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ROSE POLYTECHNIC INSTITUTE - - - TERRE HAUTE, INDIANA

MARKS '35.

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

The Faculty of Rose joins the Students in extending a cordial invitation to visit the

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ROSE POLYTECHNIC INSTITUTE

TERRE HAUTE, INDIANA

Surveying This Issue

THE brewing industry, after a period of dormancy, is again approaching the status of a major industry. In this month's lead article, Mr. Dillahunt describes the rapid growth of the industry since the repeal of Prohibition and explains thoroughly the components and processes of production.

SUMMER air conditioning, contrary to the layman's belief, embraces not only cooling but also dehumidification and purification. Mr. Pearce discusses the four principal methods of summer air-conditioning and the necessary equipment for each method.

EVER since alternators were developed and employed in industry, suitable means of voltage regulation was imperative. The three fundamental types of voltage regulators in use today are the rheostatic, the vibrating contact, and the electronic. Mr. Lundgren describes these principles of voltage regulation in his article on that subject.

—M. B. S.

THE ROSE TECHNIC

MARCH 1938

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—Cut Courtesy Engineering News-Record

The Spillway at Norris Dam

THE ROSE TECHNIC

THE TECHNICAL JOURNAL OF THE ROSE POLYTECHNIC INSTITUTE

Volume XLVII MARCH, 1938 NUMBER 6

Brewing, A Fermentation Industry

Joseph A. Dillahunt, ch., '38

The art of brewing, which may be traced back 6000 years has had a most interesting and unusual history from both an economic and a romantic viewpoint. In spite of the setback suffered by the brewing industry during the Prohibition era it is today more highly developed than ever before. Mr. Dillahunt explains both the economic and technical significance of modern brewing.

THE art of brewing dates back at least 6,000 years. In 1935, an expedition of archaeologists from the Museum of the University of Pennsylvania and the American Schools of Oriental Research who were excavating in Mesopotamia, found a seal or drawing baked in pottery, which showed two brewery workers using long poles to stir the contents of a brewery vat. The date of this artifact was estimated as the 42nd century, B.C.

There are numerous early written mentions of beer. The Egyptian Book of the Dead, which has been pronounced by scholars to be about 5,000 years old, mentions beer made of barley. During the Middle Ages beer was brewed and dispensed from monasteries and from the manorial houses of the feudal lords. A woodcut has been preserved, dated 1397, showing a monk at work in the brew house.

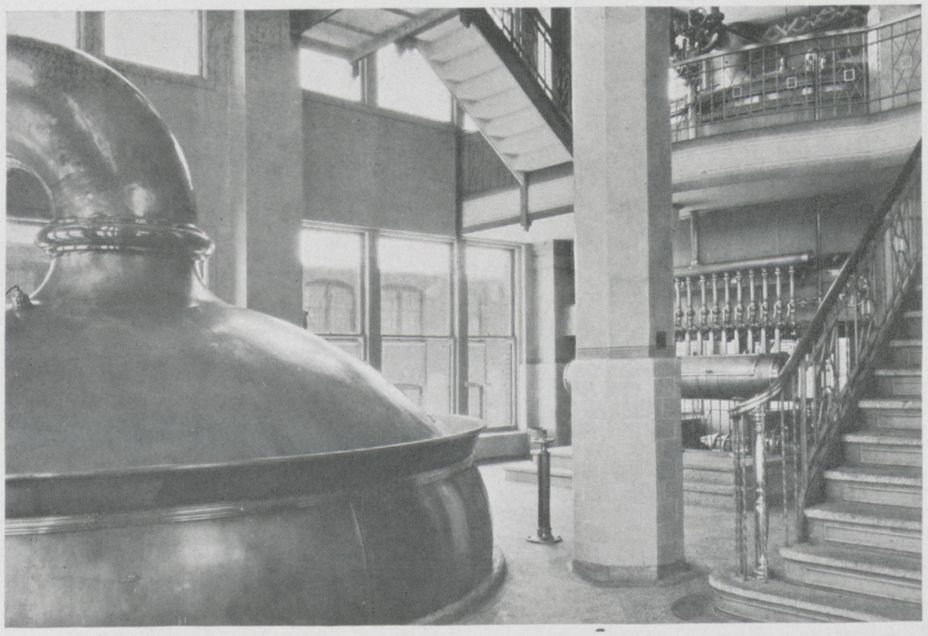
Historical record indicates that the shortage of the beer supply aboard the Mayflower was responsible for the landing of the Pilgrims at Plymouth. Numerous claims have been made as to the location and date of establishment of the first brewery in this country. One maintains that the Dutch West Indies Company built its first brewery in lower Manhattan in 1623. Another claim is based on a law of 1637 of the Massachusetts Bay Colony which bestowed the exclusive right of brewing upon a certain Captain Sedgwick.

The American beer industry, developed from the early beginnings of Colonial and Revolutionary days, was legislated out of existence on January 16, 1920, when the Eighteenth Amendment became effective. A great industry, which in its peak year of 1914 comprised 1,250 separate brewing concerns with a total capitalization of $792,914,000 and employing 75,404 persons, was virtually exterminated.

The re-legalization of beer came on March 22, 1933. It became possible to rebuild the brewing industry. The rehabilitation of plants, installation of machinery and equipment, and purchases of materials for the manufacture of beer constituted a real stimulus to the general recovery of American business.

Statistical History

The rise of the brewing industry to a point where it ranked as one of the greatest economic factors of the United States is demonstrated in the following compilation of statistics on production. The advent of prohibition naturally brought the production to a virtual standstill. However, the figures have been brought up to date since the return of the industry.



—*Cuts Courtesy Ind. and Eng. Chem.*

400 Barrel Brewing Unit

The statistics which follow are compiled from Arnold and Penmans "History of the Brewing Industry and Brewing Science in America" and from Person's "Beer and Brewing In America".

Statistical History of the American Brewing Industry:

Fiscal Year ended June 30	Production in barrels (31 gal.)
1860	3,812,346
1870	6,574,617
1880	13,347,111
1890	27,561,944
1900	39,471,593
1910	59,544,775
1914	66,189,473
1920	9,231,280
1933 (9 mo.)	20,666,918
1934	40,034,907
1935	45,143,032
1936	53,000,141
1937 (8 mo.)	38,663,824

It is interesting to note that in 1864, the population was about 35,000,000 and the production was 3,141,381 barrels of 31 gallons, giving a per capita production of 2.75 gallons. In 1914, fifty years later, the industry reached its peak production of 66,189,473 barrels. The population was estimated at 98,500,000, giving a per capita production of about 20 gallons per year. More recently, in 1936, the production per capita was about 13 gallons.

It is also interesting to note that as production increased, the number of breweries decreased. This is true both before and after prohibition. In both instances, this is largely attributed to mass production, with the consequent establishment of large breweries and innovation of extensive shipping business. This hastens the decline of the small local brewery.

Invested Capital

An important economic consideration of any industry is that of invested capital and that of expenditures and receipts. According to statistical reports of 1910, the brewing industry ranked sixth among the great industries of the United States in point of invested capital and seventeenth in point of value of product.

The figures for 1910 are:

Capital invested in brewing industry	$671,158,000
Wages paid by brewers	41,200,000
Salaries paid by brewers	22,000,000
Number of workers employed	66,000
Cost of raw materials	100,000,000
Capital invested in malting industry	60,000,000
Acres of barley harvested	7,500,000
Hops raised	
Acres	44,000
Value	8,000,000
Cooperage, invested capital	50,000,000
Coal consumption of breweries (tons)	347,726
Value of product	374,730,000
including Federal tax amounting to	57,456,411
Taxes and licenses (State and local)	80,000,000

In 1914 beer production had increased by 11% to an all time high. It would be fair to add 10% to the above figures, which would give for the year 1914:

Capital invested in the brewing industry	$744,985,380
Capital invested in the malting industry	66,600,000
Cost of materials	110,000,000
Capital invested in cooperage	55,000,000
Value of product	412,200,000

This makes an investment of about 800 million dollars for the brewing and malting industries, which are practically one for economic figuring. The investments in auxiliary trades can well be estimated at 200 million dollars, making a billion dollar industry in 1914.

No such figures are available for the industry since the end of prohibition. What figures are available, however, indicate that the brewing industry in this country is again approaching the status of a billion dollar industry. The value of products in 1935, according to the census of 1935, was $420,030,-140. This somewhat larger figure than those previously cited for greater production is due mainly to the fact that the industry is now more highly taxed than at any other time in its history.

Raw Materials

One of the primary considerations of any industry is its raw materials. The following ingredients enter into the composition of beer in the United States: barley, hops, water, and yeast. Strictly

speaking, yeast is not to be considered as a raw material as it is not used until after the wort has been prepared and generally is not found in the finished product. According to the reports of the United States Commissioner of Internal Revenue, the raw materials from which the average barrel of American beer (31 gallons) was brewed during the fiscal years 1934-35-36, were:

37.96 lbs. Malt
.69 lbs. Hops and Hop Extracts
7.68 lbs. Corn and Corn Products
3.48 lbs. Sugar and Syrup
2.69 lbs. Rice.

Barley

Barley for malting is usually purchased on the basis of hand examination. Frequently, however, the chemist is asked to determine moisture and total nitrogen and starch contents. The starch percentage alone would serve to value the barley if a high percentage of extract in the resultant malt were the only consideration. However, malt is not valued solely on its yield of extract, nor malting barley on its starch content, though this is an important factor.

So far as chemical analysis can supply any measure of the brewing "quality" of barley, the nitrogen content, expressed as a percentage on moisture free barley, is probably the most useful figure. In general, the lower the nitrogen content, the more highly the barley and the malt therefrom is prized. Moisture is determined by drying a five gram sample to constant weight and noting the loss in weight, while total nitrogen is determined by the familiar Kjeldahl method on a three gram sample. Germination tests are also frequent.

Hops

Hops are the dried and ripened cones of the hop vine. The blossoms are produced in August and are gathered from September to the middle of October. The prompt drying of the hops is essential in order that they may be safely baled. This drying takes place at about 40° C. in hot air, after which the hops are compressed into bales. Hops are of great importance in brewing, being used to precipitate certain proteins and to impart to the beer the characteristic aroma and sharp taste.

One of the most common tests of hops is an examination for the detection of free sulfur. Hops are often heavily sulfured in the field with flowers of sulfur to retard the development of moulds. Many yeast difficulties are laid to the presence of free sulfur, which finds its way into the fermenting vats, and being exposed to the action of the living yeast, is reduced to hydrogen sulfide with the consequence of an undesirable stench. Hops are often exposed to the action of sulfur dioxide in the drying process. In inferior hops, this is for the purpose of brightening them and improving the color, with a consequent increase of market value.

Water

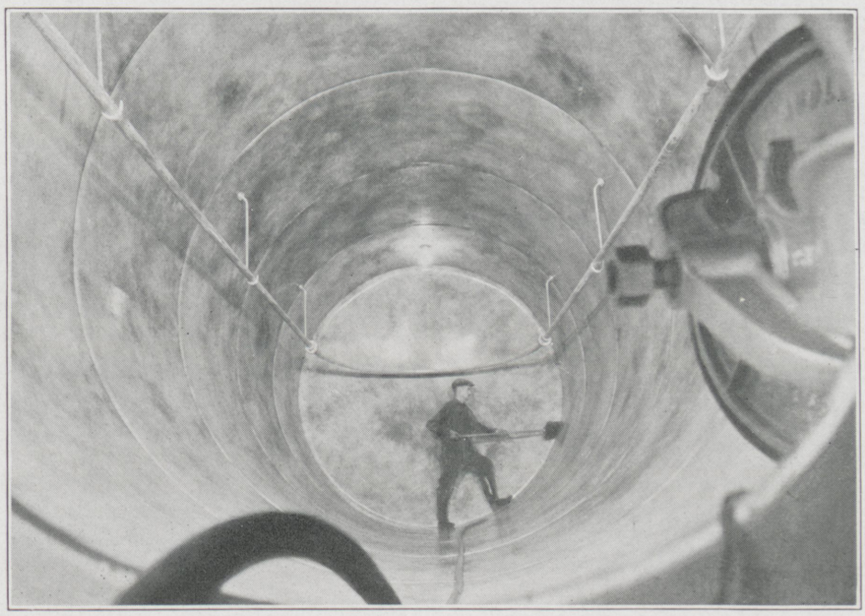
In the brewing process water is the solvent which dissolves the extractive substances contained in the malt and malt adjuncts. Water comprises between 85 and 92% of the volume of the finished beer. At first glance, it might seem that the question of water would be a relatively unimportant factor; that either any water would do, or that a very pure and possibly distilled water would be essential. The real truth lies between these extremes.

The quality of water used for brewing is very important as affecting the product. In general, the water should be moderately hard, and the salts desired in it are calcium and magnesium sulfates and sodium chloride. These salts are needed to promote proper yeast growth. If very much iron is present, it is generally held to be objectionable, and the water should be purified. More than very minute traces of nitrates give rise to yeast troubles. Very soft water is improved by the addition of gypsum.

Yeast

One of the most important parts of the brewing process is the fermentation; consequently, the yeast used is a point for serious consideration.

Fermentation is a general term applied to various chemical changes caused by the action of bodies called ferments. These are: (a) unorganized chemical substances, called enzymes, secreted by living cells; and (b) certain micro-organ-



Interior of a Brewing Tank

isms. Enzymes include such bodies as diastase, invertase, peptase, ptyalin, emulsin, etc. They usually assist in the nutritive functions of the animal or plant in which they occur, the changes which they cause being sometimes of the nature of hydrolysis. The micro-organisms produce very complex changes in the substances upon which they act, probably caused in part by the enzymes secreted by them. The product formed varies according to the kind of organism predominating in the liquid, and the fermentation is distinguished as alcoholic, acetic, lactic, butyric, etc.

Organized vegetable ferments may be divided into three classes: (1) mould growths, (2) yeast plants, and (3) bacteria. The yeasts have great technical importance, owing to the part they take in alcoholic fermentations. Yeast consists of an aggregation of plant cells, forming a slimy, yellow mass of peculiar odor, and having an acid reaction. Under proper conditions, the cells propagate with great rapidity. The temperature must be constant at from 6 to 26° C. (a higher temperature is conducive to the formation of fusel oil), and substances necessary for the growing plant must be present. These include fermentable sugar, nitrogenous matter, and, already spoken of under water, certain mineral salts such as sulfates of calcium, potassium and magnesium. Air (oxygen) is desirable, especially at first; later it is often excluded from the process to prevent secondary fermentation and a consequent conversion of alcohol into acetic acid or other products.

Through alcoholic fermentation, the fermentable sugar in the solution is converted into alcohol and carbon dioxide:

$$C_6H_{12}O_6 = 2\ C_2H_5OH + 2\ CO_2$$

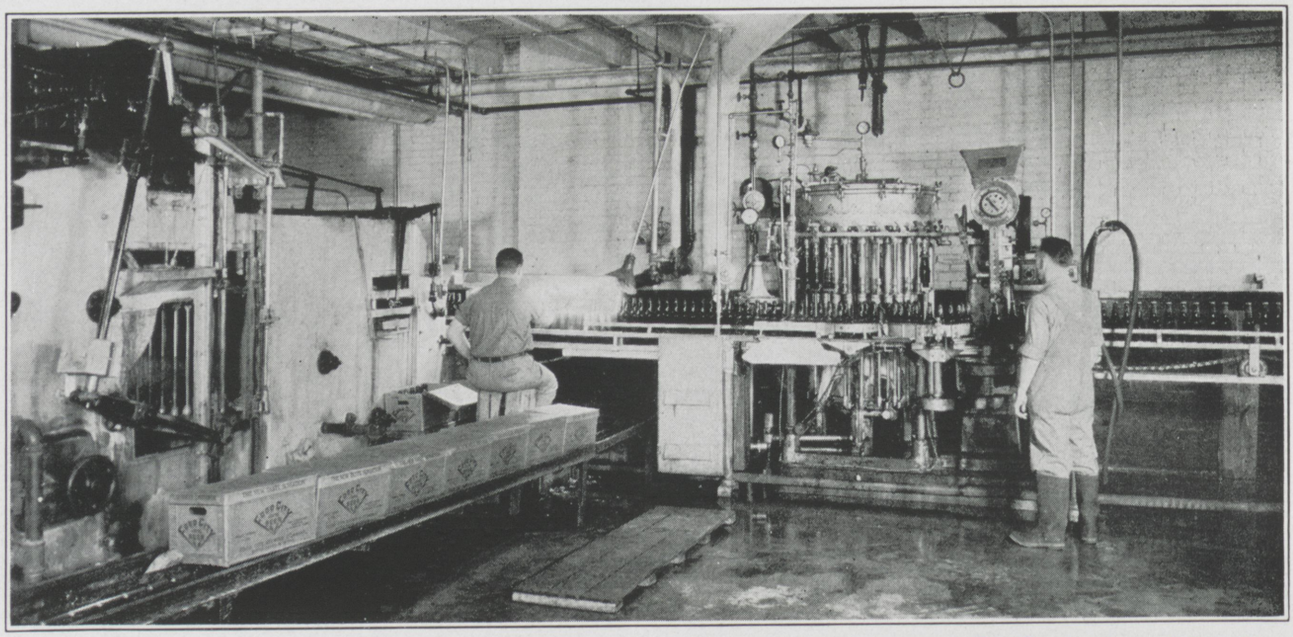
But this does not express the true decomposition, for a large number of other substances are formed at the same time, the more important being glycerine, succinic acid, various organic ethers, and most important of all, butyl, iso-butyl, and amyl alcohol, which are collectively known as fusel oil.

When the amount of alcohol formed in the liquid equals 14 to 15 percent, the yeast can no longer propagate itself, and the fermentation ceases. The presence of certain mineral salts such as borax, mercurous chloride, sulphurous acid, and free caustic alkalies often retards or prevents fermentation.

Yeasts are also grouped into two general classes: top yeasts and bottom yeasts. The former require rather high temperatures (15 to 30° C.) for the fermentation, which is very active, the rapid evolution of carbon dioxide causing the liquid to bubble violently, and carrying the yeast to the surface. This yeast is used for heavy beers and ale, for alcohol and high wines, and for some regular wines. Bottom yeasts act at lower temperatures (4 to 10° C.), and the fermentation is slow; the evolution of carbon dioxide is gradual, and the yeast remains on the bottom of the vat.

For technical purposes, it has long been the custom to use cultivated yeasts for alcoholic fermentations; but Pasteur showed that these contained many wild yeasts, i. e., plants whose actions were either unknown, or are detrimental to the product.

Brewing was the first industry to recognize the significance of controlled pure culture organisms through the work of the great Emil Christian Hansen of the Carlsberg Brewery Laboratories in Copenhagen. Hansen devised a system of pure yeast culture, obtained in a sterilized nutrient material by propagation of a single plant. Thus



—Cuts Courtesy Ind. and Eng. Chem.

Bottling department of a brewery, showing Bottle Soaker, Filler, and Crowner.

a single variety of yeast is obtained by the use of which the fermentation is more easily controlled.

There are three purposes for which the alcoholic fermentation is carried on industrially: (a) for the manufacture of yeast; (b) for the carbon dioxide formed; and (c) for the alcohol.

The first of these is usually associated with the third, while the second finds its greatest application in the baking industry. In preparation of yeast for alcohol, the process of growth is carefully watched by aid of the microscope, and the appearance of any injurious variety condemns the entire lot.

Those most generally cultivated are the S. cerevisoe and S. ellipsoideus. The cells are filtered out of the liquid culture in which they are grown by fine sieves usually of bolting cloth and are washed with chilled water, filter-pressed, and the cake heavily pressed. If the yeast is to go on the market as bakers' yeast, it is mixed with from 25 to 50 percent of starch and flour and is then known as "compressed yeast". By drying at low temperatures the plant retains most of its vitality and the familiar dried yeast results.

Processes of Production

About the simplest accurate definition of the brewing process has been given by Salem in his *History of Beer*: "A certain quantity of malted barley is taken and ground; it is then mashed with hot water, the sweet liquor or wort extracted, a portion of hops added, and the whole boiled until the preservative quality as well as the aroma of the hops is obtained. It is then allowed to cool, and afterwards fermented with yeast to produce the small quantity of alcohol it contains, and to give it life."

From this definition, it is both convenient and simple to classify four distinct general operations of the brewing process: (1) malting of the barley; (2) preparation of the mash; (3) fermentation of the wort; and (4) the storing and finishing of the beer.

Malting

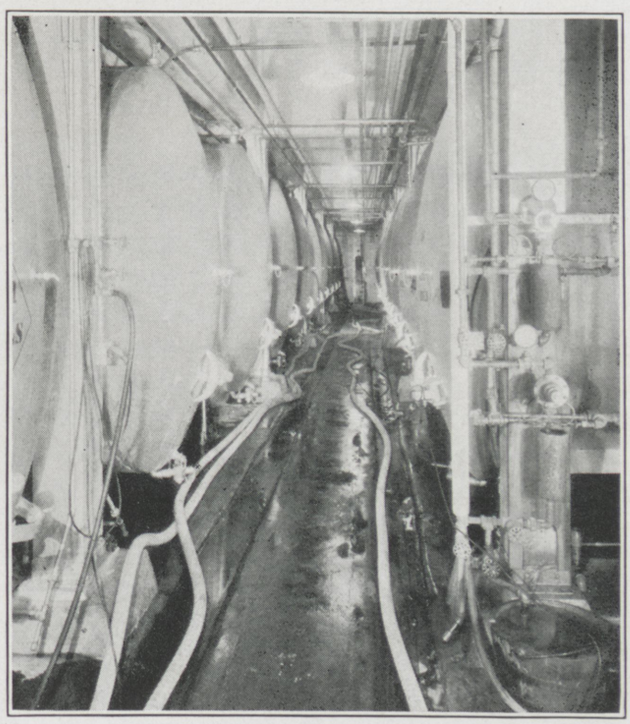
Malt without qualification has come to mean barley malt, which is everywhere the most important raw material of the brewing industry. United States Treasury Department statistics show that during the fiscal year ending June 30, 1936, the manufacture of beer consumed almost 2 billion pounds of barley malt, for which the cash return to farmers was in the neighborhood of 50 million dollars. Oats and wheat are malted to a small extent for use by brewers of special ales and stouts, but the amount of these and other cereals used is so small as to be insignificant.

Not all barleys are suitable for malting purposes. The essential notes on its examination were included in the previous section of barley as a raw material.

Malt is made by steeping barley in water for about three days, spreading it to a depth of a few inches on a floor and allowing it to germinate there for ten or twelve days, moving it from time to time onto a fresh section of the floor, in such a way that it gets uniformly aerated. Under more modern methods, the germination proceeds in rotary drums under controlled conditions of temperature and humidity.

The object of malting is as follows: The principal material of barley is starch, which is insoluble in water and useless to the brewer as such. But when the barley is supplied with moisture at not too low a temperature, enzymes are secreted which enable the embryo to draw on the reserve material stored up in the endosperm. On the enzyme diatase depends the transformations effected in the brewers mash bin, but other enzymes are developed simultaneously, and one or more of them, whose role is of first importance, bring about a partial dissolution of the cell walls of the endosperm.

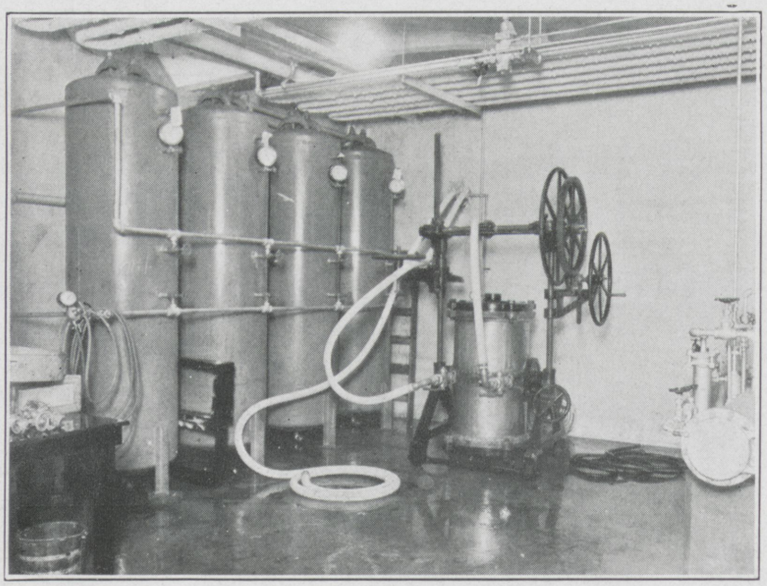
When the process of germination, spoken of as modification, has been carried far enough the germination is arrested by drying the malt in rotary kilns and finally "curing" it at temperatures which may reach 200-230° F. This drying process not only serves to arrest the growth of the malt, but induces partial caramelization of the cell contents with development of the characteristic malt flavor and yields a product which, in order to keep its moisture content around 5%, must be stored in good bins.



Pressure Storage Cellar of a brewery.

In the brewery, the malt is crushed between rolls and mashed with water at a temperature in the vicinity of 160° F. This is designed not merely to extract the maltose and dextrine of the malt, but largely to allow the diastase of the malt to act upon the starch, changing it to maltose with a consequent increase in yield of sugar, and to

allow the peptase to act upon the proteids present and convert them to peptoids. The mash tubs are heated by steam coils and are fitted with agitators which keep the mash in motion. The period of mashing is about 2 or 3 hours, at the end of which time the mash is passed to the brewing kettles, which are usually on a floor below. The residue that is left is again made up with water and this extract added to the first, a process known as "sparging". The liquid at this stage is then known as the "wort".



—*Cuts Courtesy Ind. and Eng. Chem.*

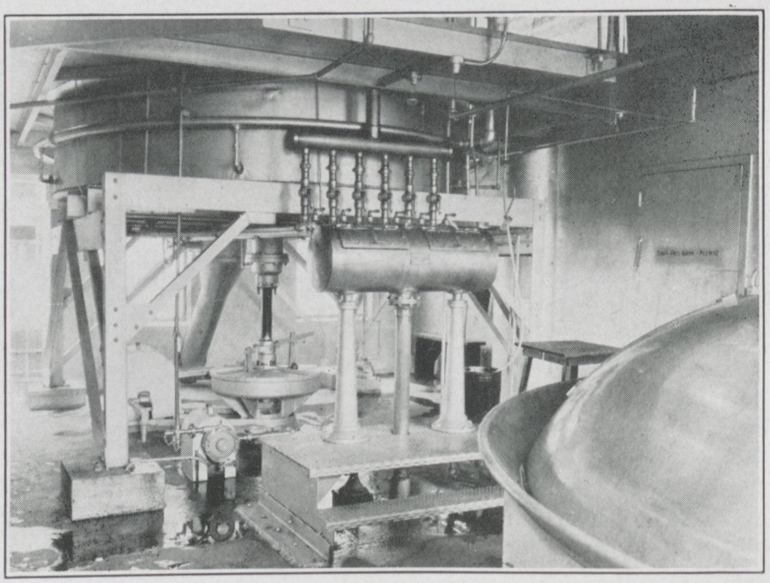
Carbon Dioxide Storage Tanks and Filter.

In the copper brew kettles, the wort is boiled by means of circulated steam for from two to three hours, at which point the hops are added and the boiling continued for another half hour or so. The objects of boiling the wort are: (a) to concentrate it, as it may be very dilute; (b) to thoroughly sterilize it; (c) to coagulate and precipitate most of the albuminous matter; and, (d) to afford an opportunity to add the hops.

At the end of the boiling stage, the steam is turned off and the boiled wort allowed to stand. After a settling period, the sediment is drawn off at the bottom, and the remaining wort is a brilliantly clear, brown-colored liquid. It is then passed to some form of cooler (usually long rectangular tanks about three feet in depth) and cooled by refrigerating coils to the temperature desired for the beginning of the fermentation.

The clear hopped wort from the cooler passes to the fermentation vats, which may be of wood, aluminum, ebonite, or glass-lined steel. The fermentation, which in America is usually of the bottom fermentation type, is carried on at a temperature of about 20° C. A bottom or lager yeast is added, the amount being about ½ to 1 pound per barrel of wort. After a few hours fermentation begins and progresses slowly; should it go too fast, the liquid is cooled by coils to retard the action. After about six days the active fermentation ceases, the temperature is reduced, and all the yeast is at the bottom of the vat. This yeast is recovered and used, provided a test culture shows it to be free from any wild strains. The greatest care must be taken to exclude other organism, and this leads to a degree of cleanliness which makes the fermentation rooms a veritable showplace.

When the fermentation is considered complete, the beer is withdrawn from the vats and piped to resting vats. After one or more days it then passes to a filtration vessel, in which "Filter Cel" or a similar filter aid is added, in order to furnish points of attachment for the colloidal substances and the lead yeast cells preparatory to filtration. Filter leaves are then immersed in the beer, and the clear beer drawn out, free from any yeast, and passed by pumps to storage cellars. It remains in storage for a minimum of four days, but better for weeks or months at a temperature of 40° F. Sometimes a small proportion of young fermenting beer is added, and an after-fermentation takes place in the storage casks. This process is called "krausening". After another filtration, the beer is ready for the bottling and barreling plant.



Mash Tub and Kettle

For shipment, the beer is carbonated in a special carbonating tank by passing in sterile carbon dioxide under pressure, and then bottled or kegged. If it is bottled, or more recently, canned, the keeping qualities must be improved. This is most legitimately done after bottling by "pasteurization" at 180° F. Less legitimate and forbidden by law is the addition of salicylic acid or calcium bisulfite. The process of production is now concluded and the beer is ready for the market.

Recent Trends of the Industry

With the rehabilitation of the brewing industry, the attitude that brewing is first an art and then a science has undergone a remarkable change. Chemical engineering has gained a foothold and promises to gain strength until it is the foundation of the industry.

With the remodeling of plants strict emphasis was placed on the chemical engineering principle of efficient plant design in order that the flow from operation to operation might be the most efficient possible. Great stress was also placed on the materials of construction to be used.

Great strides have also been made in the line of technical processes. This is especially true in the preparation of the yeast and in the fermentation process.

From a marketing angle, the most interesting trend, perhaps, is the appreciable increase in package beer, especially in cans.

A survey of the recent trends of the more important angles of the brewing industry shows that the advancements are as follows:

1. A more scientific control of production methods along the lines of chemical engineering, with a consequent increase in uniformity of product.

2. Enhanced saleability by more attractive packaging.

3. A distinct growth in consumer acceptance of advertised brands.

4. An increase in the popularity of more compact containers.

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Residential Summer Air Conditioning

Robert E. Pearce, m., '38

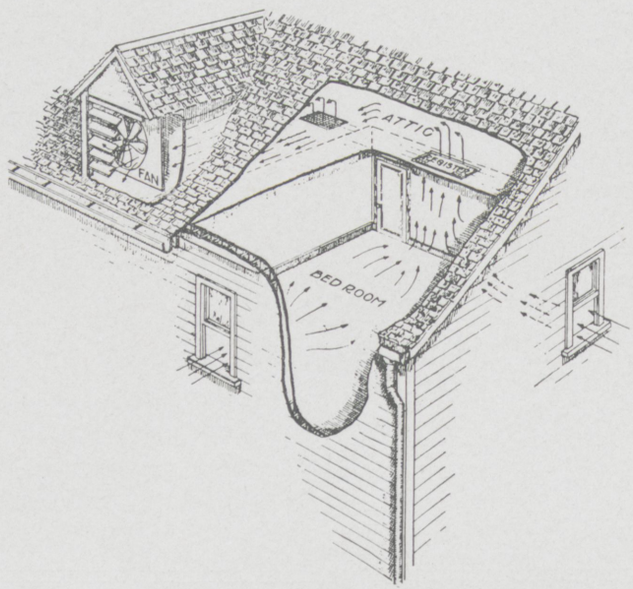
THE term "air conditioning" means positive and accurate control of temperature, both relative and absolute, movement, purity, and the component constituents of the atmosphere within an enclosure. To the average layman, air conditioning usually means air cooling. He speaks of "cooling systems" and believes that cooling is the only function necessary. He is impressed only by the reductions in temperature that can be accomplished, thinking, of course, in terms of dry bulb temperature. It has been proved that the degree of difference between outside and inside air temperature is only incidental to the conditions attained by the consideration of all the other factors involved. Air conditioning, from the engineer's viewpoint, involves simultaneous and independent control of temperature, relative humidity, and air motion.

Humidity

In the study of air conditioning the term "humidity" is used when referring to the water vapor present in the atmosphere. Closely related to humidity is the quantity known as "relative humidity". Relative humidity is correctly defined as the ratio between the actual vapor pressure of the water in the air and the pressure corresponding to the dry bulb temperature of the air.

In order to obtain a better understanding of the importance of humidity, the following discussion of humidity in heated buildings is presented. When air is heated in the absence of "free water", it becomes "drier", although the actual amount of water vapor remains the same. In other words, the absolute humidity is the same, but the relative humidity has been lowered. When constantly breathed, the heated relatively dry air is injurious to the air passages such as the nose, throat, and lungs. For this reason, when air for ventilation is heated, moisture should be added as well as heat, so that when the air is introduced into a building its humdity will be suited to the needs of the human body. The most practical method of adding moisture to the air and securing the desired humidity is by means of the air washer or the spray humidifier. The air can thus be cleaned or humidified depending on

the method of humidifying. The average home heated with a hot-air furnace is one of the worst offenders from the viewpoint of containing too dry air. The usual water pan does not evaporate enough water for normal conditions. Recirculation of air will help much towards increasing humidity; and when a small recirculating fan is provided, there will be a more rapid movement of air through the piping, and more comfortable conditions with lower temperatures at the air inlets in the room will be obtained. This is not only a practical but an efficient system, especially for the coldest weather conditions. In the larger residences, complete installations of fans and air washers may be used.



—Cuts Courtesy Mechanical Engineering

Attic Fan Installation.

Furnace and Attic Fans

Although air conditioning involves simultaneous and independent control of temperature, relative humidity, and air motion, summer-comfort conditions can be appreciably improved by such a well-known device as the furnace fan or the more recently developed attic-ventilating fan. Both the furnace and the attic-ventilating fans depend for cooling effectiveness upon their ability to circulate relatively large volumes of outdoor air at a time when the temperature is lower outdoors than indoors. Cooling by such means has been properly termed "comfort cooling."

Tests indicate that a furnace fan of the size usually installed, one capable of circulating four to six air changes per hour, cannot bring enough outdoor air into a residence to affect the indoor temperature appreciably, either at night or the following day. Similar tests show that the furnace fan must have a minimum capacity of about nine air changes per hour, if night air cooling is to be effective, and even this high rate of air change is not so effective as opening a majority of the windows and depending upon natural ventilation. Tests also have been made of the cooling effect produced by simply recirculating air in the daytime. As recirculation of air can only produce cooling by the effect of air motion, determination of this cooling value is essentially a matter of measuring the air velocity accurately and the determining, by use of the comfort chart, the effective temperature corresponding to this velocity. Tests made, using this principle and a rate of air change of 7.4 per hour, indicate that the air movement induced by the furnace-fan recirculation has reduced the effective temperature one degree, which is equivalent to about a two-degree drop in dry-bulb temperature. This is hardly enough drop in temperature to justify any claims for this method of cooling, and probably the rate of air change would have to be 15 per hour to accomplish effective cooling.

A better step in the improvement of summer comfort is the installation of an attic-ventilating fan. As the name indicates, this type of fan is installed in the attic of a residence and draws large volumes of cooler night air through open windows into the rooms to be cooled and thence through ceiling grilles or an attic stairway to the fan, where it is discharged back to the outdoors through attic windows or louvers. Installation will vary with the local conditions in each case, but the path of the air through the rooms to be cooled and to the fan should be as direct as is practicable, if the full capacity is to be utilized. It has been learned that best results are obtained when the fan circulates about 30 to 35 changes of air per hour, and for an ordinary three-bedroom, two-story house, this can be accomplished by a fan with a capacity of 3000 cfm. The gain from circulating more than 35 air changes per hour is small, but circulating less than 10 air changes per hour is not effective. Best results are obtained in the effectiveness of night-air cooling by an attic fan by operating such fans all night, as the heat stored up in the walls and ceilings soon raises the room temperatures back to uncomfortable values if the fan is shut down before midnight. One serious disadvantage of the attic fan is that bringing such large volumes of air into a residence carries with it the risk of also introducing considerable dust in certain localities, which may result in serious discomfort to people suffering from allergic diseases caused by air borne pollens.

The elimination of dust in air conditioning installation is an item of greatest importance. Common

dust consists of animal, and mineral or vegetable matter picked up by the movement of the atmosphere or wind. Dust remains suspended in the atmosphere with but little movement by the atmosphere. In this respect, the furnace fan is superior, as it usually draws its supply of air through filters.

Attic-fan installation of the type and capacity just described can be made for a cost of about $125, and the operating cost for a normal summer in a typical region, such as the Detroit area, will probably not exceed five dollars.

Insulation

The first fundamental requirement in the summer air conditioning or cooling of a structure is that the structure itself be well-constructed and well-insulated, and that steps be taken to shade the windows against the effects of the sun. A residence insulated with rock wool or its equivalent, both in the ceiling and side walls, may be considered a well-insulated structure. A study of cooling loads made on a cooling plant in a structure which was not insulated, and a comparison of these results with those obtained in similar tests conducted on a cooling plant installed in a well-insulated residence, showed that insulation can be credited with about a 30 per cent reduction in cooling load. The same tests also showed that awnings or blinds at the windows reduce the calculated cooling load by 25 per cent and the actual operating cost of the cooling system by 20 to 30 per cent. Both the investment and operating costs for cooling a poorly constructed and uninsulated residence are much higher than can usually be warranted by the benefits obtained.

Air Ducts

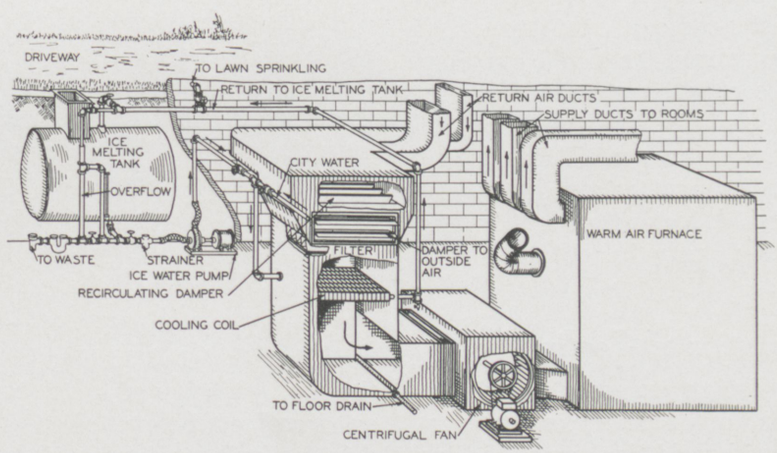
The second basic requirement is that means be provided for both distributing the cooled air to the rooms and returning the warm air to the cooling unit. This is a more important consideration, in many instances, than the design and installation of the cooling unit itself, as it frequently proves difficult to install air ducts in an existing structure heated by radiators. In many cases where installing duct work for air distribution is difficult, installing space-cooling units is most economical, and the newly developed self-contained air-cooled unit is well suited to this type of cooling, as these units require no water or drain connectors. Such a unit and its operation will be discussed later.

Structures heated by mechanical warm-air heating systems present an easy problem in air distribution as the existing duct work and registers, including those of the older baseboard type, have proved satisfactory for distributing cooled air. Many of the newer homes are being equipped with indirect warm-air heating systems, with high side wall registers in many instances, and installing a cooling coil in the same housing with the heating coil is comparatively simple. The existing distribution system will usually be found to be well adapted to cooling, especially if high side-wall registers are used.

Accuracy in estimating the resistance to the flow of air is of basic importance in designing duct systems. Any serious discrepancies between estimated and actual resistances will result in failure to pass the required volume of air in a given time. Any pronounced variation in volume is undesirable whether the air is used for heating, cooling, ventilating, or for the combustion of various fuels. When the resistance to flow is overestimated, an increased movement of air results, and although it is an easy matter to produce any required reduction in volumes by means of dampers, the air is continuously handled at an unnecessarily high pressure, involving a waste of power. On the other hand, if the resistance is underestimated, it is necessary to speed up the fan or change the duct system.

Any duct system can be considered to be a greatly elongated box with numerous changes in shape and several bends causing changes in the direction of flow. In designing air ducts the following procedure can be employed:

a. Ascertain the total volume of air to be handled per minute by the fan and also the fractional volumes comprising the total, which are to be supplied to or withdrawn from various parts of the house.



Ice Cooling System.

b. Locate the fan in the most convenient place.

c. Locate the air outlets or inlets for supply and extraction systems respectively and at the positions so located on the building plans indicate the air volumes to be handled.

d. Divide the building into zones and proportion air volumes

per minute in accordance with the different zones.

e. Determine the size of each outlet or inlet on the basis of passing the required amount of air per minute at a suitable velocity.

f. Calculate the areas and select suitable dimensions for all branch and main ducts.

g. Ascertain the resistance of the duct which sets up the greatest friction. In many cases this will be the longest run, although not invariably so. This will be the resistance offered by the duct system as a whole to the flow of the required amount of air per minute. The shorter runs which offer less resistance will have to be throttled by dampers or regulators, so that their resistance will be raised to equal the resistance of the longest run. Unless this is done, more air will take the easier paths and the supply to the longest run will be insufficient.

h. Revise the dimensions and areas of the shorter runs, so that the ducts themselves will create resistances equal to that of the longest run. This will cut down the cost of sheet metal, and the result will be just the same as if dampers were used. Too high a velocity must be avoided.

Suitable duct velocities, as used in step f, may be obtained from tables.

Calculation of Cooling Load

For design purposes, certain indoor and outdoor temperatures and relative humidities must be assumed as a basis for calculating cooling loads. It was found from tests in a Detroit residence that maintaining an indoor effective temperature of 72 to 73 degrees, corresponding to 77° to 79° F. and 50 to 60 per cent relative humidity, gives satisfactory results. By "effective" temperature is meant an empirically determined index of the degree of warmth perceived on exposure to different combinations of temperature, humidity, and air movement. Because of the heat capacity of the walls and ceilings, it was found that the calculated maximum cooling load is usually about one-third higher than the actual, unless the factor of time lag in heat transfer, caused by heating of the building structure, is taken into account. Tests at the University of Illinois research residence showed that the maximum load on the cooling coils was 30,000 Btu. per hour, while the calculated load was 40,000, and this maximum load persisted for about four hours after calculations showed that the load should be below this figure.

Calculated figures would be correct if transmission of heat were instantaneous, but, allowing for lag in heat transfer, while the total amount of cooling in British thermal units removed corresponds approximately with the calculations, actual maximum load required under the assumed conditions was about 25 per cent less. This simply means that the cooling equipment operated at a lower maximum capacity than calculated but over a much longer period so that the net cooling result was the same. An important point to be realized, therefore, is that some correction must be applied to the maximum cooling load, as normally computed, to avoid installing equipment possibly one-third larger than necessary.

A suggested method of correcting the calculated cooling load for the heat capacity of a structure is as described below. Essentially, this method consists in deducting the calculated cooling load, due to occupancy and infiltration, from the total actual cooling load and assuming that the difference is the test-transmission load and that the ratio between test-transmission and calculated heat-transmission loads is a measure of the proportion of the heat received by the outside walls and ceilings which is actually transmitted into the rooms in the particular period for which the load is calculated. This correction factor would have to be determined for the different types of wall construction and the various kinds of structure. Both the experience with the Detroit residence and tests at the University of Illinois research residence indicate that the actual heat-transmission load for a residence of good frame construction will be reduced sufficiently by the heat capacity of the structure to make an actual maximum cooling load about 25 to 30 per cent less than the calculated maximum load.

Choosing Cooling Methods

Artificial cooling of a residence can be accomplished by any one of four principal methods: well water, ice, refrigerating machine, or a combination of dehumidifying and cooling equipment.

Well-water cooling is, of course, limited to those localities where water is available and is a fairly satisfactory means of cooling if the water temperature is around 55° to 60° F. Water of higher temperature is not satisfactory for cooling. Drilling a well for cooling purposes involves, however, many uncertainties as to the quality and quantity of water obtained and frequently is not nearly so satisfactory as anticipated.

If the structure is to be cooled artificially, by either ice or a refrigerating machine, and a central cooling system is to be employed, choice of cooling method lies between an air washer and extended-surface finned-tube cooling coils. An air washer provides an effective and popular means of humidifying in addition to its application as a dehumidifier. It further serves the purpose of air cleaning. The latter is simpler and is better adapted for use in small installations than the air washer, especially so since refrigerants are now available which can be safely expanded and evaporated in coils placed in the main air stream.

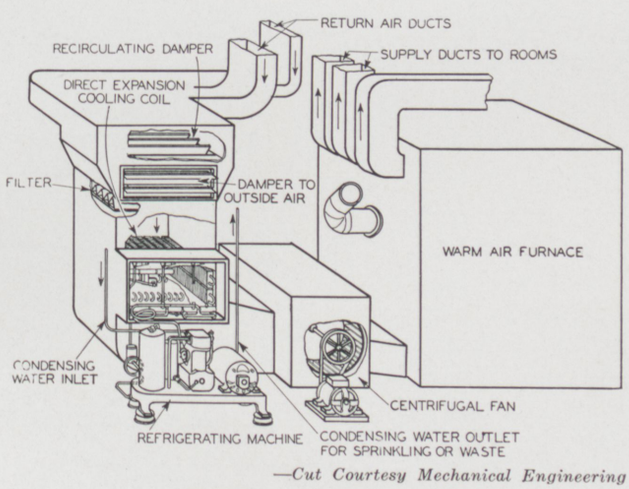
Aside from the distribution system, a mechanical cooling system can be very simple and essentially

need only consist of the refrigerating machine, direct-expansion cooling coils, and circulating fan.

Self-Contained Cooling Unit

A newly designed self-contained cooling unit for residential and office cooling is manufactured in one size to provide a ¾-ton cooling capacity with a sensible heat rating of 6,400 Btu per hour and a total rating of 9,000 Btu. Air circulation is 360 cubic feet per minute. This unit can be situated anywhere in the room, and does not have to be near or under a window.

The unit consists of a reciprocating "Feron" compressor, evaporator, fan and motor, all automatically controlled and housed in a compact, insulated cabinet. Air is drawn through an evaporator in the rear of the cabinet, where it is cooled and dehumidified. It is then directed to the occupied portion of the room by a propeller fan through a grille which delivers the conditioned air directly downward and across the floor. This produces a maximum cooling effect per unit of electrical energy used, so the maker says. Two control knobs are located on the side of the cabinet. With one knob the fan can be turned on separately or with the compressor. The other knob provides adjustment of the automatic thermostat for the degree of cooling desired. The cabinet is about 32 inches high, 31 inches wide, and 15 inches deep.



—Cut Courtesy Mechanical Engineering

Mechanical Cooling System.

Conclusions

As has been shown, there are a large and varied number of factors that must be taken into consideration in air conditioning. The space allotted for this paper allowed only a hasty sketch of these factors, and by further research these factors may be studied to a much greater extent.

From the paper, however, there are several conclusions that may be reached, namely:

1. In residences, where cooling load comes largely from external sources, conventional methods of calculating heat transfer and cooling loads will give results about one third higher than actual maximum loads and correction should be made for a time lag in heat transfer caused by the heat capacity of the structure.

2. Cooling of a moderate-sized eight-room residence with a two-ton refrigerating machine is feasible if the climate is similar to that prevailing in the Detroit area and if the residence is well insulated and its windows shaded against sun effect.

3. Ice cooling systems in residences and small commercial offices will operate satisfactorily, but prevailing prices of ice, $4 to $5 per ton, result in operating costs that are excessive and out of proportion to the benefits derived.

4. Natural infiltration will provide sufficient outdoor air for ventilating requirements of a residence under normal conditions of occupancy, and adding to the cooling load by bringing in outdoor air is not necessary.

5. Numbers of hours and days that artificial cooling is required in a well-insulated residence is much less than has been generally estimated.

6. Present average cost of installing either an ice or a mechanical cooling system in a residence is rather high and seems out of proportion to the number of days when it will be used in summer seasons such as Detroit's. Fixed charges are three to four times as high as operating charges. A reduction in first cost greatly enlarges the field for residential cooling.

7. Comfort cooling of small structures, or a modified form of air conditioning, need not be expensive if designers give credit to the modifying effect of time lag in heat transfer, take advantage of insulation and shading of windows, and concede that maintaining optimum conditions at all times is not necessary.

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Voltage Regulators for Alternators

Clemens W. Lundgren, e., '38

Voltage regulators are to alternators as governors are to steam engines. Satisfactory governors have been employed for many years, but correspondingly satisfactory voltage regulators are a comparatively recent development. Mr. Lundgren discusses in his article the most important types of regulators and the advantages and disadvantages of each.

ALMOST as soon as the alternating current appeared in industry, it was found that some means of automatic regulation of machine voltage was necessary. At first attempts were made to build alternators with good inherent regulation, but this did not prove satisfactory because of variable conditions of speed, power-factor, and self-heating. Also, the special alternator was more expensive to build. So the practice has become to control voltage regulation by means of suitable external regulators operating in the circuit of the alternator field or in the circuit of the field of the exciter.

One of the first, if not the first device for regulating the voltage, was the rheostatic-type current regulator developed in 1880 by Charles F. Brush. The Brush regulator was in the form of a solenoid-operated compression-pile rheostat.

Then came the vibrating contact type, which was a regulator in which the periodically closing of a short circuit around a regulating resistance in the excitation circuit of the alternator did the controlling. This was invented by Thomas A. Edison in 1882.

The next important step in the vibratory regulator was introduced by James K. Fotte in 1903 when he added the important feature of the combination of an electrically actuated main contact and an electrically controlled vibratory contact. Also, in 1903 Allen A.Tirrill introduced the much-used arrangement of the vibratory regulator, comprising a pair of cooperating contacts in which one of the contacts is controlled by the electrical properties of the exciting circuit and the other by the condition to be regulated.

The Tirrill type regulator with various improvements has been used most extensively, and until the necessity for high speed regulation became important, (1926-29), this type was entirely satisfactory. At present the direct-acting rheostatic type is replacing it for this type of work.

It was not until the vacuum tube was well developed that the electronic method was devised. Diode or triode tubes are employed in this type of regulator. Since this type is usually satisfactory for regulating comparatively small alternators in which extremely good regulation is wanted, and since industry does not generally use this system, this will be discussed in not as great detail as the other systems.

Commercial Regulators

Three fundamental principles are utilized in alternator voltage regulation: the rheostatic, the vibrating contact, and the electronic. These principles are used separately or in combination in the various commercial regulators.

To prevent "hunting" of the regulated voltage, which is caused by inertia, regulators are operated by two opposing forces. One force seeks to restore the voltage and the other, relatively weak when the action begins, overpowers the restoring force just in time to prevent over-correction of the generator voltage.

Vibrating Contact Regulators

In a vibrating contact regulator, contacts open and close across a field rheostat. When the contacts open, the resistance is inserted, and when they close, all resistance is shunted out. Because of the rapidity of contact vibration, and the inductance of field windings, the excitation does not have time to reach the ultimate value but assumes an intermediate value corresponding to the effective resistance. The effective resistance is that resistance which, if substituted for the actual resistance, would not change the regulated voltage but would cause the contacts to stop vibrating and remain open.

The contacts are moved by the control element which balances the electromagnetic or electrodynamic effect of the voltage against a definite mechanical pull, such as caused by a weight or spring. Since the mechanical force is constant (for a given setting), unbalance results only from a change of voltage. Any unbalance immediately causes a change of constant engagement in a direction to restore the voltage.

The vibrating contact type regulator may control several alternators in parallel, and an economy of regulating and exciting expense is obtained. This system, however, does not control the division of load between the machines. This function must be controlled manually.

Operating a Vibrating Contact Regulator

The following is an excerpt of the method and cycle of operation of a General Electric type T A voltage regulator. Reference is made to Figure 1, Plate I.

Figure 1 shows the direct-current control magnet connected across the exciter bus and provided with two cores, the lower being a fixed stop core, the upper a movable core attached to a pivoted lever at the opposite

end of which is mounted a flexible contact. The pull of the magnet is shown opposed by one spring. A differentially wound relay magnet is also shown connected to the exciter bus, one winding is arranged to be opened and closed by the main contacts. The core is attached to a pivoted lever, at the opposite end of which a counterweight is supported to assist in bringing the lever and core to a point of equilibrium, and on the same end of this lever is shown the lower main contact which, in combination with the upper main contact, produces what are known as the floating main contacts.

At any constant load, speed, and power-factor, the a.c. magnet core does not actually move, and the regulator acts as a direct-current regulator maintaining the proper exciter voltage to give the correct alternating voltage. Should the power-factor change or should a heavy load be thrown upon the alternator, the previous exciter voltage will then not give the correct alternating voltage; therefore the a.c. core will drop slightly. This forces the lower main contact against the upper main contact which in turn closes the relay contacts. This, as previously explained, causes the exciter voltage to increase. The travel of the a.c. magnet core will continue until the exciter voltage has reached a value corresponding to that required to give normal a.c. voltage under the new conditions. The a.c. side of the regulator will then operate and maintain the exciter voltage at this high value in order to again hold the proper a.c. voltage.

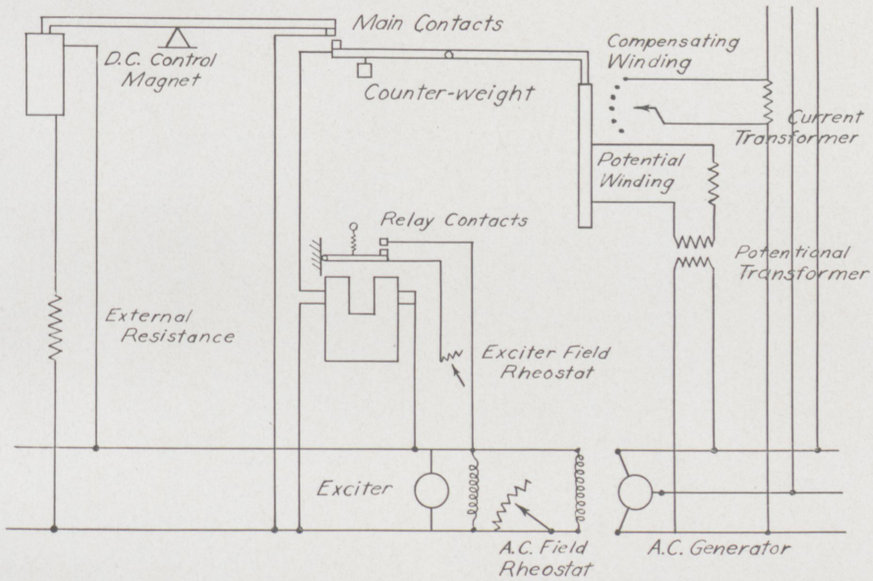


Fig.1

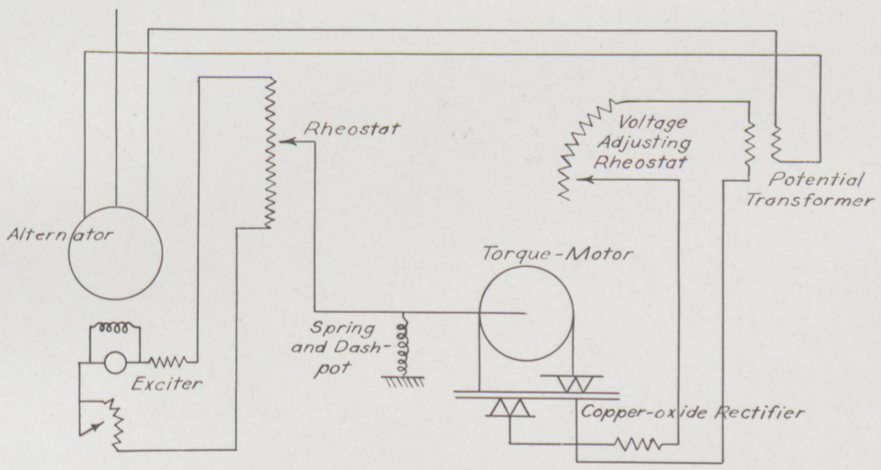


Fig.2

Plate I

Rheostatic Type Voltage Regulators

The regulators involving continuously vibrating contacts were not suitable to handle high-rate-of-change field currents, for contact trouble became serious, and a wide range of exciter voltage control was not possible. As a result of this, direct-acting rheostatic type of regulators were designed to operate in the shunt field circuit of self excited exciters.

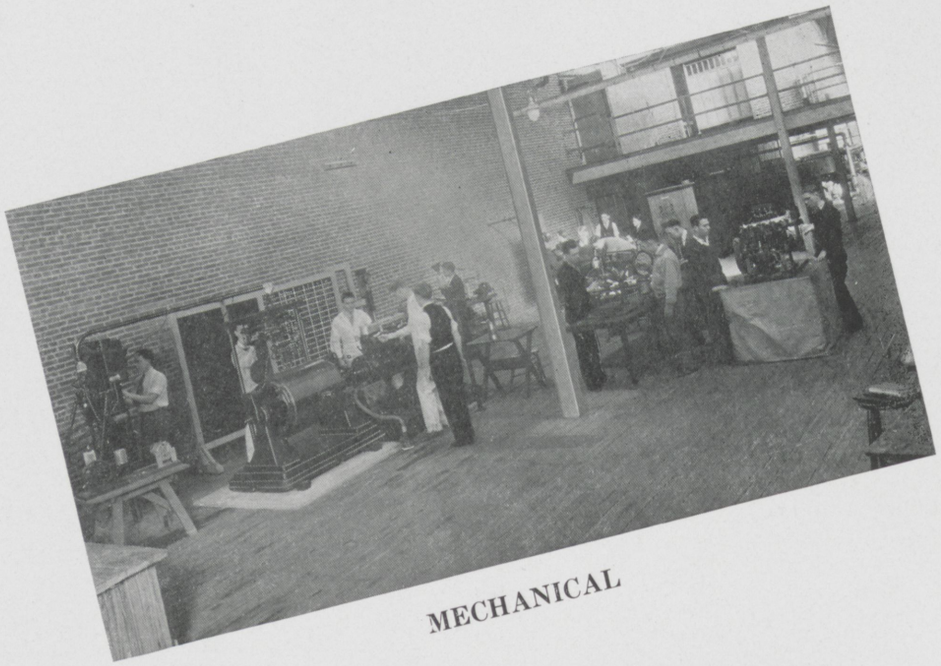
Excitation is controlled by automatic adjustment of the rheostat element which is capable of varying its resistance from practically zero up to the maximum required. It has no vibrating contacts and operates only when a change in excitation is required. These regulators may not be used to control alternators in parallel.

Operation of Rheostatic Type Voltage Regulators

In the following excerpt reference is made to Figure 2, Plate I.

The direct-acting generator voltage regulator operates on the principle that any change in a.c. voltage causes the armature of the voltage-sensitive torque motor, which is normally balanced, to move against a spring and assume a new position. The armature directly operates the rheostat element in the proper direction and amount to correct excitation conditions of the a.c. machine and restore the original voltage.

The regulator is normally at rest and operates only when a change in excitation is required. Operation consists of a slight motion of the torque-motor armature either with or against the main spring, which moves the lever and linkage operating



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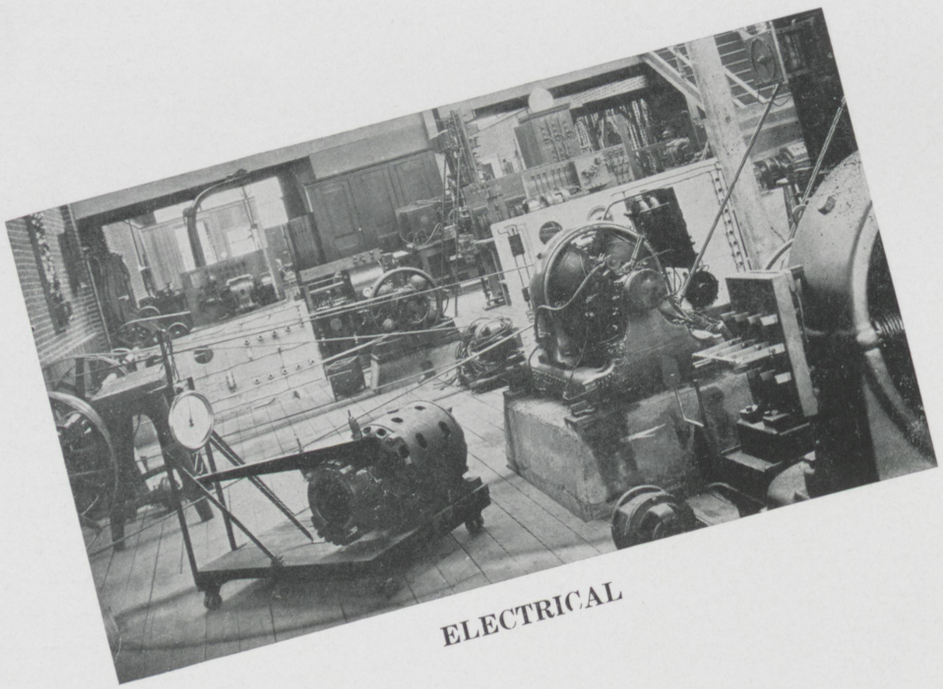

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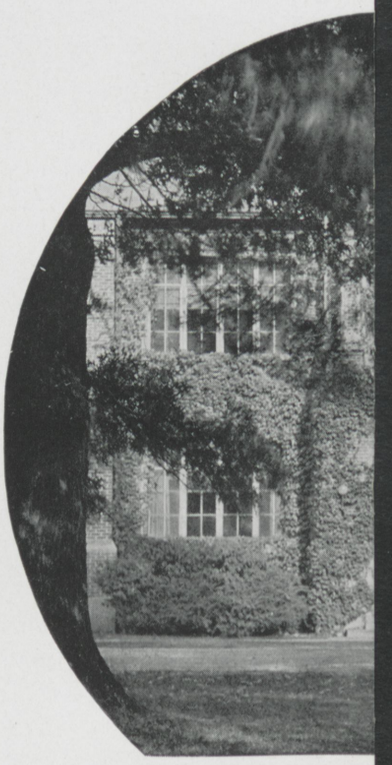

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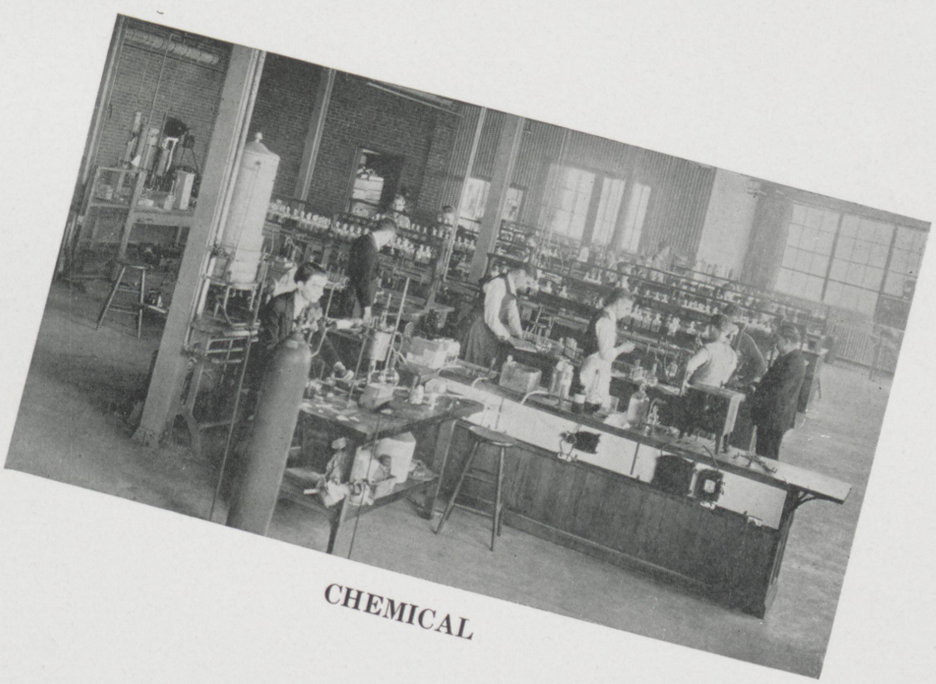

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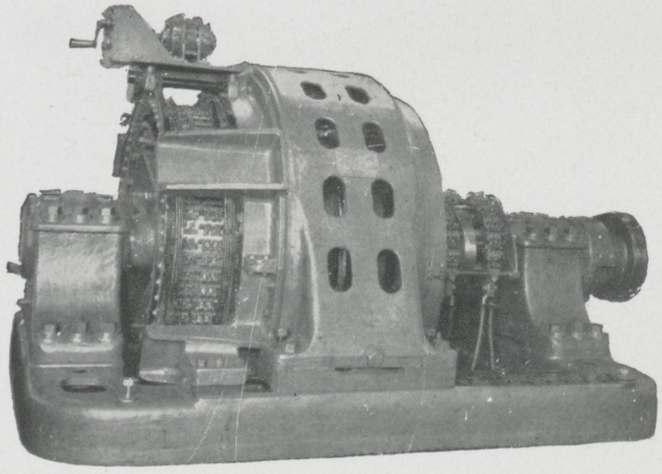
the rheostat element. This tilts the rheostat stacks slightly, one way or the other, changing the resistance to correct excitation. All of this resistance may be inserted or removed within a few cycles or the resistance removed slowly, in an infinite number of steps, depending on the required excitation changes. This permits smooth voltage control over the entire range of operation and makes a practically ideal regulating device.

The rheostatic type of regulator is becoming more widely used, and for automatic control on large alternators, the indirect-acting rheostatic type regulator is used. Large alternators generally require field currents that are beyond the practical capacity of either vibrating contact or direct-acting rheostatic type of regulators. The indirect-acting regulator consists of a remotely operated control rheostat combined with occasionally vibrating contacts for providing quick response for large changes in voltage.



The main control element includes a sensitive torque-motor, which is a motor having its torque balanced against a spring and having a contact arm on its shaft. It provides a means of averaging the 3-phase alternator voltages in one device and is so constructed and designed that it has practically a flat voltage-torque characteristic for the usual range of frequency and temperature. Also are included magnetic damping devices and a synchronous contact motor. This type of regulator is very fast, requiring 1½ cycles to close its main accelerating contacts and 1½ cycles for the accelerating relays to operate, or an overall time of 3 cycles to obtain the maximum rate of voltage correction.

Electronic Regulators - - Diode Type

Vacuum tubes, by their particular feature of allowing a current to flow only from plate to filament, can also control alternator voltages. An example of a diode regulator that can keep the alternator voltage within 1% of constant value is given below.

A d.c. source, E, supplies excitation current through a resistance Rv (Plate II) to the rotor of an alternator. The anode filament circuit of the diode is connected in parallel with the excitation winding. The filament current is supplied by the secondary of the transformer, the primary of which is connected to the alternating voltage to be held constant. The diode has a certain definite emission corresponding to a predetermined voltage of the alternator. Should the voltage of the alternator decrease, the filament current of the diode will decrease, consequently the emission also, the decrease in emission being proportionally larger than the decrease in filament current. The rotor and the diode being both connected to the d.c. supply, the current passing through the rotor increases, hence the excitation of the output increases as a result.

The diode can, however, be connected in parallel to the field winding of an exciter instead of to the exciting winding of the alternator. In order to obtain greater accuracy without it being necessary to increase the output of the diode, the exciter should be operated with low flux saturation.

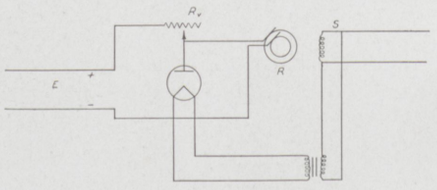


Plate 2

Summary

Briefly stated, the three types of voltage regulators may be applied as follows:

The direct-acting rheostatic regulators are used on small and medium-sized alternators, operated nonparallel. The indirect-acting rheostatic regulators are used to control medium and large-sized alternators.

The vibrating contact regulators are used to control small and medium-sized alternators operated parallel or nonparallel.

The electronic type regulator is used when extremely fine regulation is desired but is only used on small alternators having self-excited exciters.

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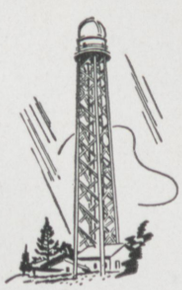

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HENRY C. GRAY AND HERMAN A. MOENCH ..... *Faculty Advisors*

Can We Afford Integrity?

Anthony Eden, until his recent resignation as England's foreign minister, proved that he enjoys one of life's greatest luxuries. To use the words of Stuart Chase, he enjoys the luxury of integrity. Eden fought for over two years for a principle—a principle which he honestly believed to be right. He fought a battle for democracy against the autocracy of dictators. When, under pressure of a few British industrialists and two foreign dictators, Eden's former backers showed their true jelly fish character, the young statesman stepped out and made it known that he would have nothing to do with a cabinet that had conceded to such demands. He would have no part in a scheme in which he must betray himself.

In this world of yes-men the man who dares to say no is to be applauded. But most of us, unlike Captain Eden, are financially unable to refrain from saying yes whether or not we believe it to be the correct answer. Authors must write things they do not believe, artists must draw pictures which they know are not good art, salesmen must sell merchandise which they know is misrepresented, and, to strike close to home, engineers must manufacture goods which they know are inferior and, in many cases, worthless. The word "must" is used because financial inability is the compelling factor.

In the present economic trend men *must*, more often than not, choose between the necessities of life and the luxury of integrity. If integrity must be sacrificed and abilities prostituted, then the United States about which historians brag has become a myth. If the courage of one's convictions is becoming the barrier to success, decay has set in. *R. S. K.*

Student Activities

Few students seem to realize the opportunities that may be derived from student activities. Although the returns from any particular extra-curricular activity may not be immediate, nevertheless the yield from such an investment of time and effort will in later years be realized multifold.

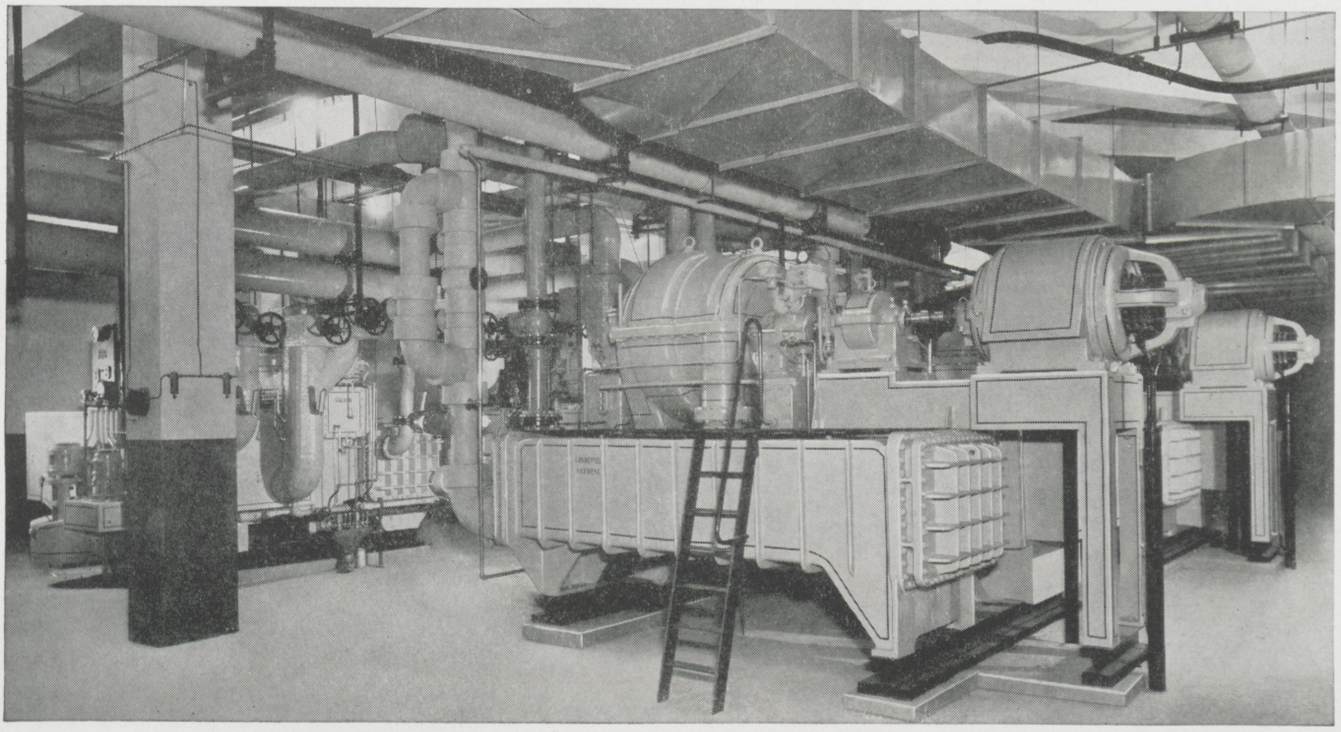
A college campus with its many activities is an excellent cross section of what may be expected in later life. Students matriculating from various sections of the country form a representative body of Americanism. A college campus should be a place where one asserts positively his abilities and ideals. No student who takes an insipid, self-centered attitude, contributing nothing to the success of student activities, can ever hope to enjoy a place of responsibility in later life. Why must the larger part of the student body lie about dormantly while the minority carry the burden of the activities? It is not that the active members of the minority are jealous of their positions. Rather, it is a pathetic fact that the sluggish majority never awaken to the opportunities offered them.

No one can deny the student's right to the philosophy of getting through school with the least amount of work, provided, of course, that the student is willing to accept his fate after graduation. Those students who go through four years of college with a languid, indifferent, spiritless attitude can rightfully expect to be considered last for a position in the industries—and if such a fate is in store for one, he might much better spend his time in a place other than college. *L. J. G.*

Student Lounge

The furnishing and redecorating of the student lounge entailed considerable expense. The desirability of having such a recreation room had long been recognized, and two years ago the need was satisfied by the Institute. This improvement was opened with the expectation that the privilege of enjoying such surroundings would not be abused by anyone. For some time the expectation was fulfilled, but as the novelty of the new lounge faded out, proper care of it was not taken.

Recently, a few of the students have been so careless in their actions that the Student Council has found it necessary to appoint a committee to enforce the existing rules governing the use of the room. The success of this committee in enforcing these rules depends upon the cooperation of every man in school. It should be remembered that so long as the present lounge is misused, no new furnishings or improvements will be added. *N. G. W.*



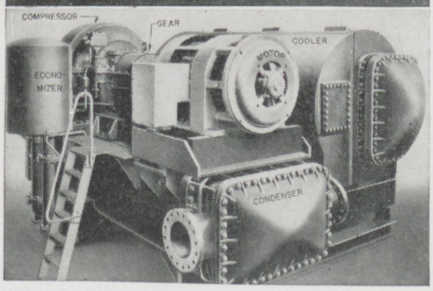
CARRIER CENTRIFUGAL REFRIGERATION—

the development that revolutionized an industry!

IT'S a simple matter to provide refrigeration for air conditioning small stores or buildings. A good conventional compressor will do the work in a satisfactory manner, and at reasonable cost. But it's a different matter entirely to supply the thousands of tons of refrigeration required for cooling skyscrapers—or for industrial processing. Space is costly. Power costs must be controlled. Paralleling the trend toward rotating, high speed, smooth-action machinery, Carrier engineers developed Carrier Centrifugal Refrigeration—a development that literally revolutionized the industry!

Think of a compressor capable of supplying cooling equivalent to melting 1000 tons of ice each day—yet so compact that it can be installed in a fraction of the space required for conventional compressors. So economical that power costs are reduced as much as 25%—yet so simple that no skilled attendants are required. So efficient, the first machine constructed is operating today, as effectively as when installed, 15 years ago.

Above: Carrier Centrifugal Refrigeration machine providing refrigeration for air conditioning of skyscraper. *Below:* Diagram of construction.



Centrifugal Refrigeration . . . Evaporative Condensing . . . safe refrigerants . . . in fact every Carrier contribution to the comfort and efficiency of the world has been brought about through engineering. And the opportunities for young engineers to gain recognition at Carrier are greater now than ever before. At Carrier, young men hold responsible positions—their capacity gauged, not by age, but by ability. Whether that ability is fostered best by laboratory research or field work in the far corners of the world, Carrier enables engineers to progress.

☆ ☆ ☆

During 1937, Carrier trained 300 recent graduates from leading engineering schools in every section of the country. Carrier needs more men. If you had a good school record, and are interested in the world's most fascinating and fastest-growing industry, write us.

Carrier
Air Conditioning

CARRIER CORPORATION, SYRACUSE, N. Y.

AN ORGANIZATION OF ENGINEERS

—*Cuts Courtesy Bell Telephone Laboratories*

Figure 1. The Isograph in use.

Research and Progress

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

The Isograph

In various theoretical investigations, especially those connected with electrical networks, it is frequently necessary to determine the roots of a polynominal equation. In even a simple case, such a solution is tedious and quite laborious sometimes requiring days and even weeks for a complete solution. Research men at the Bell Telephone Laboratories have recently perfected a mechanical root-finder which has reduced the complete operation to a few manual settings. The isograph pictured complete in Fig. 1 will handle polynomials in which the highest power is not greater than ten, although it could be built to handle polynomials of higher degree. The isograph will determine any one or all roots, either real or complex with an accuracy equivalent to a ten-inch slide rule. Multiple roots are also easily determined.

The isograph operates on a mathematical theory which has long been known. Although the mechanical construction of the isograph is of prime interest, the mathematical basis on which it operates must first be generally understood before its mechanical features can be fully appreciated.

Suppose the polynomial whose roots are to be determined is as given below, where both Z and W are complex quantities:

$$(1)\ W = a_0 + a_1 Z + a_2 Z^2 + a_3 Z^3 + \cdots + a_n Z^n$$

If Z and W complex planes are considered, for every point in the Z complex plane such as $x+iy$, the polynomial W will have a corresponding value $u+iv$. The roots of the polynomial occur when, for a particular value of Z, the corresponding value of W is zero. If some closed contour such as a circle is chosen in the Z plane, as a point moves around the circle in the Z plane, the corresponding point in the W plane will also trace some closed curve. The shape of the curve will depend entirely on the radius of the circle and, of course, on the polynomial. Now in the theory of complex variables, it is shown that if n roots are present in the region enclosed by the circle of radius R_1 in the Z plane, the corresponding curve in the W plane will encircle the point, W=O, m times. If the radius of the circle is decreased to a value of R_2, and if the corresponding curve in the W plane now only encircles the point, W=O, n—1 times, it is immediately known that there is a root whose absolute value lies between R_2 and R_1. By successive trials, the root can be evaluated as accurately as desired. It is conceivable that the above process could be carried out manually by physically plotting the individual curves in the W plane by substitution of the values of Z in the equation of the polynomial.

Since a circle was originally chosen in the Z plane, it would simplify the discussion if Z were considered in its polar form, thus:

$$(2)\ Z = R(\cos x + i \sin x)$$

substituting this polar value of Z in equation I, it can be rewritten:

$$(3)\ W - a_0 = \sum_1^n a_k R^k \cos kx + i \sum_1^n a_k R^k \sin kx$$

where the summation symbol represents the summation of a number of terms in which k assumes successive integral values equal to the successive powers of Z in equation 1. The fact that the constant a_0 has been transposed to the left side in equation 3 only means that the W plane curves will now loop the point, $W=a_0$, instead of the previous W=O. From equation 2 it is seen how the complex value of the root can be determined. Thus the absolute magnitude of the root R will cause the W plane curve to pass through the point $W=a_0$, and the angle which yields the point a_0 itself will be the angle of the complex root.

From equation 3 it is seen that the real part of $W-a_0$ is equal to

the sum of harmonic cosine terms with coefficients a_kR^k, and the imaginary part is the sum of similar harmonic sine terms with identical coefficients. This suggests the use of a series of cranks of lengths a_kR^k rotating at harmonic angular velocities, and a system by which the horizontal and vertical components of each angular motion are summed up. Thus, for the isograph built to handle a tenth degree polynomial, ten cranks are geared to a single drive shaft by means of a worm drive such that when the first crank makes one complete revolution, the second makes two, the third makes three, and the last makes ten complete revolutions. The drive shaft with five of the associated gears and the electric motor to drive it are shown in figure 3. Provisions have been made so that the length of the crank arm can be accurately set to correspond to the coefficients a_kR^k. A crank pin is attached to the outer end of each crank arm, and this pin moves in two rectangular slots cut in two slide-bars, each of which can move back and forth in one direction only—the two directions being at right angles to each other. By means of this pin and slot mechanism, the rotating motion of each crank is resolved into its component cos kx and sin kx displacements. It is now necessary to sum up the individual cos kx and sin kx displacements of each of the ten cranks. To accomplish this summing up of all sine components and cosine components, the ends of all the slide-bars carry pulleys so that a single wire may be carried around all the sine pulleys and another wire around the cosine pulleys. Stationary pulleys mounted between the movable pulleys keep the direction of pull on the wires in line with the motion of the slide-bars. The crank pins, slide-bars, pulleys and wire are shown in figure 2. Each wire is suitably counterbalanced so as not to permit slack in the wire. The sine wire is rigidly attached to a pencil carriage and moves the pencil and pencil carriage back and forth in one direction only. The cosine wire is attached to the drawing board and moves it back and forth in a direction perpendicular to the pencil motion. The pencil carriage and drawing board can be seen in figure 1.

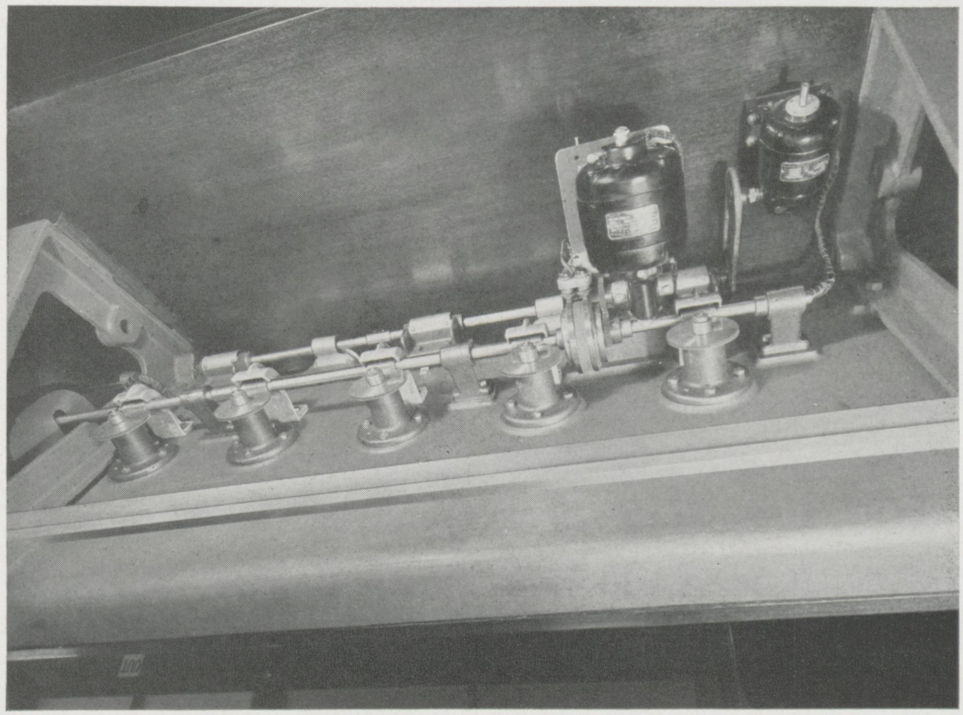


Figure 3. Motor Drive showing five of the ten gears.

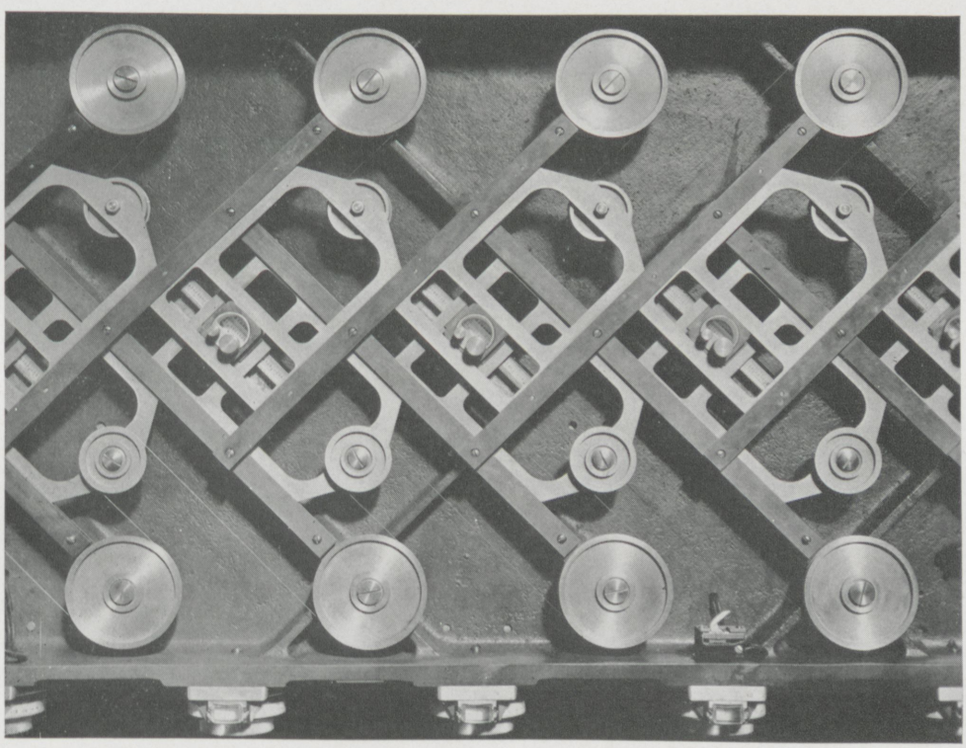


Figure 2. Summating the Harmonic Components

Thus the isograph first breaks down the circular motion of the Z plane into 10 separate circular motions corresponding to the 10 terms of the polynomial. Crank arms proportional to the coefficients of the polynomial then separate the circular motions into component perpendicular motions. The perpendicular motions are then summed up separately and transferred to the

W plane represented by the drawing board on which the pencil draws the desired curve.

Another feature of the isograph is ten circular mechanically driven slide rules which evaluate the coefficients $a_k R^k$. These circular rules placed on the bottom edge of the isograph are visible in figure 1 as well as in figure 2. Since the successive coefficients of the polynomial are proportional to successive powers of some base R, a drive similar to that used for the crank arms can be used in the mechanically driven slide rules. Thus the shaft rotations are in the ratio of 1, 2, 3, etc., to give the successive powers of R. It is only necessary to set the factor of proportionality, a_k, on each rule first and then rotate until the first rule shows the correct answer. The other nine rules will give the other nine coefficients. These coefficients are then set on the corresponding crank arms and the procedure carried on.

Sports

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

On February 12, 1938, Rose Poly traveled to Upland, Indiana, to play a return game with Taylor University. The Engineers were determined to avenge an early season defeat but fell short eight points to lose 34-26.

At the beginning of the game it looked as if the battle were going to be very close. Time after time the lead changed hands with first Taylor ahead and then Rose leading. Both teams were playing defensive basketball to the best of their ability, and consequently neither team was able to show much offensive strength. Rose's zone defense was an equal match for Taylor's man-to-man defense for most of this period, but near the end of the half, Stuart, high scorer for Taylor, sank a couple, and Taylor went into the lead, 22-14 as the half ended.

In the second half the game resolved itself into another defensive battle. Rose came back fighting hard and played improved basketball in the first ten minutes of the second half. At one time Rose was able to come within three points of tieing the score. However, at this point, Smith and Eckerman, Rose guards, were both removed from the game by virtue of four personal fouls each. From this time on, Taylor made a determined drive and ran the score to 34-26 as the game ended.

Colwell was the high scorer of the game with twelve points. Stuart, one of the state's high scorers, collected eight points.

Rose vs. Anderson

On February 18, 1938, Anderson College from Anderson, Indiana, came to Rose, and the game resolved itself into a fight. However, enough time was devoted to basketball to enable Anderson to win 36-27.

The game began rather as any other game would begin. The ball was tossed at center, and the teams were away to a flying start. Throughout this game the play was unusually fast, with both teams tearing up and down the floor time after time to take one shot and lose the ball. On these speedy exchanges Anderson gained an advantage, and the score at half-time was 21-12 in favor of Anderson.

The second half began as usual with the ball being tossed at center. However, by this time there was a decided air of vengeance. It went a little farther than friendly opposition. Several times opposing players could be seen down in the corners of the floor, out of sight of the officials, distributing blows to each other that resembled a boxing match. Near the end of the game several Anderson players lost their heads and openly signified their intention of fighting. However, nothing much occurred until the end of the game when Van Dyke of Anderson and Smith of Rose swung one blow each. In the locker room after the game a reconciliation was effected, and everyone was happy. Incidentally, Anderson won 54-37.

Colwell was high for Rose with nine points while Morgan scored twelve points for Anderson.

Rose vs. N.C.A.G.U,

On February 26, 1938 the Rose Engineers traveled to Indianapolis, Indiana and played the Normal College of the American Gymnastic Union. The team displayed some very good basketball at certain times during the game and came away on the long end of the score, 39-37.

In the first half Rose Poly started fast and showed some remarkable shooting to gain an eight point lead. The game was played on a very small floor, and the center line rule was dispensed with. This somewhat upset the Rose offense and also disturbed the defense. As a result N.C.A.G.U. began shooting long shots and connected on several occasions so that the score at the half showed Rose leading 25-22.

In the second half the game resolved itself into a battle of fast breaks. Each team consistently tried to catch the other off guard and to score by means of a fast break. Near the end of the period N.C.A.G.U. forged into a one point lead, but Rose overcame this and was leading 39-35 with one minute to go. At this point a N.C.A.G.U. man found himself open under the basket, and he scored. For the remainder of the game Rose Poly controlled the ball.

Colwell was high for Rose with sixteen points while Bowker scored twelve points for the Normal team.

Campus Activities

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

Commencement Committees

The Senior Class has announced the committees for the commencement exercises which will be held on Saturday, June 4.

Robert W. Dispennett, John E. Whitesell, John R. Hayes, and Ora E. Meyers were named for the committee which governs the selection of caps and gowns; J. Allan Greenland and Max L. Stanfield will choose the announcements, and Ralph A. White, John R. Merrifield, Claude J. Zinngrabe, and Wayne E. Alexander will determine the manner in which the class will commemorate itself.

Junior Prom

Committeemen for the major social function on the Spring calendar, the Junior Prom, have been appointed.

Robert W. Underwood, class president, is general chairman. The public relations council includes Malcolm A. Steele, chairman; Robert S. Kahn, Lamont J. Forsyth, Richard D. Altekruse, C. Paul Stark, Richard G. Weldele, and Gene E. Petty. J. Ewing Ross is chairman of the orchestra committee, with Victor Peterson and George W. Smith assisting him. The finance committee includes Robert J. Burger, chairman; Franklin G. Doenges, and Jack W. Rustamier. On the program committee are Robert N. Ladson, chairman; Robert P. McKee, and Robert W. Schilling.

The event will be held in the month of May at the Mayflower Room of the Terre Haute House with a name orchestra in attendance. The committees will meet soon to complete the detailed plans.

Indiana Engineering Council

The Indiana Engineering Council, formerly called the Indiana Engineering Society, held its fifty-eighth annual meeting at the Hotel Lincoln in Indianapolis on Friday, Feb. 25.

A number of papers were presented at the all-day meeting and officers were elected for the next year. Mr. James T. Hallett, traffic engineer for the Indiana State Highway Department, was elected president. He graduated from Rose in 1914.

President Donald B. Prentice, Prof. Herman A. Moench, Prof. Edward A. MacLean, Prof. Roland E. Hutchins, and Mr. Henry C. Gray represented the Rose faculty, accompanied by a group of juniors and seniors.

Mr. L. W. Wallace, Director of Research for the Crane Company of Chicago, spoke at the banquet in the evening on "The Engineer and Civilization." President Prentice acted as toastmaster at the banquet.

Vote of Thanks

The residents of Deming Hall wish to express their sincere appreciation for the generous gift of Professor James A. Wickersham of more than one hundred and fifty volumes from his extensive library. The books range from complete works of classical literature to late detective fiction, and they will assuredly serve to dissipate many an hour of tedium.

Professor Wickersham taught languages at Rose from the opening day in 1883 until he retired in 1920, and after that thirty-seven years of service he states that he is inclined to teach nothing but chess, his reputation as a chess player being widespread. He is preeminently qualified to compile the history of Rose because he has maintained a close relationship with the school after retirement; this is shown by his ability to place a finger directly on one of the less apparent needs.

The school library was also enriched by several technical works.

Shattered Records

Henceforward we shall take some credence in the greybeards, cracker-barrel philosophers though they are, when they shake their venerable heads and sadly exchange glum comments on the decadence of the younger generation.

Patience, your virtue shall presently be rewarded when the reason for this bent is divulged. More rare than a day in June, it comes like a

bolt from the blue; Doc Sousley failed to meet a class! (The Basic Military Text prescribes that the clothing be loosened, that warm draughts be administered, and absolute quiet prevail in cases of shock.)

It seems that our Doctor was victimized by circumstances in this way: President Prentice was the guest of the Cincinnati Rose Tech Club when it met at the Netherland-Plaza Hotel on Monday, February 21. Part of the program was devoted to the solution of various mathematical problems which the members proposed, and President Prentice, remembering one unique method of solution upon his return, related it to Doc. Doc concentrated so intently on the possible methods of solution that the bell escaped his observation.

We thought you'd like to know.

A.I.Ch.E.

The American Institute of Chemical Engineers student branch at Rose assembled on Tuesday, February 15, to hear Mr. John G. Appel and Mr. Frank G. Pearce, student members, lecture on the purification of water for both industrial and domestic usage.

The speakers interested themselves in this field some time ago in preparation for the Rose Show and have devoted considerable effort to the organization of material and the inspection of various utilities units. Mr. Appel chose the bacteriological side of the purification problem and presented several cultures of organisms to illustrate his points. Mr. Pearce presented tests and figures to prove the cause and effects of the many types of water unsuited for industrial purposes.

A.I.E.E.

The American Institute of Electrical Engineers chapter at Rose, for its February project, ran a sound film Tuesday evening, February 15, in the assembly hall.

Mr. J. E. McArthur and Mr. C. R. Tufts, representatives of Thomas A. Edison, Incorporated, were introduced by Professor C. C. Knipmeyer, and they proceeded to explain the feature which was titled "Storage Batteries in the Mining Industry."

In addition to the student members, Dr. B. A. Howlett, and Professor H. A. Moench, second vice-president of the Indiana section, a considerable group of visitors representing the local mining industry attended the showing.

Page Demosthenes

The members of the Debate Club participated in the debating tournament which Manchester College holds each year at North Manchester, Indiana.

Two hundred and four teams engaged Friday and Saturday, February 25 and 26, in the argumentation which was centered around the resolution "Resolved That the National Labor Relations Board Should be Empowered to Enforce All Industrial Disputes."

Robert S. Kahn and James E. Ducey, who composed the Rose negative team, were victorious in three out of six debates, defeating Loyola, Marion, and the Manchester No. 1 teams, and losing to Heidelberg, Hope, and Wheaton Colleges. Lawrence J. Giacolette and Joseph A. Dillahunt, the Rose affirmative team, defeated Monmouth College.

The club was host to Hanover College on the preceding Thursday in a nondecisional debate.

Radio Club

This year as in the past, the Rose Radio Club endeavored to serve the increasingly large group of amateur radio operators, especially those who have just begun the hobby, by disseminating lessons in the International Morse code.

The daily lessons were given each evening, except Saturday and Sunday, from 6:30 to 7:30 o'clock by the club station, W9NAA, operating on a frequency of 1875 kilocycles with a power input of 250 watts. Each lesson was divided into four fifteen-minute periods. The extremely slow rate of transmission in the first period was intended for the beginner. The more rapid rates of the subsequent periods furnished practice for the advanced students.

Both mechanical and hand methods of sending were employed in the lessons which extended through a period of five weeks.

The club fully appreciates the response from those who were benefitted by this course and pledges itself to continue the lessons in the future.

Alumni Notes

edited by

Robert S. King, m., '40

Rose Tech Club Meetings

A meeting of the Southern California Rose Tech Club was held at the Hotel Rosslyn in Los Angeles, California, on January 21, 1938. The meeting consisted of a dinner and a general discussion of the Institute and club activities. The Rose men present at the meeting were: Archie Wade, '95; Max Hammel, '01; August Albrecht, '12; W. Scott Heer, '12; W. Scott Mace, '12; Joseph O'Connell, '13; Arthur Arnold, '15; Paul Brown, '16; Philip Minnis, '25; Scofield, ex-'28; and Homer Holmes, '28.

The present officers for the Southern California Rose Tech Club were re-elected to serve for the ensuing year.

A dinner meeting of the Cincinnati Rose Tech Club was held at the Netherland Plaza Hotel on Monday evening, February 21. Lester J. Bachman, '17, presided. An informal discussion of Polytechnic affairs and engineering education in general led to reminiscences of the undergraduate days and continued until nearly midnight. Those present were: Raymond F. Abbett, '19; Robert B. Asbury, '35; Lester J. Bachman, '17; John W. Bolton, '18; Donald M. Hubbard, '12; John B. Huntly, '03; William H. Junker, '21; Harry W. Knox, '17; Harry J. Loving, '31; O. Wayne Motz, '25; Warren T. Reddish, '13, and Donald B. Prentice.

Obituaries

L. Clifford Anderson, 64 years old, vice-president and sales manager of the Sorg Paper Company, Middletown, Ohio, and vice-president of the American Bank and Trust Company, Middletown, died February 3, in Christ Hospital, Cincinnati.

After graduating from Rose in the class of 1895 Mr. Anderson took up his residence in Franklin, Ohio. For several years he was manager of the municipal light plant there, and, following its sale to the Middletown Gas and Electric Company, he became manager of that company in Middletown. He was also a former manager of the Nashua Gummed and Coated Paper Company factory in Middletown.

He is survived by Mrs. Anderson, a daughter, Mrs. Mary B. Craig; and a brother, George Anderson.

Word has been received of the death of Professor William L. Ames at Datona Beach, Florida, on February 7. Mr. Ames was a member of the faculty of the Rose Polytechnic Institute from 1883 to 1896, holding in succession the professorships of drawing, descriptive geometry, and machine design. Professor Ames was a graduate of Worcester Polytechnic Institute and came to Rose with President Thompson, who resigned the presidency of Worcester to open the new engineering college in Terre Haute. Professor Ames was a brother-in-law of Mrs. Sarah P. Burton and the late Professor John Peddle of Terre Haute.

James J. Byrne was killed a few weeks ago in an automobile accident at Fort Worth, Texas. He was riding in an automobile with a special salesman, enroute from Dallas to Fort Worth, when the machine struck a bridge abutment.

Mr. Byrne attended Rose several years ago, and for two years after he left the Institute he traveled for Hulman and Company of Terre Haute. For the past two years he has been conected with Atlas, Incorporated, in Dallas, Texas.

Besides the parents he is survived by the widow, Doris Greene Byrne and two sisters, Florence and Betty Byrne.

Weddings

Announcement has been received of the marriage of Mr. John Robert Vendel to Miss Margaret Elizabeth Cordiner. Mr. Vendel is an alumnus of the class of '29. Mr. and Mrs. Vendel now reside at 321 North Piedmont Street, Buckingham Community, Arlington, Virginia.

George Owen Howson, '32, was married to Miss Yvonne Sublette of Pensacola, Florida, at Yuma, Arizona, November 19. They are now stationed at Coronado, California.

Engagement

Announcement is made of the engagement of Arthur C. Keiser to Miss Margaret Kraeger. No definite date has been set for the wedding, but it is understood that it will be soon. Mr. Keiser is a graduate of Rose of the class of 1928.

Births

Mr. Gilbert Shew, Rose, '30, is the proud father of a red-headed, eight pound baby girl. The baby is the first and was named Delilah Martha. Mr. Shew is now located in Vincennes.

Here and There With The Grads

'11 Henry W. Ker has accepted a position as sales manager for the International Machine Tool Company at Indianapolis.

'17 M. Harold Smith is with the Indianapolis Paint and Color Company, Indianapolis.

'21 William H. Junker was chairman of the committee on arrangements for the Golden Jubilee Dinner Dance held by the Engineers Club of Cincinnati, Ohio. The gala event was held on the evening of February

12 in the Hall of Mirrors of the Netherland Plaza Hotel with music by Clyde Trask and his orchestra.

'24 Leo F. McCullough has presented the Institute with a number of engineering text books.

'29 Theron S. Bell is commercial engineer with Gies, Incorporated, of Cincinnati.

'30 Morris T. Shattuck, with the du Pont Company at Belle, West Virginia, has been made assistant superintendent.

ex'30 Charles O. Barbre is now with the Agfa-Ansco Company at Binghamton, N. Y.

'32 Paul H. Sawyer, with the State Highway Department, has been transferred to Greenfield, Indiana.

'33 Edwin J. Withers has taken a position with Hiram Walker and Sons Incorporated in Peoria, Illinois.

'34 William A. Belstrom is with the Gulf Refining Company at Albion, Illinois.

James G. Brown, with the American Machinery and Metals Manufacturing Corporation, has been transferred to Moline, Illinois.

H. Loren Thompson is office engineer with the R. W. Hunt Company of Chicago.

'35 Ernest J. Welsh is now with Seagram and Sons Company, in Louisville, Kentucky.

John A. Cushman has taken a position with Seagram and Sons Company at Lawrenceburg, Indiana.

'37 J. Robert Penisten with Universal Oil Products Company, has been temporarily transferred to Riverside, Illinois.

Tommy N. Wells and James A. Hughes, immediately after graduation, spent four months in the training school of the Electric Bookkeeping and Accounting Machines Division of the International Business Machines Corporation at Endicott, N. Y. Mr. Hughes has now been transferred to Toeldo, Ohio, and Mr. Wells has been transferred to Flint, Michigan.

FRATERNITY NOTES

MARKS.

Alpha Tau Omega

Indiana Gamma Gamma chapter of Alpha Tau Omega is pleased to announce the pledging of the following freshmen as the result of the recent rush season: John E. Bartmess, Frank M. Beeler, Somers E. Blackman, John F. Carroll, John L. Combs, Joseph W. Dreher, Glenn R. Eudaley, Simon P. Gary, William M. Hales, Herbert W. Hall, C. Roger Howle, Charles A. Howlett, Robert D. Phelps, David F. Roach, John R. Roberts, Todd Rockstroh, Robert W. Rowe, William T. Rynick, Harry K. Strassel, and Lawrence N. Succop.

Friday evening, February 11, Gamma Gamma held an open house in honor of the new pledges. It was indubitably the most successful open house of the year, being well attended by both actives and pledges. Mr. and Mrs. John Phelps and Miss Helen Mahley and Captain F. A. Henney acted as chaperones. Dancing, cards, and refreshments constituted the evening's entertainment.

The chapter wishes to congratulate Brother Ewing Ross upon his election to the post of Financial Secretary of the student body for the calendar years, 1938-39.

On Saturday, March 5, the four Indiana chapters of Alpha Tau Omega held their annual state banquet and dance at the Lincoln Hotel in Indianapolis. The banquet, held at 4 o'clock, was followed by an address by the fraternity's national president, Judge Willard M. Benton of Kansas City, Kansas. This program was followed by the formal dance in the Travertine Room of the Lincoln.

Sigma Nu

Beta Upsilon chapter is proud to announce the following pledges: Nick Anderson, Terre Haute; Fred Bradshaw, Terre Haute; Jack Giddens, Indianapolis; John Kramer, Terre Haute; Bill Kerns, Attica; Harold Mallinson, Paris, Illinois; George Schull, Harrisburg, Illinois; Bill Rustamier, Terre Haute; John Tracy, Terre Haute; Jack Wilkerson, Terre Haute; and David C. Reifenberg, Brazil. Formal pledging services were held Monday, February 14.

The annual pledge banquet was held Friday, February 21, at the fraternity house. Several alumni were present.

The chapter had the pleasure of having Professor Edward A. MacLean at the meeting Monday, February 21. He gave an interesting talk on the subject "The Will to Learn."

The pledge dance was held March 11, in the redecorated fraternity house.

Theta Kappa Nu

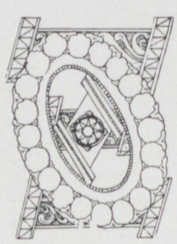
Gamma chapter installed the following officers at a recent meeting: Victor Peterson, worthy archon; Randall Wise, treasurer; Robert Underwood, scribe; and Robert Schilling, oracle.

The fraternity is happy to announce the pledging of Thomas F. Lane, Paris, Illinois; Lucien Nelson, Staunton; William R. Ringo, Brazil; William Ingle, Hubert I. James, James E. Shake, and William W. Turner, all of Terre Haute.

A card and bingo party was held at the house on Friday evening, February 25. Chaperons were: Dr. and Mrs. Berton A. Howlett and Dr. and Mrs. Weldon N. Baker.

Prizes were won by Frances Pearson, Lamont Forsyth, Betty Worley, Elmer Menefee, Anna May Turner, Bill Ingle, Dr. Howlett, John Whitesell, Mrs. Howlett and Herman Parsons.

Theta Xi

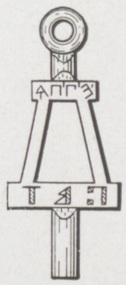


Kappa chapter has been quite active since the opening of the new term. The members were the guests of Mr. and Mrs. Floyd Foltz on January 6 for a Hungarian Goulash dinner, and the entire fra-

ternity has become confirmed enthusiasts for this gourmet's delight. Mr. Hubert Merrill, chapter D.L.G., entertained the members with a stag party at Hillcrest Lodge on January 26.

The fraternity takes pleasure in announcing the pledging of thirteen men. They were: E. LaRue Allen, Roy J. Babcock, B. Franklin Cook, Albert J. Crowe, Robert K. Gerow, Ivan C. Frakes, G. Clare Harper, Raymond C. Hogan, John D. Lent, William W. Loman, Don L. Morris, Thurber H. Morrison, and Edward J. Klecka. The pledge banquet was held at the Elk's Club, February 11. Mr. Henry C. Gray, Mr. H. Merrill, and Mr. Hartman were guests of honor.

Tau Beta Pi



The Tau Beta Pi Honorary Engineering fraternity met at Antoninni's in Clinton at 8:30 on the evening of February 16, for a spaghetti dinner.

Following the meeting President Wittenbrock opened a general discussion. At this time, it was decided that the annual Tau Beta Pi dance be held shortly after the Rose Show.

Humor

edited by

James E. Ducey,
ch., '40

THIS

This is not very interesting,
But if
You have read this far already
You will
Probably read as far as this:
And still
Not really accomplishing
Anything at all,
You might even
Read on
As far as this.
Which brings you to
The line which you are reading now.
And after all that, you are still
Probably dumb enough to keep right
On making
A dope
Out of yourself
By reading
As far down
The page
As
This.

—*Tiger.*

"Do you know what happens to little boys that don't tell the truth?"

"No, what?"

"They grow up and become Mechanical Engineers."

—*North Dakota Engr.*

Mullins: "Hosack, is it true that you lived in the dorm for two months before you found that it had showers instead of bathtubs?"

"Certainly I respect your legal advice, Mr. Jones, but what good is alimony on a cold night?"

There's the wonderful love of a beautiful maid,
And the love of a staunch, true man;
And the love of a baby that's unafraid—
All have existed since time began.

But the most wonderful love, the love of loves,
Even greater than that of a mother,
Is the tenderest, infinite, passionate love
Of one dead drunk for another.

—*Exchange.*

Junk Man: "Any old beer bottles you'd like to sell, lady?"

Spinster: "Do I look as though I drank beer?"

Junk Man: "Any vinegar bottles you'd like to sell?"

The Congressman's wife sat up in bed, a startled look on her face. "Jim," she whispered, "there's a robber in the house."

"Impossible," was her husband's sleepy reply. "In the Senate, yes, but in the House, never."

—*Penn Triangle.*

He: "Dear, this is heaven."

She: "Well, I'm no harp."

—*Ohio State Engr.*

"A skunk sat on a stump. The skunk thunk the stump stunk and the stump thunk the skunk stunk."

—*Montana Engineer.*

"Why was Adam created first?"

"To give him a chance to say something."

—*Ohio State Engr.*

Prof. Moench: "What is an armature?"

Kahn: "It's a guy who sings for Major Bowes."

Carroll: "Why is a ship a she?"

Scharenberg: "Because her riggin' costs more than her hull."

Was Sears burned up when some guy who lisped asked him whether he was a man or a mouth!

Sarge: "Now take this rifle and find out how to use it."

Eder: "Tell me one thing. Is it true that the harder I pull the trigger the farther the bullet will go?"

"Hey, mister! Your engine's smoking."

"Well, it's old enough."

Salt is what makes potatoes not so good if you don't put any on them.

"Ah wins."

"What you got?"

"Three aces."

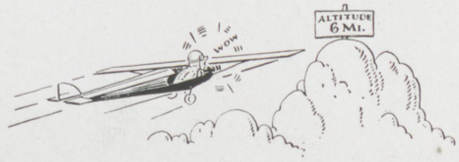
"No yuh don't."

"What yuh got?"

"Two eights and a razor."

"Yuh sho' do. How cum yuh so lucky?"

G-E *Campus News*

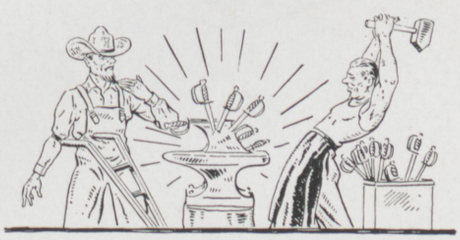


"SOUPED" ENGINES FOR SIX-MILE HEIGHTS

AS THE bellows is to the forge, so is the supercharger to the airplane engine. Because of the rarefied atmosphere at high elevations, airplane engines require superchargers which operate like fan blowers, maintaining air pressure in the engines and permitting the motor to operate at normal efficiency.

Today, twelve-hour flights from coast to coast at an average height of six miles are the objective of transport airlines. Experiments in this field have been successfully conducted by Transcontinental and Western Air, Inc., and the U.S. Army Air Corps with very encouraging results, using G-E turbine-driven superchargers.

Military, transport, racing, and transoceanic planes are equipped with G-E superchargers which increase motor efficiency, speed, and flying distance. The superchargers were developed by Dr. S. A. Moss, of General Electric and are built in the River Works in Lynn, Mass. Student engineers on Test at Lynn have an opportunity to inspect and test these devices as a part of their training course.



BEATING SWORDS INTO PLOWSHARES

WELL, not exactly swords into plowshares, but rather discarded rails, superheaters, and boiler tubes into steel for the overhead system of an electrified railroad line. In this manner the old steam railroad of the Witwatersrand Gold Mining Area was replaced by a completely electrified line.

Because of the rise in gold prices during the last few years, an increased suburban passenger traffic in that section of South Africa necessitated an enlargement of the railroad.

Mercury-arc rectifiers made by the British Thomson-Houston Company, an affiliate of General Electric, supply the power for the "Reef Scheme," as it is called, while 115 four-motor, multiple-unit car equipments were furnished by G.E. through the International General Electric Company.

The engineering and sales work on this project was done by several former G-E Test men. Many such opportunities are open to graduates of college engineering schools who have successfully completed the G-E Test Course.

AMERICA'S OUTSTANDING YOUNG ELECTRICAL ENGINEER

DR. CHAUNCEY GUY SUITS, research physicist of the General Electric Research Laboratory, in Schenectady, has been named by Eta Kappa Nu, honorary electrical engineering fraternity, as the outstanding young electrical engineer for 1937.

Born in Oshkosh, Wisconsin in 1905, Dr. Suits graduated from the University of Wisconsin in 1927 and from the Technische Hochschule in Zurich, Switzerland (Sc.D. '29). An ardent skier, he spends most of his spare time on the snowy slopes around upper New York State.

As a member of the Research Laboratory staff, his work has been on the fundamentals of electric arcs, showing how arc temperature can be measured by sound, and it was for this work that the Eta Kappa Nu award was given him. Other activities for which Dr. Suits is noted include the investigation of non-linear circuits, high-pressure arcs, and the development of automatic tuning for radio receivers.

Last year the award was given to Frank M. Starr, U. of Colorado '28, G-E Test '29, who is employed in the Central Station Engineering Department of General Electric. The Test Course, of which Starr is an alumnus, provides a practical education supplementary to the theoretical knowledge obtained in college.

GENERAL ELECTRIC