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Rose Technic Staff
*Rose-Hulman Institute of Technology*

# ROSE TECHNIC


Vol. XLVI March, 1937 Number 6

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MARKS-'35.

## . . ST. PAT'S NUMBER . .

# Wearproof by Welding

## Thus engineers obtain the service of the best alloys at the cost of ordinary steel

THROUGHOUT industry, wear on metals is an important cost factor. Until recently, most wearing parts had to be made entirely of special high-cost materials. Now, by welding, rapidly wearing surfaces can be covered with a wear-resistant alloy. Welded additions of bronze or Haynes Stellite—a wear-resisting alloy of cobalt, chromium and tungsten—create excellent wear resistance at low cost.

### Long Life at Low Cost

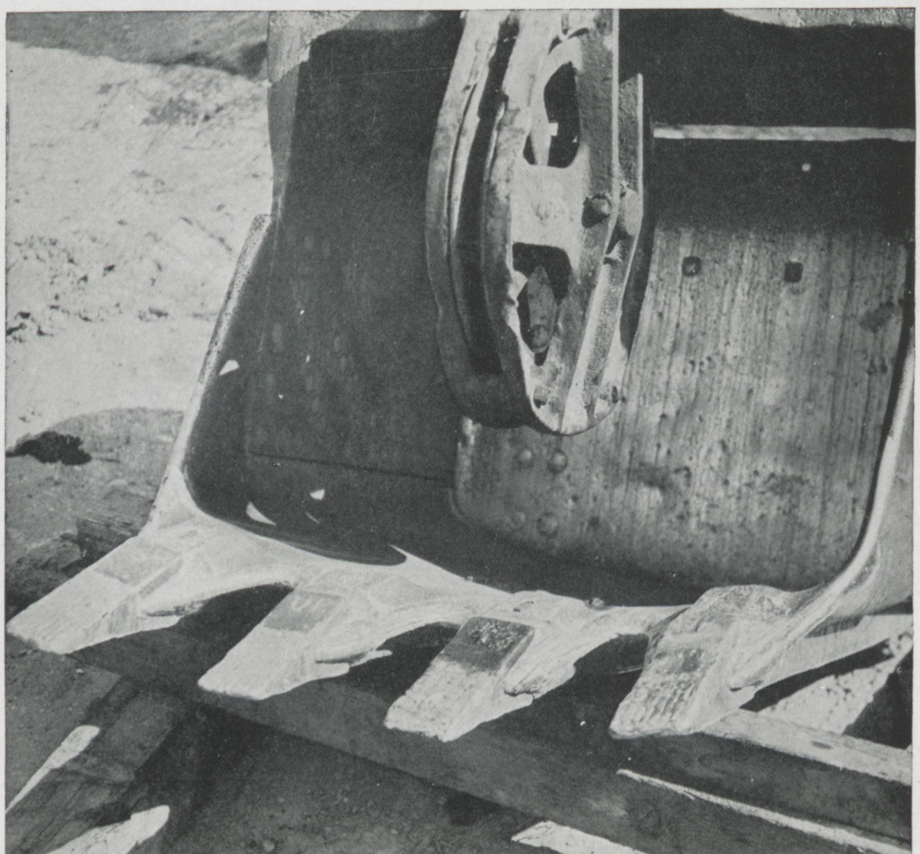
Wherever metal has hard work to do, wearproofing by welding plays an important part. Under the toughest conditions, in mines and mills, in factories and on farms, in construction and oil-drilling, it is saving money and time.

Wearproofed parts will last many times as long as those made of unprotected iron or steel. Welding cost, including the necessary alloy, is only a fraction of the total cost of a new part. Then, after long, hard service, the part can be re-covered—another wear-resisting surface can be welded on at small cost, and the part is again as good as new.

### Extensive Savings

Savings through the application of wear-resistant alloys are not confined to the lower cost of the part involved. Less power is used. Inventories are cut due to the consequently lowered investment and simplified control. Machine shutdowns for replacement are fewer. Maintenance costs are decreased, and a smaller crew can handle the necessary repairs. Further, the plant, without added equipment, can turn out a greater volume of production.

Figures drawn from case-histories where wearproofing is used are often surprising. A glance at the adjoining column will indicate many of the possibilities inherent in this process.



INTO THIS YAWNING CAVITY goes the dirt to make Grand Coulee Dam. Bucket front and teeth were hard-faced by welding. The result of this wearproofing was six months' service on Bonneville Dam, and many more months of trouble-free, repairless service on Grand Coulee.

## *Welding Savings*

Welding makes automotive exhaust valve seats good for 150,000 miles and more, with no regrinding in truck and bus motors, the toughest kind of service. These valve seats are wearproofed by welding Haynes Stellite to the contact surface. Ordinary cast-iron seats need regrinding every ten thousand miles.

* * *

Welding saved $2200 in one year for an Ohio pulp mill. Haynes Stellite was welded to the wearing surfaces of shredder knives. This work cost $90; knives, from the scrap heap, cost nothing. Hard-faced knives lasted for six months, and were again refaced by welding. New knives cost $200, last one month.

* * *

Welding a wear-resistant facing on the cutting edges of boiler-tube cleaners yields a twenty-fold saving—each cleaner will clean twenty times as many tubes as an ordinary cutter. When worn, hard-faced cutters are rebuilt for another long service.

* * *

Welding cured pump troubles in a pulp mill. Shafting on a sludge pump was wearing rapidly. Packing glands had to be tightened every hour, completely repacked once a week. The shaft was fast disappearing. Hard-faced by welding with wear-resistant metal, the shaft ran for three months with no attention, no appreciable wear.

* * *

Welding lengthens the life of blooming-mill shear clutches three times. Clutches previously ran 49 days, then went to the scrap pile. Now, wearproofed by welding, these clutches average 217 days before any attention is necessary. The same clutches are then refaced and used again.

* * *

Welding has solved an impossible lubricating problem. At a Southern mill where heater furnaces are fed by internal conveyor, rolls and bearings operate at 750 degrees Fahrenheit. Lubrication is impossible. A wear-resistant coating, built up on the rolls and bearings by welding, makes the conveyor last indefinitely, eliminates *need* for lubrication.

* * *

Tomorrow's engineers will be expected to know how to take advantage of this modern metalworking process. Many valuable and interesting technical booklets describing the application of the oxy-acetylene process are available without obligation. For further information write any Linde office.

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*Surveying This Issue*

THIS month's lead article by Albert W. Lotze presents a description of the utilization of the piezo-electric properties of quartz.

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ROBERT Kahn gives a brief history of the development and use of laminated glass.

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A NUMBER of the diverse applications of the thyratron tube are described by Robert A. Averitt.

*C. R. W.*

# THE ROSE TECHNIC

MARCH 1937




*Engineering College Magazines Associated*

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Iowa State College, Ames, Iowa

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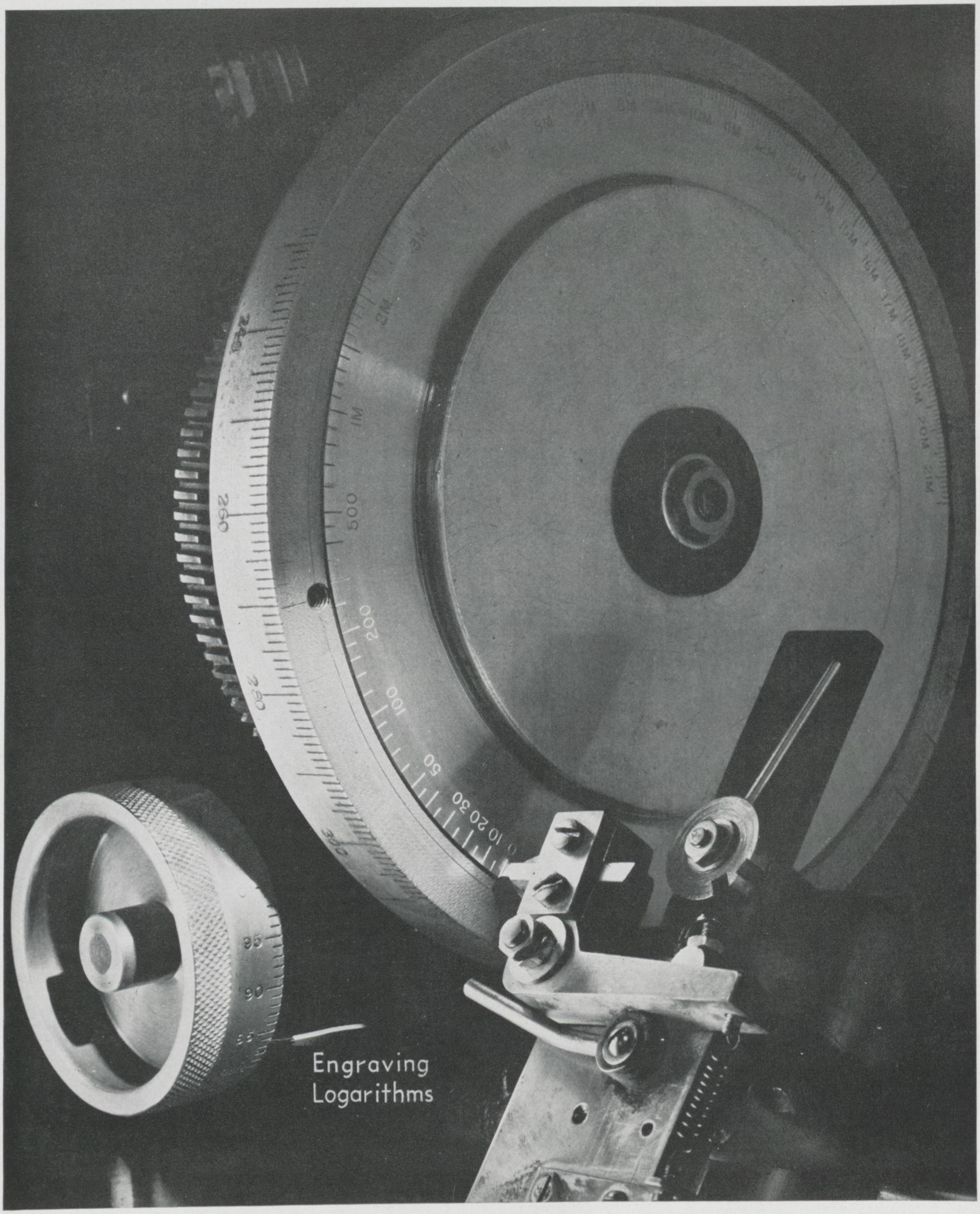

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*Cut Courtesy Electronics*

# Quartz Crystals

by

Albert W. Lotze, Jr., e., '37

WITHIN the last year all of the available channels in the radio spectrum have been allocated to the various radio services. The number of communication channels which can be operated in a given part of the frequency spectrum is largely determined by the accuracy with which the carrier frequency of a transmitter can be maintained at its assigned value. Since at the present time all of the available channels are occupied, the requirement of accurate frequency control becomes so important as to dominate the entire design of radio transmitters. Only by the use of quartz crystals has the full utilization of the frequency spectrum been made possible.

In the early days of radio transmission the frequency adjustment of a transmitter was determined by the values of inductance and capacity used in the oscillatory circuit. These inductances and capacities were shunted by the capacities of the vacuum tube elements used in the circuit. As a transmitter of this design "warmed up" under operation, the capacities between the elements of the tube varied, the inductance of the coils increased, and, as a result, the circuit constants were so changed as to cause, not uncommonly, a frequency change or "drift" of as much as five kilocycles.

With the great influx of new radio services within recent years, it was realized that a new, precise method of frequency control was required. The first application of a piezo-electric quartz crystal to control the oscillations of an electric circuit was announced by W. G. Cady in 1922. Cady explained that the frequency stability of an oscillator could be made very high by replacing the usual resonant circuit with a mechanically vibrating quartz crystal, and using the piezo-electric effect to obtain the connection between the electrical circuits and mechanical vibrations.

The properties of quartz crystals which make them useful in many electrical circuits is due to the piezo-electric effect. This effect was first noticed by Pierre Curie in his work on crystalline materials in 1890. It was found that if a piece of crystalline quartz is strained mechanically, it sets up an electric field in its neighborhood inducing charges or electrical potentials on conductors in that field. Hence the derivation of the term "piezo-electric," from the Greek expression "piezen," which means "to press." Conversely, when a crystal is placed in an electric field, a mechanical deformation takes place.

Quartz, however, is not the only crystalline material to exhibit these effects. Rochelle salts crystals have even a more pronounced piezo-electric activity. Common cane sugar also has marked electrical properties. In addition to its piezo-electric properties, quartz has other desirable properties such as low internal friction, chemical stability, and hardness, which make it the most used piezo-electric material. Tourmaline also has piezo-electric properties and has been used to some extent for oscillator control in the higher frequency range, the highest frequency obtainable being around sixty megacycles. Because of its scarcity and consequent high price, however, its use is not nearly so extensive as that of quartz.

Quartz crystals which are suitable for the manufacture of piezo-oscillators for radio uses are obtained from Brazil, Madagascar, Japan, and some parts of the United States, Brazil being the principal source of supply for large crystals. These crystals are hexagonal in shape and, when in their true form, have an apex at each end. The methods of mining and also the process of growing are such, however, that the crystals received in this country are rarely of ideal form, but usually have only one apex, and even that apex and the sides are very irregular.

The oscillating quartz plates cut from these crystals are generally square, from one-half to one inch on the side, and from one-eighth to one-hundredth of an inch thick. Quartz plates when used for radio frequency control purposes are generally termed "crystals." The properties of such a crystal plate can be expressed in terms of three sets of axes. The axis joining the points at the apices of an uncut crystal is known as the optical axis, and electrical stresses applied in this direction produce no piezo-electric effect.

Figure 1 shows a Y-cut or 30°-cut plate, that is, the face is perpendicular to a Y (mechanical) axis. Figure 2 shows an X-cut or Curie cut plate in which the face is perpendicular to an X (electrical) axis. Figure 3 shows how the plates are cut from the crystal.

If a flat section is cut from a quartz crystal so that its flat sides are perpendicular to an electrical axis as indicated in Figure 2, it is found that mechanical stresses applied along the Y-axis of the section produce electrical charges on the flat sides of the section. When the direction of these stresses is changed from tension to compression or vice versa, the polarity of the charges on the crystal surfaces is reversed. Conversely, when electrical charges are placed on the flat sides of the crystal by applying a voltage across the faces, a mechanical stress is produced along the Y-axis. Thus, if mechanical forces are applied across the

faces of a crystal section having its flat sides perpendicular to a Y-axis (Y-cut plate), piezo-electric charges will be developed, because the forces and electrical potentials developed in the crystal have components across the Y- and X-axes respectively.

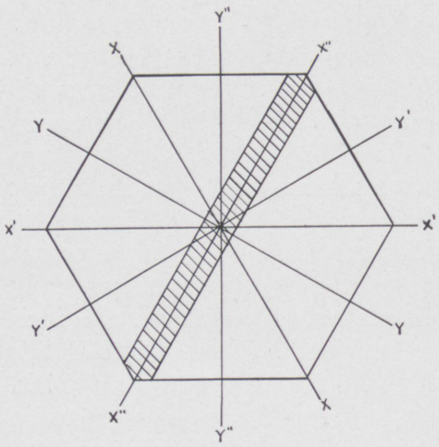

**Figure 1**

When a crystal is placed in a circuit so that an alternating voltage is applied in such a direction as to cause a component of electric stress in the direction of an electric axis, similar alternating mechanical stresses will be produced in the direction of the Y-axis, which is perpendicular to the X-axis involved. These stresses will cause the crystal to vibrate, and if the applied alternating voltage approximates a frequency at which mechanical resonance will exist in the crystal, the amplitude of the vibrations will become relatively large.

At the resonant frequency of the crystal, the current through the crystal is exactly the same as the current that would flow through an equivalent series circuit compound of resistance, capacity, and inductance.

From the preceding discussion it was seen that the resonant frequency of the quartz crystal must be a function of its mechanical properties. It is found that the frequency of oscillation of a quartz plate varies inversely as the thickness. Experiments have shown that for an X-cut plate the thickness as given in the *Radio Amateurs' Handbook* may be determined by the equation:

$$T = \frac{112.6}{F}$$

T is the thickness in thousandths of an inch, and F is the frequency in megacycles.

For a Y-cut plate the equation is:

$$T = \frac{77.0}{F}$$

This shows that for the same frequency the thickness of a Y-cut plate is approximately seven-tenths that of an X-cut plate.

The higher frequency limit for which crystal plates can be made is theoretically limited only by the practicability of grinding an extremely thin plate. It is seen from the thickness formula that an X-cut plate ground for operation on a frequency of ten thousand kilocycles, that is, ten megacycles, has a thickness of only eleven one-thousandths of an inch. If the frequency of this plate were to be accurate to within one-tenth of one per cent, the thickness must be accurate to within eleven-millionths of an inch. The cost of crystals manufactured for frequencies as high as this is determined almost entirely by the finishing of the plate for the exact frequency required.

Earlier in this article it was pointed out that the piezo-electric crystal is a mechanical vibrator. As a result of the molecular friction set up when the quartz plate is vibrating at the tremendous rate required for the production of radio-frequency oscillations, heat is generated. This heating causes the crystal to change its characteristics slightly, so that the frequency varies with the temperature. The rate of the frequency change with temperature depends upon the type of cut, the precision with which the crystal was cut, its size and shape, and the individual characteristics of the quartz used. The temperature coefficient of an X-cut plate is negative, that is, the frequency decreases with an increase in temperature. The value of the coefficient lies between minus fifteen and minus twenty-five cycles per million per degree centigrade. The temperature coefficient of a Y-cut crystal is generally positive, the frequency of oscillation increasing with an increase in crystal temperature. This coefficient may have a wide range of values.

The heating of a quartz crystal increases as the amplitude of the crystal vibrations. The vibration of the crystal is extremely complex; in addition to the vibrations of the type wanted for frequency control, there may also be present vibration of other types which produce only heating and mechanical stresses in the crystal. Since the heating is a function of the voltage applied across the crystal, it is essential that this voltage be limited for the type of crystal used. It is interesting to note that often, when a large enough voltage is applied, the vibration becomes so intense as to shatter the crystal.

Earlier in this paper the need for extreme precision in frequency control was stressed. Although the crystal is made exactly for a specified frequency, what is to keep it from changing its frequency slightly with a change in its operating temperature or even a change in room temperature? This obstacle has been surmounted by enclosing the crystal, and perhaps other portions of the oscillator circuit, in a temperature-controlled box, or, as it is more generally known, a "crystal oven." A crystal oven is a small box built of material with very good heat insulating properties and has a construc-

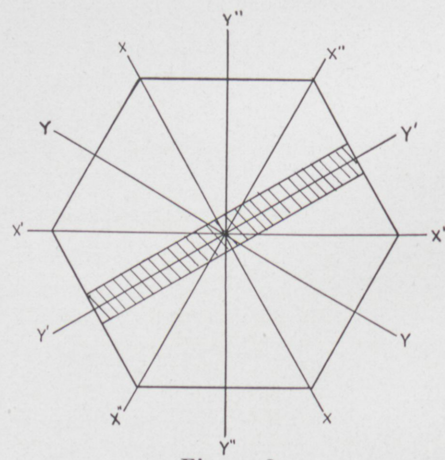

**Figure 2**

tion like that of a refrigerator. The heat for this oven may be supplied by a small electric heating element. More often, however, ordinary lamp bulbs are built in for this function. Temperature control is obtained by having the heating elements operated by a thermostat, usually of the bi-metallic type, or by a thermometer with built-in electrical contacts.

The operating temperature of the oven is fixed at some value well above the highest atmospheric temperature to be encountered, and the thermostat is arranged to maintain this temperature. That is, when the temperature of the oven drops below the normal operating temperature, the thermostat turns on the heating element in the oven and allows it to remain on until the operating temperature is again reached. A well-constructed crystal oven will maintain the crystal temperature to within plus or minus a fraction of one degree Centigrade, keeping the crystal frequency within very close limits of the assigned value.

Recent developments in new crystal cuts have made possible a crystal with a temperature coefficient of practically zero. It was stated that the temperature coefficient of an X-cut crystal is negative and that that of a Y-cut is positive. By cutting experimental plates at different angles to the Z-axis ranging from an X- to a Y-cut, a point is found at which a compromise of temperature coefficients is reached, or where the positive and negative effects so balance as to give a crystal plate with a temperature coefficient of practically zero.

The zero temperature coefficient crystal cut with its faces making an angle of thirty-five degrees with those of an X-cut plate is known as an AT-cut plate. According to Lack, Willard, and Fair, these plates are even thinner than a Y-cut plate; their thickness equation being:

$$T = \frac{66.2}{F}$$

An AT-cut plate can handle approximately three times the power handled by an X- or Y-cut plate, is much more active, and promises to replace the older types of crystal cuts.

Another crystal cut with a temperature coefficient of practically zero is known as the V-cut. Very little information on this crystal cut, developed in the RCA laboratories, has been divulged to the public, except that its properties are essentially the same as those of an AT-cut plate.

To make use of the properties of quartz crystals, they must be placed between two metal electrodes which are ground to plane surfaces. The crystal may be mounted by placing the electrodes in intimate contact and under a small pressure, or by maintaining a small air-gap between one electrode and the crystal. The pressure type mounting is best suited for applications where the crystal is to develop rather high potentials and also where the mounting may be subject to vibration. The air-gap mounting is generally manufactured with provision for varying the air-gap in order to provide for an adjustment of the frequency of the crystal.

Where automatic temperature control of the crystal is not used, it is best to employ a mounting having one electrode large and exposed to facilitate heat dissipation and thereby reduce frequency drift caused by crystal heating. These electrodes are mounted in a small container known as the crystal holder. The holders are generally constructed of bakelite or some ceramic material having good insulating qualities and have a provision for plug-in mounting in order to facilitate change of crystals.

The only aspect of the question of transmitter design thus far considered has concerned that circuit of the transmitter which contains the crystal and generates a radio-frequency voltage at the crystal frequency. This circuit or "stage" of the transmitter is known as the "crystal oscillator stage", and only in very small transmitters operates by itself. The power limitations of the crystal are the deciding factors in the use of the crystal oscillator. Most crystal oscillator power outputs are limited to about five watts. The oscillator stage is generally run at a lower power than this to keep the crystal current a minimum. The power de-

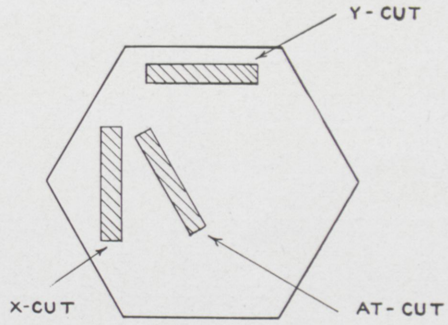

Figure 3

livered by the oscillator is used to drive an amplifier stage, consisting of one or two vacuum tubes and their associated equipment. If the transmitter is designed to work at a very high frequency, this amplifier may be operated as a frequency multiplier stage. A frequency multiplying stage receives power from its exciting stage at one frequency and delivers power at some integral multiple of this frequency. If the stage doubles the exciting frequency, it is known as a "doubler"; if it triples the exciting frequency, it is known as a "tripler." The first multiplier may be followed by any number of other multipliers, so that the power delivered by an oscillator on one-thousand kilocycles may be delivered by the final doubler at eight-thousand kilocycles.

In this manner frequency multipliers do away with the need of the extremely thin, fragile, and expensive quartz crystals used to control transmitters at very high frequencies. Following the multiplier is the final amplifier, or, if the output of the doubler used is insufficient to drive the final amplifier, one or more intermediate amplifiers. The size of the final

amplifier depends upon the amount of power output needed and ranges from a single ten-watt tube in small transmitters to a dozen fifty-thousand watt tubes as used by WLW, the largest broadcast station in the United States.

Quartz crystals are now also used in radio receiving apparatus. Their use as filter elements in intermediate-frequency amplifiers has made possible the so-called "single-signal" radio receivers. The complex operations of quartz crystals as filter elements are, however, beyond the scope of this paper.

In this paper only a few aspects of the use of quartz crystals as frequency controls in radio work have been considered. Although transmitter designs have continued, and will continue to improve at a rapid pace, the use of quartz crystals for frequency control will probably never be outmoded.

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# Laminated Glass


by

Robert S. Kahn, ch., '39


## Introduction

WITHIN the memory of all of us, ordinary plate glass was used in all automobiles. One of the most dreaded and dangerous features of collisions was flying glass. No matter how minor the accident, serious injuries were usually sustained through the medium of these razor-like, death dealing pieces. Even a sudden stop not infrequently caused a severed vein or artery. Although safety glass was known for years before its installation in automobiles, still it was not developed highly enough for general use until eight or ten years ago. Even then it would not withstand temperature changes and high temperatures. The first really successful safety glass for automobiles did not enter the market until about five years ago. In this paper it is the purpose of the author to cover the subject of laminated safety glass in as broad and general a manner as space allows.

## History

Before discussing the subject of the history of laminated glass, a few words with regards to the history of ordinary glass are in order.

The origin of glass is still doubtful. Many authors, ancient and modern, have endeavored to explain its discovery (or invention), but all they are able to do is recount legendary tradition. Some authorities credit the Egyptians with the first glass, while others believe it was the Chinese who first came upon this revolutionary discovery. The generally accepted and most plausible explanation is that offered by C. Pliny the Second in his "History of the World". He stated that there was, in Phoenicia, a river with exceedingly pure sand on its banks. One day some traders who had been gathering a cargo of nitre, sought, along the banks of the river, stones on which to mount a tripod to cook their food. None being available, they used blocks of nitre. Under the heat of the fire, the sand coming in contact with the nitre, which acted as a flux, formed a vitreous substance—"glass".

Although there is room to doubt this story, still there are basic features that make it perfectly logical and plausible. The experiment was duplicated several years ago, and it was found that glass did form with nitre present to lower the fusion point, but none formed with just plain glass sand.

The principle of laminated glass as such is old, dating back to the latter part of the nineteenth century. During its early stages little or nothing was done to aid its development. Hence, until ten years

ago, the industry was still in its infancy.

The art of laminating glass dates back to 1885, when Fullicks, an Englishman, obtained a patent for the manufacture of glass for church and cathedral windows. He proposed to get different coloring effects into one composite sheet by carefully arranging pieces of differently colored glass in pattern form and cementing this pattern between two sheets of clear glass. As bonding materials he proposed the use of gelatins, varnishes, or other materials which would stick glass articles together.

For the origin of laminated safety glass as we know it today, we are indebted to another Englishman, Wood, who, in 1905, obtained a British patent for the manufacture of safety glass by the use of Canadian balsam for cementing a sheet of transparent celluloid between two sheets of plate glass. The product was exhibited in 1906, but because of the high cost of manufacture, small demand, and general unsatisfactoriness, the patent was allowed to lapse. Much work was carried on by different scientists, and during the war, laminated safety glass found a ready outlet for gas mask lenses, goggles, automobiles, and airplanes. After the war, demand for the product sank to negligible proportions, but a few far-sighted executives of glass companies saw that with the advent of closed cars, there would be a renewed demand for safety glass. These men also realized that a product must be developed which would give complete satisfaction throughout the life of the car, and realizing this, large amounts of money were expended for research in the field.

## *The Principle of Laminated Glass*

The basic principle of laminated glass consists of bonding together two or more plates of glass with one or more interposed sheets of plastic or non-brittle material to produce a composite structure. The problem involved is unique in engineering fields, owing chiefly to the difficulties encountered in bonding together such unlike materials to give a perfectly transparent finished product. However, the characteristic properties of the finished article with respect to greater strength and more resistance to shock and penetration can be likened to other well known materials which depend upon lamination for their desirable properties. Examples are: laminated wood structures for airplane propellers, boat construction, etc., and laminated steel structures such as common railroad rail and armor plate.

Although bullet-proof glass and decorative glass comprise a portion of the outlet, still their application is small compared to that of the product for automobiles, airplanes, and speed boats. The types of usage last mentioned require a three ply lamination made by bonding in a unitary structure two sheets or plates of glass with an interposed sheet of transparent plastic. Because of the greater demand and wider application, the manufacturers have concentrated their research and development work on this type of glass-plastic structure, known to the public as laminated safety glass.

## *Types of Plastic Materials*

One of the oldest plastics—namely, pyroxlin, invented in 1860—was the plastic suggested by Wood in 1905, and it still has commercial significance in safety glass manufacture. Pyroxlin plastic is manufactured by colloidalizing cellulose nitrate (pyroxlin) with suitable plasticizers, the most common of which is camphor. Since the discovery of this plastic, refinements have been made both in nitration and purification of cellulose nitrate, with the result that the present day pyroxlin plastic is sufficiently clear for all practical purposes. It has as low a temperature coefficient of plasticity as any other material suitable and commercially available for safety glass manufacture.

From the standpoint of stability, pyroxlin, because of its higher energy level, is less stable to light and heat than other cellulose esters and ethers. However, sheet pyroxlin has a much longer life when properly bonded between sheets or plates of glass than when exposed directly to sunlight because all plate glass possesses the inherent ability to filter out the major portion of the shorter wave length radiations that adversely affect the pyroxlin plastic. Also glass manufacturers have improved the stability of the glass itself, as well as its color, so that from a practical standpoint the glass gives considerable protection to the plastic in this regard.

Cellulose acetate methods as recently developed produce an exceedingly stable plastic and one which, like pyroxlin, is transparent to light to a sufficient degree to make it commercially important. It equals pyroxlin in temperature coefficient but falls slightly short in tensile strength. However, cellulose acetate plastic, when used slightly thicker than the pyroxlin, proves equally resistant to shattering.

## *Types of Laminating or Bonding Processes*

Of equal importance with the plastic layer in safety glass is the bond or adhesion between the glass-plastic laminations, for the character of the bond obviously determines to a large degree the unique properties of laminated safety glass. A review of patent literature shows that there have been many methods proposed and relatively few accepted.

The nature of the various adhesives and bonding agents proposed for joining together glass-plastic surfaces may well serve to group the laminating processes into two groups: (1) a process using as a bonding agent a material strictly foreign chemically to both glass and plastic, and (2) a process using as a bonding agent a material

possessing chemical properties similar to those of the plastic.

Examples of the first class include the well-known adhesives such as gelatin, glue, isinglass, casein, etc., and, in addition, various natural and synthetic resins. They are applied by flowing, spraying, or otherwise coating one surface of each of the two plates of glass. After the adhesive is dried to the proper consistency, the glass plates are assembled with a sheet of plastic in sandwich form and subjected to heat and pressure to effect bonding.

Examples of the second class depend upon the adhesive forces of colloidalized cellulose derivatives, usually combined with compatible resins to promote better adhesion to the glass surfaces. They are applied in a thin coat to the glass and allowed to dry thoroughly. After drying, the surfaces of the skin coat and plastic are both softened or peptized by applying a small amount of solvent or high boiling point plasticizer, and the three layers are then bonded by heat and pressure.

In years past, multi-operation, slow, batch methods were used to assemble the safety glass. Today not only have quality and stability been improved, but bonding agents have been developed to make a better product which can be produced continuously at 60 to 70 feet per minute.

## Edge Sealing

As a result of the bonding operation of the glass-plastic sandwich, there is obtained a composite structure of safety glass with the marginal edges exposed. If this is put in service in severe climates, such as the southern states and tropical climates, the alternate expansions and contractions of the edge of the plastic with humidity changes, coupled with a slight shrinkage of the plastic due to loss of plasticizer at the edge, results in a gradual destruction of the bond at the marginal portions of the sheet.

It is therefore desirable that the marginal edge of the plastic layer be protected against this kind of weathering by hermetically sealing the composite structure. To accomplish the edge sealing, the marginal portion of the plastic sheet, following the bonding operation, is removed to the approximate depth of one eighth of an inch, and this groove is filled with a thermoplastic sealing material capable of resisting weathering and thereby sealing the composite structure.

## Summary

The bridge from the discovery of glass by Phoenician traders in a pre-Christian era to the safety glass today protecting and aiding us is a long one. Among supporting piers of this bridge are the discoveries of Fullicks in 1885 and Wood in 1905, as well as much well-directed effort in the field of research. While we have by no means reached the peak of perfection, still a satisfactory product is being produced commercially. We cannot truly estimate the value of this product in pecuniary measure, but rather in lives saved. The world owes a great debt to safety glass, and it is not unmindful of this debt. The benefits of this product are of such importance that practically every car produced today is equipped with it.

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# Thyratrons

by

Robert A. Averitt, e., '37

## Description

ONE of the comparatively recent additions to the electron tube family is the thyratron. The word "thyratron" is a Greek derivative meaning "a door." The name is particularly appropriate for the tube, since it has been the means of opening the door to many operations previously considered highly impracticable. The thyratron tube is a three electrode tube similar to the grid-glow tube. It is very different from many other electron tubes in that after the tube has been exhausted, a small amount of inert gas or vapor is sealed within the tube. The presence of the gas or vapor changes the otherwise pure electron discharge from the cathode to an arc. The thyratron in appearance is very similar to most other electron tubes. However, as might be expected, its behavior and electrical characteristics are very dissimilar to any other type of tube. Because of its arc discharge, the thyratron is, to all intents and purposes, an electrostatically controlled arc rectifier.

## Development

The first method of controlling a power arc was suggested by Dr. Langmuir in 1914. Langmuir

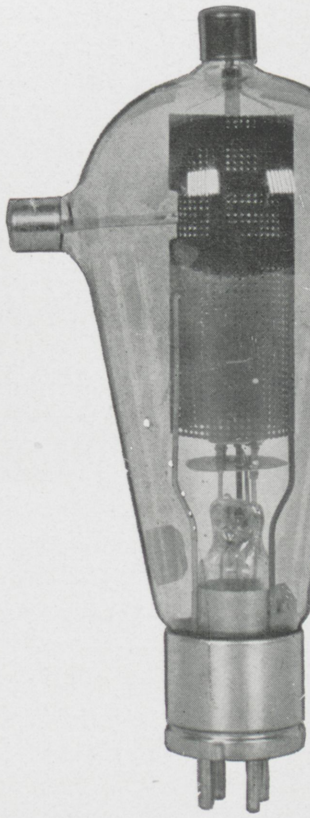
showed that the time of starting a power arc in an electron tube in each cycle could be controlled by the relative size of the grid voltage. This led to the notion that the average arc current flow could be controlled by applying alternating voltages to both grid and anode of an electron tube. Langmuir constructed a thyratron tube that performed very much as he had suggested.

Dr. P. Toulon became interested in Langmuir's achievements, and, in 1922, improved upon Langmuir's thyratron by discovering that the time of starting the arc could be controlled by varying the phase of the grid voltage with respect to the anode voltage. He was the first person to suggest such an idea. Toulon constructed a thyratron and successfully demonstrated his theory. Langmuir collaborated with D. C. Prince and constructed an improved tube. This improvement consisted mainly in making the grids completely surround the anodes.

After the arc has been started in a tube, the grid is powerless to stop it. It was found that the arc could, of course, be extinguished by removing the anode voltage. Since the time of starting in each cycle is controlled by the phase position of the grid voltage, it is easily seen that the thyratron is capable of converting an alternating current into a direct current flow. The reason that the grid is unable to control the extinguishing of the arc was found to be due to the formation of a layer of positive ions about the grid. Regardless of the potential of the grid itself, the potential of the "sheath" of ions surrounding it is always the same as that of the discharge. The effect of the sheath is that of an insulator surrounding the grid.

## *Construction*

It has been found that the thyratron tube is capable of utilizing any type of electron-emitting substance for a cathode. In small thyratrons, a tungsten filament similar to those used in vacuum tubes may be employed as a cathode. For more powerful tubes, it has been found advantageous to use a more massive construction which entails a heavier mechanical support. For the ordinary filament cathode tubes, conservative rating specifies about 60 watts of heating energy per ampere output. One major



**Thyratron**

problem in the design of thyratrons has been that of increasing the life and efficiency of the tubes. It was desired, therefore, to obtain the maximum electron emission with a minimum of heating energy. In order to increase the efficiency of the tube, advantage was taken of the principal difference between gas filled and vacuum tubes. In a vacuum tube the heat radiation and electrons both flow in straight lines. In a gas or vapor filled tube the heat radiation flows in a straight line, but the presence of the gas ions enables the electrons to turn corners. This theory has given rise to the present practice of placing heat insulators or shields around the cathode. Another method prevalent in modern practice consists of constructing the filament from a broad tungsten ribbon and winding it spirally so that adjacent turns shield each other. The increase in efficiency has been remarkable. Thyratrons have been constructed with heat shields which require only about two watts of heating energy per ampere output.

The inert gas used in the thyratron tube is mercury vapor. The best range for the vapor pressure has been found to be between one and 50 microns, depending upon the operational characteristics desired for the tube. This is a very small pressure compared to that required for Tungar rectifier tubes. All experimental evidence has led to the conclusion that purity is an essential requisite for the vapor. If impurities are present, the efficiency of the tube is low, and its life short. The degree to which the tube is exhausted before the mercury is introduced is also most important. A thyratron should be evacuated at least to the degree of a good vacuum tube.

In considering the construction of thyratron tubes in general, it is interesting to note that there is no apparent limitation, either practical or theoretical, to the power capacity of a single unit. In 1929 the largest unit constructed was to operate on 100 amperes at 10,000 volts.

During the past few years many varied applications of the thyratron tube have been developed. Progress has been comparatively slow, however, in the actual industrial installation of these tubes. This is due in part to the fact that many power engineers of the present generation are more or less reluctant to accept an electron tube for power control. This is clearly shown in the following, as stated by L. W. W. Morrow:

"Those who predicted that the present decade in power would be an electronic decade were slightly bullish on tubes. They overlooked, other than the unpredictable depression, a number of important

factors. Thus, they failed to take into consideration the vast amount of developmental work that had to be undertaken and the natural inertia of the present generation of engineers in responsible executive positions, resulting from their lack of early familiarity with electronic devices. In spite of these difficulties, some manufacturers and a few companies have gone ahead and expanded the field of tubes on power systems. As a result, there are today in use successful electronic devices in the power field that offer distinct advantages over any other type."

One of the fields in which the application of thyratron control is developing very rapidly is that of theater lighting. One notable example of this application is found in the Chicago Civic Opera House. Such a control unit for the stage and house lights eliminates all of the bulky back-stage switchboard and places the entire control directly at the lighting director's fingertips. The control pit is directly in front of the stage so that the operator can see the effects he is producing. No complicated hand-switching devices are used. Complete control is to be had by the turning of a dial or tripping a small switch. The control scheme used consists, essentially, of a group of thyratron units which supply a variable amount of direct current to saturable-core reactors whose alternating current circuits control the lights. The control of the tube supplying the direct current is obtained, as has been explained before, by varying the phase relationship between the grid and anode voltages. Necessarily, there are a great number of tubes in a single control system, for there are numerous separate circuits to be controlled. In the Chicago Civic Opera House there are 147 separate circuits which are controlled in this manner. The entire scheme is called the thyratron-reactor control system. There are several other similar installations in other theaters, for example, the Metropolitan Opera House in New York City, the Earl Carroll theater in New York City, and the R. K. O. theaters in Schenectady and Albany.

In several instances a thyratron-reactor system has been used for control in mobile lighting. Instead of hand control for the grid voltage as in theaters, these mobile lighting systems employ a small automatic induction voltage regulator. The Netherlands Plaza, a hotel in Cincinnati, Ohio, the dining room of the Great Captain's Island and Yacht Club near East Portchester, Connecticut, the Staley Building Tower in Decatur, Illinois, and the Southern California Edison building in Los Angeles, California, all use this system of automatic control for mobile lighting.

Another application of the thyratron tube is found in the field of direct current machinery. Through the use of the tubes, an entirely new type of motor has been developed. There has been a great deal of time devoted to the study of an experimental machine having the essential construction of a synchronous motor and using thyratron tubes for a commutator. This motor may be run from either alternating or direct current. When supplied with alternating current, it shows marked advantages in that its speed is variable over a wide range and that it operates at a high power factor. Reverse rotation presents no difficulty, since it is accomplished by shifting the phase of the grid voltage 180 electrical degrees with respect to the motor armature position. When the motor is operated on direct current, the motor offers several advantages over the conventional type. The construction is greatly simplified and the insulation much improved. Probably the most important advantage of the thyratron commutator motor is that the commutator may be located at any convenient place and the motor placed wherever desired.

The applications specifically mentioned in this paper do not by any means comprise the entire list.

## Conclusion

One purpose of this paper has been to point out a few of the many and varied applications of the thyratron tube. Let it not be misunderstood that its use is limited to the control of heavy machinery. The tube is capable of controlling the most delicate operations.

While it is not the purpose of this paper to delve into any of the theoretical or mathematical considerations of the tube, it is well to point out that the thyratron brings to a focus a great many of the results obtained from research concerning the electronic discharge through gases. It is doubtful that Dr. Langmuir himself realized the importance of his laboratory toy back in 1922. An attempt has been made to show the rapid progress it has made from that time to this, in spite of unforeseen economic handicaps. One can only conjecture whether or not further developments will be made upon that already existing, or whether some entirely new methods will be derived. Regardless of that, the thyratron tube is one of the greatest aids to industrial endeavor that has been developed during the past 15 years.

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# THE ROSE TECHNIC

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## *Formulas*

Mathematical formulas are perhaps the most powerful tools the professional engineer has at his disposal, yet an excessive degree of dependence on the use of formulas detracts from the engineer's ability to perform successful engineering work.

The formation of the habit of dependence on formulas is exceedingly simple among students, and, once the habit is firmly entrenched, the student becomes not an engineer but an expert in the art of substitution. It is the common tendency of a student, when confronted by an engineering problem, to determine what quantities are given, what is to be found, and then to attempt to recall or to search for a formula which contains the unknown in terms of the given quantities. Although this method of solution may enable the student to arrive at the correct answer, no engineering training has been employed, and the student is no more benefitted than had he plucked the answer out of thin air.

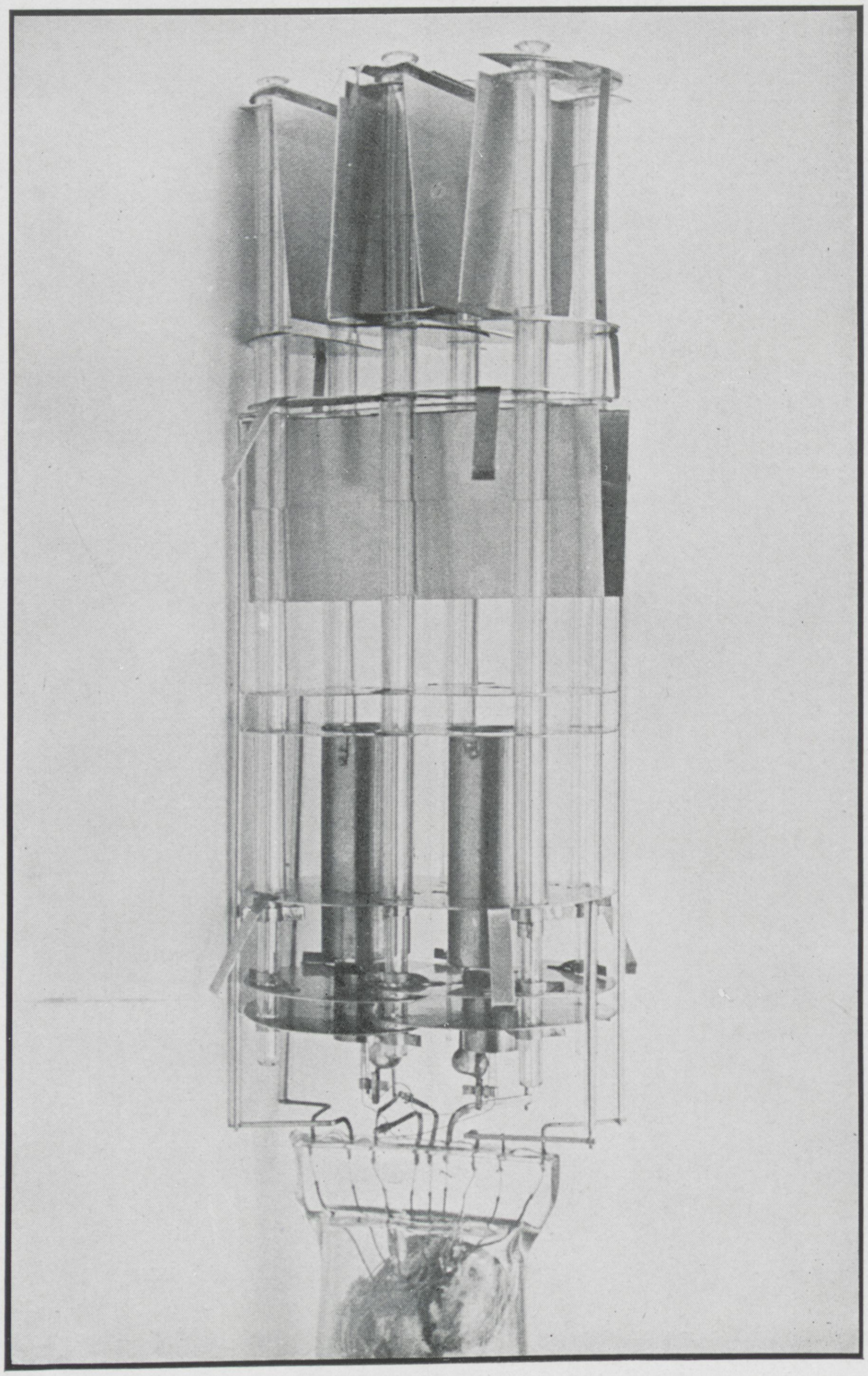
For example, a typical, simple, engineering problem is the determination of the horsepower transmitted by a rotating shaft, given its speed and enough data to find the torque transmitted. The well known formula applicable to this problem is $H. P. = \frac{NT}{63,025}$. A student may know that, if the speed is expressed in revolutions per minute and the torque in pound-inches, these values substituted in this formula will enable him to determine the answer. But has the solution of this problem benefitted the student?

On the other hand another student may attack the problem in this manner: he knows that torque, if expressed in pound-inches, is a product of a force of F pounds multiplied by its force arm of r inches. The product of this torque T and the constant 2pi is equal to the work in inch-pounds transmitted by the shaft during one revolution. If this quantity of work is divided by twelve to convert the quantity of work into units of foot-pounds per revolution and multiplied by the number of revolutions per minute, the result will be the work in foot-pounds transmitted by the rotating shaft each minute. The horsepower is defined as the rate of doing work at 33,000 foot-pounds per minute; therefore, the student realizes that if the value of the work transmitted by the shaft per minute is divided by the constant, 33,000, the quotient is the required number of horsepower transmitted by the shaft. By solving the problem in this manner, the student has improved greatly his ability to analyze and solve similar engineering problems.

Naturally, the student or the professional engineer cannot be expected to have the derivation of every formula used in engineering practice at his finger tips, nor can the so-called empirical formulas be treated as in the above example. Therefore, the use of some formulas is inevitable; nevertheless, if problem analysis instead of formula substitution is employed wherever possible, the derived benefit will prove invaluable to the engineering student.

## *Classroom English*

Of all the subjects taught engineering students one non-technical group should command more than passing attention. A student's classroom English may be fairly good, yet the applications of the rules of punctuation and grammar never seem important on that laboratory report or even on *Technic* copy! Yet good classroom English is really far less important than either of these. After a student has spent several hours in one of the laboratories observing data, he may feel that he cannot give much time to the report. Perhaps this is true; but no matter how brief, a laboratory report should represent the student's best efforts to present his results effectively, in grammatically correct, well phrased sentences. As in every other phase of engineering work, accuracy in report writing is absolutely essential. One purpose of the laboratory report is to present an account of the procedure in such a clear, concise manner that another, who may be totally unfamiliar with the details of the work, can repeat the experiment to check the original result. Adherance to a few easily remembered rules provides a substantial framework upon which to build effective structures of good English. While laboratory report writing is not particularly essential to the prosperity of future generations, it does serve a very definite purpose in providing practice for the writer. Therefore, let's adopt classroom English for all-around use.



Cut Courtesy Electronics

**Double Beam Cathode Ray Tube**

# Research and Progress

edited by
L. J. Giacoletto, e., '38

In the construction of the oscilloscope, a high-vacuum tube was used. The two beam producing systems are connected in parallel. However, the controls which vary the intensity of the electron beam are separate, that is one control for each electron beam. This was done for the following reasons: (a) to permit discrimination between the two oscillograms by the relative brightness of the two curves; (b) for the purpose of introducing certain timing marks, separate control electrodes are necessary; (c) to correct "writing speeds." That is, the beam which traces a longer path appears less bright, so that the intensity of this beam must be increased to equalize the linear brilliance of the two patterns.

The time-axis deflectors, that is, those plates which sweep the beam horizontally, are formed by a single pair of plates. These extend across the entire tube. They constitute the lower pair of plates shown. The connections to the other four deflectors extend radially outward from the plates, and their terminals protrude from the glass bulb.

The tube has been so constructed that the two oscillograms can be studied either with separate horizontal axes or with a common axis.

## *Double-Beam Cathode-Ray Tube*

Manfred von Ardenne of Berlin, Germany, has perfected a double-beam cathode-ray tube which can be used very conveniently for the simultaneous observation and comparison of two phenomena. Beside the mechanical difficulties which arose in the construction of the tube, the main problem was to keep the two electron beams entirely independent of each other. The two beams can become partially coupled to each other through interelectrode capacities of the deflecting systems or through space- charge coupling between the two moving beams. Both of these disturbing influences become more pronounced as the frequencies of the phenomena being studied increase. The problem presented by these two difficulties was circumvented by the careful shielding of the parts and by placing four of the terminals on the glass bulb.

## *The Strobotron*

The strobotron is a cold-cathode, gas-filled control tube designed primarily for producing stroboscopic light. The tube consists of a cathode, two grids and a plate. The cathode consists of a caesium coated surface which breaks down easily and liberates free caesium.

Caesium was used because it permitted the cathode spot to form more quickly, thereby reducing the time delay of the tube. The cathode-spot is merely the point where initial breaking down occurs. In order to aid in the formation of the cathode-spot, the surface of the cathode is made rough and irregular.

The inner grid is directly above the cathode, and the function of this grid is to materially reduce the breakdown voltage. The inner grid is also coated with caesium. The outer grid of the tube, however, is of graphite, and it effectively shields the cathode and inner grid from the plate. The plate is set vertically and is directly behind the cathode and grid assembly. Thus when a condenser is discharged through the tube, a luminous column of light about three-eights of an inch in diameter is produced from the plate to the cathode. The tube is filled with neon at a pressure of 1.5 cm. Argon could have been used, but it did not produce as intense a light as neon.

The strobotron is used mostly in stroboscopes of which the "Strobotac", an adjustable-frequency stroboscope manufactured by the General Radio Company, is a good example. However, the strobotron can also be used as a relay, or trigger tube for various purposes. It is particularly adaptable in such cases since it requires no power and involves no time delay for cathode heating. Differing from other stroboscopic tubes, the Strobotron is capable of carrying very large peak currents with a low tube voltage drop.

The tube was developed in the electronics laboratory of the Massachusetts Institute of Technology.

## *Photo-Electric Judge*

In order to eliminate all chances for an argument as to the true winner of a horse race, a photo-electric judge is now being installed at many race tracks.

The photo-electric judge consists of three cameras which are timed to make exposures a fraction of a second before the first horse crosses the line, at the precise moment, and a fraction of a second afterwards. In extremely close races, it is thereby possible for the judges to tell from these pictures whether a horse is just completing a forward stride or beginning a new one, which in itself will indicate the comparative forward motion. The exposures made just before and just after the one made at the finish serve as checks. There is also no great time lost in waiting for a decision as the pictures are developed and available to the judges four minutes or less after the pictures have been snapped.

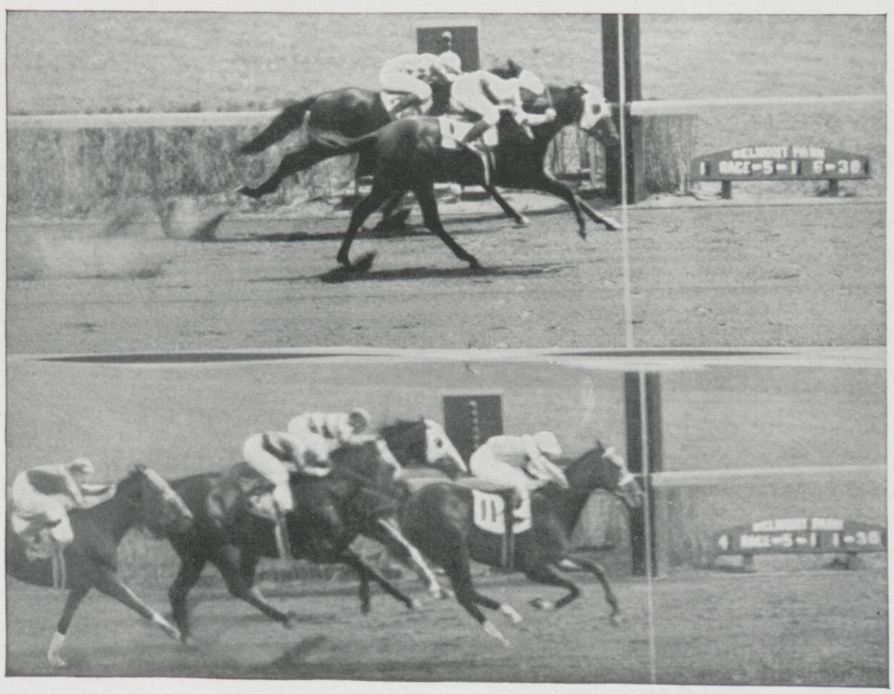
The electrical equipment consists of a searchlight which casts a fan-shaped beam across the track and a series of photo-electric tubes arranged one above the other on the receiving side. The cameras are located high in the air in the cupola over the judges' stand directly at the finish line. The photo-electric device is placed approximately four feet ahead of the finish tape. It is mounted on the inside rail so that this distance can be adjusted to produce a perfectly-timed photograph. Perfection in this case occurs at the moment at which the part of the horse farthest forward cuts the finish line. The exact distance between photo-electric equipment and the cameras has been carefully worked out and is based on the average speed of the horses.

The beam of light projected by the searchlight is narrow when viewed from directly above, but fans out vertically, producing a veritable barrier of light. When a moving object obstructs the light as little as 10 per cent, a relay operates the cameras. Operating time is one-twentieth of a second. The barrier of light plays upon all eight of the electric eyes. The obstruction can be detected by any one of them, since the eight relays they operate are interconnected, and any one of them operates the cameras.

Track officials are particularly pleased with this method of judging races, as it produces an infallible record upon which to base a decision, thus relieving judges from any possible charges of unfairness or carelessness.

## *A $100,000 Safety Net*

The importance of safety measures in construction work is now being recognized by the engineer.



*Cut Courtesy General Electric*

**The finish as seen by the Photo-Electric Judge**




The use of a safety net is not new, but its application on such an enormous scale as seen at the Golden Gate Bridge across San Francisco Bay marks another major step in the extension of safety measures.

In order to get an idea of the size of safety net required, the following data on the size of the span will be enlightening. The span is nearly a mile and a quarter in length (6400 feet to be exact), rises 250 feet above the surface of the bay, and is 90 feet wide. However, the net must not only be as wide as the span, but it must also be wider in order to project outward on either side sufficiently so as to afford a margin of protection to the steel workers, painters, and pavers who move about on the unfinished structure.

Allowing 15 feet on either edge of the bridge, the total width of the net is 120 feet 6 inches. The net is constructed of three-eighths inch Manila rope and is woven in the form of a six by six inch mesh. It is therefore light enough to permit its use over a wide expanse, strong enough to catch and hold any falling worker, and porous enough to permit white hot rivets to fall harmlessly through. The net has been made so that it is flameproof and waterproof and has been especially designed to facilitate repairs on it.

Not only will the regular safety net be used, but separate safety nets will be used to protect the workmen who are putting up the large net. These "traveling nets," as they are known, are 121 feet wide and 126 feet long and form part of the traveling section. These traveling sections, built on a metal frame, are attached by cables to wheels which ride on the upper member of the deck truss. One traveling section travels toward the center of the bridge from either end. A box is attached to the rear of each traveling section. This box contains sections of the permanent net which are paid out and fastened in place as the section moves along. Each section of the permanent net is 52 feet long. The borders of each section are provided with lash lines so that the sections can easily be fastened together or fastened to some other object.

On tests made on the net, a 400-pound bag of sand was dropped 53 feet onto a 20 by 30 foot section. The stout sand bags burst under the dead weight of their content, but there was no appreciable effect on the net.

The total cost of the permanent net will be $100,000. This is a very small amount indeed when compared with the number of lives it will probably save.

# Sports

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

### *Giffin College Game*

On February 7, 1937, Rose Poly played the second home game of the season with Giffin College of Van Wert, Ohio. The game was played at the Armory. The Engineers finally broke into the winning column and downed the Giffin cagers 30-24.

Beginning the game in good style the Rose team gained a secure lead in the first ten minutes of the playing time. At this point in the game the Giffin team took on renewed spirit and hit a couple of shots. The score at the half was 11-6 in favor of Rose.

Opening the second half of the game, the inspired Giffin team came back with a world of fight. By sinking some remarkable shots, the visiting team pulled to within one point of tieing the score. The Rose team hung on to this lead only by making a couple of free throws while holding Giffin to two charity tosses. Within three and one-half minutes of the end of the game the score stood 24-21, Rose. With remarkable precision and skill the team then scored three field goals on three successive shots making the score 30-21. During this rush only thirty seconds elapsed. After gaining this lead the team held the ball the remaining time until the end of the game.

Although this game was won by the Rose team, the team has played much better basketball this season. Defensively the playing of certain men was outstanding, but others allowed their men many unnecessary shots. Eckerman held Giffin's high-scoring forward to one field goal. Previous to this game this player had averaged nineteen per game. A team composed of the tallest Rose men started the game, but they could not match the speed of Giffin, so a team of smaller men was substituted. For the first time this season Rose showed the beginning of an excellent fast break, but the shots were missed by the speeding players. After some practice at making the shots good while moving fast, the team should score a great number of points on a fast break. Part of the poor showing of the team in this game was due to the two weeks lay-off with no practice, which was occasioned by the final exam period.

The high scorers for Rose were Colwell and Ladson, while Eckerman played an excellent defensive game as well as scoring some points himself.

On Tuesday, February 17, 1937, Rose Poly played a return with St. Josephs College of Renssalaer. This game was played at the Rose Gymnasium. Starting out to avenge an earlier three point defeat, the Rose team fought hard, but weakened in the last half and lost 30-28. The score of the earlier game was 30-27.

As far as Rose was concerned the account of this game should include only the first half. At the beginning of the game both teams started out deliberately, neither team taking many chances. Rose scored first on a long shot by Smith, and ran the score to 6-0. For a full eight minutes the Rose defense was impenetrable and the St. Joseph cagers were unable to score. Then, by virtue of two quick baskets by Scharf, St. Joe forward, and a long shot, the score stood 8-6. At this point the Engineers took charge of the situation and completely bewildered the St. Joe team to run the score to 19-8 at the half. During this splurge the Rose passing was excellent, and the boys were following their shots well. Several times the two forwards, Wodicka and Dusza, grabbed the ball from the St. Joe guards and scored. This is the greatest lead the Rose team has had this season, and it evidently was too much for them.

Opening the second half the defense of St. Joseph suddenly became very alert and stopped practically every scoring thrust of Rose Poly. Their offense was also renewed with vigor, and gradually they cut down the Rose lead. As the St. Joseph cagers came closer, the team put up a good fight, but was unable to stop the rush. St. Joseph went into the lead with only two minutes to go, and the ball see-sawed back and forth on the court for the last two minutes, with Rose desperately trying to score and St. Joseph desperately trying to avert that score.

The game was rough throughout, and the St. Joseph center was put out on fouls, while Wodicka and Smith were slowed up by three

fouls each. Colwell, as usual, was the Rose star, scoring 13 points on five field goals and three foul shots. He consistently controlled the center jump. Wodicka played a very good floor game as well as scoring five points. The margin of victory came as a result of poor foul shooting of the Rose team as they made only six out of twenty attempts.

Rose Poly again this year broke even with Anderson College, each team winning one game. Earlier in the season at Anderson, Rose Poly was defeated 38-35 after leading most of the game. Striking back with great fury, the Rose team unleashed its full power both defensively and offensively and overpowered the bewildered Anderson College team 45-25. All season the team has been potentially stronger than the scores of the games indicated, but this game demonstrated the team's ability. From the fan's viewpoint the game was interesting to watch, and there was a goodly number present to view the proceedings.

A great part of the credit for the victory should go to George Smith, outstanding Rose guard. For the full forty minutes, he guarded Byrd, flash of the visiting team, holding him far below his usual scoring form. Finally, in the latter part of the game, Byrd became panicky at Smith's remarkable defense and was ousted from the game for shouting at the officials. Frost, Anderson's other scoring threat, managed to garner eight points, but only through long shooting over the tight defense of Captain Wodicka. As Frost and Byrd go, so goes the Anderson team. With these two men practically stopped, it was a fairly easy matter to crush the scoring threats of the other men.

Offensively the team also played the very best ball of which they were capable. Combining a fast break with a set offense, which the team has been perfecting all season, a large number of open shots were obtained. Colwell and Wodicka followed the shots nicely, and Eckerman and Stout seemed to have the knack of breaking at the right time.

Both teams played excellent defensive ball. Rose opened the scoring only to be headed immediately by some quick baskets by Anderson. However, a couple of long shots put Rose back in the lead, and they were never seriously threatened again. The score at the half was 19-13.

Very early in the second half the final outcome was soon made certain. For several minutes Rose held the Anderson team scoreless while running up a lead of twenty points. From this time on the difference between scores remained about the same, and the game ended with Rose Poly winning 45-25.

The outstanding players for Rose Poly were Wodicka with thirteen points and Colwell with twelve points. Smith played an excellent defensive game.

# Campus Activities

edited by

William A. Reddie
ch., '39

## *R. O. T. C.*

Appointments of cadet officers and non-commissioned officers in the Rose Engineer R. O. T. C. Battalion were announced by Captain Joseph A. Stevenson, Professor of Military Science and Tactics at Rose.

The policy of the Department of Military Science and Tactics in the matter of appointments is to rotate the seniors in the various positions of command as officers, the juniors in the positions of non-commissioned officers, and the sophomores in the positions of corporals during the fall term, and during the course of the spring term to make permanent appointments and assignments based upon ability demonstrated during the preceding term.

This policy was followed this year, as in the past, except that the choice of the Cadet Major and the Cadet Adjutant has been deferred until later in the term. Two Cadet Captains were appointed who will rotate in the command of the battalion in addition to their duties as company commanders. Later in the semester permanent appointments of a Cadet Major, two Cadet Captains as Company Commanders, and four First Lieutenants will be made.

The appointments as announced to date are:

To be Cadet Captains: Robert A. Averitt and Walter R. Snedeker, both of Terre Haute.

To be Cadet First Lieutenants: James A. Hughes and Clyde E. Cromwell, both of Terre Haute.

To be Cadet Staff Sergeants: Edward H. Eckerman, Joshua A. Greenland, Jr., Merton B. Scharenberg, and Norman G. Wittenbrock, all of Terre Haute.

To be Cadet Corporals: Richard D. Altekruse, Harry L. Davis, Jr., William A. Reddie, Joseph E. Ross, Stephen J. Rozgony, Victor W. Peterson, Edward O. Spahr, Paul C. Stark, Malcolm A. Steele, Oscar C. Tonetti, Robert W. Underwood, Richard G. Weldele, all of Terre Haute, Cornelius V. Coady, Paris, Illinois, and George W. Smith, Prairieton, Indiana.

## *Camera Club*

At a recent meeting of the Camera Club interesting talks were given by Ed Wodicka on "The Chemistry of Photography" and by William Brubaker on "Lenses". The meeting was open to the entire student body and was well attended.

This year has been outstanding so far as the Camera Club is concerned at least. The membership roll is larger than ever before, and the interest taken in the club by the individual members is running higher. Even negative drying space is at a premium—almost.

The club store keeps on hand a limited stock of films and photographic paper for the convenience of the students. The complete facilities of the club for developing, printing, and enlarging are available to all members of the Camera Club.

## *Rifle Club*

All stages of the Fifth Corps Area Match have been finished, and the score of the Rose team totalled 7,210 points, 20 points lower than last year's total. As yet, the returns of the match have not been received. Fourteen of the fifteen men who fired in the match placed in at least one stage and will receive the rifle insignia. The S. A. M. E. and the Hearst Matches are now in progress.

## *A. S. M. E.*

At a recent meeting of the A. S. M. E., which was preceded by a dinner at the dormitory, and to which members of the A. I. E. E. and A. S. C. E. were invited, a very interesting lecture was given by Herbert A. McAninch, class of '34, who is now engineer with the

Link Belt Company of Indianapolis. The subject of his lecture was "Applications of Photo-Elasticity to Stress Determination". The speaker illustrated his talk with both lantern slides and Bakelite models. Mr. McAninch's undergraduate thesis was along the line of his talk, and he has been engaged in such work for the company with which he is connected. He will talk on the same subject at the Indiana-Illinois meeting of the S. P. E. E. Several members of the faculty were present at the meeting. Clyde E. Cromwell, chairman of the student branch of the A. S. M. E. at Rose, presided over the meeting.





## *Glee Club*

On Thursday, March 4, the Glee Club sang a very enjoyable program before the students of Gerstmeyer Technical High School in Terre Haute. The club opened the program with the singing of "Dear Old Rose". Included on the program were: "High Barbary" by Bartholomew, the waltz song "Sympathy" from "The Firefly" by Rudolph Friml, sung as a duet by Walter Snedeker, senior in chemical engineering, and Miss Miriam Connor, who is appearing with the club this year as guest soprano; "Moonbeams" by Victor Herbert; a Czecho-Slovakian Folk Dance; the "Marching Song" from Victor Herbert's "Naughty Marietta"; and a tone poem "Romany Life." Miss Connor sang a group of three numbers. Another group of three numbers was sung by the newly organized octette. These were "John Brown's Body", a spiritual "Who Did?", and a novelty "Two Little Flies". The octette was very enthusiastically received and promises to have a busy season ahead. Closing the program the club sang Brahm's "Lullaby" and "Dear Old Rose". The club, under the direction of Clyde A. Bennett, is accompanied by Mrs. Bennett.

## *A. I. Ch. E.*

The Council of the American Institute of Chemical Engineers announced the grant of a charter to the Rose student chapter on February 12. A preliminary organization was affected on March 11. The chapter will be formally installed in the near future. The committee on organization consists of J. Robert Penisten of the senior class, Max Eyermann of the junior class, William Reddie of the sophomore class, and James E. Ducey of the freshman class.

## *Southern California*

The Southern California Rose Tech Club held its annual meeting and dinner on January 22, 1937. The men met at the Rosslyn Hotel in Los Angeles. Motion pictures of the undergraduate life at Rose were shown. The election of officers for the coming year resulted in the selection of Homer E. Holmes, '28, president, and Clifford Lamb, '34, secretary-treasurer. The following alumni were present at the meeting: Archie E. Wade, '95; Max J. Hammel, '01; Robert J. Schefferly, '03; Benjamin L. Heer, '12; W. Scott Heer, '12; W. Scott Mace, '12; Charles A. Dutton, '14; Arthur T. Arnold, '15; Homer E. Holmes, '28; Clifford Lamb, '34; and Frank Mansur, '34.

# Alumni Notes

edited by Norman G. Wittenbrock, ch., '38

## *Here and There With the Grads*

*Here and There With the Grads*

**'93** Svend E. Johannesen has retired from active business and is spending the winter in Florida. His permanent home in in Pittsfield, Massachusetts.

**'95** Archie Wade, formerly with the California Industrial Relations Commission, has retired.

**'98** William E. Ford is Engineer of Plans and Surveys with the State Highway Department at Little Rock, Arkansas.

**'11** Thomas T. Barret is working in the oil industry in Los Angeles, California.

**'12** W. Scott Heer is now associated with his brother, B. L. Heer, at the Kite Mold Company at Los Angeles, California. Robert A. Wilson is continuing the W. S. Heer Engineering Company activities.

**'16** Robert A. Weinhardt is with the Decal Products Company of East Liverpool, Ohio.

**'20** Whitcomb W. Moore, who is with the American Telephone and Telegraph Company, has been transferred to New York.

**'27** Baird F. West has taken a position with the United States Steel Corporation in New York.

**'29** Albert E. Baker is an Electrical Engineer with the I. R. T. Subway, at New York City.

A. Wayne Dicks with the Michigan Bell Telephone Company has been transferred to Bay City where he is Exchange Repair Foreman.

Collins W. Raines is a Draftsman-Engineer with the Ralph M. Parsons Company of Chicago.

Francis E. Tapy is Chief Engineer for the Kroger Grocery and Baking Company at St. Louis, Missouri.

**'30** Jim S. Brevoort, with the TVA, has been transferred to Chattanooga, Tennessee.

John W. Rockwood is with the United States Gypsum Company in Chicago.

**'31** Stanley H. Davis, who is with the General Electric Company, has been transferred to Chicago.

Frank J. Sabla is in the Engineering Department of the Terre Haute Malleable and Manufacturing Company.

Donald T. Spangenberg, with the Public Service Company of Colorado, has been transferred to Boulder, where he is Distribution Engineer.

**'32** George O. Howson, who has been flying at Pensacola, is now with VS Squadron 3B, Fleet Air Detachment, Naval Air Station, San Diego, California. When the fleet puts to sea, he will be on the aircraft carrier Lexington.

Christopher J. Schultz is with the Northern Indiana Public Service Company at Hammond.

John A. Wells is a designer for the Stimpson Computing Scale Company of Louisville, Kentucky.

Floyd E. Wilson has taken a position with the Northern Indiana Public Service Company at Gary.

**'33** Homer W. Fisher is with a Triangulation Party of the United States Coast and Geodetic Survey in the Southwest.

Glen T. Lautenschlager, with the Ohio Power Company, has been transferred to Canton.

Russell A. Powell is with the Youngstown Sheet and Tube Company at East Chicago, Indiana.

**'34** Willis S. Biggs is a Junior Metallurgical Observer at the Carnegie Illinois Steel Company's Chicago plant.

Brent C. Jacob, Jr., with the C. J. Tagliabue Manufacturing Company, has been assigned to the Indianapolis division.

Frank Mansur, with the Southern California Edison Company, has been transferred to Placentia, where he is local agent.

Howard A. Staderman is in the accounting department of the Illinois Bell Telephone Company at Jacksonville, Illinois.

Richard K. Toner, who received a Master's Degree from Purdue in June, has been elected to Phi Lambda Upsilon, an honorary chemical fraternity at that university.

Albert L. Yates, with the Pennsylvania Railroad, is Assistant Supervisor at Derry, Pennsylvania.

**'35** Gordon L. Burt, with the Chicago, Milwaukee, St. Paul and Pacific Railroad, has been transferred to Milwaukee.

Russell R. Kerr is an architectural draftsman with M. Carlton Smith and Virgil C. Hoagland, Associate Architects, of Indianapolis.

Joseph B. Weaver, who received his Master's Degree from the University of Tennessee in June, is a student engineer with the General Electric Company at the River Works, Lynn, Massachusetts.

**'36** Francis M. Blair is in the Maintenance Department of Servel Incorporated at Evansville, Indiana.

Raymond J. Harrod is a junior engineer with the Edward G. Budd Manufacturing Company of Philadelphia.

# FRATERNITY NOTES


## *Theta Xi*

On February 12 Kappa of Theta Xi held its annual pledge banquet at the Elks' Club. At this time a formal pledge ceremony was held for the thirteen new pledges. Kappa is very pleased at this time to announce the pledging of William H. Brubaker of the class of 1940. On Sunday, February 28, Max Stanfield, Robert Dispenett, Robert Burger, and LeRoy Foltz were formally initiated into the fraternity.

A dance in honor of the pledges was held on March 12 in the Venetian Room of the Terre Haute House. Leo Baxter and his orchestra furnished the music for the occasion.



## *Sigma Nu*

Beta Upsilon Chapter of Sigma Nu held open house on Saturday evening, February 20. Entertainment for the evening consisted of dancing, cards, and ping pong. The chaperons were the Rev. Mr. and Mrs. F. LeRoy Brown.

Formal pledge ceremonies were held on Sunday, February 14, at the house. Sigma Nu congratulates these pledges.

A dance in honor of the pledges was held on March 12 in the Venetian Room of the Terre Haute House. Leo Baxter and his orchestra furnished the music for the occasion.

## *Alpha Tau Omega*

On Saturday, February 20, Indiana Gamma Gamma of Alpha Tau Omega was host to its new pledges at an open house. The gathering was well attended by both actives and pledges. Professor and Mrs. Alfred T. Child and Mr. and Mrs. J. Allan Greenland were chaperones.

The annual state banquet and dance of the four A. T. O. chapters in Indiana were held at the Hotel Lincoln in Indianapolis on Saturday, March 6. Music for the dance was supplied by Joe McCartney, alumnus of the DePauw chapter, and his orchestra. Most of the actives and pledges in the state as well as many alumni were present, and all considered it an outstanding meeting. The chaperones from the Rose chapter were Mr. and Mrs. John Phelps and Mr. and Mrs. John Foulkes.

## *Theta Kappa Nu*

Indiana Gamma chapter of Theta Kappa Nu entertained both its active members and pledges at an open house on Friday, February 27. Chaperons for the occasion were Dr. and Mrs. Clarence P. Sousley and Professor and Mrs. Orion L. Stock. Refreshments consisting of cherry pie, ice cream, cakes, and fruit cocktail were served. The evening was spent in dancing and playing bridge.

The Mother's Club of the chapter has been particularly active during the last few months, and the chapter wishes to take this opportunity to extend to them its sincere appreciation for the new furnishings given the chapter.

## *Tau Beta Pi*

Indiana Beta Chapter of Tau Beta Pi, national engineering fraternity at Rose, held a Valentine dance in the school gymnasium on the evening of February 13. Wayne McIntyre

and his band played for the occasion. The gymnasium was attractively decorated for the occasion. Chaperons for the dance were Professor and Mrs. Orion L. Stock and Professor and Mrs. Roland E. Hutchins.

J. Robert Penisten, senior in chemical engineering and president of the Rose chapter of Tau Beta Pi, was in charge of the dance.

## *Alpha Chi Sigma*

Iota chapter of Alpha Chi Sigma held an open meeting recently in the chemistry lecture room. The speaker of the evening was Dr. Morey of the Commercial Solvents Corporation. Dr. Morey's talk, which was a very interesting one, dealt with the behind-the-scene preparation of the exhibits shown in the Hall of Science at the recent Chicago World's Fair. In his talk Dr. Morey stated that all exhibits set up were purely commercial. He also mentioned the fact that literally scores of artists, technicians, and artisans were employed in setting up the exhibits.





## *Tau Nu Tau*

On Friday evening, February 19, Tau Nu Tau held a formal dance in honor of the new initiates. These men are: Kenneth L. Buis, Richard E. Dennis, Edward H. Eckerman, J. Allan Greenland, Clemens W. Lundgren, George A. Neyhouse, Merton B. Scharenberg, John F. Weinbrecht, Norman G. Wittenbrock, William D. Wolf, and Charles Whitesell, all of Terre Haute, and John R. Hayes of Indianapolis. The dance was held in the newly redecorated Elks' ballroom, with Wayne McIntyre supplying the music. Captain Joseph A. Stevenson, Miss Helen Mahley, and Professor and Mrs. John L. Bloxsome were the chaperones.

# Humor

edited by

George W. Smith IV

m., '39

"What you need is an electric bath."

"Nothing doing, doc. I had an uncle drown that way up at Sing Sing."

---

"Tell me, are you one of those blondes who uses peroxide?"

"Sure, I'll drink anything."

---

Conductor: "What are you doing with those towels in your suitcase?"

Passenger (with presence of mind): "Oh, they are some I used the last time I was on this train. I had them washed and brought them back."

---

"How do you know that people can see me dressing through the window?"

"Well, ma'am, I've gone to some panes to find out."

---

"Hey, mister Yer engine's smokin'."

"Well, it's old enough."

---

A censor is a lovely man—
I know you think so too:
He sees three meanings in a joke—
When there are only two!

---

Highway Cop (peering into parked car): "Say, are you two married?"

Chap: "Why, we're not doing anything out of the way, officer."

Cop: "I know it. That's why I asked if you were married."

### Lost for Words

An Englishman visiting the United States attended a banquet at which one of the speakers offered a toast, saying, "Here's to the happiest days of my life, spent in the arms of another man's wife—my mother."

This titillated the Englishman considerably and upon his return to his native country, he lost no time in repeating the toast, which he did thusly: "Here's to the happiest days of my life, spent in the arms of another man's wife—er, er—oh dear, I cawn't recall who the bally lady was."

---

She (awkward dancer): "This dance floor is certainly slippery!"

He: "It isn't the dance floor, I just had my shoes shined."

---

### Ditty

He knew a girl named Passion
He asked her for a date
He took her out to dinner
And gosh! How passionate!

---

Ladson: "Those two-hour lectures always make a new man of me."

Noel: "You mean they give you something you've been lacking?"

Ladson: "Yes, sleep!"

---

Marriage is an institution.
Marriage is love.
Love is blind.
Therefore marriage is an institution for the blind.

"What are you writing?"

"A joke."

"Well, give her my regards."

---

Guy: "And when I'm away, I'll write you a love letter every day and sign them with X's."

Gal: "For kisses?"

Guy: "Oh, no, for safety!"

---

"I draw the line at kissing,"
She said in accents fine;
But he was a football hero,
So he crossed the line.

---

Doc Sousley: "If I have talked too long, it's because I haven't my watch with me, and there isn't a clock in the hall."

Student: "Yes, but there's a calendar behind you."

---

Convict (reading newspaper): "Dere's justice for yer! A football player breaks two men's jaws and another man's leg and is de lion of de hour, while I gets ten years for only stunnin' an old guy wid a blackjack!"

—*United Mine Workers Journal.*

---

Diner: "I see that tips are forbidden here."

Waitress: "Lor' bless yer, mum; so was the apples in the garden of Eden."

---

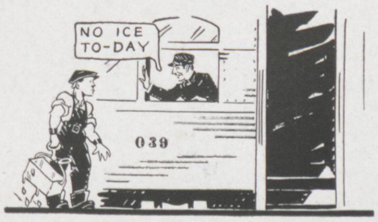
He: "Let's sit out this dance."

She: "We can't; you know I'm married now."

---

A co-ed can't always tell what kind of a necker a fellow is by the number of loving cups he's won.

# G-E *Campus News*




### ICE WATER

New electric drinking-water coolers introduced by General Electric have replaced the antiquated ice-cooled type on several prominent Midwestern railroads. This is another step in the modernization program being carried on by railroads to increase passenger traffic.

The new coolers are designed to overcome many disadvantages of the ice-cooled units. With foot operation of the self-contained units, only one hand need be used to get a drink. Cleanliness is promoted because of the absence of ice-filling operations, and the expense for maintenance and service is reduced to a minimum.

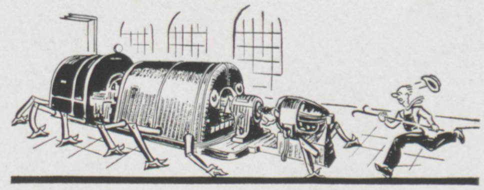
The water is automatically maintained at a healthful and refreshing temperature through thermostatic control. Coolers are designed either as self-contained units or as separate cooling and refrigerant condensing units for remote installations in the car.

### AS VACUUM TUBES GREW UP

As the vacuum tubes grew, they found their style cramped because metal could be sealed to glass only in thin strips. Research took up the problem, and it is now possible to fabricate glass and metal together, in any size or shape, very much as two metals are fabricated.

In a successful glass-to-metal seal, the temperature coefficients of expansion of the glass and the metal must agree exactly over a wide range of temperature. Painstaking investigation—much of it in the General Electric Research Laboratory, at Schenectady—developed new alloys and new glasses, which could be used for this application.

The first application of this new knowledge has been in metal radio tubes, now standard in almost all radio receivers. Power thyratrons, switches, capacitor bushings—all these follow along the new trail. We cannot predict how far this new technique will go, but the possibilities are numerous and inviting.



### TURBINE STEEL CREEPS

If the wrong kind of steels were used in turbine construction, the machine would not go creeping across the floor with the operator in hot pursuit, but the results might be even more disastrous.

Part of the increase in efficiency that has come about in the power-generating field in the last few years has been due to increased steam temperatures and pressures. As a result, the modern turbine shell runs, almost literally, red hot. This shell must withstand pressures such as exist half a mile down in the ocean and must keep a 20-ton rotor spinning perfectly in line. Heat softens metal, just as it softens candy, and permits it to stretch. This stretch, however, must be kept to the merest creep—about one part in 1000, if the changes are uniform.

In the Schenectady Works turbine shop, automatic electric furnaces hold samples of turbine steel at the temperature which will occur in the turbine. Gauges, which indicate changes of one part in a million, measure the creep as the pieces are exposed to heat for years at a time. From these tests, the best steel is selected.

It has been largely due to this research carried on by General Electric that the temperature and pressure of steam used in power generation have been raised to unexpected highs in the last few years.

96-363DH

**GENERAL ELECTRIC**


My compliments on your
very good taste, sir
for the good things
smoking can give you
Chesterfield
Wins
Chesterfield
CIGARETTES
LIGGETT & MYERS TOBACCO CO.
CHESTERFIELD