Fall 11-1937

Volume 47 - Issue 2 - November, 1937

Rose Technic Staff
Rose-Hulman Institute of Technology

ROSE TECHNIC

Vol. XLVII November, 1937 Number 2

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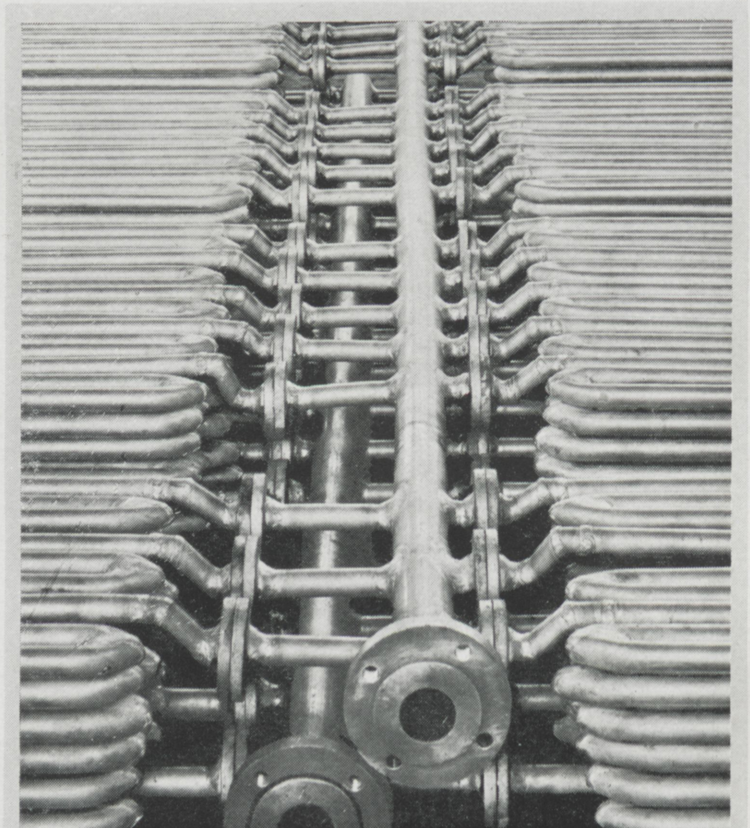

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Surveying This Issue

IN this month's lead article, Mr. Giacoletto presents the first part of his review of the evolution of atomic theories.

MR. Ross explains a new method of hardening razor blade steel as used by a large company.

WATER may be purified by several methods. Three of the more modern methods are explained by Mr. Reddie in his article.

—*M. B. S.*

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Subscription, per year, $2.00. Address all communications to THE ROSE TECHNIC, Terre Haute, Indiana. Entered in the Post-office at Terre Haute as second-class matter, as a monthly during the school year, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 13, 1918.

Published Monthly from October to May by the Students and Alumni of Rose Polytechnic Institute.

High Speed Diesel-Electric Train

Courtesy General Electric Review

THE ROSE TECHNIC

THE TECHNICAL JOURNAL OF THE ROSE POLYTECHNIC INSTITUTE

Volume XLVII | NOVEMBER, 1937 | Number 2

The Evolution of Atomic Theories

by

Lawrence J. Giacoletto, e., '38

THE Greeks were among the first to speculate as to the ultimate nature of matter. They attempted to resolve all matter into one primary element or reality. The Greek poet and philosopher, Heraclitus, based ultimate reality on an ethereal fire, a kind of soul stuff, of which all was made and to which all returned. In one sense, perhaps, this viewpoint does not differ greatly from the theory held by a large group today that the ultimate composition of matter is electrical in nature. The Pythagorean school of philosophy (450 B.C.) taught the famous hypothesis of four elements; all things on earth consisted of earth, water, air, and fire in varying composition. At about 400 B.C. the Greek philosopher, Democritus, established the first important atomic theory. Democritus laid down six axioms or statements. An interesting fact concerning these statements is that with a little change they would very easily pass for the fundamental truths of the atomic theory as understood today. Democritus' original statements are as follows:

(1) From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules.

(2) Nothing happens by chance. Every occurrence has its cause from which it follows by necessity.

(3) The only existing things are the atoms and empty space; all else is mere opinion.

(4) The atoms are infinite in number and infinitely various in form; they strike together and the lateral motions and whirlings, which thus arise, are the beginnings of worlds.

(5) The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation.

(6) The soul consists of fine, smooth, round atoms like those of fire. These are the most mobile of all. They interpenetrate the whole body and in their motions the phenomenon of life arises.

Statement 2 is quite contrary to the present principle of uncertainty as advanced by Heisenberg, which will be discussed more thoroughly later.

The Greeks were profound thinkers. They loved to philosophize; yet their philosophy was based on pure thought and not on experimental facts. It is for this reason that the postulates as established by Democritus were discredited by later philosophers as Plato and Aristotle. The development of atomic theories in later centuries was in the state of a verbal see-saw. One school of thought would advance an idea only to be discredited a little later by another school of thought. Suffice it to say that none of the theories advanced before the early part of the nineteenth century are worthy of mentioning.

John Dalton--Combination by Proportion

In 1803 John Dalton, an English chemist, established his three remarkable laws of combination by proportion. These laws are:

(1) Law of Definite Proportions.
(2) Law of Multiple Proportions.
(3) Law of Equivalent Proportions.

Dalton's first law stated that elements combined with one another in certain definite and constant proportions by weight. Thus 1 gram of hydrogen always combines with 35.5 grams of chlorine to yield hydrochloric acid, with 80 grams of bromine to form hydrobromic acid, and so forth. The second law stated that, if two elements formed more than one compound, the amounts of the second substance which combine with equal amounts of the first substance are in simple proportions. Thus, for example, the elements nitrogen and oxygen form five different compounds viz.; (1) Nitrous oxide, N_2O; (2) Nitric oxide, NO; (3) Nitrogen trioxide, N_2O_3; (4) Nitrogen tetroxide, N_2O_4; (5) Nitrogen pentoxide, N_2O_5. From an inspection of the five formulas, it is readily seen that the amounts of oxygen which combine with a molecule of nitrogen, N_2, are in the proportions of 1:2:3:4:5. This is, of course, what Dalton's second law of proportion states, and is true for all compounds.

The third law stated that since the weight of an element in combining was always a whole number multiple of some base number, then the atomic weight of that element must be a simple multiple or a simple submultiple of that number.

The three principles, as Dalton realized, follow naturally the establishing of the granular structure of matter. Dalton, therefore, established atoms as indivisible particles which were the same for any single element but different for different elements. Combination was then considered to take place between atoms of different elements. Dalton pictorially represented the atoms by different symbols as shown in Figure 1. Under each symbol is the present day notation of what he intended to represent. Dalton experimentally determined the atomic weights of several elements, but his atomic weights were not of much value. It remained for the Swedish chemist, Berzelius, to determine fairly accurate values of atomic weights.

Later Developments

The Italian physicist, Amerigo Avogadro, in 1818, was the first to distinguish clearly between an atom and a molecule. Dalton had supposed that elementary gases existed as atoms. Avogadro showed that in most cases two atoms of an elementary gas tended to group together to form a molecule. By further consideration of chemical facts, Avogadro was able to deduce the fact that equal volumes of gases of different elements under the same conditions contain an equal number of molecules. Present day calculations of Avogadro's number, as it is called, place the number of molecules in one cubic centimeter of gas at 0°C. and 760 mm. of mercury at 2.705×10^{19}.

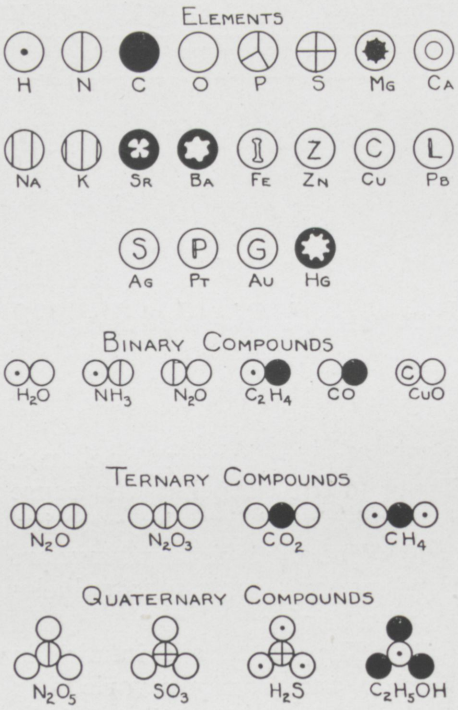

Fig. 1

As the number of known elements increased, there were repeated attempts made to correlate the atomic weights of elements with their physical properties. The Russian chemist, Mendeleeff, discovered that when the elements were placed in the order of increasing atomic weights, the properties of the elements tended to repeat themselves at intervals of eight. There were several exceptions to the rule, but in general the rule held. It was thereby possible to group the elements in columns of eight. These eight columns were also a rough guide to valence which describes the combining property of an element.

As time went on, Dalton's simple indivisible atom had to take on different aspects to explain various phenomena. Dalton, himself, clothed the atoms in a caloric sheath to explain their heat properties. In attempting to explain the inner mechanism of the atom, the simple atoms were successively equipped with forces or caloric atmospheres, surrounded by globes of electricity, or provided with etherspheres. Attempts were made from 1838 to 1848 to collect the various aspects of the atom into a single atom which would successfully explain the various properties of matter. These attempts proved thoroughly unsuccessful. In 1867, Sir William Thomson, afterward Lord Kelvin, proposed the vortex atom which aroused much hope of an answer to the many, and sometimes conflicting, demands made upon the internal atomic mechanism. Thomson's vortex atom arose from the mathematical considerations of the German physicist, Helmholtz, who had imagined a perfectly incompressible frictionless fluid which would immediately form vortices when disturbed. Thomson assumed these vortices to be formed in the universally homogeneous substance called the ether. The vortex atoms, like Dalton's atoms, were indestructible. They could change their form and therefore possessed flexibility and elasticity. The vortex atoms never achieved great importance, although they did interest the great English physicist and mathematician, Clerk Maxwell, who desired an atom that had a natural period of vibration for the explanation of his theory on wave propagation. This vibration of the atom was prohibited by the Dalton atoms which were pictured as small, hard, sluggish particles.

The Downfall of the Dalton Atom

Toward the end of the nineteenth century several events occurred which could only be explained on the basis of an electrified atom. The electrolysis of materials by passing an electrical current through a solution of that material could only be explained if the atoms of the material were of electrical nature or temporarily carried an electrical charge. The electrical nature of the atom had been strengthened by Faraday's discovery in 1834 that during decomposition by the electrical current, chemically equivalent weights of substances were liberated by the same quantity of electricity. Therefore, in the decomposition of water by electrolysis since a given quantity of electricity liberated twice as much hydrogen as oxygen, the oxygen was assumed to carry a double charge of electricity, and the ionization of water was then written:

(1) $H_2O = H^+ + H^+ + O^{--}$

The electrical nature of the atom was further strengthened by the study of discharges through highly exhausted tubes. At first these cathode rays as they were called were thought to be similar to visible light. However it was found that the rays were seriously deflected by both a magnetic field and an electrostatic field. This was not true of light waves so that a further explanation had to be sought. By noticing the direction of deflection of the rays in a magnetic or electrostatic field and also by catching the particles in a small insulated tube, it was shown that the particles were negatively charged. Sir J. J. Thomson's measurements in 1907 showed that the cathode ray particles were about 1700 (later calculations gave this number as 1845) times as light as the hydrogen ion and their speed was 100 times greater than the average speed of hydrogen molecules at 0°C.

Speculative thought pictured these cathode ray corpuscles, as Sir J. J. Thomson preferred to call them, as the "primordial" atoms which had been sought so long. Another alternative was that the corpuscles might be the unit negative electricity, itself. This latter conception would necessitate that electricity have mass as Sir Thomson and the other scientists of that time had previously suggested. This mass is an inertial mass which is manifested by a magnetic field surrounding a charged particle when it is set in motion. Sir Thomson's cathode ray corpuscles were soon given the name of electrons and were shown to be the fundamental units of negative electricity.

It was also discovered that positive particles were emitted when a discharge took place in a vacuous tube. By similar methods of measurements it was found that the weight of these positive particles changed when the gas in the tube was changed. The electrical nature of matter was thereby conclusively proved. In 1895, Roentgen added a third set of rays which emanated from discharge tubes. These rays being true light rays of higher frequencies were not deflected by either a magnetic or electrostatic field. They were called Roentgen rays or as they are better known today, X-rays.

Speculative Atomic Structures

Now that the electrical composition had been proved beyond a doubt, there was an attempt to incorporate electricity in the atomic structure. The first atomic structures embodying electrical features were patterned closely after the old Daltonian atom. Thus it was, that in 1903 the atomic structure of Lenard consisted of an outer shell containing in the center what he called dynamids, and Sir Thomson's model consisted of an electron circulating in a positive sphere. In Figure 2(a) is shown a pictorial representation of Lenard's model for hydrogen. Lenard considered a positive charge and a negative charge as making up one dynamid. A cluster of dynamids then made up the other elements. In the figure the heavy line represents the circumference of Lenard's atom. Only the dynamids which lay in the center were considered by him to be impenetable.

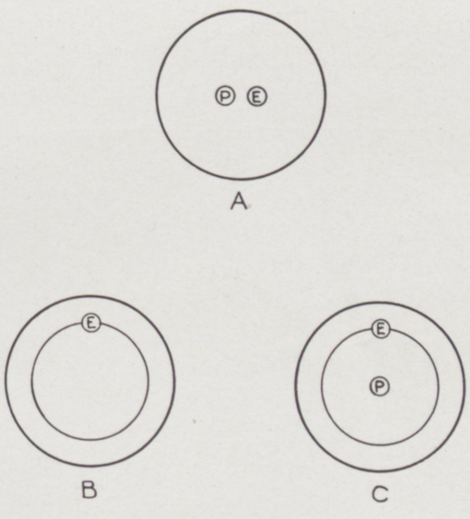

FIG. 2

A Saturnian system was suggested by Nagaoka in 1904. Nagaoka considered the negative electrons to be rotating about the positive center. The radiating characteristic of the atom, which as previously stated was necessary, was secured by a halo of mobile negative electrons rotating round a central nucleus. This model was a forerunner to Rutherford's model (Figure 2,c). Sir Thomson's model (Figure 2,b) retained the rotating electron but considered the positive nucleus to be spread out in a sphere of influence.

The Rutherford Nuclear Atom

Sir E. Rutherford first introduced his nuclear atom in 1911. As has been previously stated, Rutherford considered the electrons to be rotating about the more dense nucleus. Furthermore, although the nucleus contained most of the mass in size it was only a very small part of the total atom. The atom was now comparable with our own planetary system. Indeed most of the atom now became empty space. How different this was from Dalton's indivisible atom!

Since the atoms themselves were neutral electrically, any positive charge contained in the nucleus of the atom had to be counterbalanced by the orbital electrons revolving in their particular orbit. Also since most of the mass was contained in the nucleus, the more massive elements necessitated a larger positive nuclear charge and consequently more electrons revolving about the nucleus. In other words, the complexity of the atomic structure increased with the atomic weight.

If, after all the elements have

been listed according to their increasing atomic weights, they are numbered consecutively beginning with hydrogen as 1 and on through to uranium which becomes 92, then these latter numbers are known as atomic numbers. H. G. J. Moseley showed that the atomic number was proportional to the square of the frequency of the strongest line present in the X-ray spectra arising when various materials were used as targets in an X-ray tube. The atomic numbers also denote the charge on the nucleus, or what amounts to the same thing, the number of orbital electrons. Thus uranium, the heaviest element known, must have 92 electrons revolving about the positive nucleus.

Chemists had for some time been troubled by the occurrence of two materials that had identical properties but different atomic weights. These "twin elements" were called isotopes. To explain this Rutherford postulated the presence of electrons within the nucleus so that the resultant nuclear charge was the difference between the total positive charge and the negative charge. Thus it was possible for the total mass of the nucleus to change while the nuclear charge remained constant. The general structure of an atom could be represented equationally thus:

Nuclear Constituents / Orbital Constituent

(2) $(xP+yE)$ $(x—y)$ E

where x is the atomic weight and y the number of nuclear electrons. The representation of isotopic elements, where m is an integer, is:

(3) $(x+m)P+(y+m3$ E $(x—y)E$

Taking the element chlorine, for example, one atomic weight is 35, and the number of nuclear electrons is 18. Substituting in equation 2, the composition of the atom is:

(2a) $(35P+18E)$ $(17)E$

Then by letting m in equation 3 be 2, we get for equation 3:

(3a) $(37P+20E)$ $(y7)E$

Equation 3a shows that an isotope of chlorine has an atomic weight of 37, contains 20 electrons within the nucleus, and, of course, as in the case of the isotope 35, has 17 orbital electrons. It is the mixture of the two isotopes, 35 and 37, in the approximate proportions of 28 to 8 respectively that had puzzled chemists so long by giving the fractional atomic weight of 35.458 for chlorine. Almost all the elements have been found to be the combination of one or more whole number isotopes.

Since the nucleus is positively charged there is a force on the orbital electrons tending to draw them into the nucelus. This force is counterbalanced by the centrifugal force of the electron as it revolves about the nucleus. It is easily conceivable that since the force of attraction varies inversely as the square of the radius, the velocity of the electron must increase rapidly as it approaches closer to the nucleus. Something very peculiar must also happen to the electrons contained within the nucleus. Since the nuclear electrons are very closely packed within the nucleus with the positive charges, the normal assumption would be that the negative charges coalesce with an equal number of positive charges thereby cancelling the charges on both particles. Yet the mass of both particles must remain to effectively explain isotopes. The result is matter which does not have an electrical basis. Modern physicists claim to have found such a particle and call it the neutron.

EDITOR'S NOTE:

The conclusion of Mr. Giacoletto's article will appear in the December issue of the *Technic*.

A New Method of Hardening Razor Blade Steel

by

J. Ewing Ross, ch., '39

RAZOR blades have long been used and are considered to be a necessity in our modern life. Today it has been found that in order to obtain as nearly a perfect blade as possible, a uniformly hardened steel is one of the first requisites of good razor steel. The uniformity must be in composition, microstructure, and hardness.

The composition of the steel is maintained at a uniform analysis by the steel manufacturer. This can easily be done by the modern methods of producing better grade steel. Razor blade steel, necessarily being a high grade steel, is prepared in the electric furnace or the crucible. If electric power is cheap, then the electric furnace is preferable. In either of the processes the composition of the steel can be very accurately controlled. The microstructure and the hardness of the steel are somewhat dependent on each other. When the proper microstructure is obtained by heat treatment and electromagnetic control, the hardness of the steel is also at the proper state. Chromium is added to the steel in order to produce a blade hard enough to give maximum wear without losing its sharpening properties. The steel now being used by a well known razor blade company has the following analysis: 1.20% carbon and .20% chromium. In 1925 the annealed strip was passed through long heating furnaces of the muffle type which were heated to the desired temperature by gas or electricity. All the heating was pyrometrically controlled, and the furnace maintained at a given temperature. From time to time there were improvements in the general design, but the research at that time was being conducted with the idea of trying to hold constant the temperature of the furnace. The steel supply was furnished in 35 lb. coils, and the structure varied from coil to coil and in a single coil. The steel varied both in the size of the spheroidized cementite particles and in the amount of carbide in solution. In the new process a piece of standard steel is used with each separate consignment of steel so that the steel being compared will have the same geneality as the standard piece.

In the new process of control recently adopted by this company, the key to the control is the electromagnetic controller. After the steel has been perforated with the trade name, it is passed through a long muffle-type heating furnace. This furnace was developed along with the magnetic control because it was necessary to have a furnace that would react quickly to the demand of the control. The furnaces are equipped with nichrome muffles, inside of which passes the steel strip. Around the muffles are copper induction coils of the high frequency type that have water running through them. There are about 500 turns of this copper coil to a furnace. The inside diameter of the coil is about ⅛ in. The muffle insulation is only ½ in. thick. Cooling and heating are very rapid due to the small insulation and the running water respectively. There are two heating contacts on these furnaces; one being for accelerated heating, the other for holding the temperature constant. Also the magnetic control can turn the furnace entirely off if the heat becomes too great. The furnaces can be heated up in about 35 minutes, giving economical operation because of the small losses due to cooling and heating the furnace.

After the steel comes from the furnace, it is quenched between water-cooled blocks from a temperature of about 1460 degrees F. to about 65 degrees. The razor blade must have an extremely hard yet fully workable edge so as to insure long life and easy sharpening. The chromium combines with the iron and tends to increase the hardness of the cutting edge.

From the quenching blocks the strip of hardened steel passes through the magnetic controller. In this piece of equipment the strip coming from the quenching blocks is compared with a strip of standard steel. The testing equipment consists of balanced step-down transformers with bucked secondaries which constantly compare the strip with the standard piece. This actuates an alternating current galvanometer which in turn is the operating element for the controlling instrument of the furnace. The whole control depends on the fact that the permeability after hardening is inversely proportional to the amount of carbide in solid solution. When this electromagnetic control is used with the extremely flexible furnace previously described, the temperature can be raised or lowered very rapidly. This allows a fairly accurate control of the steel issuing from the hardening furnace.

In the microstructure of the steel after hardening it is desired to have the carbides as small and as uniformly distributed as possible. When in this form the blade will hold up under continued use. The hardening process tends to decrease the size of these small carbides and give them a more uniform distribution, being the desired result. The magnetic control, since it is constantly comparing the hardened strip with a standard piece of steel and constantly correcting either extreme, tends to produce a uniform steel which is not possible under the old method.

In the factory where the new process has its origin and where it is exclusively used, there are eighteen of the high frequency furnaces. For each furnace there is an electromagnetic control box to regulate the temperature of the furnace. The control boxes were developed by the company's engineers. The furnaces were developed by a separate company to work with the control boxes. Since the furnaces can be quickly heated to the hardening temperature, they can be very economically operated because of the relatively small losses of energy in allowing them to heat up or cool down. This allows the furnace to be used only when needed. They can also be very readily repaired because of the short cooling time. The temperature of the hardened strip after leaving the furnace and measured five inches from the end of the muffle was found to vary from 1440 degrees F. to 1481 degrees F., these being the extreme ranges.

While seemingly complete, the new process has been questioned by metallurgists who wish to know whether these blades which pass through the control box before the error is corrected by the furnace are marked as being rejected or whether these blades merely pass on. This new process has been highly advertised, and not a little of the value of the new equipment is secured in this way. Nevertheless, a large company has spent a huge sum of money to install this equipment, there being the decided advantages already mentioned to the electromagnetic control to warrant this expense.

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New Methods of Water Purification

by

William A. Reddie, ch., '39

WITH the increasing demand for pure water, coupled with a decreasing number of sources of unpolluted water, there has come a very rapid advance in the methods of water purification. Such advancement has been due to the joint work of the chemist, engineer, physicist, bacteriologist, and biologist. Each has contributed his quota, which today makes it possible to turn a tap and obtain a plentiful supply of clear, pure, and wholesome water. This commodity, a manufactured article, is obtainable at the amazingly low figure of about 6 cents per ton, and that for a product of not less than 99.55 per cent purity.

The first serious and successful attempt at water purification on a large scale was the design and installation of the first slow sand filter by James Simpson, engineer of the Chelsea Waterworks Co., in 1829. Such filtration certainly improved the water and it was some twenty years later when London was in the grip of a cholera epidemic that it was suggested that the disease could be transmitted by contaminated water. It was the development of bacteriological technique and the work of Percy Franklin on water analysis that placed water purification on a much sounder foundation. About this time, 1861, it was reported by the Medical Officer of Health for London that the water supplied by the New River Company was not objectionable, but that the water from the city pumps was charged with decaying matter and many of the pumps were closely situated to graveyards.

Concerning filters A. H. Waddington says: "The next advance came from America where rapid sand filters used in conjunction with chemical treatment were first installed about 1890. It was just before this date that the first water-softening plant was installed in England, using the process patented in 1841 by Dr. Clark of Aberdeen and giving practical application of the discovery of Cavendish in 1766 that the addition of lime to certain natural waters precipitated the carbonates of calcium and magnesium. Many variations were made in the design of rapid filters, and coagulants were experimented with until the next milestone was reached which was the far-reaching one, that chlorine could be applied to water to control undesirable bacteria."

It was in 1905, during a typhoid epidemic in Lincoln, that the late Sir Alexander Houston, later Director of Water Examination for the Metropolitan Water Board, used bleaching powder as a bactericide. Bleaching powder in modern plants is replaced by gaseous chlorine.

The large number of serious epidemics of water-borne disease, mainly typhoid fever, dysentery, and gastric disorders, and the greatly improved analytical technique, have led to more stringent standards of purity for water intended for drinking. During the present century such standards have resulted in a large number of purification plants, consisting of mechanical filters with chemical treatment, being laid down, and very few slow sand filters.

Activated Carbon

One of the newer methods now used in the purification of water is the use of powdered activated carbon. Powdered activated carbon is a substance chemically the same as wood-char or charcoal. It is a by-product of the paper pulp mills and is simply charred wood pulp in a much purer state than ordinary charcoal and with many times the adsorption power.

Credit for the pioneer efforts leading to the practical application and economical use of activated carbon as a taste removal measure must be given to George R. Spalding. It was in the spring of 1929 when Spalding first applied activated carbon on a plant scale at the New Milford, N. J., filter plant of the Hackensack Water Co. The use of activated carbon has increased with rapid strides and through a variety of procedures.

The extensive use of powdered activated carbon for the removal of objectionable tastes and odors from water justifies the assumption that this type of treatment has come to stay. It has proved effective in the removal of all kinds of tastes and odors. Since it appears to be the only treatment so far found which removes certain tastes and odors, it is almost indispensable for water treatment when palatable water is desired. Although the cost is fairly high when there is a very disagreeable taste or odor, such taste periods are usually of short duration, and the average cost of removing the tastes and odors is usually well within what the water-works can afford to pay.

Since activated carbon is now produced in a very finely powdered and highly activated form, it is merely a question of proper application of the material to secure the best results. Three things are essential: (1) a thorough mix to obtain uniform and complete distribution of the carbon particles through the water treated; (2) sufficient contact period before filtration; and (3) application at the proper point in the purification process. The carbon can be applied in the raw or in the settled water, depending on the condition of the raw water, the kinds and intensities of odors, and the plant layout and equipment.

The presence of carbon in coagulated water appears to retard the usual growth of algae in piping and on the basin walls. The carbon also aids in reducing the filter wash requirements. When used in the raw water, odor conditions throughout the plant are greatly improved. When odor and taste conditions are pronounced, the best and most economical application is to the settled water.

When there is no unusual odor present in the raw water, the use of activated carbon seems to lower the chlorine demand. This decrease in chlorine demand varies with the efficiency of clarification, oxygen requirement, and the amount of carbon used.

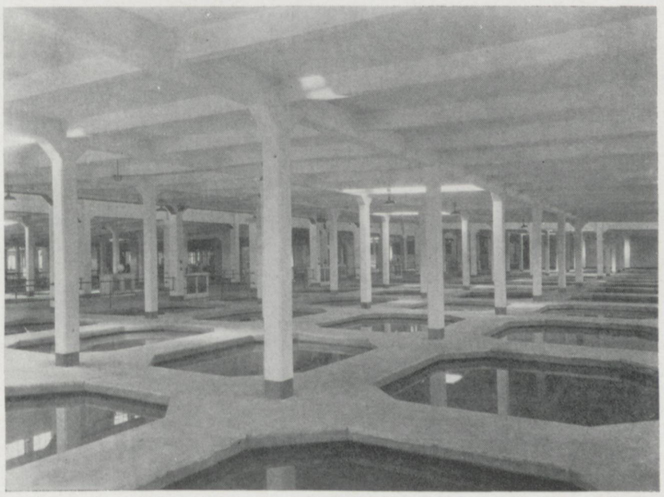
If little chlorine is used, there is little chance of taste compounds developing. In fact, mechanical and physical treatment of water gives a much more palatable product than does treatment depending upon the chemical action of soluble agents. In this respect activated carbon is unique as compared to other agents added to water. If coagulants are used, chlorine and ammonia residuals are carried on in the water, which may or may not result in an ultimate satisfactory reaction. This is not the case with activated carbon. It imparts no disagreeable properties if too much is added or the demand for it drops or ceases.

Carbon removes odors and tastes because (1) it is not absorbed by the water; (2) it has greater solvent action for taste-producing substances than has water itself; and (3) it is removed from the water after doing its work.

The addition of an enormous excess of the carbon results in no harmful effect on the quality of the water produced, but it is costly. For small plants it is usually cheaper to use an excess of the material than to employ chemical supervision. The use of powdered carbon in small plants at present demonstrates that it may be used quite efficiently in any size plant.

Several different methods of applying the carbon to the water are being used. The most extensive use is of dry feed machines developed for the purpose of handling other chemicals in water treatment plants. At some plants, a suspension of the carbon in water is used, and also appears to be a satisfactory method.

The carbon may be added to the water at various points in filtration plants. If the amount of carbon required is small, it is generally added to the water as it goes to the filters. This seems to be the point where maximum efficiency of the carbon is obtained, for it is filtered out and retained in the filter beds until the filters are washed. The amount of carbon used at this point is limited due to shortening the filter run. A definite amount cannot be set as the maximum which may be applied on the filters, for it will vary considerably for different plants and different conditions. If very large amounts are used, it is essential to apply it where there will be partial sedimentation of the carbon before the water goes to the filters. Generally, the best point to apply the carbon back of the filters is in the mixing basins. If this is done, the material is kept suspended and evenly distributed throughout the water during the mixed period. Sometimes there is a reduction of the organic matter by coagulation and sedimentation, and if the carbon is added in the mixing basin, there is a chance that the larger amount of organic matter present will reduce its effectiveness somewhat for removing tastes and odors, and it will then be necessary to use more carbon.



Courtesy: Civil Engineering

Modern Water Filter

Activated carbon is sometimes used in the granular form, especially in bed constructions. When beds of granular activated carbon are first constructed, they are very effective in removing tastes and odors. There is not much information available as to the useful life of carbon in beds or the probable cost of removing tastes and odors with beds of the carbon. The cost of carbon units will depend upon the cost of the material and its useful life. When the taste and odor periods do not occur often and are not of long duration, powdered carbon is cheaper, but when they are frequent or of long duration, it is more economical to use beds of the granular material. In some of the smaller purification plants, where it would be very difficult to apply the powdered materials, beds of the granular material are used quite effectively.

Metallic Silver

Another new method used in the purification of water involves the use of metallic silver. The silver purification process depends upon the so-called oligodynamic action of silver. It is a well known fact, first reported by Naegeli in 1893, that silver metal exerts an inhibitive action toward bacteria, algae, and certain other forms of microscopic life. The term "oligodynamic", coined by Naegeli, refers to that bactericidal action of silver, copper, mercury, etc., and their salts, which occurs in such a dilute concentration that a chemical determination is extremely difficult. It was because of this that for many years the inhibitory action of the metals remained mysterious, but it is now generally accepted that the metals act entirely through the solution of traces of salts or oxides on their surface.

When water is exposed to metallic silver, it develops oligodynamic properties reaching a maximum in about eight days, but by increasing the area of the metal exposed to the water many hundreds of times, the time factor is greatly reduced.

In this new process certain "activators" such as palladium or gold are sometimes added to the silver. Their primary purpose is to hasten the oligodynamic action of the silver.

Water for the new swimming pool at the Congressional Country Club of Washington, D. C., is purified by the silver process.

As the water enters the tank, it will flow past two sterling silver electrodes using, at less than 1.6 volts, about enough direct current from a battery to light a 50-watt bulb. The cost of sterilizing the 150,000 gallons will be about $2 in silver (say 4 oz.) and a few cents' worth of energy. The apparatus will be entirely automatic. Some years hence, the electrodes will have to be replaced. That, and keeping the battery charged, is all the attention required. Meanwhile, the water will have no noticeably changed odor, flavor, or color.

Those particularly interested in the process are the silver producers, chemists and bacteriologists, sanitary engineers, and food manufacturers. The silver producers foresee a big new market for their product, the more highly prized because none of the silver used in the process will be recoverable. Should the silver process replace half the chlorination or violet ray sterilization plants eventually, it would be the largest industrial use of silver ever developed, far exceeding photographic use.

Strictly speaking, there are two methods of purifying water by the use of silver. The electrolytic method is the important one, commercially, but there is a limited application for a simple contact method. Beads of porcelain or pebbles of quartz are coated with silver. If water is allowed to percolate through little portable filters made with these beads or pebbles, it becomes germ-free. The effect, however, is slow; it is greatly accelerated by the use of electricity.

Courtesy: Civil Engineering
Interior of a Modern Filtration Building

It is possible to buy a pocket device consisting of two silver rods connected to ordinary flashlight batteries. To purify water the electrodes are immersed in a glass of water for 20 seconds, removed, and within a short time, the water is safe for drinking.

Some of the claims made for this new method are as follows: (1) there is no taste, odor, or color to water treated by this method; (2) water which has been exposed to silver has the power of sterilizing other polluted water mixed with it; (3) it is claimed to sterilize polluted water independent of the temperature of the exposure; (4) there is no reduction in the efficiency of this new process by the presence of minerals or organic matter in the water (5) the quality of water is only of importance when it contains much suspended matter; (6) it is recommended for the treatment of water in swimming pools, laundries, drains, ice plants, etc.; and (7) certain claims for medicinal applications are made.

Ammonia-Chlorine

A comparatively new and quite satisfactory treatment given our water today is the ammonia-chlorine treatment. This method has become so valuable in effecting better sterilization of water that its use for this purpose alone would justify very extensive application. It is a particularly valuable and attractive treatment because of its ability to maintain a high residual chlorine in the water without causing a chlorinous taste. In some instances where both the pollution and chlorine absorption are fairly high, there is a saving in the cost of sterilization over the use of chlorine alone.

Although the germicidal properties of the chloramines were recognized more than twenty years ago, it was not until 1929 that certain conflicting viewpoints were to some extent reconciled and the advantages of ammonia-chlorine treatment recognized.

Today, however, with several years of country-wide experience behind them and with the benefit of a large number of ammonia installations, waterworks engineers are in a position to make and support with evidence definite statements regarding the efficiency of the ammonia-chlorine process.

There is no doubt but that the ammonia-chlorine treatment has resulted in increased bactericidal efficiency in many water supplies. Even though the chloramine is not a stronger sterilizing agent than chlorine, it is the residual which is maintained for a much longer time

"Roguery is never quiet!"

So said Chicago's chief of police in 1880—the year that city speeded up its war on crime with the world's first police telephone system.

From that day to this, the telephone, the teletype and more recently police radio—an outgrowth of Bell telephone making—have made "roguery" harder and harder to get away with.

This is just one more way in which the telephone helps to make your life a happier, broader and safer one.

BELL TELEPHONE SYSTEM

AMERICAN TELEPHONE & TELEGRAPH CO. BELL SYSTEM AND ASSOCIATED COMPANIES that produces the very efficient sterilization. The bactericidal action of chloramine is much slower than that of chlorine; yet if the water is treated several hours before it reaches the distribution system, there is little danger of harmful bacteria being present when sufficient residual chlorine is maintained.

The ammonia is purchased in two forms, anhydrous ammonia and ammonium sulphate. At present nearly all of the plants are using anhydrous ammonia. The anhydrous ammonia is sold in steel cylinders like chlorine, and the flow is controlled with machines somewhat like those for chlorine. The machines for feeding anhydrous ammonia gas are accurate and require about the same attention as the chlorine machines. In many plants it is equivalent to having another chlorinating plant to maintain. Duplicate machines are generally provided to insure continuous operation. The ammonia should be applied to the water sufficiently in advance of the chlorine to produce fairly uniform distribution of the ammonia before the chlorine is added. Ammonium sulphate is used as the source of ammonia in several plants, and aqua-ammonia (30 per cent) also is used in several plants. The ammonium sulphate contains approximately 25.8 per cent of ammonia. The effectiveness of anhydrous ammonia differs hardly at all from that of an equal amount of ammonia obtained from the sulphate. Usually the ammonium sulphate is dissolved in a large excess of water and the solution fed into the raw water. The equipment required and work involved are nearly the same for handling an equal amount of aluminum sulphate by solution feed. At one plant the ammonium sulphate is mixed with the aluminum sulphate solution. Such a procedure requires no extra equipment for applying the ammonia to the water.

Sometimes the ammonia is used after the chlorine. In some instances advantage is taken of the power of the chlorine to destroy certain tastes which would not be destroyed with chloramine. This procedure is also used when there is a short period between the time the chlorine is added and the time the water reaches some of the consumers. The chlorine must be added sufficiently in advance of the ammonia to produce the desired sterilization. This time is less than when the ammonia is applied first.

The "persistent residual" characteristic of the chloramines makes their use an extra safeguard to public health because of added protection to the water supply after treatment. The use of the ammonia-chlorine treatment has undoubtedly prevented a large number of cases of typhoid and dysentery during the past few years.

Some of the claims as to the advantages of the chloramine treatment are as follows: chloramine is a more effective bactericide than chlorine; it retards or prevents aftergrowths; eliminates chlorinous tastes and chlorophenols; reduces the amount of chlorine necessary to sterilize the water; allows a high residual chlorine to be maintained which will be sufficient to overcome a sudden increase of bacterial load; and it is non-toxic to the human body.

That the development of American water supply practice during the last hundred years has been one of continuous advancement was demonstrated at the Century of Progress Exhibition, held at Chicago in 1933, where many interesting exhibits showed how the purification of our water supplies has depended upon discovery and development in the sciences. Since early sources of water were naturally good, they required little purification; but with the growth and expansion of cities, danger of contamination increased. At the same time the difficulties of finding suitable natural supplies multiplied. Since new supplies were not procurable, muncipalities were forced to treat the ones available. As a result of this, various methods of treating raw water have been developed.

Largely as a result of improvement in the quality of drinking water furnished to city dwellers, there has been a steady decrease in typhoid fever in this country. This disease is now chiefly a rural problem. In fact, during 1930 there were only 1.6 deaths from typhoid for every 100,000 persons in 78 of the largest cities of the United States. Thus, notwithstanding the rapid growth and increasing congestion of our cities, their water supplies have been made safer than ever through the application of science. Although it is still highly desirable to obtain as pure water before treatment as is financially practicable, it is now possible to so treat polluted waters that they will not endanger the public health.

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THE ROSE TECHNIC

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Military Intervention

From the internationalist's point of view a great world crisis exists over the Shanghai situation. These internationalists are divided into two groups. There are those who conscientiously desire world peace, and there are also those who desire to have their foreign financial interests protected. The latter group, while fewer in number, is infinitely greater in power. But these two groups together do not compose over two per cent of the population of the United States. The great majority learned its lesson in the last war. It wants peace at any price!

There is no logical reason for the United States to have even one marine in the Shanghai area today. Public opinion says that never again will the United States send its men overseas to protect the financial interests of a few. American citizens have had their opportunity to leave, and any who have not done so should remain at their own risk. We cannot be expected to defend the lives of a handful of over-zealous missionaries who voluntarily went to China to stuff their religion down the throats of a race who have had a satisfactory form of worship for thousands of years.

President Roosevelt had the country fooled to the extent that it believed he would demand a neutrality policy. Then in his Chicago speech last month he rattled the saber by intimating strongly that the United States could not remain disinterested regardless of developments in the Orient. Now he has sent a delegation to a nine power conference. Does Franklin Roosevelt think that he is so much smarter than any other president that we have ever had that his delegates will not be outwitted at this parley? Since the founding of the United States, our finest statesmen have been, almost without exception, ensnared by foreign diplomats. Even President Wilson and his aids, brilliant all, were not shrewd enough to cope with unscrupulous Europeans at parleys.

In spite of the fact that the masses in England are pacifists, Great Britain has been the leading influence in inducing the administration to become involved in the Orient. It is an undisputed fact that when trouble starts anywhere, Great Britain is always the first foreign power to be present, and when hostilities cease it always has the lion's share of the spoils. No wonder England seeks American intervention in China. By expending billions of dollars and slaughtering the youth of our nation, we could be an indispensable aid in helping John Bull acquire new territorial possessions.

Public sentiment has not been dormant this time as it was twenty years ago. Such a protest has been registered that the President has not dared, in the last few weeks, to suggest a possibility of further intervention. As the cannon fodder of the nation, it is up to the college men of America to demand of the administration a policy of strict neutrality.

Technic Articles

One of the hardest jobs which falls on the shoulders of the Editor is the securing of suitable feature articles. This is mostly due to the lack of interest in writing articles, which results in a small group of students contributing all of the material. Practically every Technic reader, student or alumnus, is particularly interested in some engineering problem or has a hobby that could be used as the subject for a contribution which would interest a large number of our readers. From the student's viewpoint, the writing of an article consumes a great deal of time, but the experience of writing a paper helps to broaden the man's interests, especially if he writes about a subject that he has not studied in class.

Broaden Your Interests

Concerning engineers, it has been justly said that they are extremely narrow in their interests. That this fact has been recognized by the leaders in engineering education, can be seen by the addition to the engineering curricula of public speaking, psychology, more English courses, and other similar subjects.

The fault can not be overcome entirely by correction of the engineering curricula, but engineering students will have to take some of the responsibility themselves. One of the best ways to remedy this situation is to take an active part in some extra-curricular activity. Everyone should read the daily newspaper, as well as occasionally some good books. If you do not play on any of our intercollegiate teams, you most certainly should take part in the intramural tournaments.

Plan to Attend

the

MILITARY BALL

of

TAU NU TAU

DECEMBER 4

MAYFLOWER ROOM

Dick Jurgens and his Orchestra

9:00 P. M. $3.00 per couple

Campus Activities

edited by
J. Edward Taylor,
ch., '40

Assemblies

At the October 14 assembly Coach Phil Brown gave a short talk on the merits of a strong cheering section at athletic contests. Following this, our new yell leaders, Babcock, Beeler, and Hess, led a vigorous pep-session in preparation for the homecoming.

On Thursday, October 28, the faculty and student body convocated to discuss the sixth biennial Rose Show. President Prentice, after speaking in behalf of the faculty and their willingness to cooperate, called on Professor Knipmeyer to remind the upper classmen and describe to the new students the magnitude of the undertaking.

Professor Knipmeyer is an authority on the subject since he has had a hand in the success enjoyed by all of the former shows. However, he emphatically stressed the point that the entire show must be built by the students with the faculty acting in an advisory capacity only. Notwithstanding, every organization on the campus immediately went on record to support a show next spring, this being necessary since precedent is the only rule for continuing this tradition.

The first step having been taken, a planning council was instructed to meet soon to map out a program of progress to extend throughout the winter, thus avoiding the last minute madness and promising a greater show than ever before.

At the same convocation the Blue Key national honorary fraternity pledged five new members. They were John Wilson, George Smith, Robert Kahn, Robert Ladson, and Edward Spahr. The sponsors for these men affirmed that they measured up the the qualifications required for membership. The requisite qualities are extra-curricular activities, personality, character, and scholarship. Men who are in the junior or senior classes and meet the above requirements may be elected, the total not to exceed fifteen percent of any class.

Class Elections

Election of class officers was completed at the Institute Monday, October 18, when the sophomores and the freshmen balloted.

The Hare system of proportional representation is employed exclusively in determining the results of these elections. Under this system any member of each class is permitted to run for any office provided three members of the class nominate him in writing. The electorate must then place the name of every nominee on their tickets in the order that they prefer them. The candidate who receives the greatest number of first choice votes is elected president if this number of votes is equal to or greater than an established minimum. If one person receives more votes than is necessary to elect him the excess votes are transferred to the credit of the candidate having the greatest number of second choice listings, thus every vote is effective in the poll, making for maximum representation. The person having the second greatest number of first choice votes is elected vice president, etc.

The new officers for this year are:

Senior—John H. Wilson, president; Merton B. Scharenberg, vice-president; Edward H. Eckerman, secretary-treasurer; Wendell Carroll and Charles Fuller, athletic representatives.

Junior—Robert W. Underwood, president; J. Ewing Ross, vice-president; Robert J. Burger, secretary-treasurer; H. Logan Davis and Edward O. Spahr, athletic representatives.

Sophomore—Stanley R. Craig, president; Walter T. Zehnder, vice-president; Robert G. Brittenbach, secretary-treasurer; Robert H. Colwell and Max L. Mitchell, athletic representatives.

Freshman—Frank M. Beeler, president; John L. Combs, vice-president; George C. Harper, secretary-treasurer; Raymond C. Hogan and John R. Roberts, athletic representatives.

Military Ball

Plans are being made by the committees for the annual military ball of the Tau Nu Tau Military Fraternity of Rose. This event will take place on Saturday evening, December 4, in the Mayflower Room of the Terre Haute House.

The ball will be strictly formal and open to the public. It is planned to engage Dick Jurgens and his orchestra to furnish the music for dancing during the evening.

Previous years have established the fact that this is one of the most colorful events of the season on Terre Haute's social calendar. This year will be no exception. From all indications it will surpass those of former years due to more careful planning and greater effort on the part of the committees.

The committee in charge includes K. L. Buis, general chairman; J. R. Hayes, chairman; M. B. Scharenberg and G. A. Neyhouse, orchestra; N. G. Wittenbrock, chairman, and J. F. Weinbrecht, decorations; J. F. Weinbrecht, chairman, and J. A. Greenland and E. H. Eckerman, publicity, and R. E. Dennis and W. D. Wolf, tickets.

The E.C.M.A. Convention

On October 28th and 29th Mert Scharenberg, editor, and Allan Greenland, business manager, of the *Technic* attended the annual convention of the Engineering College Magazines Associated in the beautiful city of Minneapolis, Minnesota. The host to the convention was the staff of the Minnesota *Techno-Log* of the engineering school of the University of Minnesota.

Over fifty percent of the twenty three magazines in the Association were represented by two or more delegates.

The convention was opened Thursday morning by the National Chairman, Prof. Richard W. Beckman, Iowa State College. The business of the day included a session on advertising led by Tom Rogers, Eastern Vice-Chairman, and reports were given by the chairman, vice-chairman, and the association advertising representative. A banquet was held during the evening in the Union Building. The address of the evening was given by Mr. R. W. Beckman, editor of *Farmer's Wife* and former chairman of Agricultural Magazines Associated. Entertainment was then provided by talent from the University.

Friday's business consisted of editorial sessions, circulation sessions and committee reports. A plan for districting the association was discussed. In the evening an informal supper was held at the Minnesota Union. The speaker, Mr. Edwin H. Ford, Assistant Professor of Journalism, gave a short talk. After this the awards, of which the Michigan *Technic* received three first places out of a possible five, earned for the past year were presented.

The presentation concluded the business of the convention. The place for the next convention was not decided at this time.

The delegates from Rose learned much from this trip which they hope to use toward the improvement of the Rose *Technic* for the students of Rose. They take this opportunity for thanking the *Technic* for sending them on the enjoyable trip.

Radio Club

The Radio club held a meeting on October 5, for the purpose of electing officers for the year. Lawrence Giacoletto was elected president; Avery Kelsall, vice-president; Franklin Doenges, secretary-treasurer; and Lloyd Krause, board member.

The meeting was opened with a general discussion of business matters. Among other things the club decided to repair its amateur radio station, W9NAA, immediately. The station, situated just south of upper Lake Deming, was damaged during a storm last year to the extent that club members will have to donate several Saturdays before it can be restored.

Physics Teachers Association

Three Rose faculty members participated in the sessions of the fall meeting of the Indiana Physics Teachers Association which was convened on Friday, October 22, at the Purdue University physics building, a new addition to the Lafayette institution and said to house the last word in equipment for teaching physics.

The representatives from Rose were Dr. Howlett, Professor Moench, and Dr. Crozier. Dr. Crozier read a paper, "Elementary Laboratory Experiments Made Effective by the Use of Amplifiers," at the Friday afternoon session. Dr. Howlett spoke at the general session that evening. His topic was "Some Factors Which Will Aid the Physics Graduate Who Goes Into Industry."

The last meeting of the association was held at Rose.

A.S.C.E.

Seniors in civil engineering at Rose participated in a two-day inspection trip which featured the annual fall meeting of the Indiana Section of the American Society of Civil Engineers on the week-end of Friday, October 22.

The members of the society from all parts of the state and their student guests visited the Calumet industrial area, in and around Gary. The next day was spent in Chicago, with the forenoon covered by a trip on the Chicago River and its branches, inspecting the construction and operation of movable bridges. During the afternoon the group toured the Calumet Sanitary Works and the construction of the Southwest Works, both projects of the sanitary district of Chicago.

Senior civil engineering students from Purdue and Notre Dame also joined the group. The details of the two-day meeting were arranged by Professor Charles A. Ellis, Purdue faculty member and president of the society, and by Fred Kellam, Indianapolis engineer and secretary of the society.

A. I. E. E.

Professor Knipmeyer led a delegation of seniors in the electrical department to the first fall meeting of the central Indiana section of the American Institute of Electrical Engineers at Indianapolis Friday, October 22, at the Indiana Bell Telephone Auditorium on North Meridian street.

Mr. Stanley Green of the Duncan Electric and Manufacturing Company was the speaker of the evening, talking on the subject of "Improvements in Watt-Hour Meters." The inner working of this complex instrument was an enigma to most of us until Mr. Green lifted the veil with his scholarly dissertation, however well we are acquainted with the effort it takes to reimburse the utilities company for the energy it measures.

Professor H. A. Moench, also from Rose and second vice-chairman of the section, was present at the meeting.

The program committee arranged diversion of a lighter nature in the way of special entertainment and refreshments.

At the latest meeting of the Rose Polytechnic Branch, on October 27, Clemens Lundgren gave a report of the Indianapolis trip for the benefit of those unable to attend. Wendell Carroll then took the floor to relate his experiences as a student engineer with the Detroit Edison Company this summer. George Neyhouse gave a condensed talk on "Some Technical Electrical Aspects of Boulder Dam." The coming Rose show was also given some consideration during the meeting.

S. P. E. E.

The faculty, composing the Rose branch of the American Association of University Professors, met informally on October 12 to discuss plans for the spring meeting of the Illinois-Indiana branch of the Society for the Promotion of Engineering Education which will convene at Rose next Spring.

The date is to be selected by the executive committee headed by President Orion L. Stock, professor of engineering drawing at Rose, when the committee meets here early next month.

Other committee members are R. E. Rich, Notre Dame; H. A. Moench, Rose; Stanton E. Winston, Armour Tech; L. H. Creek, Purdue, and W. M. Lansford and R. P. Hoelscher, both of Illinois.

The general session of the society usually is addressed by a speaker of national reputation. Later, specialized group meetings give the exponents of each branch of engineering education the opportunity to confer on the latest modes of transmitting educational matter.

A. I. Ch. E.

The Rose student chapter of the American Institute of Chemical Engineers was called to order for the first time this year on Thursday, October 21. After routine business had been disposed of, President Norman Wittenbrock called on various members to discuss their work during the summer.

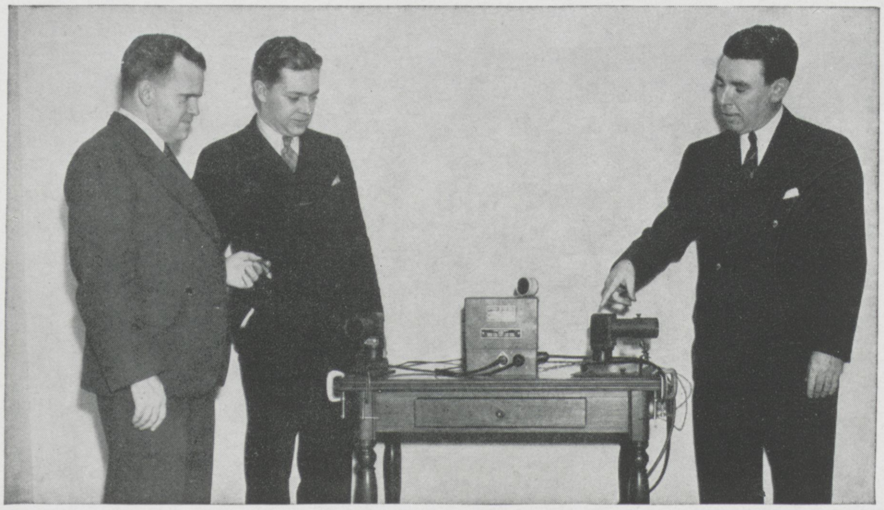
Plans were launched for the A. I. Ch. E. convention to be held in St. Louis on November 15 to 19, inclusive, in order that the Rose chapter will make a good showing. Mr. Tator, a member of the professional branch and friend of Dr. Strong, dropped in for the meeting while passing through on his way to the Massachusetts Institute of Technology.

All members are giving the coming exposition attention and some are well on the way to completion of their brain children.

Research and Progress

edited by

L. J. GIACOLETTO, e., '38



Cut Courtesy General Electric Company

The Brains of the Protective System

Invisible Protection

A system of invisible protection which is both flexible and complete has been developed by engineers of the Signaphone Corporation. The system depends primarily on the operation of a phototube which operates suitable relays when the incoming beam is interrupted. More specifically, the area or room to be protected from intruders is honeycombed by invisible rays. The light rays are actually a single ray reflected back and forth across a room, around corners, and at different levels and angles from a multiple system of mirrors. The ray is made invisible by filtering out the visible spectrum of a beam from a standard 32 candlepower automobile headlight bulb. At the receiving end, the invisible beam is focused on a phototube through a special lens. The output of the phototube is connected to an amplifier which increases the sensitivity of the system making it possible to employ a single beam over such a long distance.

Whenever the ray is interrupted at any point, a relay is operated which can be used for sounding various alarms such as an outside bell or siren. In an experimental setup at a General Electric building, the method of alarm was unique and presaged more modern and effective methods. The system, when the ray was interrupted, automatically cleared a telephone line, dialed police headquarters, and transmitted a spoken message summoning aid. After this message had been repeated for a minute and a half, the device "hung up" and then called the telephone company, repeating its message for the same period as a check upon the first call. Having done this, it once more cleared the line and automatically placed the telephone back in service. As a further assurance of continued operation, the system was so arranged that a battery supply of electricity is automatically connected if the regular supply is interrupted. Furthermore, since the rays are also sensitive to smoke, the system could just as easily be arranged to dial the fire department for aid. In this phase of operation, it serves quite effectively as a protection against fire hazards.

No doubt future years will bring about more extensive use of this and related protection systems.

Photoelectric Guiding

In taking astronomical photographs, it is usually necessary to make a long time exposure due to the small light intensities of the remote stars. Due to the rotational motion of the earth, stars would appear as streaks of light on a time-exposed plate unless suitable correction is introduced. Ordinarily the telescope is guided manually; however the task is very exacting and during long photographic exposures becomes quite tedious.

Several methods of automatically guiding the telescope have been suggested and tried. The requirements are very severe, not only must the instrument be accurate, but it must retain that accuracy over a period of time. A. E. Whiteford and G. E. Kron have devised a system of photoelectric guiding which meets the exacting requirements.

The incoming light from a remote star which is to serve as the guiding light is caused to fall on the vertex of a 90 degree roof-prism aluminized on its upper surfaces. If the center of the star falls exactly on the vertex, the total light is divided into two exactly equal beams which are separately converged and focused on a single spot of a photocell. A light-chopper consisting of a semi-circular plate rotating at a constant angular velocity is placed with its center in the plane of the two beams and equally spaced between the beams. Thus at any angular position of the chopper, the amount of light equivalent to one beam is intercepted and a like amount is transmitted to the photocell. Thus it is readily evident that as long as the beams are of equal intensities, the light falling on the cell is constant and the photoelectric potential will likewise be constant. However as soon as one beam becomes stronger than the other (this corresponds to the star center moving off the vertex of the prism), the chopper will no longer intercept equal quantities of light in all positions, but rather the quantity of light transmitted to the photocell will depend on the angular position of the cutter and thus the photoelectric potential will be a variable quantity. The output of the photocell is connected to the input of a series of vacuum tube amplifiers which of course will only amplify a varying potential and not the constant potential present when the light is centered. The output of the amplifier is used to drive an electric motor which either changes the position of the telescope or of the photographic plate to correct for the error. The field of the correction motor is supplied from a commutator on the light chopper and is thus of the same frequency as the amplifier current supplied to the armature. Thus when the star image moves from one side of the prism vertex to the other, there is a 180-degree change in the phase of the armature current and the motor runs in the reverse direction to correct the change.

In tests of the performance of the guider, it has repeatedly enabled the operator to obtain more clearly defined photographs of celestial objects than was previously obtainable by manual operation. Although the apparatus tried corrects for motion along one axis only, the authors have suggested that a prism with its axis running along a perpendicular axis could correct for motion along this axis or possibly a four-sided reflecting pyramid could be used.

Million Volt X-ray Generator

An improved high voltage x-ray generator has been developed by J. G. Trump and R. J. Van de Graaff of Massachusetts Institute of Technology for the Huntington Memorial Hospital of the Harvard Medical School in Boston.

The new generator is designed according to the principles of Van de Graaff's original electrostatic machine. The most important part of the apparatus is the huge terminal which acts as a storage body for the electrostatic charge. The terminal has maximum dimensions of 13 feet by 15 ft. by 5 ft. high. It is constructed from 1/8 inch aluminum plate supported on a rectangular steel frame. The terminal has a flat top, cylindrical ends, and well rounded corners. The bottom has been made re-entrant to further reduce corona erects in this region.

The high voltage terminal is supported on a rectangular insulating column 10 feet in height. The generator proper consists of six four ply fabric belts each 3 feet wide traveling within the column. Three 7½ h.p., 1800 r.p.m., d.c. motors cause the belt to travel over pulleys located at the base and in the terminal. A 250-watt 20 kilovolt transformer rectifier set sprays negative electricity on the lower end of the belt from rows of corona points.

The generator is used in conjunction with a million volt x-ray tube consisting of twenty porcelain sections mounted vertically. The sections are sealed together and continuously exhausted by means of a mercury-vapor diffusion pumping system. A filament is enclosed in the upper end of the tube. The electrons emitted from the filament surface are accelerated toward the base since there is a potential gradient between the upper terminal and ground. The electrons impinge on a water-cooled lead target 16 feet below the filament, the target being in the treatment room just below the generator room. The sudden stoppage of the electrons causes x-rays to be emitted from the lead surface. The rays are then focused on the point to be treated. The generator offers a readily controllable source of very intense and penetrating radiation.

Electrostatic Air Conditioner

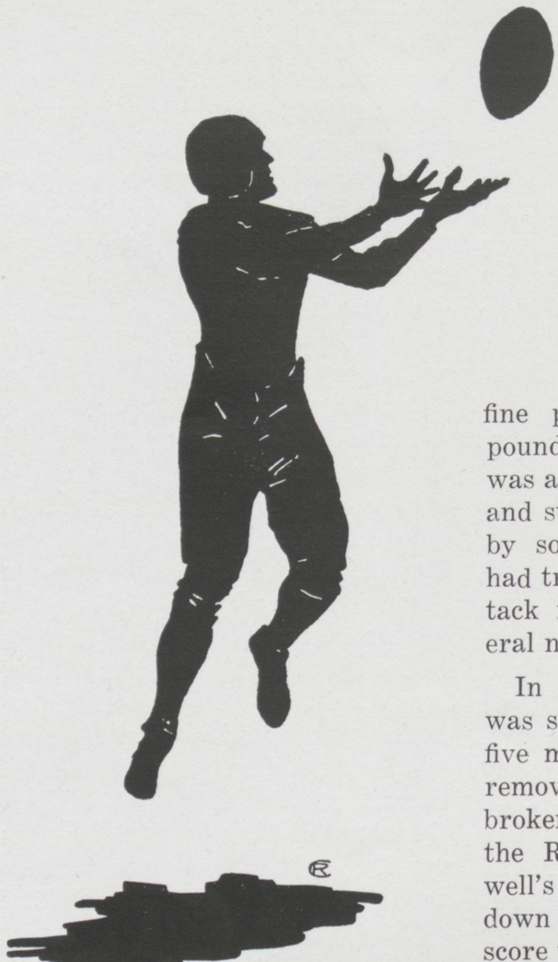
Although air conditioning itself is a relatively new field, rapid strides have been made in the development of effective and convenient units for cleaning air. The Westinghouse Research Laboratories have announced an electrostatic process of air conditioning which is claimed to be much superior to former methods.

In the electrostatic cleaning process the air is first bombarded by ions emitted by fine wires carrying a potential of 12,000 volts. The ions attach themselves to particles in the air thus giving the particles an electrical charge. The treated air is next drawn through a series of cells consisting of alternately spaced high-potential and grounded plates. By charging the high potential plates at 5,000 volts an electrical field is established. As the treated air passes through these cells, the charged particles adhere to the plates and the air so freed of all solid matter passes on through ducts and is distributed to different areas.

The electrostatic system of air conditioning is claimed to be superior to mechanical filters in that smaller particles are removed. Particles under two and one-half thousandths of an inch in size pass readily through 200-mesh screens used in mechanical filters. The electrostatic cleaner also removes minute dust particles and even particles of cigarette smoke which are approximately four-millionths of one inch in diameter.

An electrostatic installation at the Field Building, Chicago, contains 369 cells. Each cell contains 111 flat aluminum plates, 8x9 inches in size. The tungsten ionizing wires are but .005 inches in diameter and nearly half a mile of this wire is required for this installation. It is estimated that 600 bushels of impurities will be removed yearly with this installation. By weight, the collection will consist of one-third ash; another third fixed carbon, soot, lampblack and other derivatives; and the remaining third volatile matter such as oils and greases.

Physicians have already tested the reactions of hay fever and asthmatic patients of electrically cleaned air. Those with hay fever caused by breathing pollen-ladened air have found almost immediate relief. Asthma sufferers whose troubles result from breathing the dusty air of cities have been aided.



Sports

edited by
Robert N. Ladson, ch., '39

On October 2, 1937 Rose Poly journeyed to Greencastle to battle the DePauw Tigers. The Engineers were unable to score while DePauw made three touchdowns making the score 20-0.

This score is not as indicative of the battle that took place as it might be. Rose, primed to the utmost for this, the big game of the season, was not an easy victim. In the first half they put up a stubborn defense to hold the score at 7-0. Slightly outweighed man for man, the Rose line played a nice game. DePauw's lone first-half touchdown came just before the whistle sounded ending the first quarter. After several good gains from passes and end runs Bartley, giant fullback, broke through the center of the line for nine yards and a score. Shiak place-kicked the extra point.

In the second quarter Rose made several goal line stands to stop any attempts at scoring. A brilliant feature of the first half was the fine play of Rosy Colwell, 200 pound right halfback for Rose. He was a tower of strength on defense and staved off the DePauw attack by some excellent punting. Rose had trouble making its running attack function but completed several nice passes.

In the third quarter the story was somewhat altered. After only five minutes of play, Colwell was removed from the game with a broken collar bone. At this point the Rose defense, upset by Colwell's untimely removal, bogged down and allowed DePauw to score two touchdowns in rapid succession. The first touchdown was scored from midfield on a twenty-five yard pass to an end who raced the remaining twenty-five yards to score. On this play Smith, left half for Rose, was injured and was removed in a dazed condition a few plays later. Shiak again place kicked the extra point. The second touchdown of this period came as the result of a forty-five yard run through the still shaky Rose defense. The extra point was missed.

During the last quarter the Rose defense tightened and stopped DePauw's scoring thrusts short of the coveted scoring territory three successive times. The Rose team was led by Captain Stanfield, and Colwell played good ball while he was in the game. The game was played under nearly ideal conditions, although the temperature was a little too high to permit the players to play their best.

In the first home game and the third game of the schedule Rose Poly dropped a bitter conflict to the St. Joseph's College team by a 13-7 score. Playing before a homecoming crowd of returning graduates, the Engineers fought hard but were unable to stop the drives and passes of Scharf, St. Joseph halfback.

At the beginning of the game Rose Poly gained possession of the ball on a bad punt on the thirty-five yard line. By successful line plays mingled with a couple of passes, the ball was driven to the two yard line. After a couple of passes, the ball was fumbled and recovered by St. Joseph. After the punt, Rose took the offensive and brought the ball to the twenty yard line where St. Joseph held for three downs. On the fourth down Harper, Rose quarterback, decided to try for a field goal but the ball fell short.

St. Joseph took the ball on the twenty yard line and moved through a stubbornly resisting Rose team to within striking distance where Scharf hurled a pass over the goal line for the first score of the game. The try for point was missed.

At this point of the game Rose again displayed a brilliant offensive, bringing the ball to the forty-five yard line. On the next play Captain Stanfield, on a clever sneaker, ran the total distance to score. The St. Joseph team was so dumbfounded by this play that Stanfield scored ten yards ahead of the nearest potential tackler. Dependable Norm Eder place-kicked the extra point. The battle was nip and tuck for the rest of the first half and the score stood Rose 7—St. Joseph 6.

At the beginning of the second

half St. Joseph took the ball on their own thirty yard line and advanced to the Rose thirty. Scharf immediately passed to Curvsh who ran the remaining distance to the goal line unmolested. The point after touchdown was good making the score 13-7 in favor of St. Joseph.

For the remainder of the game the play was fairly even with Rose Poly trying many passes most of which were unsuccessful. Ed Eckerman, senior left end for Rose, was by far the most outstanding Engineer. He played a remarkable defensive game, and stopped virtually every play that came his way. Lew Lohr, hard driving right end, played a good game until he had to be removed because of an injured shoulder. In the backfield, Brittenback and Stanfield made several good gains and carried the brunt of Rose's offense. Playing the first game without Rosie Colwell, injured two weeks before, the Engineers did not show their usual defensive ability.

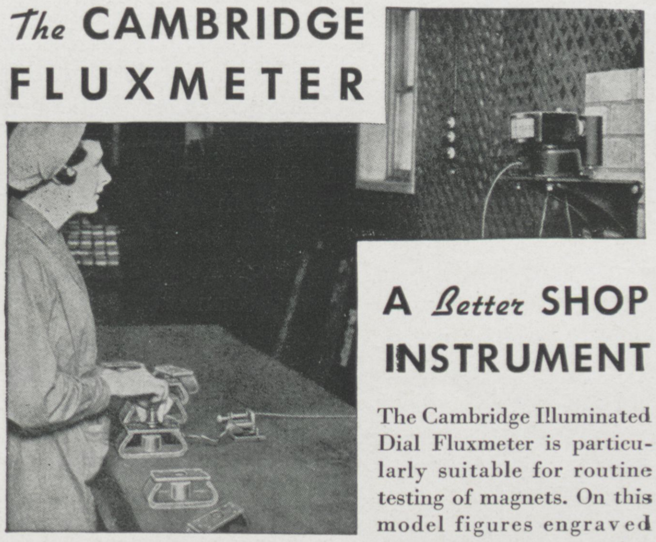
On October 23, Rose Poly traveled to Crawfordsville to play Wabash College. The score at the end of the game was 25-0 Wabash. This is a rather topheavy score, but a real battle took place.

At the outset, Rose Poly's line smashed through to block a Wabash punt. The ball was advanced to the Wabash seventeen yard line where a pass was dropped and a running play stopped. After an exchange of punts Wabash advanced to the Rose nineteen yard line to end the first quarter. On the first play of the second quarter Wabash was penalized fifteen yards, but three passes brought the ball to the Rose two yard line. The Engineers held for three downs, but on the fourth down Wabash scored. Zinngrabe, Rose right end, blocked the try for point.

After the kickoff to Rose, the Engineers punted, and the Wabash safety man carried the ball to the Rose twenty eight yard line. A few plays later, Wabash scored on a pass, completed in the end zone. An attempted pass for the point after touchdown was incomplete. The half time score was Wabash 12, Rose 0.

After an exchange of punts in the third quarter, Carr, substitute Wabash back, ran 65 yards behind excellent, down field blocking to score. A pass for the extra point was good.

For the rest of the game Rose put up an excellent battle with the exception of shortly before the end of the game. An excellent Wabash punt rolled to the two yard line where it was downed. Eckerman punted out to the 40 yard line, but a long pass was completed on the Rose one yard line. On this play there was an argument over whether or not the Wabash man caught the ball out of bounds. Rose braced for two downs, but could not stop Wabash's third attempt. The point after touchdown was unsuccessful. Hogan, Eckerman, and Brittenbach were the outstanding players for Rose. Wabash made eight first downs, and Rose six.



Alumni Notes

edited by
Robert S. King, ch., '40

G. A. Kelsall

When G. A. Kelsall joined the Western Electric Company on the thirtieth of September, twenty-five years ago, he little thought that he would take an important part in developing the remarkable new magnetic materials which have since become known as the permalloys, perminvars and permenders. After graduating from the Electrical Engineering course at Rose in 1906 he spent three years with General Electric Company at Schenectady and with the Indiana Steel Company at Gary. In 1909 he accepted the position of instructor in Electrical Engineering at Michigan State College. In 1912 he joined the Western Electric Company in New York. Since then his work has been closely associated with magnetic materials; for the first five years his work dealt with loading coils in the Physical Laboratory. During this period, taking part in the development of powdered-iron core material, he developed an a.c. permeameter for measuring the permeability of toroidal cores. This has been a large time saver as it does not require winding the specimen. These permeameters have been used continuously in the Laboratories in the development of new magnetic alloys and at the Hawthorne plant of the Western Electric Company in the inspection of magnetic cores. He also developed the permeameter furnace for measuring a.c. permeability at elevated temperatures. Patents have been issued to him relating to loading coils, magnetic testing apparatus and magnetic materials. Since 1917 he has investigated about twenty-five hundred alloys with different compositions. On account of his extensive knowledge of these alloys he acts as consultant in problems relating to their properties and uses.

Mr. Kelsall's son, Avery C. Kelsall, is a member of the sophomore class at Rose.

Weddings

Wedding vows of Miss Jeanette Turk, attractive and popular daughter of Mr. and Mrs. Paul E. Turk of Terre Haute, and Fred W. Wiles of Akron, Ohio, son of Mr. and Mrs. W. D. Wiles of Struthers, Ohio, were heard at 4 o'clock Saturday afternoon, October ninth, in the presence of the immediate families.

An informal reception was held following the ceremony for the young friends of the couple. Mr. and Mrs. Wiles left early that evening on their wedding trip east. They will make their home in Akron, Ohio.

Mrs. Wiles is a graduate of the Indiana State Teachers College, and for the past two years she has been connected with the WPA offices in Terre Haute and in Lafayette, Ind. Mr. Wiles is a graduate of Rose, class of '35, and is now connected with the B. F. Goodrich Rubber Company in Akron.

Announcement has been received of the marriage of Baird F. West, son of Mrs. C. W. West of Terre Haute, and Lucile Ault Sergeant, daughter of Mr. and Mrs. William D. Ault of Wellsville, N. Y. The marriage took place at St. John's Episcopal Church in Wellsville on Saturday, Oct. 23.

Mr. West is a graduate of Rose, class of '27, and is in the office of public relations of the United States Steel Company at 71 Broadway, New York City. For the present, Mr. and Mrs. West will live at 347 Bellmore avenue, Bloomfield, N. J. Later, they will move into New York City.

The wedding of Miss Irene Allais, daughter of Mr. and Mrs. Edward Allais, Terre Haute, and John Jakle, son of Mrs. Minnie Jakle, Terre Haute, was solemnized at the home of the bride's parents.

Only the immediate families were present at the ceremony.

Mr. and Mrs. Jakle left immediately following the ceremony on their wedding trip and upon their return will be at home with the bride's parents.

Mrs. Jakle attended the Indiana State Teachers College and graduated from the University of Illinois. She has been teaching school in Terre Haute. Mr. Jakle attended Rose and is now a salesman for the Columbia Mining Company at Chicago.

Obituaries

Word has been received of the death of Ned M. Austin, Sunday, October 24. Mr. Austin, formerly of Terre Haute, was Chief Metallurgist of the United Engineering Foundry Co., Canton, Ohio. Mr. Austin graduated from Rose in 1898. Surviving him are the widow and two brothers.

Albert H. Lyon, who graduated from Rose in 1917 died October 12 after a protracted illness. Mr. Lyon, who engaged in civil engineering work with several railroads after graduation, had more recently been connected with real estate and insurance business in Terre Haute.

Births

William H. Hineline, graduate of 1932, announced the arrival of a daughter born August 26.

C. A. Lotze, '30, reports:

"I see that it will soon be no easy matter to enter Rose, so I would like to make reservation for a member of the class of '59. He's my seven pound boy born at St. Vincent's Hospital, September 21. We will call him Frederick Charles Lotze."

Here and There With The Grads

'92 Benjamin R. Putnam has moved to Los Angeles.

'93 Clifford E. Albert has been made president of the U. S. Playing Card Company.

'01 Harry A. Schwartz has been appointed a "Professorial Lecturer" in metallurgy on the faculty of the Case School of Applied Science. Dr. Schwartz is Manager of Research of the National Malleable and Steel Castings Company, Cleveland.

'04 Harry Smith is with the Pullman Standard Car Manufacturing Company, Chicago.

'06 Roy Thurman is now Sales Manager for the Indianapolis Power and Light Company.

'11 David J. Johnson is Chief Estimator for Lundoff-Bicknell Company, Chicago.

'13 Camille C. Bains is owner of the Peerless Sound Equipment Company, Louisville, Ky.

'14 George M. Derr is Assistant District Sales Manager for Truscon Steel at Washington, D. C.

'25 Lester W. Glenn is a member of the firm of the Atlas Boiler and Welding Works of Louisville, Ky.

Charles C. Withrow is Assistant Engineer with the U. S. Engineers, Concord, N. H.

'35 Fredrick W. Wiles has a position with the Talon Fastener Company at Meadville, Pennsylvania.

'36 Carrol R. Merriman, with the Pennsylvania Railroad, has been transferred to Cincinnati as Assistant on the Engineer corps.

Robert A. Waddell has a Graduate Assistantship in the Speech Department at Ohio State, where he is finishing work for his Masters Degree.

'37 Robert Averitt and John Sonnefield recently joined the General Electric Company as Student Engineers and both are located in the Pittsfield, Mass., plant of that Company.

John Stineman, with General Electric, has been transferred to Schenectady.

ex'39 Oscar C. Tonetti received an appointment to West Point and was sworn in with the new class of July first.

FRATERNITY NOTES

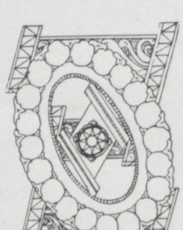
Sigma Nu

Beta Upsilon Chapter of Sigma Nu held open house for the members, pledges, and their guests on Friday evening, October 22. Entertainment for the evening consisted of dancing, cards, and ping pong. The chaperons were Professor and Mrs. Edwin W. Mann and Mr. and Mrs. Henry C. Gray.

On September 29, Beta Upsilon was visited by Mr. Ellis B. Hall, inspector of the five Indiana Chapters of Sigma Nu.

A dinner was given by the chapter for its members and pledges on October 29. Charles Edward Thomas, editor of *The Delta* and Assistant General Secretary of the fraternity, presented an interesting talk about famous Sigma Nus that he has interviewed. The chapter plans to have a dinner every month for the remainder of the year at which there is to be present some prominent Sigma Nu.

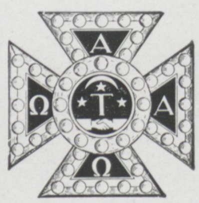
Theta Xi



Kappa Chapter of Theta Xi was pleased to welcome Nelson B. Trusler, '35, back for homecoming. Several other alumni of Kappa Chapter were present at the Homecoming Dance.

The chapter wishes to congratulate pledge brother Zehnder on his election as vice-president of the sophomore class and Brother Burger, who was elected secretary-treasurer of the junior class. Kappa Chapter is represented on the football team by Captain Stanfield and Lohr.

Alpha Tau Omega



Gamma Gamma chapter of Alpha Tau Omega is pleased to announce the pledging of J. Ewing Ross, Stanley R. Craig, and Frank G. Pearce. Gamma Gamma also wishes to congratulate the following members: Stanley Craig, elected president of the sophomore class; Ewing Ross, elected vice-president of the junior class; Merton Scharenberg, elected vice-president of the senior class; Ed Eckerman, elected secretary-treasurer of the senior class; Wendell Carroll, elected president of the Athletic Association; William Reddie, pledged to Tau Beta Pi; and Robert Kahn, Robert Ladson, George Smith, and Edward Spahr, pledged to Blue Key.

A dinner meeting of the entire chapter, held November 1 at the chapter house, was a huge success. Thirty-nine actives and pledges attended the dinner and their respective meetings. Guests of the chapter were J. J. Maehling, province chief, Professor Carl Wischmeyer, and Mr. Henry Gray. Similar meetings will be held the first Monday of every month.

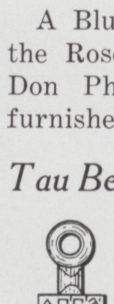
Brother Norman Wittenbrock, who represented the local chapter of Tau Beta Pi at the national convention held at Austin, Texas, reports that he was one of seven Alpha Taus present. Brothers Mert Scharenberg and Al Greenland represented the Rose Technic at the E.C.M.A. convention held at Minneapolis, October 28 and 29.

Blue Key

Blue Key National Honorary Fraternity is pleased to announce that the following men have been pledged to Blue Key: John Wilson, C.E., '38; Robert Kahn, Ch.E., '39; Robert Ladson, Ch.E., '39; George Smith, M.E., '39;and Edward Spahr, M.E., '39. Blue Key congratulates these men for their achievements.

A Blue Key dance was held in the Rose Gym on November 13. Don Phillips and his orchestra furnished the music for the dance.

Tau Beta Pi



The Indiana Beta chapter of Tau Beta Pi at Rose announced the names of those men who were honored on Wednesday, October 20, by being elected to membership in this select fraternity. The members of the senior class who were elected are

Ralph A. White, John H. Wilson, and Claude Zinngrabe. Richard D. Altekruse and William A. Reddie are the juniors who were pledged. An initiation is to be held in the near future.

On October 14, president Norman G. Wittenbrock attended the national convention of this fraternity in company with delegates from sixty-seven other chapters at Austin, Texas. One of the highlights of the convention was an inspection of the Pan-American Exposition at Dallas, Texas.

Tau Nu Tau

The officers of Tau Nu Tau for the year 1937-38 were elected at a late meeting of last year. They are: Kenneth L. Buis, president; Edward H. Eckerman, vice-president; John R. Hayes, secretary; and J. Allan Greenland, treasurer.

The first meeting of this year was held September 30 at the Alpha Tau Omega house. Plans were then formulated for the annual Military Ball.

A group of fifteen men were pledged November 1. The chapter congratulates these pledges: Richard D. Altekruse, Robert J. Burger, Franklin G. Doenges, Robert N. Ladson, W. Merritt Noel, Victor Peterson, William A. Reddie, J. Ewing Ross, George W. Smith, Edward O. Spahr, Robert W. Underwood, Roy E. Warren, Richard G. Weldele, Randall H. Wise, and John W. Yaw.

Humor

edited by

James E. Ducey,
ch., '40

Selenium for Alma Mater

A mineral expert was recently solicited by the Harvard Fund. He replied as follows:

"As I am an aluminum of two other colleges besides Harvard, and can not, with my bismuth in its present state, pay antimony to all three, I hope you will not think me a cadmium if I do not ceasium this opportunity of making a donation. So far this year I have metal current expenses, but in these troubled times when the future holds in store we know not phosphorus, I could not make a contribution without boron from the bank. It would nickel out of my savings. A manganese spend his dollars these days; a tin spot is gone in no time. One is lead to feel he is pouring them down the zinc. Much better to sodium up in a stocking. But don't be silicon not make any contribution this year."

The Fund wrote him simply: "Iron stand you. But as alloyman, mica suggest opening up a bromine and issuing stock certificates with the promise to selenium for dear old Alma Mater."

—*Chemical and Metallurgical Eng.*

Said Kahn at the opening of the debate: "Ladies and Gentlemen, before I begin my speech I have something that I want to say to you."

The question in the physiology exam ran: "How may one obtain a good posture?"

The country boy wrote: "Keep the sows off it and let it grow up a while."

Mike: "What makes this tobacco so juicy?"

Ike (reaching in his pocket to pull out a chew): "Dunno, musta been an accident."

A straw is something you sip through two of them.

She wasn't his best girl—just necks best.

UNBEATABLE

Last night I held a little hand,
So dainty and so sweet.
I thought my heart would surely
break,
So wildly did it beat.
No other hand in all the world
Can greater solace bring,
Than that sweet hand I held last
night—
Four aces and a king.

Prof. Bloxsome: "What are the three verb forms?"

Roberts: "Indicative, interrogative, and imperative."

Prof. B.: "Give an example of each."

Roberts: "Tom is sick—pause—Is Tom sick?—longer pause—Sick 'em, Tom!"

Captain Hawkins: "Cadet Lieutenant Greenland, what is a blank file?"

C. L. G.: "Sir, it's the space occupied by the man who isn't there."

A half breed is a fellow with a cold in one nostril.

MERRYGOROUND

"You look like the man."
"What man?"
"The man with the power."
"What power?"
"The power of Hoo-Doo."
"Hoo-Doo?"
"You do."
"Do what?"
"Look like the man."
"What man?"
etc.

BLAME IT ON THE TYPEWRITER

I often sit and medit8
Upon that scurvy trick of f8
That keeps me still a celibr8
Oh, cruel f8.
I want a 10der maid sed8
To love me and be my m8
My 40 2de is not so gr8
I cannot w8.
Oh, f8 be9! B4 2 l8
Relieve my awful single st8
And when I've 1 this maid sed8
We'll oscul8.

—I 8 2 much.

—*The Penn Triangle.*

Hank: "Describe the mechanism of a steam shovel."

Harper: "Don't kid me. You can't carry steam on a shovel."

An Irish priest offered twenty-five cents to the boy who could tell him who was the greatest man in history.

"Christopher Columbus," answered the Italian boy.

"George Washington," answered the American boy.

"St. Patrick," shouted the Jewish boy.

"The quarter is yours," said the priest, "but why did you say St. Patrick?"

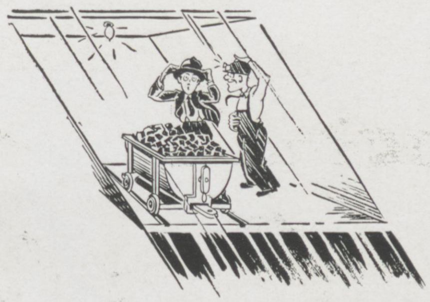
"I know'd it was Moses all the time," said the Jewish boy, "but beesiness is beesiness."

Outside of Doc Sousley's room.

Combs: "Let's cut this class and go in town."

Eudaley: "Nope, I can't afford to miss my afternoon nap."

G-E *Campus* News



A 40-MILE-AN-HOUR MINE HOIST

The problem of hauling a 25-ton load up a steep mine shaft at a speed of 3,600 feet per minute, or approximately 41 miles an hour, was recently undertaken by the General Electric Company for a Southeastern coal company. Upon completion, this mine hoist will be the largest and fastest in this country.

More than 6000 feet of wire rope wound around an 18-foot drum will hoist an unbalanced load of 50,800 pounds to the surface. The driving power for this tremendous weight will be a 2500-hp G-E hoist motor with dynamic braking as a safety factor to reduce the speed when men are being carried.

For the last 40 years the General Electric Company has been engaged in the manufacture of electric mining equipment. Much of the new design and development in this field has been contributed by college-trained men who were on Test.

FLOODLIGHTING DAVY JONES' LOCKER

When Capt. John D. Craig, deep-sea diver and photographer, descends to the black depths of the Irish Channel to photograph the salvage operations of the Lusitania, Davy Jones' Locker will be floodlighted for the first time in history.

The hulk of the ill-fated Lusitania lies buried in shifting sand at a depth of approximately 300 feet, with a treasure in her coffers valued at between $4,000,000 and $15,000,000. To illuminate the wreck for filming, the General Electric Laboratories in Nela Park, Cleveland, Ohio developed a 5000-watt lamp, built to withstand a pressure of 500 pounds to the square inch—more than three times the pressure believed to be around the vessel. Capt. Craig will use a battery of 12 of these lamps mounted on a submarine stage to floodlight the inky depths.

So widespread are the uses of electricity that the development of an underwater lamp merely illustrates the problems encountered by G-E engineers. Many of these men were on the college campus but a few years ago.

MODERN LILLIPUT

Wire, three thousandths of an inch in diameter, flattened between two polished rollers to a thickness of nine ten-thousandths of an inch; pivots ground to a point and then rounded to a radius half the diameter of a human hair, yet still sharper than the sharpest needle; sapphires not as large as the head of a pin. Such Lilliputian parts are to be found in the West Lynn plant of the General Electric Company.

A pivot with a point two thousandths of an inch in diameter, yet it supports a pressure of many thousands of pounds to the square inch. Hundreds of such parts are assembled to produce instruments—instruments that measure small flows of current, great flows of current, light, sound, vibration, strain, and time. These instruments are so sensitive that they measure the smallest quantities, yet sturdy enough to withstand the severe vibrations of a locomotive cab or an airplane dashboard.

The design and manufacture of precision instruments is but one of the many fields which are open to technically trained men in the General Electric Company.

GENERAL ELECTRIC

90-15DH


A pack o' pleasure
Chesterfield
CIGA
LIGGETT & MYER
Chesterfield