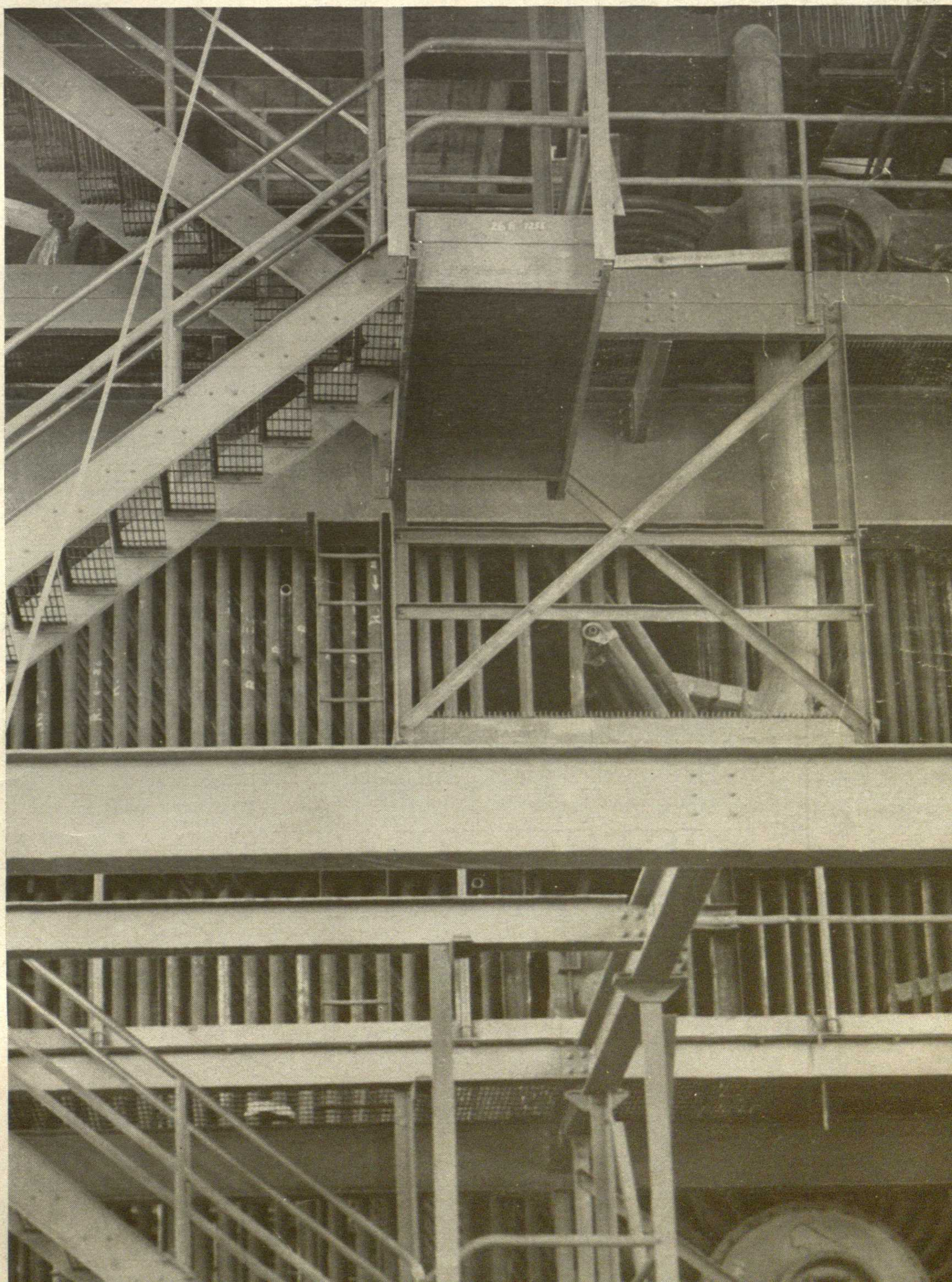
Spartan ENGINEER



SCHOOL OF ENGINEERING

MICHIGAN STATE COLLEGE

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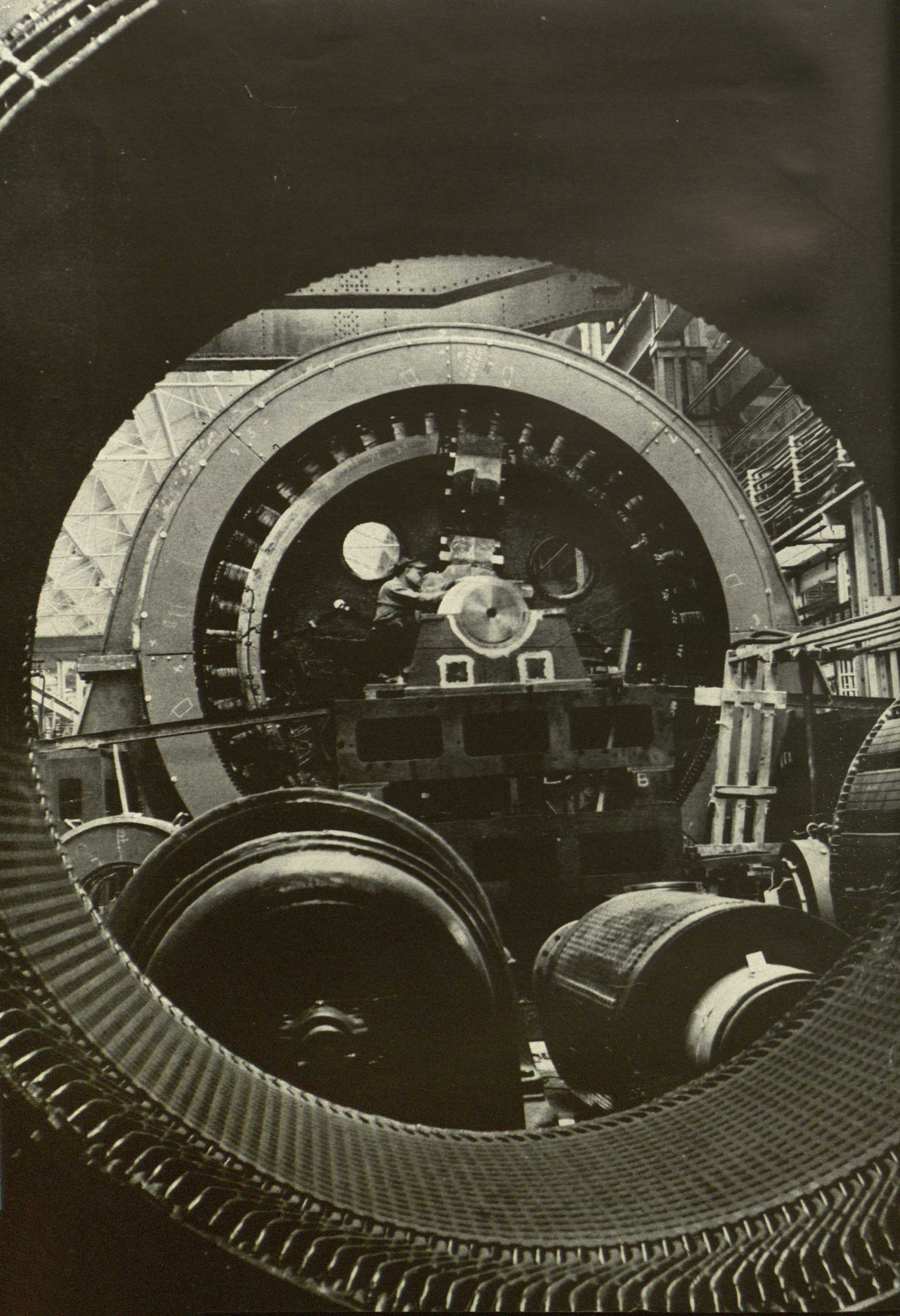

Spartan ENGINEER

Table of Contents

articles •

features •

The Cover This Issue: Interior photograph of the New Steam Generation Plant showing tubes and drums of one of the Wicks boilers during installation — Story on page four.

Frontispiece: Huge synchronous generator rated at 5,000 kw, 164 rpm, 6,600 volts, 3 phase, 60 cycles.
— Courtesy of General Electric

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Building No. 163

The New Steam Generating Plant

ROBERT M. BREZSNY

With the large influx of students necessitating a proportional increase in building facilites, the need for more electrical power output assumed a prominent place in the Michigan State College expansion program. In Michigan State's system, electric power for the campus stems from generators driven by steam turbines. Coal-fired boilers convert the water to steam, the steam turns the turbine, and the turbine in its turn drives the electrical generator by means of a direct shaft coupling. During the warmer months, the turbine runs condensing, that is, the steam is allowed to expand completely and is then removed to a condenser. For the cooler part of the year, steam removed or bled from the lower stages of the turbine at low pressure heats the various campus buildings.

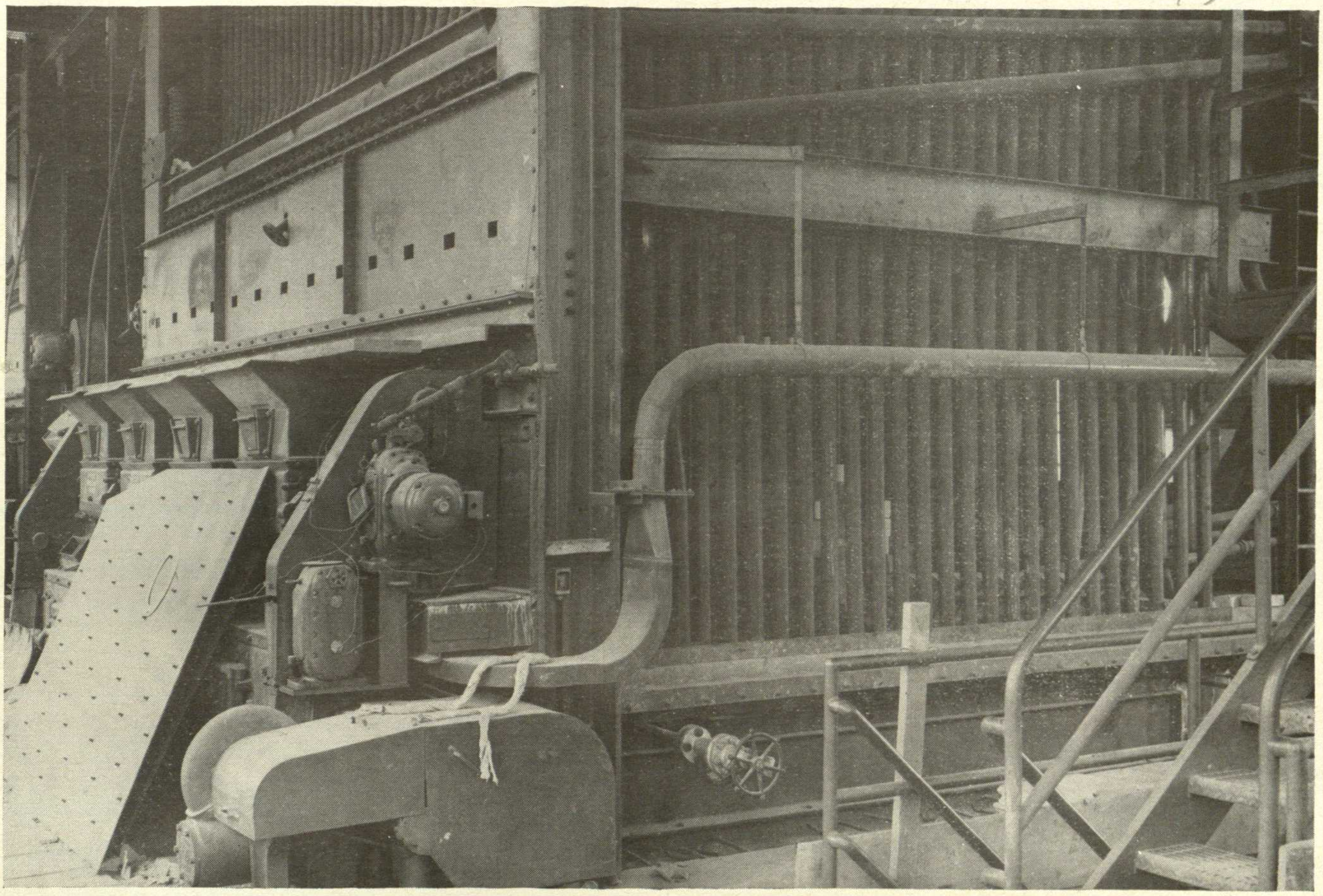
This system requires space for fuel storage, boilers, turbines, electrical equipment, and auxiliary equipment. At Michigan State these integral parts of the power system occupy a central position on the campus. Squeezed into available space between various engineering and maintenance buildings, the old power plant presents a crowded picture with its railroad tracks, coal piles, large stack, and boiler and turbine rooms. The solution to this power question could be evolved only in the erection of a new plant, or portion thereof. The college turned to South Campus as the obvious site for this much-needed building. The present boiler plant contains five boilers, however, two of these are condemned. The remaining three supply the required steam but no provision for boiler failure exists. Thus the situation can be likened to taking a long automobile trip without a spare tire. If you get a flat, you must stop and patch the tube before the car can continue to function efficiently. In like manner, if one of the boilers should break down, immediate repairs are necessary before the required amount of steam can be generated. This was the need that justified immediate action.

Claud R. Erickson, consulting engineer for the Lansing Board of Water and Light, designed the new steam generating plant now nearing completion. Situated south of the Red Cedar river, the new building occupies a space across the railroad tracks from Macklin Field.

The location near the tracks facilitates delivery of coal. The new system will retain coal as fuel. Any amount of the fuel may be stored along the tracks within easy reach of a railroad-mounted clam type crane or any type of bulldozer. Construction of the plant eliminates the necessity of lifting the coal by crane to the bunker level as in the old boiler plant layout. At the building site run two parallel sets of railroad tracks under which coal pockets have been built. The pocket under the outboard track (farthest from the building) finds use primarily as a storage hopper. The hopper beneath the inboard track feeds directly to the coal handling equipment.

Manufactured by Stephens-Adamson Company, this coal handling unit, known as the Redler System is a comparatively new development. The hopper delivers the coal to a crusher which breaks the fuel up into particles that do not exceed a maximum diameter of three-fourths of an inch. This permits the purchase of mine run coal, a cheaper grade than that used at the present boiler plant. From the crusher the fuel moves along a conveyor to an elevator shaft and is lifted seventy-five feet into the air. Another conveyor distributes the coal to the five bunkers. The elevator part of the system moves the coal upward in a solid stream. This is done by a chain consisting of flat "C" shaped plates that remain horizontal as the links rise. The Redler System can thus handle fifty tons of fuel per hour. An average coal car contains forty to sixty tons.

Enclosed bunkers keep coal dust in the air at a minimum. The bunkers feed fuel to the boilers directly by gravity and from either side by means of an under bunker conveyor built by Stock Engineering company. In older systems that do not have the under bunker conveyor, each boiler receives coal from a specific bunker. Thus if a boiler goes out of service, the coal stored in the bunker becomes useless to the plant. In State's new plant efficient planning provided a means to avoid this bottleneck. The coal is no longer tied up. A scale weighs the amount of fuel fed to each boiler and then delivers the weighed fuel thru a chute to the stoker.



One of the New Boilers During Installation

Built by the Detroit Stoker Company, the Roto-Grate stoker contains four kickers or spreaders spaced across the front of each boiler. These spreaders throw the fuel particles out on the grate. The grate itself travels slowly toward the stoker. When a point below the stoker is reached, the grate passes over a roller and reverses direction. At this point combustion is completed and the remaining ash drops off into the removal system.

The ash must be lifted from below the front of the boiler to a position at the top of an ash tank located in the northeast corner of the building. There are two types of ash removal systems—hydraulic and dry. Hydraulic removal embodies the use of water; the dry system employs air. MSC uses hydraulic sluicing in the present system, but the dry method is installed in the new plant. It will operate as follows: a vacuum, created at the top of the unit by a steam jet, causes air, admitted at the lowest point in the system, to rush upward. Picking up the ash enroute, the air moves to the top of the unit. There the ash-laden air passes thru a cyclone type precipitator. Precipitated solids drop into the ash storage tank below and the air moves on thru a washer to insure a dust-free atmosphere.

Built as an integral part of the building, the ash storage tank terminates high enough above the grade level to allow for gravity unloading of ash removal trucks. The removal process remains dustless because of the installation of a dustless unloader which automatically mixes water with the ash. United Conveyor manufactured the ash handling system. With the ash removed, attention can now be focused on the boilers.

Wicks Boiler Company of Saginaw, Michigan constructed the boilers which are designed to operate at 300 psi pressure and 550 degrees Fahrenheit. Under the preceding conditions, each boiler should develop 100,000 pounds of steam per hour with a possible four hour overload of 125,000 pounds per hour. The plant design calls for three boilers, but only two have been installed so far.

On the top level of the building forced draft fans, driven by 75 HP electric motors, supply the air required for combustion in each boiler. The air passes through a preheater on the way to an air pocket below the grate. Next the air moves upward through the grate causing combustion to take place. The products of combustion then move over the tubes, over the baffels, and into the air preheater. Thus the products of combustion preheat the incoming air. Finally the gases reach a precipitator where 93% of the solids are removed. The induced draft fans are driven by 290 HP electric motors. They are located above the boilers and carry the exhaust gases out the stacks.

The solids removed from the exhaust gases in the precipitator may be routed two ways. If completely burned, the residue may be added to the ash in the ash storage tank for removal. If, however, the solids are not completely burned, they may be blown back into the boiler by means of high pressure air. Thus efficient methods keep loss of energy to a minimum.

Four DeLaval centrifugal pumps feed the water from the condensate storage tank to the boilers. Motive power comes from two 60 HP and two 100 HP electric motors. In addition to this electric drive one of the pumps requiring 100 HP may operate by a small steam turbine mounted on the pump shaft. The smaller pumps are rated at 117 gallons per minute and the larger ones at 234 gallons per minute. Connected in parallel, all of the pumps can handle up to 702 gallons per minute. Each pump is rated at a pressure of 392 psi or 905 feet of head.

Once generated, the steam must travel to the turbine floor in the old power plant. To accomplish this, one 12 inch and one 8 inch pipe line carry the vapor from South to North Campus. Another 8 inch main returns the condensate to the new plant. These three mains pass over the Red Cedar River protected and supported by the new foot bridge which thus serves a dual purpose.

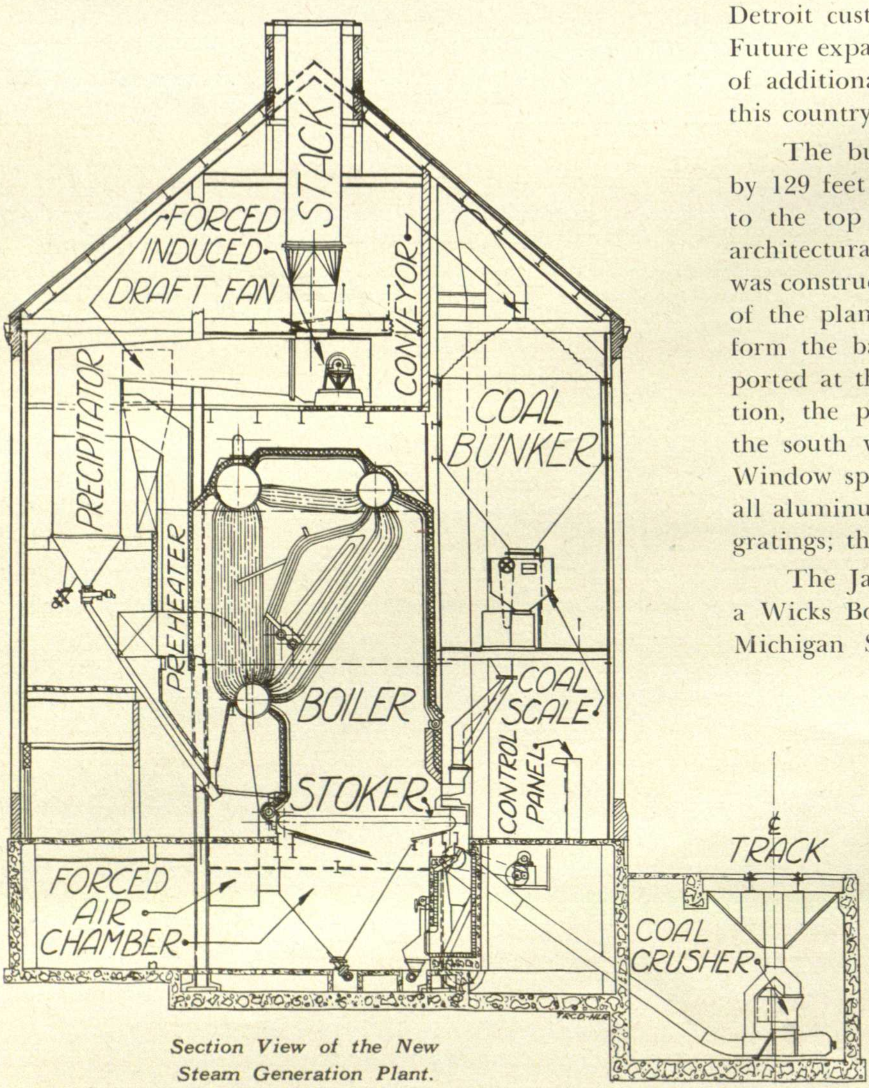
Even though the water-to-steam-to-water system is closed a small amount of water is lost in process. The water used must be soft water, otherwise the solids would precipitate in the boilers and tubes. Scale formed in such precipitation is definitely injurious to the metal and the life of the installation would thus be shortened. Boiler makeup water is supplied by a softening system at the old plant. For the new plant the present softening setup in the old plant will deliver the required makeup water.

Directly in front of each boiler stands a control panel. The equipment pertaining to each boiler can be controlled at the individual panel, however, the electrical relays and other controls occupy a space in the southeast corner of the building. These are all incorporated in a panel known as Cabinetrol. Despite the fact that General Electric manufactured Michigan State's Cabinetrol in their Detroit custom-built shop, the design is standard. Future expansion can be accomplished by purchase of additional sections. Not many installations in this country have such a system.

The building itself occupies an area 62 feet by 129 feet and measures 85 feet from grade line to the top of the stacks. Following the general architectural styling of the campus, the building was constructed only to protect the functional parts of the plant from the elements. Brick and steel form the basic structure. With the columns supported at the lowest level of the building foundation, the plant may be enlarged by tearing out the south wall and building toward Shaw Lane. Window space is ample and the window sash are all aluminum. The upper floors are made of steel gratings; the stairs are also of steel construction.

The January issue of *Power Magazine* carried a Wicks Boiler Company advertisement featuring Michigan State College's new steam generating plant. In this ad Wicks calls State's installation the best of any institution in the country. Some of the reasons for this rating can now be considered. First there is a large amount of bunker space for coal storage. One day shift at the plant should store enough fuel in the bunkers for 24 hour operation. Along with the bunkers, mention must be made of the under bunker conveyor. This conveyor eliminates isolation of coal when a boiler is

continued on page 23



Section View of the New Steam Generation Plant.

Sales Engineering

A Post-War Profession

BERNARD LESTER

The Westinghouse Electric Corporation

Sixty days ago the new plant for building pumps would have been a great place for an entertainment — walls glistening, the floor big enough for a roller skating rink. But now the steady fluorescent light from the ceiling sheds its bright rays over long rows of machine tools, conveyors, and spotless work tables. Not only a safe efficient layout, but a pleasing place to work.

It had all come about through the persistent skill of the Works Engineer and his crew, and the Sales Engineers representing suppliers of just the right apparatus for the job. A building itself years ago was ninety per cent of the investment. Now the tables have turned. The house — important enough — is designed to enclose a whole array of carefully engineered apparatus, many times its value.

Machines? Plenty of them. All were selected and tailored for one particular job. And here they were alive. Motion and power with infinite exactness all engineered to perform one particular duty — to make high grade pumps efficiently and profitably.

In accomplishing such a result the work of the Sales Engineer is seldom recognized. To the casual observer the credit for producing all this productive apparatus goes to the men at the supplier's headquarters who designed and built it, and to the people who own and run the plant where it is installed. But to the capable and resourceful Sales Engineer should go much of the credit for intelligence in putting the various tools to their proper use. His job is never done, until what he sells is properly engineered and in place, continually producing the full service for which it was intended.

Exactly what does this Sales Engineer representing the apparatus manufacturer do? He is an engineer, a practical economist, and a promotional force — these, all in one. He must know the design and construction and operating factors of what he sells. And too, he must know people — how their minds work — from the customer's engineers to their purchasing agent who places the order.

Sales Engineering during recent years has jumped by leaps and bounds into a position of singular importance. Everyone knows that the age in which we are living is becoming increasingly mechanical, but technical products are useless unless skillfully applied.

Saving the old horse and buggy with paint and repair no longer works. Machinery and equipment are on the move. There are better designs each year, with new operations to perform. Results come in the ever-expanding use of capital goods, through spending wisely, with a keen knowledge of depreciation and possible output, and through earning power.

With all this progress has come a great change in the art of selling productive equipment. Years ago the machinery salesman was a high powered entertainer. For instance, he knew scarcely more about the power plant equipment to be sold to the village than the city fathers themselves, as they accepted his entertainment and sometimes his graft. Sales Engineering is today a serious job requiring talents of a high order. Yet we still associate with selling the idea of persuasion to buy that which one may not actually need. Not so with the Sales Engineer. He does not grab the order and disappear. He must live with his customers year after year. He is the consultant — the expert in his line of equipment — the man who gets into the plant and works out the problem. Sometimes his recommendations are not to buy and often this advice creates a reputation that is worth its weight in gold for many years to come.

Creative? No class of engineering service is more creative than that of the Sales Engineer. Of course, he creates business for his employer. But materials are of little value in their native state. The value in the machine tools he sells, for instance, traced way back, is the work that has gone into the making of them.

Who could be more productive in creating work for his own company or for the plant that uses his machines, products, and services.

But Sales Engineering is creative also in another sense. Back in the black thirties there was a run-down paper mill — antiquated, inefficient,

continued on page 24

WKAR - AM

Broadcasting Service of Michigan State College

CLIFF F. GRAY

Although WKAR has been in operation for nearly eight years, the installation is still one of the most modern in the country. The amplitude modulated transmitter is a 5000 watt installation built by the Western Electric Company and employing the Doherty linear amplifier. It is located just south of the river opposite the Auditorium Building. The transmitter occupies its own building, and the antenna is located just south of it. The studios are located in the Auditorium Building.

The heart of a radio transmitter is the radio frequency section. This provides the carrier which serves to carry the program from the antenna through the ether to your radio. In radio there are two general classes of frequencies, radio and audio. Audio frequencies are those which you can hear or, in other words, are audible. The human ear is capable of hearing frequencies of from about 20 cycles per second to nearly 20,000 cycles per second, the higher the frequency the higher the note. These frequencies are those which you hear coming from your loudspeaker. Those frequencies above the audio range are designated as radio frequencies. In the case of WKAR the frequency used is 870 kilocycles, or 870,000 cycles per second. This is far above the audible range. The 870kc. radio frequency wave acts as carrier for the audio or program from WKAR's antenna to your radio.

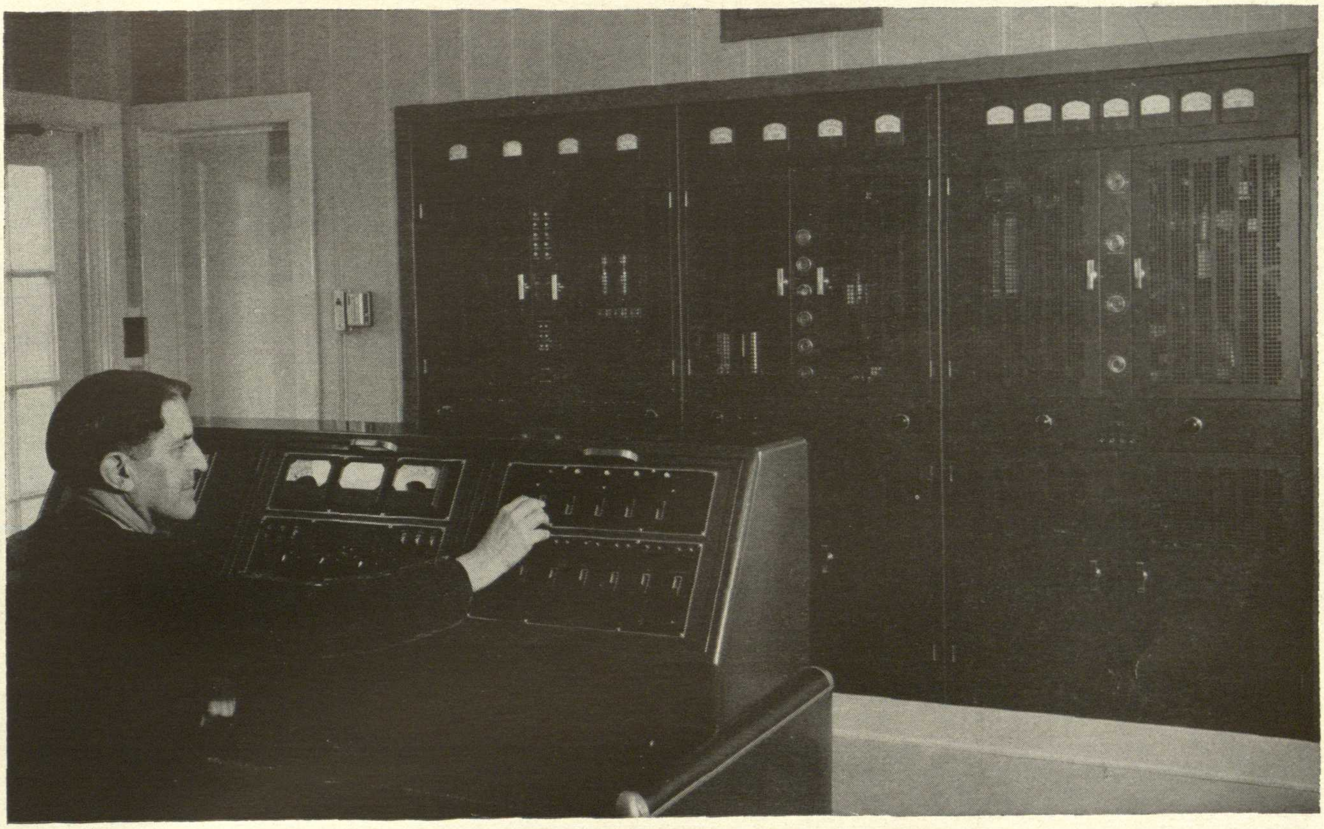
The 870kc. is generated in a temperature controlled crystal oscillator. This provides extremely accurate control of the frequency. The variation from 870kc. is generally less than 5 cycles, or roughly 1 part in 200,000. Control as accurate as this is necessary to eliminate interference between different stations operating on nearby frequencies.

To provide a check on the operating frequency at all times, a frequency meter which operates separately from the transmitter is used to measure the operating frequency. This meter reads directly in cycles off the assigned frequency. Periodic checks of WKAR's frequency are also made by a standard laboratory in Detroit. Two entirely separate crystal oscillators are maintained. If one should fail or get too far off the assigned frequency, uninterrupted operation is maintained by switching to the other oscillator.

The power output of the crystal oscillator, while accurately controlled with respect to frequency, is very small. Since the rated output of WKAR is 5000 watts it is necessary to amplify the output of the oscillator until it reaches 5000 watts. First a series of amplifiers increase the power until it is sufficient to drive the modulated stage. The modulated stage is the place where the program is introduced onto the carrier. In this case it is the stage before the final amplifier. This stage consists of two type WE 249B tubes in parallel. The 249B is a triode rated at 200 watts plate dissipation. These tubes are grid bias modulated.

The most interesting feature of the transmitter is the final amplifier, which is of the Doherty type. We shall have more to say of its operation later, but first a comparison of other types is in order.

There were, before the innovation of the Doherty amplifier, two generally used systems in high power broadcast transmitters. The first is plate modulation. In this system audio power equal to one half the power input to the final amplifier is applied to the plate of the final amplifier tube (s). The final amplifier is operated as a class C stage. The other system is that of the class B linear amplifier. In this system the input to the final amplifier is a modulated wave and the amplifier only serves to increase the power and does not modify the wave in any way. The system of plate modulation has the advantage of high operating efficiency. Most of the DC power input to the final amplifier is converted into radio frequency power. It has the disadvantage, however, of requiring an audio input power equal to one half of the DC input power to the final stage. In the case of the average 5000 watt transmitter this would be of the order of 4000 watts (the 5000 watts, it is to be remembered, is actual unmodulated carrier output in the case of broadcast transmitters). An audio system which will provide this power at high fidelity is very expensive. In the class B linear system this objection is avoided since the transmitter is modulated in some lower power stage. However, since the amplifier is amplifying a modulated wave, it must respond to changes in the input wave as they occur. This necessitates



Mr. Norris Grover, Chief Engineer, at the Operating Console of the WKAR Transmitter

operating the amplifier at a very low efficiency. The efficiency is usually of the order of 33% and is sometimes even lower. This means that for every watt of carrier output three watts must be supplied to the tubes. Therefore the tubes will have to be much larger than in the class C plate modulated amplifier, and the power consumption is also excessive.

A linear amplifier operating at the high efficiency of the class C plate modulated amplifier would provide an amplifier with the advantages of both systems and without the major disadvantages of either. While not the first such system proposed, the first to find commercial acceptance was the one proposed by William H. Doherty of the Bell Telephone Laboratories in 1938. The design of the amplifier was incorporated into the final amplifier of the Western Electric type 405B-1 transmitter installed at WKAR.

Figure 1 represents the basic circuit of the Doherty amplifier. The operation is based on the impedance inverting property of a 90 degree phase shift network, also called an artificial quarter wave line. At the operating frequency the capacitive reactance X_C of the two capacitors in the network is made just equal to the inductive reactance X_L of the inductance. This property may be observed by considering one of the networks isolated and shorting one of the capacitors. This causes the inductance and the other capacitor to form a parallel resonant circuit. Then the impedance across the other end of the network (in other words the other capacitor) is very high when the one end is shorted. If, on the other hand, the short is removed and no load is placed across the capacitor, then it and the inductance form a series resonant circuit and the impedance across the other capacitor becomes very low. Whenever the impedance is changed on the load (output) side of the network, then the impedance on the line (input) side of the network changes in the opposite direction. This property is essential to the operation of the Doherty amplifier.

The Doherty amplifier consists of two tubes. One tube is called the carrier tube, the other the peak tube. With unmodulated carrier nearly all of the load is carried by the carrier tube. On the positive peaks of modulation the peak tube carries a substantial proportion of the load. With unmodulated carrier the grid bias on the carrier tube is adjusted so that it carries the load, and the grid bias on the peak tube is adjusted so that it is nearly cut off. When the radio frequency drive is adjusted to give the rated carrier output the carrier tube is just at the point of plate saturation. That is, increasing the drive to that tube would produce no increase in radio frequency power output. This occurs when the peaks of the radio frequency voltage on the plate are roughly equal to the DC voltage on the plate of the tube. The

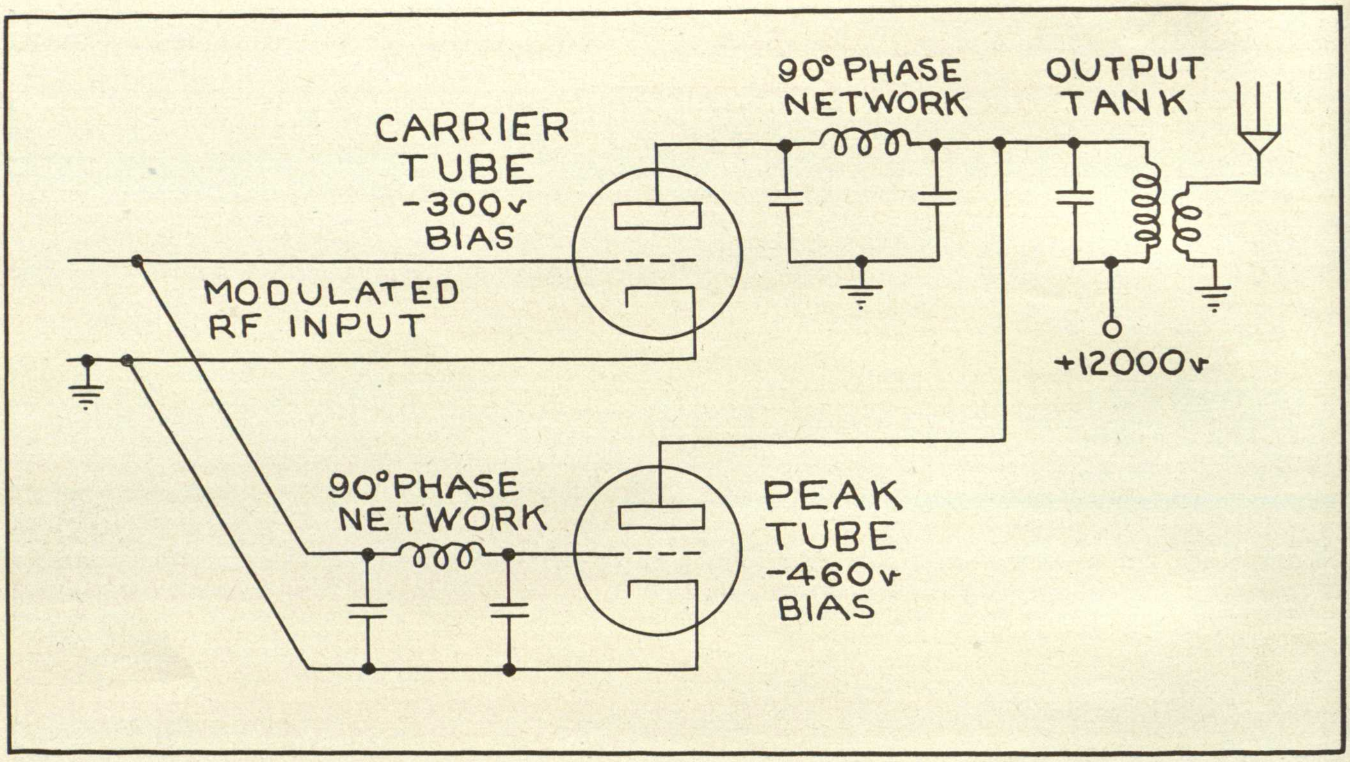


Fig. 1 Basic Circuit of the Doherty Linear Amplifier

RF voltage is, of course, dependent upon the plate load impedance which is furnished by the antenna through the output tank circuit and then through the 90 degree phase shift network. The advantage of having the tube operating at plate saturation is that the efficiency is much greater than one operated as a linear amplifier below saturation so that amplification of the positive peaks of modulation occur without distortion. However, in order for the amplification to be linear it is not only necessary that the peak tube operates on the positive peaks of modulation, but it is also necessary that the carrier tube puts out more power. This is accomplished in the following manner. On the positive peaks of modulation the peak tube begins to furnish power to the output tank circuit. An increase in the voltage results across the output tank. This causes the same effect to the carrier tube as increasing the impedance of the output tank since the carrier tube must now supply less RF current to maintain the same voltage across the tank. This is in turn reflected back through the 90 degree phase network and is inverted making the carrier tube work into a smaller value of load impedance. Since the positive peak of modulation is also applied to the carrier tube it now has an increased drive voltage. This allows it to maintain the same voltage across the lowered plate impedance thus increasing its power output on the positive peaks of modulation. The sum of the power in the peak and carrier tubes appears across the output tank, and is conducted from there to the antenna. The efficiency in the peak tube is very high since it is biased beyond normal class C operation. The overall efficiency of the Doherty amplifier is usually about 65%. The 90 degree phase shift network in the grid circuit of the peak tube serves only to make the voltages from both tubes in phase across the output tank.

The final amplifier at WKAR uses two type WE 343AA tubes. These are air cooled triodes rated at 5000 watts plate dissipation. The anode is provided with fins and is enclosed in a sleeve. Air is forced past the fins, cooling the tube. The installation at WKAR was one of the first in the country to employ forced air cooling in a 5000 watt Doherty circuit. It should, of course, be noted that the circuit of figure 1 is only a diagram of the basic circuit of the Doherty and not the actual circuit of the transmitter. The actual operating circuit employs many refinements such as harmonic and parasitic supressors. No attempt has been made in figure 1 to indicate the DC circuit.

The antenna is a shunt fed, grounded, quarter wave tower. The antenna feed line is a 72.1 ohm coaxial line. The line can be nitrogen filled but it has not been necessary to do so in the past. An extensive copper wire ground system is installed to provide a uniform field pattern and high radiation efficiency. The tower lights are automatically controled by a photoelectric cell which turns on the lights at dusk and turns them off at dawn.

The entire operating power for the transmitter is taken from a 240v. 3 phase line. All of the operating voltage for the transmitter is controled by a voltage regulator which maintains the voltage constant regardless of line voltage variations. The 12,000v. for the final amplifier is supplied by a three phase, full wave, bridge rectifier. It is interesting to note that the original six rectifiers are still in service with over 28,000 hours of operation.

The power circuits of the WKAR transmitter are controled through a series of relays. These relays provide for a definite sequence in which the units of the transmitter are turned on. The filaments for the transmitter are controled through three separate circuits. The rectifier filaments, the power amplifier filaments, and the oscillator amplifier filaments. The oscillator amplifier unit comprises all of the operating circuits of the transmitter except the rectifiers and the final amplifier. It is necessary that the forced air cooling be turned on before the final amplifier filaments are turned on. The filaments in each of the 343AA tubes dissipate over 1kw. each, and if no cooling were provided there would be danger of breaking the glass seals. The oscillator amplifier and rectifier filaments are energized as soon as their respective switches are thrown on. The rectifier filament switch also energizes a time delay relay at the time it is turned on. At the end of three minutes the time delay relay operates and turns on the bias voltages and allows the high voltages to be turned on. This three minute time delay is necessary to allow the mercury vapor rectifier tubes time to warm up. If the high voltage is applied to them before they are sufficiently warm they will be damaged beyond repair. At the end of the three minutes the rest of the transmitter may be put into operation by throwing the oscillator amplifier plate switch and the high voltage switch. The former applies voltage to all stages except the final amplifier. The high voltage switch controls the 12,000v. for the final amplifier. If these switches are thrown on before the end of the three minutes the high voltages simply come on automatically at the end of the three minutes.

That is the normal power sequence. The transmitter has, however, safety and protective devices which will interrupt this sequence to prevent either damage to the transmitter or danger to personnel. In both the final amplifier and the modulated amplifier before it there are overload relays in the plate circuit to prevent them from drawing excessive currents. Protection for personnel is provided by door interlocks in all of the operating compartments of the transmitter. These turn off all of the circuits supplying high voltage to the compartment whenever the door is opened. In the compartment containing the final amplifier it is necessary to completely short the 12,000v. supply to ground before the compartment door can be opened.

One of the best features of the transmitter is the system of indicating lights. These lights enable the operator to tell at a glance just which circuits are energized and which are ready to be energized. There are two lights associated with each switch, one red the other green. If the green light is on this means that the circuit is ready to be energized when the switch is turned on. If the red light is also on then the circuit is energized. For example, the green lights associated with the oscillator amplifier plate and the high voltage switches do not come on until the end of three minutes. This is a great help in locating trouble in the transmitter and isolating it to a particular unit. There is also another series of lights which indicates whether the overload relays are closed.

The design of the transmitter is such that it could be operated from a remote location. Operated as a standard broadcast station, as is WKAR, this would be against the law. However, in other types of service it is not necessary that the operator be at the transmitter. The power circuits are so arranged that an identical set of switches and indicator lights is on both the operating console and the transmitter panel. If the operating console were many miles away it would still be possible to turn the transmitter on and off from there. There is also a remote reading antenna current meter on the console so that the power output could be checked from the remote location.

Another feature incorporated into the transmitter is automatic change over to reduced power. There are many stations in the United States which have a different rated power at night than during the day. This transmitter is so designed that for a station licensed, for example, for 5000 watt daytime operation, and 1000 watt night time operation, all that is necessary to change from 5000 watts to 1000 watts is to throw a switch. This eliminates the necessity of having two transmitters. The change over is accomplished primarily by reducing the plate voltage on the final amplifier.

The station requires one operator at the transmitter at all times. He is required by law to keep a log of the transmitters operation. Each half hour it is necessary to log the antenna current, the final amplifier plate voltage and current, the frequency deviation, and the crystal oven temperature. In addition the time the station goes on and off the air and any interruptions in operation must be logged. In general the transmitter operator is legally responsible for what is going over the air at any time. He is also responsible for seeing that the station leaves the air at the end of

continued on page 26

Capturing Light

The Chemistry of Photography

LAWRENCE K. WARTELL

Click! An insignificant sound. Yet what an essential part it plays in photographic procedure. In the brief span of time that the shutter of a camera clicks chemical action is begun, action that requires further chemical treatment to produce a finished and permanent record of what was photographed.

The basic reaction underlying photography is the observation that certain substances, in particular the salts of silver, undergo a chemical change when exposed to light. Although silver chloride was known to the early alchemists, the first recorded observation of the darkening of a silver salt when exposed to sunlight was in 1727. In that year Johann Schultze prepared copies of stenciled letters with a mixture of silver nitrate and chalk. The last twenty-five years of the eighteenth century and the early part of the nineteenth was a period during which a large number of observations were reported on the chemical activity of light. This culminated in the publishing of a paper in 1802 by Thomas Wedgwood and Sir Humphrey Davy, which described the making of prints on leather that had been treated with silver nitrate. The prints, however, were not permanent – that is, on further exposure to light the whole print would darken obscuring the image. Also the process was very slow. The first permanent photograph was made by Joseph Nicephore Niepce in 1826. The slowness of his process and the lack of contrast rendered the method of little interest for photographic purposes. Another Frenchman and partner of Niepce, Louis Jacques Mande Dagueere, developed a silver iodide process that produced pictures of beautiful quality. The product of this process later was to bear his name as daguerreotypes. William H. F. Talbot worked on the positive-negative theory and was the first to develop a latent image in the negative and use it to make a positive print. His work, done in the middle of the nineteenth century, was made possible by the earlier development of a fixing agent, sodium thiosulfate. From this beginning, with the transition from wet to dry plates, and finally to a film base for the sensitive emulsion, the story of photography is one of constant improvement in quality and convenience.

Chemicals of a high degree of purity are used in the preparation of the two principle constituents of modern photographic films, the base or film support and the light-sensitive emulsion. It should be noted that throughout this article the term emulsion is used as in photographic terminology, i.e. it refers to a dispersion of solid particles in a liquid phase.

Two general types of film support are manufactured, namely cellulose nitrate, which is quite inflamable, and cellulose acetate, the slow-burning safety film. The quantity of the latter film has been increasing steadily. The process of manufacturing the film support is complex and involves dissolving the cellulose acetate or nitrate in such solvents as acetone. This solution is referred to as film 'dope'. Plasticizers are added to the dope to give elasticity and flexibility to the film support. Camphor is a common plasticizer. The film dope is formed into the thin transparent film support by evaporation of the solvent. This is done in drum machines that produce various widths up to 60 inches and lengths up to 2000 feet. Depending on the purpose or use the thickness varies from about .003 to .008 in. Before the support is coated with emulsion it is usually coated with a substatum to insure maximum adherance of the emulsion to the support.

The light sensitive emulsion is essentially a homogeneous suspension of silver halides in gelatin. A physical function of the gelatin is the protection of the unexposed silver halide grains against development. Silver halides without the presence of gelatin will be reduced by organic reducing agents or developers, no matter whether they were previously exposed to light or not. Silver halides imbedded in gelatine will not be affected by a photographic developer unless exposed to light. The gelatin molecules, having surrounded the silver halide particles, seem to form a protective layer preventing the developer from reacting too vigorously with the silver halide particles or 'grains' as they are called. Gelatin will not dissolve in cold water, but will soften and swell, thus allowing chemical agents to enter the emulsion and react with the silver halide. To prevent the gelatin from going into solution in moderately warm water, hardening agents, such as formaldehyde and alum, are added.

The chemical aspects of the gelatin are also important in the photographic process. Some gelatins produce very sensitive emulsions while others are unsatisfactory for photographic use. The presence of a *sensitizing substance in certain types* of gelatins was proven by Dr. S. S. Sheppard. He showed this to be mustard oil, which contains sulfur. During the manufacture of the emulsion the oil decomposes to form tiny specks of silver sulfide which later act as nuclei of sensitivity. This is the basis of the "Concentration Speck Theory" of Sheppard. The interaction of these specks with the silver halides during the 'after ripening' stage of emulsion manufacture will be discussed shortly.

Alkali chlorides, bromides, and iodides are used in the manufacture of sensitive emulsions. When a solution of silver nitrate in water is added to a solution of any one of these salts a light sensitive silver halide is produced which is extremely insoluble in water. It will settle to the bottom of the vessel in a water medium but will remain suspended in a gelatin solution. Of the three silver halides silver bromide possesses the most sensitivity to light, silver iodide the next, and silver chloride the least. Generally mixtures of two of these salts, such as chloro-bromide, chloro iodide, or bromo-iodide, are used which have a sensitivity to light intermediate between the sensitivity of the two components. However, in the case of bromo-iodide emulsion, with increasing quantities of iodide up to about 6%, the light sensitivity increases considerably over that of a pure bromide. With further quantities of idodide it falls off again.

The actual preparation of photographic emulsion is a very complicated process. The details of the process are regarded as manufacturing secrets by the companies in the field. Nevertheless, the broad principles of emulsion manufacture are generally well known and may be described as follows. A solution of gelatin of known characteristics is prepared and to this is added the correct amount of one or more sodium or potassium halides. The mixture is placed in a water jacketed kettle and stirred at a constant temperature. The necessary quantity of silver nitrate solution is brought to a predetermined temperature and then run into the gelatin-halide mixture at a definite rate. A milky precipitate of light-sensitive silver salts is produced. A further quantity of gelatin solution is usually added after the precipitation of the silver halide is complete. Then the mixture is maintained for a definite time at a moderately high temperature (110°-150°F) to permit an increase in the light sensitivity by digestion of the silver halide grains. This digestion period is known as the ripening stage. During this period the colloidal particles slowly change into recognizable crystals of silver halide. The increase in crystal size alone would, however, hardly account for the gain in sensitivity. Therefore, chemical interaction between the gelatin and the silver halide must occur. It is known, moreover, that these chemical reactions will not be as predominating during this phase of the emulsion preparation as they doubtless are during a later stage, usually referred to as the after-ripening.

There is still another chemical property of the gelatin of great importance during the ripening of the emulsion. Gelatins with the same amount of ripening substances still show differences in their ripening and it is known that the gelatin contains, besides these ripening substances, anti-fogging substances or inhibitors. These will counteract an excessive ripening effect which might otherwise lead to fog — a state where even the unexposed emulsion is blackened by photographic developing solution. These anti-fogging substances are believed to be similar to albumen. When they are removed from the gelatin very unstable, high ripening emulsions are obtained. It is believed that inhibitors retard the ripening and control the growth of the silver halide particles, but it might also be possible that they form salts with the silver. During the ripening stage both transparent and opaque crystals of silver halide appear. The larger ones appear to have the shape of triangles and hexagons, sometimes with rounded edges. The smaller ones are round but it is definitely known that they are also crystalline. The shape and size of the grains and also the speed and gradation characteristics of the emulsions are determined by the conditions during the mixing of the silver nitrate and the alkali halides. Important conditions of mixing are the *temperature*, the *concentration* of the solution, and the mixing time. In general, it can be stated that the finer grains are obtained in dilute solutions with low temperatures and short mixing time, and the coarser grains in the more concentrated solutions at higher temperatures and

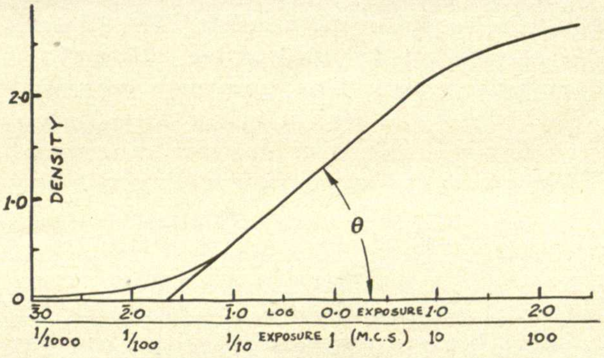


Fig. 1 Density vs Log Exposure Time

with longer mixing times. During the addition of the silver nitrate and the subsequent digestion, the larger silver halide particles grow at the expense of the smaller ones. At the conclusion of the ripening period, the emulsion is cooled rapidly and allowed to set. All of these operations starting with the addition of the silver nitrate are conducted in darkness or under a suitable red or green safe light.

At this stage the emulsion contains an excess of potassium or sodium nitrate and an excess of potassium bromide. To remove these salts the emulsion is shredded into long round strands in a hydraulic press. The strands are washed for several hours in running water until all of the soluble salts are washed out. Excess water is drained off, the emulsion is remelted, and a final addition of gelatin is made.

A certain relation exists between the grain size of an emulsion and its sensitivity. An emulsion with predominately small grains being generally less sensitive than an emulsion with larger grains. An additional increase in sensitivity can be obtained without appreciably increasing the grain size. This is accomplished during the second digestion or after-ripening period, which follows the removal of the alkali salts. This increase in sensitivity during the after ripening stage is generally attributed to the interaction of the ripening substances of the gelatin with the silver halide. This converts an extremely small part of the halide to 'sensitivity specks' of silver sulfide. These specks, it is believed, are deposited on the surface of the silver halide crystal. They enter into the crystal lattice, whereby as foreign matter they produce strain forming at the same time areas of weakness. As some authors have termed it, they represent centers of disturbance in the crystal lattice. The sensitivity specks are of greatest importance during the exposure of photographic emulsions.

If the ripening is carried out excessively, the emulsion becomes developable without exposure for one or both of two reasons. First the physical ripening or growth of the crystals is carried too far. The gelatin then renders insufficient protection to the large grains. The grains approach the state of a silver halide precipitate which is developable without exposure. The other reason for excessive ripening might be a surplus of sensitivity specks in the grains or a partial reduction of the silver halide to metallic silver induced by the gelatin. To prevent the continuation of ripening stabilizers are added prior to coating the film support with the emulsion. These stabilizers form nearly insoluble silver salts. They are added in very small quantities ranging from .001% to .2% of the gelatin.

Additional agents, added prior to coating, are physical hardening agents (formaldehyde or chrome alum), special substances to insure satisfactory coating, and usually certain dyes. These dyes increase the sensitivity of emulsions to cover a wider band of the visible spectrum.

The actual coating is accomplished in specially built machinery that essentially rolls the melted emulsion onto the film support. The coated film passes through a chilling box or around a chilling drum to set the emulsion. It is then passed into a drying oven. Time, temperature, and humidity of drying also play an important part in the sensitivity of the film. Great care is taken during the coating and drying to avoid the production of static electricity which would fog the film.

Few photographic films consist of a single coated emulsion layer. Double coated films, with two layers on one side of the support or one on each side, are desirable because of the increased

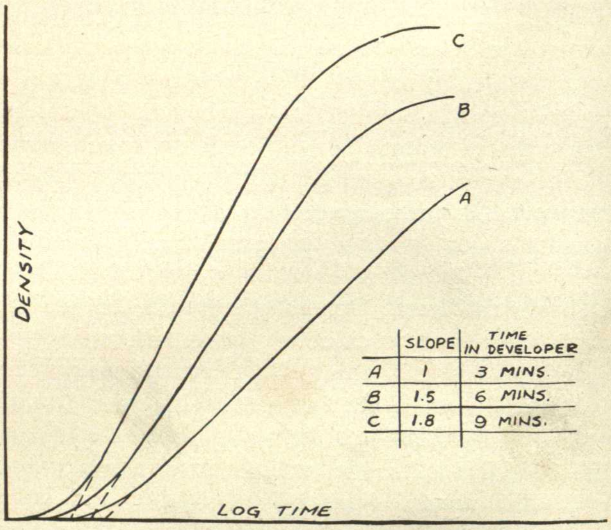


Fig. 2 Showing Variation in Gamma with Developing Time

exposure latitude. The undercoating consists of a lower speed emulsion of higher contrast than that of the top layer. Subsequent layers applied to the film include an anti-halation backing (dyes that absorb light and prevent it from reflecting back to the emulsion through the film support), layers to counteract curling, anti-static layers, and a final hardened gelatin coating to protect the emulsion itself from mechanical injury.

When the halides of silver are exposed to light they darken visibly. Silver is deposited on and in the silver halide and free halogen is liberated. In the presence of halogen acceptors (nitrite or gelatin) the darkening increases. It is now generally accepted that even during the shortest exposures atomic silver is formed throughout the silver halide grain. These silver atoms liberated from the silver halide accumulate in the neighborhood of the sensitivity specks or silver sulfide nuclei, which were formed during the after-ripening period of the photographic emulsion. The silver formed during the exposure is known as the latent image. The nature of this image is not known in spite of extensive research. However, it is known that the qualitative action (Q. A.) of light on a light sensitive emulsion is in direct proportion to the intensity of the illumination (I) and the duration of the exposure (t). This is known as the photochemical reciprocity law:

$$Q. A. = It$$

Increasing either or both would increase the degree to which the grains are effected, and therefore increase the amount of silver formed. The degree of darkness is termed density. This relationship is determined by the characteristic curve of the particular emulsion. This is shown in figure 1.

The slope of the straight line portion of the curve, the tangent of the angle theta, is referred to as the gamma of the film. An increase in the exposure time (at least over the straight line portion of the curve) will increase the density, but will not increase the variation of density between the tones. This variation in density between the tones is the contrast or the gamma of the film. The gamma to which a film develops is determined solely by the time of immersion in the developer, gamma increasing as the time of development increases. This is shown in figure 2. It is possible to produce a visible image by an exposure many thousands of times that required to produce a latent image. Such emulsions are called print out and a typical example is the gelatino-chloride printing out paper used by photographic studios to make brownish-red proofs. For a normal exposure time, however, it is necessary to develop the film before a visible image is produced.

A photographic developer is a solution containing a chemical reducing agent which is capable of reducing the exposed grains of silver halide to metallic silver. This type of development is called 'chemical' and differs from 'physical' development, wherein the solution itself contains a silver salt which is deposited on the tiny nuclei of the latent image. Physical development is used very little except to intensify the density of a weak negative. When the exposed sensitive material is placed in the developer the solution penetrates the gelatin and begins to reduce the exposed grains to metallic silver. As development progresses the contrast of the image increases. If the development is carried too far the negative may become too dark to print. Also the developer may reduce some of the unexposed grains causing a generally muddy or foggy condition over the entire negative and destroying the highlights and delicate shadows. The time of development varies with the developer used.

Practically all of the more commonly used developer formulas contain four essential ingredients: the developer or reducing agent or agents, the preservative, the activator, and the restrainer. There are many hundreds of organic compounds and a few inorganic substances that have been suggested for use as developing agents. Only a few of these compounds have ever been used to any extent and only three are in common use. These three are methyl para-aminophenol or metol (known commercially as Elon, Rhodal, and Pictol), hydroquinone, and pyrogallol or pyro. Developers containing pyro are not used nearly so much as those containing metol and hydroquinone. Each developing agent when in solution has its own energy characteristic. Metol, for example, starts to develop quickly but slows down considerably as the time of development increases. Hydroquinone, on the other hand, has much the opposite effect. Usually commercial developers combine several different agents to obtain the desired characteristics. A preservative, usually sodium sulfite and occasionally sodium bisulfite, is added to prevent the oxidation of the developer by air. Too much sulfite must not be added or some of the silver halide will be dissolved and the development retarded. It is usually necessary to add an alkali activator to the developer solution before development will proceed. Three kinds of activators are in common use: caustic alkali, such as sodium hydroxide; carbonated alkali, such as sodium carbonate; and borated alkali, such as borax or sodium borate. Higher energy developing agents such as metol, which brings up the image quickly, generally require a lower concentration of alkali than the slower developing agents such as hydroquinone. Excessive concentrations of alkali tend to give a chemical fog while a deficiency will retard the development rate. A restrainer is also necessary to prevent fogging and minimize the effect of overexposure. Potassium bromide is the most commonly used restrainer. Sometimes it is possible to eliminate the restrainer entirely in bromide films since the bromide accumulates as a byproduct of development.

In general the degree of development depends upon the time of development, the temperature, the amount of agitation during development, and the activity of the developer. Stagnant development requires about twice the time for the same contrast as development with constant agitation. Best results are secured with most photographic materials when the developer temperature is maintained between 65° and 70° F. Most developers should not be used above 75° F unless special precautions are taken to prevent swelling of the gelatin. Sodium sulfate is sometimes added as an antiswelling agent. At low temperatures the rate of development is slowed appreciably. A need exists with some of the present day films, especially when

continued on page 26

Editorial

It has been apparent for many years that with the constantly increasing complexity of the engineering fields adequate training for a career as a professional engineer and a general liberal education can not both be given in a four year college course. A blanket increase to a five year course has been proposed and put into effect in some of the engineering schools of America. This does not seem to us an entirely satisfactory solution to the problem. While it provides well for the student who desires to go into the technical aspects of the engineering profession, it means an additional year of training of questionable value to the engineering student who desires a less technical engineering career. It seems to us that the curriculum recently proposed by Dean Thorndike Saville of New York University is very nearly an adequate answer to the problem.

Dean Saville proposes that a general four year curricula be set up leading to the degree of Bachelor of Engineering. The first three years would be nearly uniform for all branches. It would include all of the basic sciences and the fundamental engineering subjects now offered. It would also include more courses in economics, public affairs, and history. It would also allow for the study of a foreign language which we personally think is a much neglected part of the education of the modern college student. The senior year of study would include a considerable number of technical electives. This would allow the student some specialization in a particular field. The program taken during the senior year would be somewhat different if the student were to terminate his course with the degree of Bachelor of Engineering than if he were to go on for further technical study. For the engineer desiring to enter the technical phases of the field of engineering Dean Saville proposes that an additional year of study leading to a professional degree as ME, CE, or EE be taken.

To us such a program would hold manifold advantages. Under the present four year program it is impossible to give a fundamental liberal education and an adequate technical education in the same four year program. If a good fundamental education in the humanities is given, then either the fundamental science courses or the technical ones must be sacrificed. Regrettable as this is, we believe that it is none the less true. Dr. Saville's program we think is an answer to this dilemma that might well be seriously considered. It would adequately train in four years the student who did not desire to enter the highly technical aspects of the field. It would leave him better prepared for managerial posts in industry and government, and for nonspecialized positions in sales and other fields.

At the same time the program does not neglect the training of the professional engineer. After all we do not try to train a doctor or a lawyer in four years, and we think it is becoming more and more evident that we cannot train a professional engineer in four years either. This has led to a situation in many schools where the masters degree is no more than a fifth year of engineering. Many schools (not Michigan State however) no longer require a thesis or research for a masters degree in engineering. It seems to us that research is one of the fundamental purposes of graduate work. That to grant a graduate degree with only course work is to reduce the graduate degree to a point where it is no better than a second undergraduate degree. This situation is excused in many schools on the basis that the student is not adequately prepared to do research work with only the bachelors degree, in other words he does not have enough of the fundamentals of his profession. The five year program leading to a professional degree would eliminate this. It would return graduate work to its rightful place and at the same time provide adequate technical training for those not desiring to take graduate work.

Dr. Saville suggests that the plan would require that adequate guidance be given to the student to help him decide whether to stop at the Bachelor of Engineering degree or to go on for the professional degree. Such a plan would, however, defer the choice of the field of specialization until the beginning of the senior year. We feel this would be a distinct advantage to the student in helping him make his choice of the field of specialization. In many schools it is now necessary to choose the field of specialization at the end of the freshman year.

This plan also provides adequate recognition of the fifth year of work by granting professional degree, and yet differentiates it from the masters degree which in our opinion should be given more for research than course work.

Dean Saville's plan seems to us the most adequate solution to the problem of providing both an adequate education and an adequate technical training for the engineer without at the same time unnecessarily lengthening the course.

Open Letter

The Editors of the Spartan Engineer wish to express their appreciation to the many people who have aided us in establishing this publication. We are especially indebted to Dean Dirks and Miss McCann of the School of Engineering, to Professor Charles Pollock and Ronald L. Randall of the Art Department for our cover and masthead designs and many suggestions in make up, to President John A. Hannah, and to Professor Arthur Farrall and the Agricultural Engineering Department for our office space and equipment.

The establishment of the Spartan Engineer brings to the Engineering School at Michigan State College a service which has already been extended to the students of other engineering colleges of this country. In establishing this publication we have tried to incorporate, in so far as possible, what we thought were the better features of the magazines published at other colleges. Our primary interest, however, is to satisfy the needs and the desires of you, the engineering students of Michigan State College. We invite your criticism and ask your help in making the Spartan Engineer provide the best possible service to you.

It is our earnest desire to provide this kind of service to you, but we cannot do this without your help. In order to do this we need first of all your criticism and views, so that we may know what you want. No less we need your direct help in publishing this magazine as members of the staff. In order to fully establish this publication freshmen and sophomores are needed just as much as upperclassmen, for they will be the future editors. We therefore extend to all of you the invitation to join us as members of the staff.

It is our sincere hope that we can fill a place of service to the College and the School of Engineering which heretofore was left vacant. In doing so we hope to be a credit to the School of Engineering and to Michigan State College as a whole.

The Editors

The Societies

TAU BETA PI

Woman Wins Freshman Scholarship Prize

Last February 19 Tau Beta Pi resumed the presentation of its annual scholarship prize to the outstanding engineering freshman of the previous year. The award for the 1946-1947 school year went to Natalie Noble. Natalie is a sophomore engineer from Cummington, Mass. She had an average of 2.941 for her freshman year. This placed her at the top of the thousand basic engineering freshmen in last year's class. In addition to being an excellent student Natalie is a member of Sigma Kappa and Tower Guard.

The Tau Beta Pi Freshman Scholarship Award has long been a tradition of the Michigan Alpha Chapter. During the war the award was discontinued, but the presentation was resumed again this year. The award consists of a K and E log-log duplex slide rule, and a certificate with the name of the award winner engraved upon it.

The presentation was made at an open meeting of the chapter. At the meeting Nick Kerbeway of the Public Relations Department showed movies of the football teams trip to Hawaii last fall and gave a commentary on the trip. Refreshments were also served at the meeting.

Tau Beta Pi Initiates 37 Men

The largest group ever initiated into the Michigan Alpha Chapter of Tau Beta Pi was taken into the chapter March 4. The group, totaling thirty-seven men, included eight seniors and twenty-nine juniors.

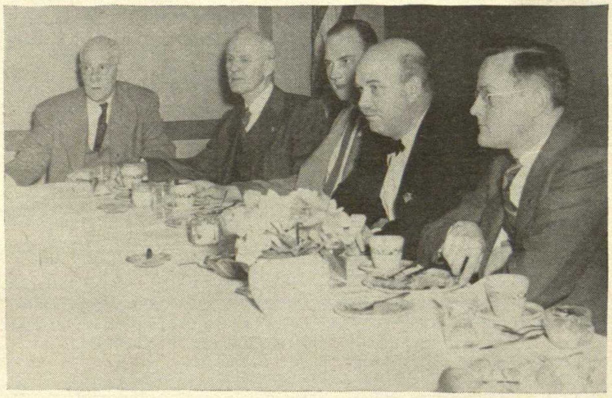
Following the initiation at the Tau Beta Pi chapter room a banquet in honor of the new initiates was held at the Home Dairy in Lansing. The principal speaker at the banquet was Mr. Claude Erickson of the Board of Water and Electric Light Commissioners. Mr. Erickson is also consulting engineer for the college, and was in charge of the design of the new steam generation plant here at M.S.C. He is a member of the Michigan Alpha Chapter here.

Mr. Erickson talked on the heat pump and its application to residential heating. He showed that if the cost of electric power is not too high, the cost of heating a home with a heat pump compared favorably with that of other methods, such as gas, oil, or coal. One of the major advantages of the heat pump is that it may be used to cool the home in summer without any additional equipment than that required for heating. Mr. Erickson compared the operation of the heat pump with that of the refrigerator. He illustrated that the difference is only one of operating requirements and not one of principle. In the refrigerator heat is taken from the cold room and dissipated into the air. In the heat pump heat is taken out of the ground or other heat source and is used to heat the home. Mr. Erickson pointed out that a home heated with a heat pump would have no furnace or chimney. The talk was illustrated with colored slides.

The initiates were welcomed into the Michigan Alpha Chapter by Paul J. Walters. The response for the initiates was given by Charles H. Single. Prof. Donald J. Renwick was toastmaster. Three guests from the Michigan Gamma Chapter at the University of Michigan attended the initiation and banquet.

The senior men initiated were Guy S. Vissing, Charles W. Bachman, Jack E. Harney, Charles E. Stevens, John F. O'Donnell, Joseph T. Aalsburg, Kenneth A. Clapp, and Merthyn E. Evans.

The list of junior men included Roy A. Paananen, Charles C. Sisler, Claire A Stepnitz, John D. L'Hote, Richard J. Lappin, George W. Michel,



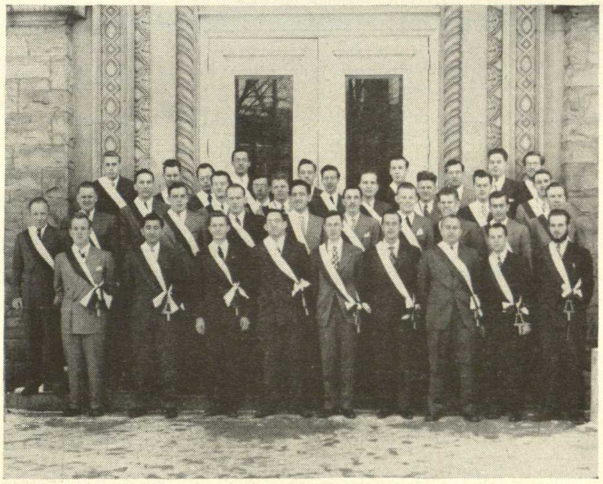
Speakers table — left to right, Professor Cory, Dean Dirks, President Gray, Speaker Erickson, Professor Renwick.

Lloyd E. Kaechele, Charles H. Single, Robert N. Edmondson, Roger J. Nelsen, Denton S. Montross, Harold V. Lee, Jr., Ross M. Robinette, Frederick P. Witte, Alfred J. Monroe, and Carl E. Christensen.

Other juniors were John C. Bullock, Jr., Donald E. Anderson, John K. Carlyle, James C. Barrett, Robert E. Clark, Raymond E. Mohlie, Raymond E. Gale, Takashi Nakamura, George S. Breitmayer, Jr., Robert W. Jurgensen, George A. Seymour, Melvin A. Nuechterlein, and Richard A. Hiscox.

Metallurgical Engineer Society

Last fall term with the help of Professor Sweet, James Bostwick, Robert Dickenson, Robert Shimkus, Vance McIntyre, and Robert Fisher formed the newest student professional group on campus, the Metallurgical Engineer Society. Through most of fall and winter term the group was busy organizing and going through the necessary steps to bring the society on campus. After an OK from Student Council the Met. E's started making up for lost time. At their first meeting in January they saw a color movie entitled "Steel — Man's Servant". A business meeting was held in the last part of the month. Mr. F. T. Hook of the American Brass Company talked to the group on February 4 on the "Properties of Copper and Its Alloys". In conjunction with his talk Mr. Hook had a film on copper mining in Chile, South America, and Arizona here in the United States. "Factors Influencing the Choosing of Steel for Fabrication" was the topic of a talk that the Met. E's heard at their next February Meeting. The speaker was Mr. R. A. Allen, assistant chief metallurgist at the Republic Steel Corporation.



Winter Tau Beta Pi Initiates

American Society of Civil Engineers

The M. S. C. student branch of the A. S. C. E. heard two speakers and saw one movie at their winter term meetings. The first of these speakers was Mr. J. Meyers of the Abrams Aerial Survey Company, Lansing, Michigan. Mr. Meyers spoke on "Aerial Photography and the Civil Engineer". The other speaker during the term was Mr. Blomquist of the college Civil Engineering department who spoke on "Registration Examinations for Civil Engineers". On January 13 a movie, "Clean Waters", on the problem of sewerage and the prevention of stream pollution was shown to the assemble members. After election this term the society plans a round table discussion. The topic will be "Is Graduate Work Necessary?" Participating in the discussion will be professional men, professors, and students.

American Institute of Chemical Engineers

Mr. Roger Hewitt of the Distel Heating Company of Lansing spoke before A.I.Ch.E. members concerning opportunities for the chemical engineer in industries outside the chemical field. He pointed out that many phases of industry today have a direct need for the services of the chemical engineer. On April 13 elections will be held to determine who will fill the shoes of the outgoing officers.

American Society of Mechanical Engineers

Guiding the A.S.M.E. student branch through winter term were the following officers: Harvey Wilson, president; Edward Gillisse, vice-president; David Wolf, secretary; and Christopher Lindeman, treasurer. At their last meeting in January the society was addressed by Mr. George Sanborn of the Fellows Gear Shaper Company. In addition to his talk Mr. Sanborn showed a color movie on the generation of gear teeth. A.S.M.E. got together with the campus A.I.E.E. on March 3 to hear Mr. Sam Dean of the Detroit Edison Company. Mr. Dean is a graduate of the M.S.C. engineering school. The first thing on the business slate this term is an election of officers. After that the group will make plans for the district student A.S.M.E. convention which will be held here at Michigan State College.

American Institute of Electrical Engineers
Institute of Radio Engineers

On this campus these two groups are organized jointly with the officers as follows: William R. Carlyon, president; Clare K. Tubbs, vice-president; William J. Rupple, treasurer; Mac R. Doolittle, A.I.E.E. secretary; and Roy A. Paananen, I.R.E. secretary. The Great Lakes District of the A.I.E.E. held its convention in Des Moines, Iowa, on April 1st through the 3rd this year. Included in the district are the states of Michigan, Indiana, Wisconsin, Minnesota, North Dakota, and South Dakota. Along with the professional society, the student branches met. Of the nineteen schools in the district, eighteen were present in Des Moines. Dr. Strelzoff of the M.S.C. electrical Engineering department headed the State delegation. This group consisted of William Carlyon, Donald Beckwith, Mac Doolittle, Clare Tubbs, William Rupple, Harvey Powers, and Martin Skinner. Skinner, a graduate assistant here, presented a paper on "Electrical Computing Machines".

The Faithful Scientist

Tad was the first to reach the summit of the jagged peak. Before his surveying eyes lay the broad expanse of Tomahawk Valley where, centuries before, the Indian had chased the mighty buffalo.

Tad breathed deeply the exhilirating air, neatly keeled over, put his hand on the head of his faithful camel, Gold Dust, and turned to see how his faithful companions, Spike and the Crisco Kid, were doing.

"Get the lead out of your pants," he yelled gleefully as he playfully tossed a miniature boulder at the head of his faithful pal Spike. Poor Spike didn't duck in time.

After they had buried Spike in a fitting manner they held a wake which would have put Paddy Murphy to shame. Nearer and nearer they came to the fabulous "Mountain of Suds." Through his faithful 7 x 50 Zeiss binoculars Tad could see the green boxes studding the mountain side, with patches of Luminess here and there. Mostly there.

It was for Luminess—the magic sunshine ingredient—that the group, headed by Dr. Proctor and Prof. Gambel of the Oxydol Institute, had started their long trek. The scientists at home had long been dissatisfied with our calendar. The complications in the calendar resulting from the earths 365.28 days per solar revolution had long perplexed our greatest scientists. Why not substitute the Luminess sun for our own with its 360.00 days per solar revolution, and make all the months exactly 30 days? This would simplify things no end. And as the eminent Austrian scientist, Dr. Heinrich von Smorgan, once remarked, "What the hell! No end!"

So, onward the expedition expedited. Faithfully.

Fools! Didn't they realize that they would never reach the mountain? Hadn't they heard of Lux's theorem as applied to statistical entities? But it was even more clearly shown in Dr. von Smorgan's "Infinite Relativity of Nonentity" theory. So simple that even the most uninitiated Ph. D. could understand. If we let *E* represent the expedition, *D* the distance to be travelled, *M* the mountain, and *T* the time the expedition travels, then quite obviously:

$$\frac{DE \longrightarrow M = 1}{T}$$

From which it *can be* seen that no matter how large T becomes D would never equal zero (which would, of course, be necessary if they were ever to reach the mountain). There would always be some distance to travel.

But not knowing this Tad and his faithful companions plodded faithfully on. Faithfully.

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2	701	1122	168,379	5.03	1.60	225	432
6	1041	1666	250,000	7.47	2.25	312	624
8	1486	2378	356,843	10.66	3.40	476	915
10	1998	3197	479,896	14.33	4.57	640	1230
12	2565	4104	615,605	18.39	5.86	821	1579
16	3531	5650	847,587	25.32	8.07	1131	2174
18	4170	6672	1,000,902	29.90	9.54	1335	2567

DIMENSIONS
(Subject to change)

Diameter of Smoke Pipe Inches	Supply Opening Inches	Condensation Opening Inches	Boiler Width Inches	Boiler Length Inches Overall	Boiler Height Inches	Boiler Weight Pounds (Approx.)
6	2½	1½	26	36	60	650
7	2½	1½	26	40	62	850
8	3	2	31	44	64	1050
10	4	2½	37	50	64	1200
12	4	2½	37	55	66	1450
14	5	2½	41	65	70	1850
14	5	2½	41	70	70	2100

Morheat Industrial Water Tube Boilers for processing — 100 M.W.P., A.S.M.E. Code — National Board Inspection — Sizes 5 to 32 h.p. — for oil, gas or combination firing.

MORHEAT CORPORATION

700 East Kalamazoo Street

Lansing 12, Michigan

Building 163

continued from page 6

taken off the line, or in other words, removed from operational status.

With induced draft fans, a tall exhaust stack or natural draft chimney becomes unnecessary. The MSC stack has long been a campus landmark. In the new plant some exhaust gases are present and these pass out of the building through short stacks--one for each boiler. After the gases leave the induced draft they travel approximately 29 feet to the top of the stack.

Directly below the stack the blades of the induced draft fan are exposed to the elements. When operating, the revolving blades will throw off the water; when not operating, the fan blades become susceptible to corrosion and subsequent unbalancing. A manually operated rain gate prevents this corrosive action. Because it is so balanced, the rain gate automatically opens when the fan resumes operating.

The Cabinetrol panel discussed previously is another point of interest. Rather than scattering the controls and individual set ups through the plant as in older systems, the Cabinetrol efficiently concentrates electrical controls in one locale. Ease of maintenance is realized in this new development.

At their rated load the boilers should generate a total of 200,000 pounds of steam per hour. This leaves at 300 psi and 550 degrees Fahrenheit. The old plant using three boilers supplies 200,000 to 225,000 pounds per hour at 175 psi and 400 degrees Fahrenheit. Inability to obtain pipe fittings able to withstand higher pressures and temperatures causes the old plant to operate at this level. The generated steam activates one Allis-Chalmers 3000 KW and two 500 KW turbines. Designed to use steam at over 200 psi pressure, the 3000 KW turbine is obviously not operating at full capacity. One more turbine, a 3000 KW General Electric will be added to this group. In fact, it is now in the process of being installed. One of the boilers has already been dried out and put on the line. The extra steam is required in campus operation.

MSC engineers are contemplating moving the coal storage, boiler room, and eventually the whole power setup to South Campus. Design of the new plant calls for three boilers but so far only two are installed. Addition of the third boiler is the next project. If more steam becomes necessary, the building may be extended toward Shaw Lane. Perhaps a turbine floor could be added to the plant at some future date. Removal of the railroad bridge and the tracks would turn the central portion of the campus, presently dominated by the power plant installation, into an engineering circle. Included would be the electrical engineering building now under construction. *the end*

Sales Engineering

continued from page 7

tottering. The Sales Engineer of an important equipment builder looked upon it with vision and intelligent enthusiasm. He set to work. Nothing was farther from the mill owners mind than to buy — unwillingness — inability. But the Sales Engineer had resourcefulness and ability. He studied the mill and its inactive layout. He drew sketches and developed a new possible productive layout — all reduced to figures of expenditures and resulting reduction in the production cost and price per ton of paper. He interested local bankers and consulted with other apparatus suppliers in lines parallel to his own, gaining their support. Finally he developed a practical program of revamping, and the willingness to invest funds. The decision was made to go ahead — even in the poorest times. He got a substantial order for apparatus. Was he creative?

Innumerable examples can support this same idea. In 1934 the steel mills rolled cold-rolled tin plate at a maximum speed of 400 feet per minute. Only five years later, in 1939, a mill was in operation producing this tin plate at a speed of 2300 feet per minute. This remarkable improvement came about largely from the efforts of a Sales Engineer selling rolling mill machinery and a Sales Engineer selling electrical equipment, both working in conjunction with the engineers connected with the steel mill.

Where do Sales Engineers come from? How are they trained? Some few capable men, likely the older ones, never took an engineering degree. Most manufacturers of machinery as well as of special products to be technically applied such as alloys, lubricants, and chemicals, take on from the technical schools each year a number of engineering graduates for training. Larger companies can establish definite and thorough training courses. With many of the smaller companies, the boy is simply put to work to learn the business.

Though the work of the Sales Engineer is an art, back of it stands science. It is a science based upon a knowledge of business organization, markets, distribution methods, and an understanding of group and individual human effort. More and more the heads and executive staff of manufacturing companies are now drawn from the ranks of the Sales Engineers.

continued on the next page

Thirty or forty per cent of engineering graduates within a few years are engaged in work that is largely of a commercial nature. The various courses in salesmanship — so commonly given in any important city — are often of little significance to the Sales Engineer, for they concentrate on merchandise and commodity selling. The fundamental training most needed by the prospective Sales Engineer is a combination of technical training and business training — the latter dealing with capital investment for technical accomplishment. The Sales Engineer must have one eye well trained to engineering — and the other trained to detect values and economic results. He must possess not only technical skill, but an understanding of where the use of this technical skill is leading us.

Salesmen and salesmanship are often frowned upon in academic circles as too close to the peddler or slap-the-back promotor. Because the Sales Engineer sells, he is often mentally catalogued as a pronounced extrovert. Unfortunately too few of us have had a chance to meet a mature, friendly individual selling mining machinery, foundry equipment, power plant equipment, or a host of other classes of equipment or highly technical products, and to watch him exercise an ability, quite his own, comprehending a whole system of specialized production. His tools of accomplishment are in his head, crammed full of experience.

The great need today in technical accomplishment is an understanding of where the invention, the new design, the improved process, the new material, will lead us, quite apart from the skill to create it physically. Sales Engineers can lend a vision to management, for they can be skilled in detecting the over-all result, whether it be mechanical, economic, or social. They can give the "Why" so greatly needed today, to guide the "do."

Although the Sales Engineer is the mouthpiece for the company he represents, he is also the eye which detects customers' needs. He is the one who can point to improvements. He can guide the designer in the character of the apparatus built. He often points to new items which his company might build, and provides the necessary spark to accomplishment.

The barometer of business activity points to various conditions at different times. Only about one quarter of the time is the emphasis on production — times when plants are loaded and the chief problem is to produce. The remainder of the years, plants are not working up to capacity, and the pressure is on distribution — not production. Even today, when we are still wriggling out of the harness of war, the importance of distribution is coming to the front again with alarming force, and the Sales Engineer is taking his place at the head of the parade. *the end*

Capturing Light

continued from page 15

they are to be enlarged to considerable size, to reduce the size of the silver particles. Much research has been done on this problem. Paraphenylenediamine obtains the best results in reducing the particle size, but it is very slow and also quite toxic to the skin. Another compound, sodium thiocyanate, has been suggested for this and has the advantage of being non toxic.

After the developing has been completed, but before the image is fixed, it is necessary to remove all of the developer from the film. This is usually done by washing the film with water. A dilute solution of acetic acid, about 1%, is also used.

After development all of the unreduced silver halide still remains in the film. If this is not removed it will darken upon exposure to light and make the entire film black, obscuring the image. The process of removing this silver salt is called fixing. About the only chemical which will dissolve the silver halides without otherwise affecting the film is sodium thiosulfite or hypo. In the process of fixing hypo combines with the silver halides to form complex silver salts which are removed in the final washing after fixing. Besides the hypo the fixing solution usually contains the following: a preservative, an acid, and a hardening agent. The most common preservative is sodium sulfite although sodium bisulfite is used if the hardening agent is to be omitted. The sulfite prevents decomposition of the hypo by the acid. Otherwise free sulfur would form and stain the gelatin. Acetic acid is included to neutralize the developer and stop its action. Potassium alum is used as a hardening agent to harden the gelatin and reduce the possibility of mechanical injury to the emulsion. Certain ratios of these three chemicals must be used for best results. Otherwise the acidity may be too high and cause breakdown of the hypo, or too low and allow a reaction between the sulfite and the alum to form a white sludge of aluminum sulfite which will deposit on the film. The stability of fixing baths is improved by the inclusion of boric acid. Films are usually fixed for about twice the time it takes to clear them, and the temperature of the bath should be about 70° F.

After fixing, a final washing is given the film to remove the hypo. Since it is difficult to remove the last traces of hypo some chemical means have been suggested. Most of these have been unsatisfactory because other undesirable chemicals are left in the emulsion. One recently proposed method uses two volatile chemicals, hydrogen peroxide and ammonia. This solution oxidizes the excess hypo to sodium sulfate which is inert and soluble in water. Any excess eliminator evaporates on drying.

In summary, the action of light on a silver halide suspended in gelatin forces a small amount of metallic silver to gather around a speck of impurity. This silver acts as a nucleus for further development which causes more silver to be deposited, forming a visible image. To make this image permanent we fix it by removing undeveloped silver halides, thus rendering the film immune to further action by light. This is the process used in capturing light. *the end*

WKAR-AM

continued from page 11

its legal operating time, if it is operating on limited time. The operator of a standard broadcast station must hold a first class radiotelephone license. This license is granted by the Federal Communications Commission after the licensee passes the examination for that class of license.

WKAR is licensed to operate from sunrise to sunset. These times are computed on an average basis for the month and are specified in the station license. The license also specifies the operating power, the antenna current, the impedance of the antenna transmission line, the call letters, and the operating frequency.

The WKAR transmitter was installed in 1940 and began regular operation in June of that year. Previous to that the transmitter was located in the Power House and the operating power was 1000 watts. The transmitter, built by the Western Electric company, was installed under the supervision of Mr. Norris Grover, chief engineer of WKAR. Since then the transmitter has been in continuous operation during its allotted operating time. *the end*

Educational Gas Turbine

A major step has been taken in providing student engineers with the means of studying at first hand the type of power plant which drives jet planes, and which promises to play an important role in land applications. Rensselaer Polytechnic Institute has installed in its Mechanical Engineering Department laboratory an "educational gas turbine", the first of its kind to be acquired by any engineering school.

In this unit students are provided with a means of studying the performance and characteristics of the gas turbine cycle, according to Dr. Neil P. Bailey, head of R.P.I.'s Department of Mechanical Engineering. He pointed out that the equipment would be employed to "substantiate and supplement the theory of the classroom".

The installation is built around a G. E. design of a turbosupercharger which has been equipped with a combustion chamber, compressor inlet flow nozzle, compressor discharge, control, and other accessory equipment. The turbosupercharger was purchased from the War Assets Administration and is of the type used in the B-29 Superfortress to provide high pressure air to engines at high altitudes.

In addition to the gas turbine performance cycle, the equipment can be used in the study of centrifugal compressor performance and air flow measurement.

Spartan Engineer

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SIDE TRACKED

Student — "Why didn't I make 100 on this history exam?"

Prof — "Do you remember the question 'Why did the pioneers go into the wilderness?' "

Student — "Yeah."

Prof — "Well, your answer, while very interesting, was incorrect."

☆

And then there was the Frosh who thought that steel wool came from hydraulic rams.

☆

An engineer wandered into a tennis tournament one day last season and sat in the stands. After a few minutes of interested watching he said, "Whose game?"

The shy young thing sitting next to him spoke up hopefully, "I am."

☆

There are a lot of couples who don't like to sit in parked cars. In fact Pinetum is full of them.

☆

Then there was the story of the two old maids that went for a tramp in the woods.

☆

Do you neck?
That's my business!
Oh good, a professional.

☆

A group invented an atom bomb so powerful that it could destroy the world. They couldn't resist trying it just once. When the smoke had cleared away, the only two things left on the face of the earth were two monkeys somewhere in Tibet. The male monkey leered at his companion and said, "Well, shall we start the whole damn thing over again."

☆

Breathes there a man so much
  abnormal
That he isn't stirred by a low cut
  formal?

POME

I tried to kiss her by the mill
  One starry summer night.
She shook her head and sweetly
  said,
  "No, not by a dam site."

☆

1st ME — *Busy?*

2nd ME — *No. You busy?*

1st ME — *No.*

2nd ME — *Well then, let's go to class.*

☆

Industrial advertisement:
For Sale: One high-powered wench in good condition.

☆

"Damn," exclaimed the contractor as the block of new prefabs collapsed, "I told those carpenters not to take down the scaffolding until *after* the walls were painted."

☆

Little dog looking up at a parking meter. *Hell, you gotta pay now.*

☆

A Scotsman walked up to a friend at the bar and began telling him about a hunting trip. "We shot a couple of deer," he said, "but the biggest thrill was tracking yures."

"What's yures?" asked the friend.

"I'll have a beer thanks," replied the Scotsman.

Just as they reached the bottom of their glasses, the friend remarked, "Well I'll have to get going. Got to get home and do my chores."

"What chores?" asked the Scotsman.

"Beer, please," the other said.

☆

He who laughs last has found a double meaning that the censors missed.

Once upon a time, so the story goes, the fence between Heaven and Hell was broken. St. Peter appeared at the broken section and called to the Devil, "Satan, since all of the engineers are over at your place, how about getting them to mend the fence?"

"Sorry," replied the Devil, "my men are all too busy to go about fixing measly fences."

"Well, then," replied St. Peter, "I shall have to sue you if you don't."

"Oh yeah," chortled Satan, "where are you going to get a lawyer?"

☆

Freshman — *What is the difference between a sewing machine and a girl running for a street car.*

Senior — *A sewing machine has only one bobbin.*

☆

As Prof. Cade says in Mechanics, "Every couple has its moment."

☆

Two small negro boys were sitting on a curb. One turned to the other and said:

Ah's five. How old is yo?

Ah doan know. Ah reckon ah's five too.

Does you dream of wimmen?

Nope.

Yo's only foh.

☆

CAMPUS REGULATIONS

1. No lighted tobacco may be brought into or through college buildings.
2. Do not drop ashes or butts on the floor.

☆

You can lead an engineer to water but why disappoint him.

☆

I'm sorry I slapped you — I thought you were trying to steal my sorority pin.

By SPARTY