne as a Voltage Regulator." This particular application of the amplidyne is thought to be unique. The paper summarizes two quarters work in the Electrical Engineering Laboratories by Brown and Robert H. West under the supervision of Professor Frank A. Eastom. The paper was presented at the A. I. E. E. District Student Branch Conference at the University of Denver.

The Denver Branch Conference of April 18-19 featured an address by Professor John M. Cage of University of Colorado on "Developments in Electron Tubes." Student papers were presented, representing each school of the district. The Sixth District embraces North Dakota, South Dakota, Nebraska, Wyoming, and Colorado. "Frequency-Response and Efficiency Measurements of a Loud-Speaker," by Frank H. Slaymaker of the University of Nebraska, was the winning paper. Brown's paper placed second. "A Method of Magnetizing Small Permanent Magnets," by John Decker and Art Siegal of the University of Denver, took third place. The group of approximately 75 was also addressed by Dean Alfred C. Nelson of the University of Denver and by Dr. R. W. Sorenson, national president of A. I. E. E., a graduate of the University of Colorado college of engineering in 1905.

American Society of Mechanical Engineers



The local student chapter of A. S. M. E. held its first meeting of the spring quarter to discuss student papers for presentation at the district student conference. The papers selected were, "Post-War Mobilization of Industry—A Challenge of Today," by Stanley Proffitt; and "Why Not Attend a Technical Cram School," by Charles Elzi.

The district convention of student branches was held in Golden and Denver, April 18 and 19. Approximately 75 delegates registered from seven schools in Utah, Wyoming, Colorado, and New Mexico. Colorado School of Mines was the host school. The winning paper was, "The Economic Aspects of Octane Rating," by John L. Ronayne of Colorado School of Mines. "High Lift Devices for Airplanes," by Ray W. Hammond of Colorado State College, took second place. Proffitt's paper placed sixth. A banquet was held at the Albany Hotel in Denver in conjunction with the American Society for Metals and the Colorado A. S. M. E. section. The chief speaker of the evening was Arthur F. Lyster, of the research department of the Socony Vacuum Oil Company, a graduate of the University of Colorado College of Engineering in 1916. His topic was "Fuel and Lubricants of Gasoline and Diesel Engines." An inspection was made of the Union Pacific crack streamliner, "The City of Denver." The convention will be held at the University of Wyoming next year.

American Institute of Chemical Engineers



On April 2 the members of the American Institute of Chemical Engineers combined their quarterly banquet in Memorial with a business meeting. After the banquet, a representative of the Gates Rubber Co., Mr. D. C. McRoberts, illustrated his discussion of "rubber" by coagulating the native latex to form crude rubber. Chemical engineers present got a good idea of the changes rubber must undergo before manufactured rubber articles are placed on the market. Following this talk pictures were shown of the rubber manufacturing process in the Gates factory in Denver.

Election of officers of A. I. Ch. E. was held just before adjournment. Those elected were Robert Lund, president; Elbert Michael, vice-president; William Dobbs, secretary; and Morton David, treasurer.

American Society of Civil Engineers



March 26, Mr. James B. Kenney, managing director of the Colorado Association of Highway Contractors, addressed the local A. S. C. E. student chapter on "The Engineer and the Contractor."

At the meeting of April 2, Howard F. Smith presented a paper on "Soil Tests for Earth Dams." Howard C. Beaver followed with his paper on "The San Jacinto Memorial." Officers for next year were elected at this meeting. They are as follows: E. Thomas Punshon, president; Leonard Nordeen, vice-president; Allen Ziegelmeier, secretary; and Lee Alden, treasurer.

The meeting of April 16 featured an address by Mr. Roland K. Linder, president of the Colorado chapter of the American Institute of Architects.

The second annual Rocky Mountain Conference of the student chapters of A. S. C. E. met on the campus of the University of Wyoming at Laramie, Friday, April 25. After registering at the Engineering Hall, the group inspected the Monolith Portland Midwest Plant and the Forest Products Treating Plant in Laramie. At a round table discussion in the afternoon, Professor C. L. Eckel, head of the University of Colorado civil engineering department spoke.

Joseph W. Fountain opened the April 30 meeting with a talk on "Architectural Uses of Concrete." Samuel Tammings followed with his paper on "Albert Kahn, Inc." "The Moffat Tunnel Project" was Daniel J. McQuaid's topic, and Fred A. Kelsall closed the meeting with a talk on "Air-Raid Shelters."

At the A. S. C. E. meeting of May 7, Ralph C. Brendle presented a paper on "The Denison Dam." Eugene W. Docter spoke on "Developments in Structural Welding." The last paper was "Transportation in the United States" by Walter R. Hogue.

BEHIND THE SCENES

(Continued from page 111)

Doug Brawner

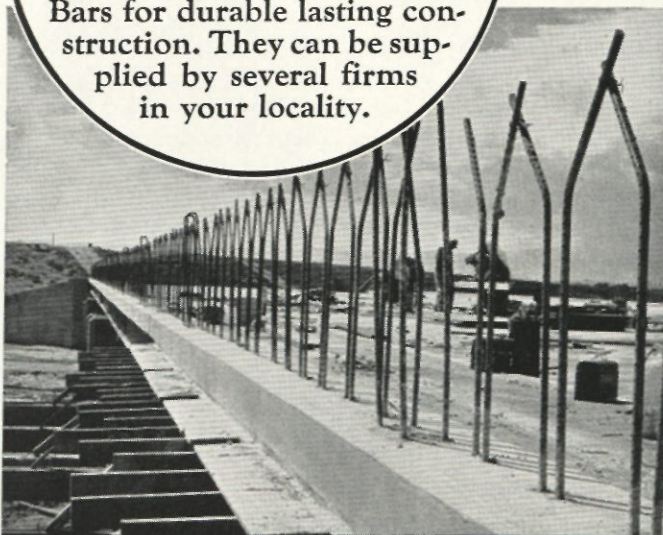


Doug Brawner

Douglas Brawner, senior architectural, was born on August 13, 1919, in Golden, Colorado. He graduated from Golden High School as valedictorian of his class, and, like three other members of his family, decided to attend the University of Colorado. Besides maintaining a 2.8 average, Doug serves as the Oil Can editor, is a member of the Engineers' Day committee, and is an associate editor of *The Transit*, civil engineering magazine. A

Glee Club member, his hobbies are fishing and composing songs, a few of which we heard at the Rhythm Circus. After graduation Doug has a scholarship for M.I.T., where he will continue his studies for another year. Incidentally, Doug is president of Pi Mu Epsilon and a member of Tau Beta Pi, Sigma Tau, Chi Epsilon, Sigma Pi Sigma, A.S.C.E., and Sigma Alpha Epsilon social fraternity.

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Harold Lawler

Harold L. Lawler, senior chemical, was born in Raton, New Mexico, on June 8, 1919. He moved to Dodge City, Kansas and was graduated from high school there with a definite bent toward engineering in the line of explosives. Moving again, he went to La Junta, Colorado, and thence to the University of Colorado. Busy in many fields of campus activities, Harold was a photographer for the *Coloradan* last year and has since served as assistant business manager of the *Colorado Engineer*. He is a member of the A.I.Ch.E., Radio Club, Camera Club, and an officer of the newly organized Alpha Phi Omega service fraternity. After graduation he plans to enter the field of commercial explosives and has accepted a job with the Hercules Powder Co.



Harold Lawler

Joe Gulinson

Joe Gulinson, office manager of the *Colorado Engineer*, is another of the numerous electricals on the staff. Graduating from North Denver High School, Joe entered Colorado University because it had the best engineering school hereabouts. He was on the varsity debate squad in high school and has continued with this avocation in college, being a member of Adelphi. Besides membership in the A.I.E.E., Joe has also been on the *Engineer* staff for four years and has participated in intramural sports.



Joe Gulinson

Marvin Pope

Marvin Pope, assistant business manager, is a Pueblo boy. He is a graduate of the Central High School of that city, where he was editor of both the school paper and the year book. He entered the University on a scholarship, has pursued the intricacies of mechanical engineering for four years, and has been rewarded with a position with General Electric Co. upon graduation. He is a member of Phi Kappa Psi social fraternity and has been on the *Colorado Engineer* staff for four years, formerly holding the position of circulation manager.



Marvin Pope

Bernard Levitt



Bernard Levitt

Bernard Levitt, secretary for the *Colorado Engineer*, entered the University from North High School in Denver. He started accumulating activities in high school, where he was a member of the Black Masque Dramatic Club, French Club, and the Senior Literary Society. He has continued here by becoming a member of Tau Beta Pi, Pi Mu Epsilon, and Pi Tau Sigma. He has also served on the *Engineer* staff for three years and participated in intramural football, basketball, and baseball. Bernard hopes that the Army gets him after graduation; not, however, in the draft, but rather as a Flying Cadet in the Ground School Squadron.

Vitha Bowers



Vitha Bowers

Familiar to all who have used the Engineering library in the evening is Vitha Bowers, secretary for the *Colorado Engineer*. Vitha, one of the few girls in the Engineering school, is from Hudson, Colorado, and attended high school there. At the University, she is taking the chemical engineering course, preparing herself for engineering secretarial work. Most of Vitha's time is spent working, for she is not only night librarian in the Engineering library, but she has a hashing job and is working for her room as well. However, she has found time to serve on the *Colorado Engineer* staff for four years and to indulge in the hobbies of geology and hiking.

Paul Werner



Paul Werner

When questioned as to how old he was, Paul Werner, graduating chemical engineer, replied, "Old enough for the Army." Paul has lived in Colorado all his life, Denver being his home town, where he was graduated from North Denver High School. He has held the positions on the staff of the *Colorado Engineer* of staff assistant, assistant business manager, and was for two years the Denver advertising manager. Paul is a member of Pi Kappa Alpha social fraternity, Alpha Chi Sigma chemistry fraternity, and A.I.Ch.E. Upon graduation Paul will go to work for the American Rolling Mills at Middleton, Ohio.

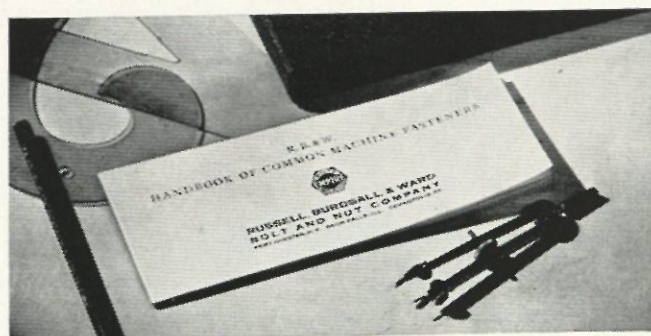
Ray Volluz



Ray Volluz

Versatile Ray Volluz, Illustrations editor of the *Colorado Engineer*, although born in Terre Haute, Indiana, graduated from South Denver High School. Entering the University partly because his father attended here, partly because of the excellence of the mechanical engineering department, and partly because he wished to remain in Colorado, Ray has participated in many activities. He has distinguished himself scholastically as shown by his membership in Tau Beta Pi, Sigma Tau, and Pi Tau Sigma. He also belongs to the A.S.M.E. and Sigma Phi Epsilon social fraternity. Ray played freshman basketball and baseball, and has played intramural football, basketball, and baseball, twice being on championship teams. In addition, at one time he had his own dance band. A position with the Shell Oil Corporation in their Martinez, California, testing laboratory awaits Ray.

Because of its resistance to the corrosive effects of liquids and gasses, glass is now being used as a lining for valves.



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THE BUSINESS SIDE OF ENGINEERING

(Continued from page 104)

by type of improvement. The line that cuts across the bars shows what percent each class of construction is to the total reported construction for the year. Thus 1933 produced the heaviest relative demand on engineers for bridge work, 1937 the heaviest relative demand by private industry for industrial building work, 1934 for sanitary works, 1940-41 for airports and air bases, and 1940-41 for public buildings. This is a measure of the engineer's need for flexibility, for his capacity to adapt what he knows to new conditions.

FROM SELLER TO BUYER

After the engineer has sold his services and his ideas of how the job can be done, his talents are then devoted to getting the best possible job for the money available—the best value for his client. Now he becomes a buyer. Should he buy raw materials and fabricate and work them on the job? Should he buy semi-fabricated units and assemble them at the site? Should he let the whole work to a contractor? Should he handle the job by day labor under his own direction? These are all fundamental buying problems. What work can he mechanize? What work can be more economically done by hand? That omnipresent \$ sign—all his other tools are marshalled to outwit it.

Besides his special knowledge of stresses and strains and hydraulic gradients, the engineer needs wide knowledge of what the market affords in materials and equipment together with familiarity with what other engineers have discovered and what new processes they have adopted. Books can give him some of this information, but books lag behind current practice. Books are historical records. Only through current engineering periodical literature and advertising can an engineer multiply continuously knowledge gained through personal experience. This literature not only keeps him informed on products but gives him basic figures on prices and cost trends. In the present emergency defense market, speed is the primary consideration, cost is secondary. This is not always true. In more normal times an engineer can save his client money by timing his buying shrewdly according to market trends.

A useful guide in appraising his own observations and bringing his own cost experience up to date is found in the cost indices published by various organizations to measure not only the direction of costs or prices but the relative extent of their change. Such general cost or price indices are an outside check or warning and can never be precise. Every engineer must reinforce them with his own precision records of unit costs of various classes of work, to be set up as a measure of his own proficiency and as a mark improved upon on the next job.

Yes, the \$ sign, the symbol of the business side of engineering, challenges the engineer at every stage of his career.

LIFE INSURANCE

(Continued from page 109)

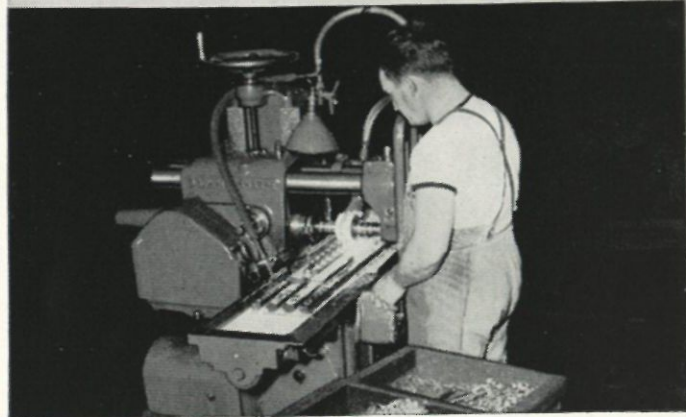
beneficiaries of an insured whose death results from accidental means will receive a sum twice that of the face of the policy. To become effective this feature provides that accidental death must occur before the age of 60, 65, or 70 years of the insured.

A policy holder's primary interest in life insurance investments should be to know that his premium dollars are in sound securities. When one buys life insurance he is hiring the best available investment brains to handle his finances. If you have wondered how a life insurance company invests the money which you pay as premiums, you might be surprised to know how many public schools, hydro-electric plants, farms, homes, office buildings, dams, sewer systems, hospitals and highways have been made possible because of life insurance dollars. Many millions of dollars of policy holders' money are invested in U. S. Government, State, Municipal, Railroad and Public Utility bonds, still other millions are helping industrial concerns build more and better mills and safer laboratories.

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CORROSION IN STRUCTURAL STEEL

(Continued from page 107)

off the member, taking with it part of the shop coat of paint. This makes a considerable amount of spot-painting necessary.

After the surface of the steel is thoroughly cleaned, the paint may be applied. Two methods commonly used in painting are spraying and brushing. Following is a typical example of the specifications for painting: "After the sandblasting operation is completed, dust and light rust shall be thoroughly removed by brushing or wiping, and the number of coats stipulated on the plans shall be applied. The paint shall be applied in full coats well brushed out, completely covering every part of the surface, and well worked into all joints and open spaces. The paint shall be kept thoroughly mixed and shall be spread evenly so that no excess collects at any point. The paint shall be thoroughly dry before the succeeding coat is applied." (The term "thoroughly dry" is defined as the absence of gloss in appearance of the paint film.) "Paint shall not be applied when the air temperature is below 40 degrees Fahrenheit, when the air is misty, or when, in the opinion of the engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces. Material painted under cover in damp or cold weather shall remain under cover until it is dry, or until weather conditions permit its exposure in the open. When it is completed, the work shall present a neat,

finished appearance, satisfactory to the engineer."

These specifications are written for a brush job. If the contractor were going to spray, the specifications would include the pressure at the paint pot to be maintained, and would cover the use of efficient guns.

Spraying paint is much faster under certain conditions than brush painting. Grating would be difficult to paint with a brush, as there are so many cracks and crevices. To get a brush to fit every condition would be impossible. On the other hand, it is argued that spraying conveys air and moisture to the metal, the paint trapping it on the surface; while in brushing, the paint is well rubbed out, and the air is squeezed away from the surface. In spraying the operator is not as apt to get as uniform a coat of paint on the steel as in brushing. On windy days it is not feasible to spray paint, as the paint blown away amounts to a great deal more than that applied to the surface. In a shop or inside a building this condition does not have to be contended with, but it is of great importance on outside work. The protection of traffic and adjacent properties must be considered in spraying paint, as the slightest movement of the air will carry a paint spray quite a distance.

Paint to be used depends upon the judgment of the engineer in charge of the work, the most common first coat being red lead. The subsequent coats are usually aluminum, which consists of a good varnish as a vehicle with flakes of metallic alumi-

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num as the pigment. There are many good paints on the market, and the type of work to be done should be a governing factor in choosing the kind of paint.

The weight of the paint used is an important item and depends upon the ability of the painter to properly brush it out. A heavy red lead will make a thicker coat of protection on the surface, but if it is too thick, the painters will not brush it out, as it would be too tiresome; therefore, the painter will go to any extreme to dilute the paint, usually using gasoline which is a very poor vehicle. In aluminum paint, the varnish must not contain too much drier, as it will be too sticky to brush out.

Chemists and engineers may sometime develop a corrosion-proof structural steel, but to insure adequate protection of the steel, engineers must now take special care to see that the steel surfaces are in fit condition to receive the paint, that the quality of the paint is satisfactory, and that the time and method of application is proper.

The magnet of the new 4,900-ton cyclotron to be built at the University of California will be 56 feet long, 30 feet high, and over 15 feet wide. It will be completed in 1944.

During the great magnetic storm of April, 1938, energy at the rate of two billion kilowatts per hour were expanded over a two-hour interval. This is 100 times the capacity of all the hydroelectric energy developments in the country.

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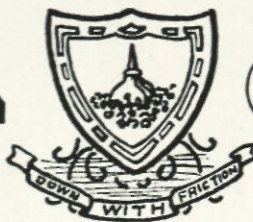
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Lubricity shall lack no champion . . .
Friction shall not thrive unopposed

by Douglas Brawner, α, '41

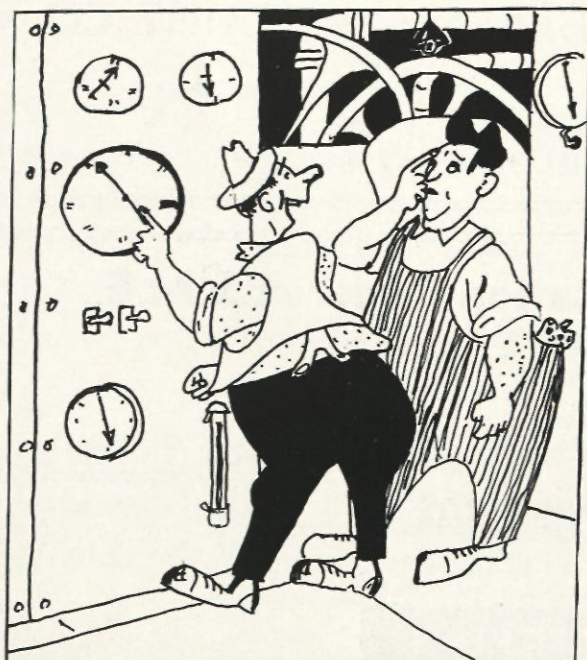
We heard when we were freshmen that if a prof were more than five minutes late to class, the class could leave and have a free cut. Well, we have waited four long years for this Utopian event to occur, but, alas, it has not. We have kept this hope as our only guiding light—the one thing for which life was worth living. But now we are despondent. You know, I think someone was fooling us. We believe, now that this is just one of those myths which are passed to gullible freshmen, but which never materialize. At least, the professor who comes in late is very, very rare; in fact, he would be in a class by himself. At this late date I would promote a Society for the Prevention of Perpetual Punctuality of Professors. Anyone wishing to co-operate on this may do so by seeing the head of his department (there must be some student crazy enough). Now, if we were only younger—

Getting back to the "Oil Can," half of these jokes we've seen before, and the other half we don't see yet—

★ ★ ★

In Building Construction, Bob Hiester stated that frame construction may be made entirely of wood, or of wood with a "vernier" on the exterior walls!

★ ★ ★



"The chief engineer says not to let it go up to that red mark—superstitious, I guess."

CHEMIST'S ANALYSIS OF A WOMAN

Symbol—woo

Atomic Weight—120 (approx.)

Occurrence—Can be found wherever man exists.
Seldom occurs in free and natural state.

Physical Properties

1. All colors and sizes.
2. Always appears in a disguised condition.
3. Boils at nothing—freezes at any point.
4. Melts when properly heated.
5. Very bitter if not used correctly.

Chemical Properties

1. Extremely active in the presence of man.
2. Great affinity for gold, silver, platinum, and precious stones.
3. Able to absorb expensive food at any time.
4. Undissolved by liquids, but activity is greatly increased when saturated by a spirit solution.
5. Sometimes yields to pressure.
6. Turns green in the presence of more perfect specimens.
7. Ages rapidly—the fresh variety has a greater attraction.
8. Highly dangerous and explosive in inexperienced hands. (Experienced hands are rare.)

★ ★ ★

Mr. McNair: "We will now take sum of forces."

Bob Whelan: "You say 'some' of the forces. Which ones do you mean?"

★ ★ ★

Rex Ellington thought it was only an April Fool's Day prank when his classmates told him that the small glass tube on his desk was going to explode. Oh, well, it was an old ear drum, anyway!

★ ★ ★

Prof. (putting assignments on the board): "This is a week's work."

Dick Dawson: "That's no idle dream!"

★ ★ ★

Williams: "They say fish is good brain food."

Walker: "I eat lots of fish."

Williams: "Oh, well, that's just another theory shot to hell."

★ ★ ★

Professor in Physics: "You don't understand the derivation? Well, watch the blackboard while I go through it."

★ ★ ★

Breathes there a man with a soul so dead

Who never to himself has said,

"To hell with these studies, I'm going to bed."

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G-E Campus News



JUNGLE JIVE

MISSIONARIES working among a newly discovered tribe of savages in Netherlands New Guinea, which has many times been called one of the "earth's remotest spots," had a strange experience.

They invited natives into their bamboo hut and turned on their short-wave radio. The tribesmen looked at one another in frightened amazement. Rev. C. Russell Deibler, one of the missionaries, says this of what happened: "As they heard voices coming from the receiver, they crouched over close and jabbered back, utterly bewildered where the strange voice was coming from."

The missionaries wrote their experience in a letter to Station KGEI, G.E.'s short-wave station in San Francisco, which sends its radio signal into Asia, using special directional antennas.



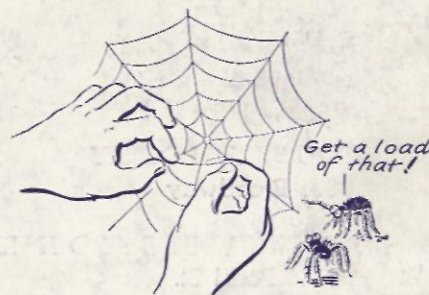
PRESTO!

THREE tiny 1000-watt mercury lamps, mounted in the new television floodlight de-

veloped by G-E laboratory engineers, yield as much light as 225 ordinary 60-watt bulbs. For the same amount of illumination these powerful little lights produce only one-fourth as much heat as do incandescent lamps. Water cooling dissipates much of the heat and so makes possible the very small size.

The new lights are equipped with motors and gears for remote control, so that they can follow the movements of studio performers.

These tiny lamps were developed at G.E.'s Lamp Department at Nela Park, Cleveland, which each year selects promising young engineering-college graduates from "Test" to train them in the lighting game.



SPIDERCRAFT

COULD you spot-weld wire one quarter as thick as a human hair?

That's the problem G-E engineers faced in producing filaments for thermocouples, those little super-sensitive devices used in measuring high-frequency alternating currents or voltages. These dainty filaments are $1/2000$ of an inch in diameter—so small that they are almost invisible—and have to be welded into a "K" shape.

The work is so fine that it must be done under a microscope, using a pair of tweezers to hold the wires.

At Schenectady there's a whole section of the G-E Industrial Department devoted entirely to welding. Practically all the men in this section are graduates of the G-E Test Course. General Electric Company, Schenectady, N. Y.

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