BRIDGE

eta kappa nu

Spring, 1963

Bridge

of ETA KAPPA NU
Electrical Engineering Honor Society

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the cover

The crack of lightning brings many reactions, from fear to wonder to curiosity. Lightning has long plagued electrical engineers, producing radio interference, inducing current in control circuits, and causing power interruptions. "The Mechanism of a Lightning Stroke," beginning on page 3, describes the phenomenon from the viewpoint of lightning protection of transmission lines.

Features

The BRIDGE is published by the Eta Kappa Nu Association, an electrical engineering honor society. Eta Kappa Nu was founded at the University of Illinois, Urbana, October 28, 1904, that those in the profession of electrical engineering, who, by their attainments in college or in practice, have manifested a deep interest and marked ability in their chosen life work, may be brought into closer union so as to foster a spirit of liberal culture in the engineering colleges and to mark in an outstanding manner those who, as students in electrical engineering, have conferred honor on their Alma Maters by distinguished scholarship activities, leadership and exemplary character and to help these students progress by association with alumni who have attained prominence.

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Real and Imaginary

The Calf Path

One day through the primeval wood,
A calf walked home as good calves should;
But made a trail all bent askew,
A crooked trail as calves all do.

Since then three hundred years have fled,
And I infer the calf is dead.
But still he left behind his trail,
And thereby hangs my moral tale.

The trail was taken up next day
By a lone dog that passed that way;
And then a wise bellwether sheep
Pursued the trail o'er vale and steep.

And drew the flock behind him, too
As good bellwethers always do.
And from that day, o'er hill and glade,
Though these old woods a path was made.

And many men wound in and out,
And dodged and turned and bent about,
And uttered words of righteous wrath
Because 'twas such a crooked path.

But still they followed . . . do not laugh,
The first migrations of that calf.
This forest path became a lane,
That bent and turned and turned again.

This crooked lane became a road,
Where many a poor horse with his load
Toiled on beneath the burning sun
And traveled some three miles in one.

And thus a century and a half
They trod the footsteps of that calf.
The years passed on in swiftness fleet;
The road became a village street.

And thus, before men were aware,
A city's crowded thoroughfare.
And soon the central street was this
Of a renowned metropolis.

(Continued on Page 29)

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The Mechanism of a Lightning Stroke

C. F. Wagner
Eminent Member

Many disciplines of learning are interested in the mechanism of the lightning stroke. The meteorologist is interested in the separation of the charges that form the initial streamer of the discharge, in the methods of streamer propagation, and in the charges and currents involved. The physicist is interested from the viewpoint of conduction of electricity in gases, from the corona and low-current streamer formation to the high-current return stroke that constitutes the ultimate in gaseous conduction of electricity.

On the other hand, the electrical engineer is more concerned with its external manifestations, but even here the interest is divided. Because of interference with transmission, the radio engineer must have knowledge of the electromagnetic disturbances which may originate thousands of miles away. The power engineer is more concerned with the effects in the immediate vicinity of the stroke as he must protect against the effects of direct strokes or their propagated effects on the transmission line and in substations connected to the transmission line. My interest falls in the latter category.

For the power engineer to fully evaluate these effects he must have knowledge of the characteristics of the stroke current at the ground both in magnitude and wave shape. He must also have some knowledge of

Dr. Charles F. Wagner, recently made an Eminent Member of HKN, is a consulting engineer for Westinghouse Corporation and a leading authority on power system engineering, particularly in the field of high voltage transmission and lightning protection.

the manner in which the stroke approaches the stricken object and the manner in which the charge above the transmission line tower varies immediately after impact.

Flash Characteristics

A lightning flash, while it may appear to the eye as a single discharge, may consist of many components that take the same path to earth. There may be as many as 42 components in a single stroke. Fig. 1 illustrates the general nature of the phenomenon with a somewhat distorted time scale. This is the type of figure one would obtain by means of a camera in which the film moves at a very high speed. The manner in which the charge separation takes place will not be discussed. It will merely be assumed that charge separation has taken place so that the cloud is charged at a very high potential, which is usually negative with respect to earth. The discharge to earth of the first component of the stroke is initiated in the form of a stepped leader as is shown. The average velocity of the initial leader is relatively slow in comparison with the velocities of other phenomenon to be discussed in connection with the stroke. It is of the order of 1/20 to 1/10 of 1% of that of light.

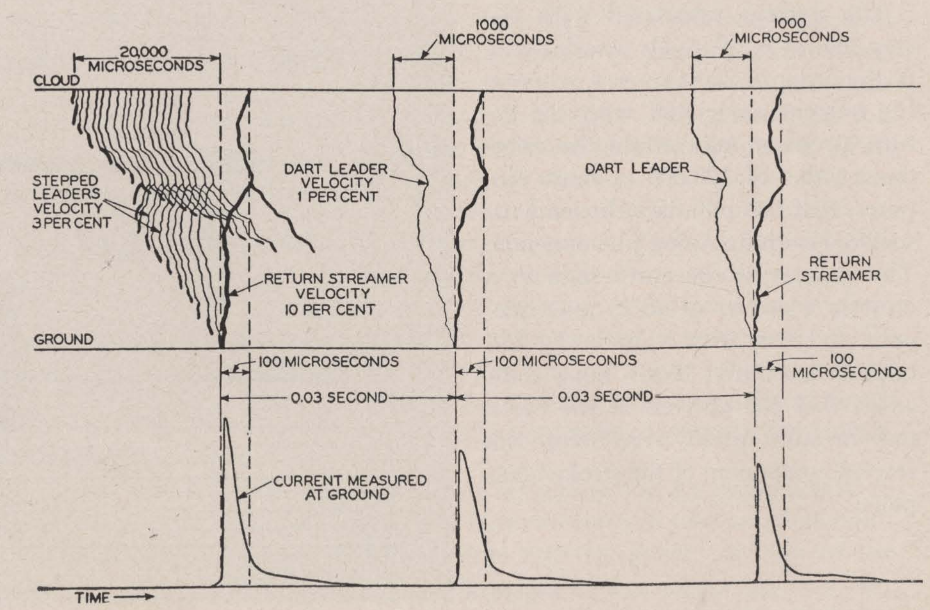


Figure 1.

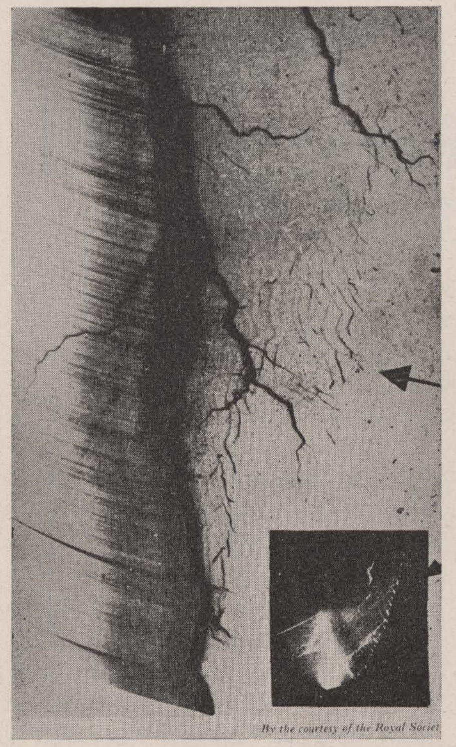


Figure 2.

As its name implies, the step leader moves toward earth in halting steps of about 50 yards in length. Each new advance is evidenced by a very bright step. Without discussing in detail at the moment the phenomenon at the earth, the evidence shows that after the earth is reached a very bright return streamer propagates upward along the same channel at a velocity of about 10% that of light.

The current associated with the step leader is relatively small, being of the order of 200 amperes, whereas the current associated with the return streamer may attain the enormous value of 100,000 or more amperes, that has popularly become associated with lightning phemonenon. The current at the earth rises to a crest in a matter of 10-15 microseconds and then decays gradually and approaches zero. Tests have indicated that the current at the earth may be substantially zero before the second component of the stroke takes place.

After a time of the order of 0.03 seconds, a second component may be initiated from the cloud. The leader of this component differs from that of the first component by the absence of the pronounced steps of the step leader. The leader of the second component moves at a much more rapid velocity than the leader of the first component, being of the order of 1% of the velocity of light. Again, as the head of the so-called dart leader of the second component reaches the earth, a similar high-current return streamer takes place along the same path. After the elapse of another dead period, a subsequent component similar to the second can take place. This may continue for many components.

A great deal of information concerning the mechanism of the stroke was obtained by Sir Basil Schonland and his associates in South Africa where the frequency of occurrence of lightning is very great. Their information was obtained largely by means of rotating cameras. Figure 2 is a typical record that shows the progress of the steps of the first leader.

Earth Current

As mentioned previously, the author's interest lies largely in a knowledge of the current at the earth delivered by the stroke. The collection of complete data concerning this parameter of the stroke is very difficult because the total duration of a single flash may cover the interval of one second but at the same time resolution of the records must be less than one microsecond. The most elaborate installation for this quantity is located on Mt. San Salvatore in Switzerland and is under the direction of Prof. Berger. This installation consists of a conventional magnetic oscillograph to measure the slow variations in current and the sequence of the components comprising an individual stroke. Then, in addition, a film is mounted on a rotating drum that makes many revolutions during the duration of the stroke. Even this arrangement can only provide a very crude time reso-

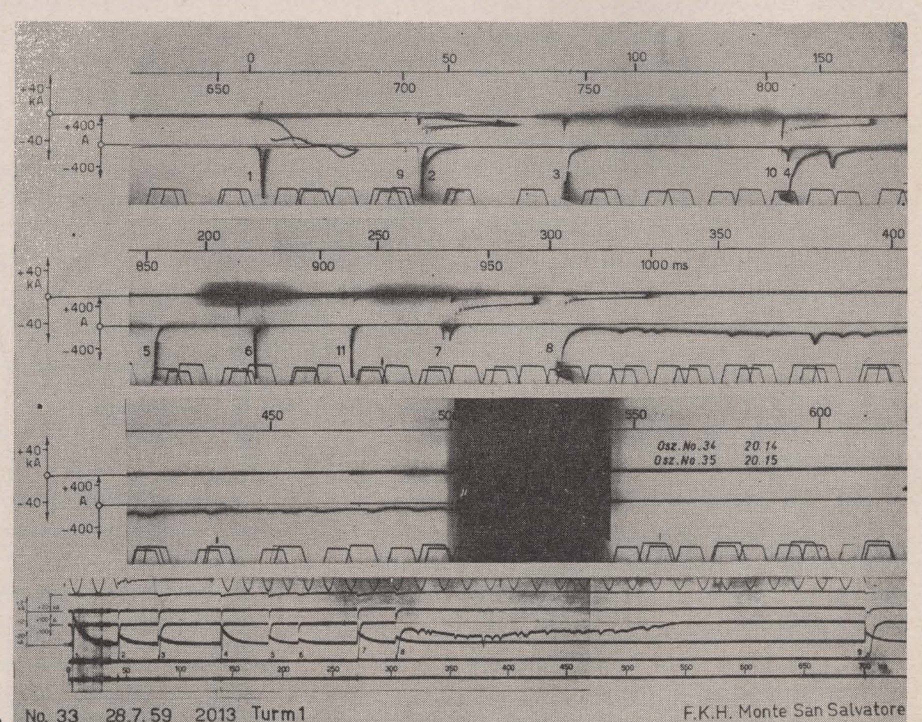


Figure 3.

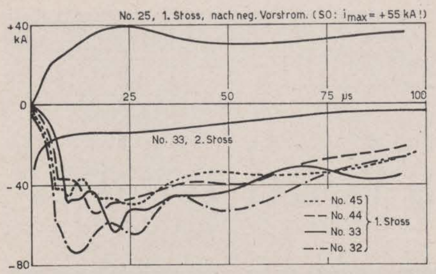


Figure 4.

lution and so each individual component of current trips a time scanning circuit that moves the cathode ray beam at a very high speed along the time axis.

Figure 3 is a typical record obtained by Berger. By comparing the high-speed record shown at the top with the slow-speed record shown at the bottom it is possible to pick out the first and subsequent components of the stroke. From this he has determined that the current of the first component rises very slowly at the beginning of current flow and then increases at a faster and faster rate. Components subsequent to the first rise very rapidly and may have a time slightly less than a microsecond. The traces in Fig. 4 are first component currents with the exception of the one marked "No.33, 2. Stoss" which is a second component trace.

This description serves to illustrate the complexity of making such measurements. Because of the cost both of the equipment and the time of the personnel only a few installations of this character can be justified. There is always present in addition the question that a location that would justify such equipment would be of such character, for example, a very high building or tall mast, as to attract a large number of strokes. Then the question arises whether the strokes to such a location are typical of strokes to lower objects.

On the other hand, there is a wealth of information available concerning the crest magnitude of the stroke currents. These data have been obtained by mounting small permanent magnets to conductors that carry the stroke current. Upon exposure to such currents the permanent magnet is magnetized and by the measurement of the remnant magnetism the crest value of the stroke current can be determined. By such methods the probability of occurrence of currents of different magnitudes have been determined.

Leader Characteristics

It is now generally agreed that the downward leader consists of two parts; a very thin good-conducting core, which will be called the channel, preceded and surrounded by a negative space charge, which will be called the corona sheath. The diameter of the channel is only about 2 mm and its drop about 50 volts per cm. Figure 5 is an idealized view of the leader as it approaches the earth.

There is considerable controversy regarding the manner in which the charge is distributed laterally over a section of the leader. Some believe that the volume distribution is uniform, others that most of the charge resides near the surface of the corona sheath. It is the author's belief that the charge density varies approximately inversely as the radius. But regardless of the lateral distribution of charge the principal role of the leader appears to lower a portion of the charge in the cloud in a uniform fashion along the length of the leader except near the head where the concentration is somewhat greater.

The function of the return streamer is to again lower this charge to earth as the head of the return stroke reaches any particular lateral section. And so since the same charge is concerned in both the leader process and in the return stroke process, it would be expected that the relative currents involved in the process would vary proportionately with the velocity. And so the currents in the leader process are small because the velocities of propagation are small and the currents in the return strokes are large because the velocities of the return strokes are large.

The current at the earth during the return stroke process is equal to $i = vcq_o$ where q_o is the charge in coulombs per cm length deposited by the leader, c is the velocity of light, and v is the velocity of the return stroke expressed as a fraction of the velocity of light. With a knowledge of the current and velocity this relation permits the determination of the charge q_o that is deposited by the downward leader. The charge per unit length constitutes the principal parameter for evaluating the potential of the stroke. When inserting such values of charge distribution into the idealized diagram of Figure 5, the stroke potential is found to vary up to several hundred million volts.

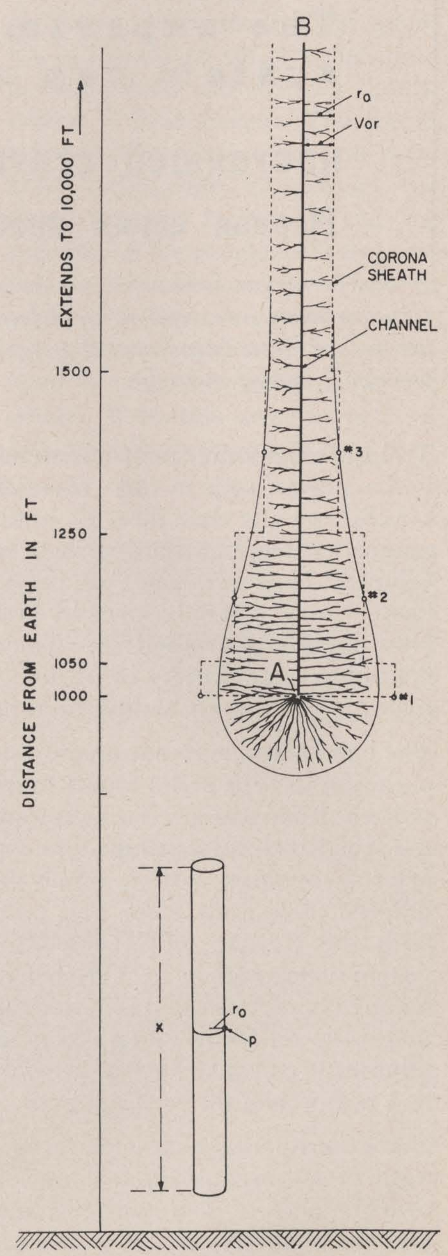


Figure 5.

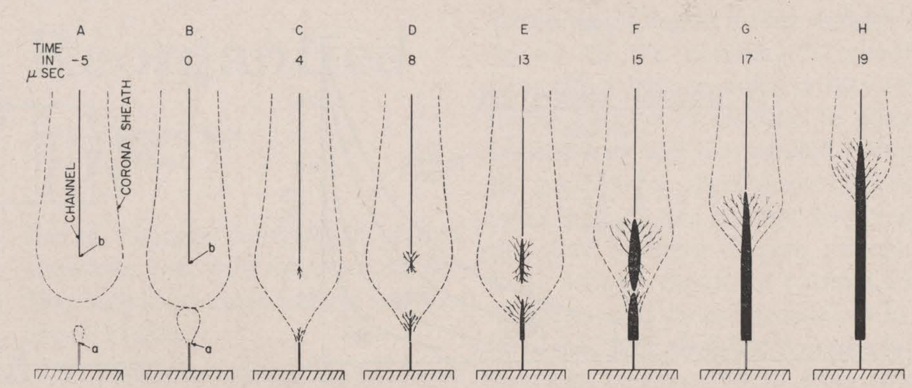


Figure 6.

Return Stroke

To the power engineer the steps of the first leader are only minor incidents prior to the main spectacle, the return stroke. And so, as the leader approaches the earth the steps will be neglected. Figure 6 shows various stages in the initial development in the return stroke. The dotted lines are indicative of the corona envelopes and the heavy lines the relative strength of the currents. As the downward leader approaches the earth plane upon which projections exist, electric gradients that exceed the critical value of 30,000 volts per cm develop around the projections and corona develops from them that forms an envelope of space charge. Such local corona sheaths do not appear to be particularly important except as they serve the secondary function of equalizing the electric gradient between the end of the channel of the downward leader and the tip of the projection from the earth. It is found from laboratory tests on gaps up to about 50 feet that breakdown of the gap will not occur unless an average critical gradient of about 6,000 volts per cm is exceeded. In this connection the author wishes to emphasize the expression "average." Now if it be assumed that the leader potential is 50,000,000 volts then the critical distance that must be attained before actual breakdown occurs is

$$\frac{50{,}000{,}000}{6{,}000} = 8300 \text{ cm} = 270 \text{ feet}$$

It would be expected that when this separation is reached breakdown conditions resembling those in the laboratory result, and the current rises very rapidly. Figure 6C illustrates the beginning of this period as plasma channels develop from both the leader and the mast. These channels increase in length and intensity until they meet as shown in Figure 6F. In the meantime, the associated current increases likewise. The current begins to grow upward from the top of the earthed mast and both downward and upward simultaneously from the lower tip of the core of the downward leader (point *b* in Figure 6B). The current above the tip of the leader core supplies the discharge current in the gap from the charge that had been deposited by the leader in its progress toward earth.

As mentioned previously, the downward leader, after having completed its passage to earth and just at the instant of initiation of the final arc plasma, can be viewed as a vertical cylindrical column of negative charge. The latter stages of the return stroke can be viewed as progressively draining this charge to earth as its head reaches any lateral section. Or conversely, a positive column of charge can be viewed as moving upward, neutralizing this charge as it progresses. If there were no forces to retard the development of the current and if the effective radius of the charge concentration were the same as the effective radius of the current, the positive charge would move vertically with the speed of light. But actually neither of these conditions exist. It is the characteristic of an arc that as the current is suddenly increased from a small value of say 200 amperes to a large value of say 30,000 amperes, its voltage per unit length immediately after the transition increases temporarily to a very high value. The steady-state voltage at 200 amperes and at 30,000 amperes is only about 60 volts but for a period of a fraction of a microsecond the drop is exceedingly high.

Wagner and Hileman have shown that these two effects, the temporary high arc drop and the difference in charge and current concentrations, can reasonably explain the velocity of propagation of the head of the return stroke. Taking these factors into consideration, Wagner and Hileman estimate that the surge impedance is of the order of 3000 ohms.

With the order of magnitude of the surge impedance of the return stroke determined, the currents obtained in laboratory tests were compared with the actual stroke currents as obtained by Berger, some of which are replotted in Fig. 7(B). It was found more convenient in plotting to use as a reference point the instant at which crest current was reached. Prior instants of time are then plotted as negative quantities. Figure 7(C) shows the current that flows when a 6-ft. (183 cm) rod-rod gap is impulsed through approximately 3500 and 6500 ohms in series. The overvoltage fac-

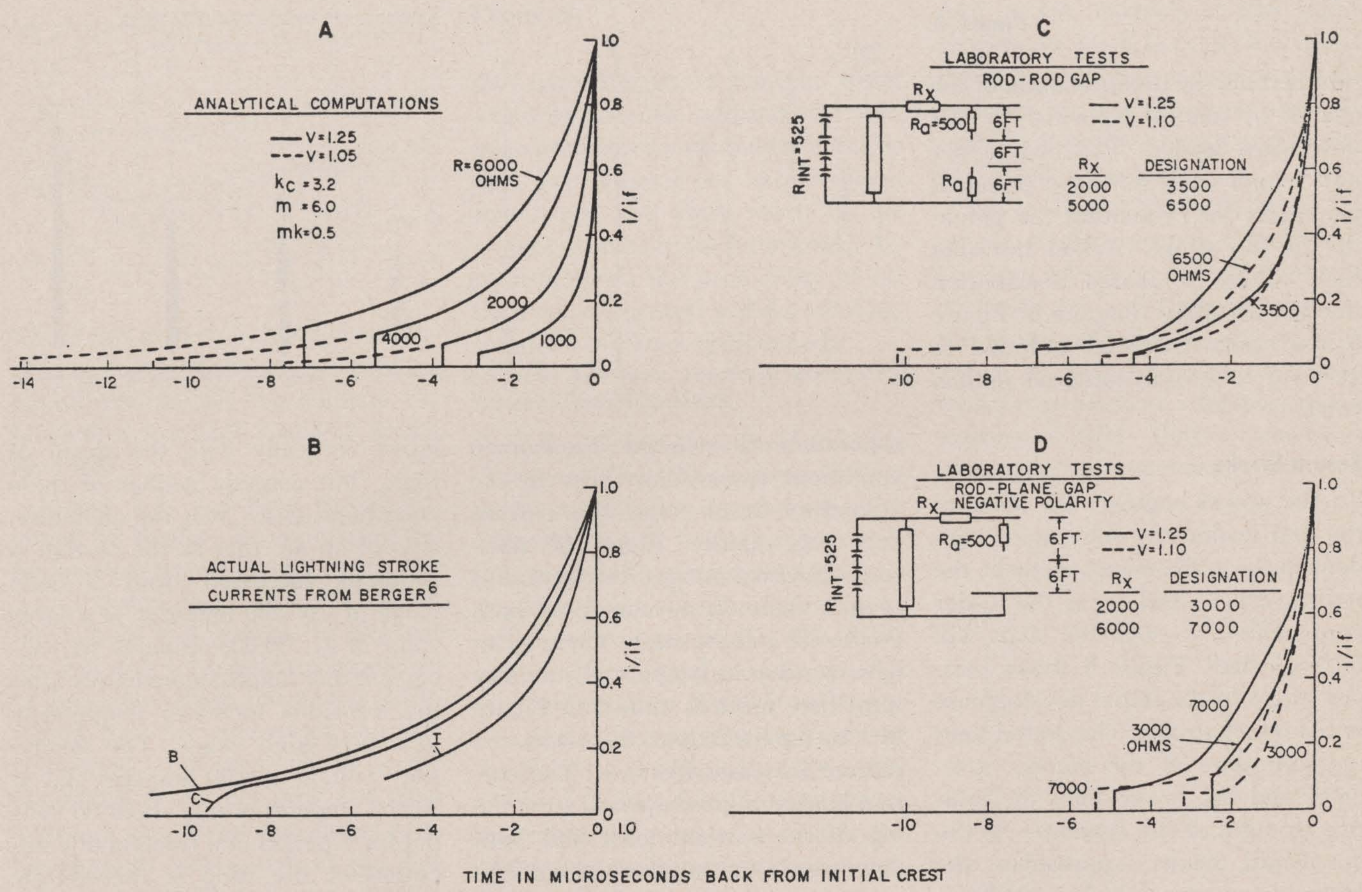


Figure 7.

tor V is the ratio of the applied voltage to the voltage just necessary to produce sparkover. The resistors, indicated by the symbol R_a, that comprise part of the series resistance were placed next to the gap as it was found that this location damped out much of the superposed oscillation. A comparison of the curves of Fig. 7(C) with those of Berger's in Fig. 7(B) shows a tolerable agreement. And actually some of Berger's first component curves rose faster than those plotted. Fig. 7(D) shows similar results for a rod-plane gap for which negative potential was applied to the rod.

Extrapolation of gaps of laboratory proportions to those of stroke proportions is justified because it was found that the time-lag curves of gaps between 20 and 100 inches were almost identical.

Electrical Characteristics

In summary, the electrical characteristics of the stroke consists of the following:

(1) The leader of the first component moves slowly in halting steps from the charged cloud toward the earth.

(2) The potential of the leader relative to the earth is of the order of 50 to 100 million volts and varies from stroke to stroke.

(3) When the tip of the downward leader reaches a point such that the average electric gradient to earth equals the average breakdown gradient of about 6000 volts per cm as obtained in the laboratory, then the characteristic of the discharge changes to that which occurs in gaps of laboratory proportions.

(4) The current increases with time in an exponential manner reaching a crest in 8 to 20 microseconds.

(5) The current at the earth is supplied by the progressive and rapid discharge of the charge that had been distributed along the path of the leader in its downward progress toward earth.

(6) After the charge laid down by the first leader is dissipated the potential in the cloud again builds up and a leader again forms that takes the same path of the first leader, but since the effects of the first leader have not been completely dissipated the same path is pursued and the characteristic of the leader changes from a stepped to a high-speed dart.

(7) The heavy current of the return streamer rises to crest more rapidly in subsequent components than in the first component.

(8) It has been demonstrated that the form of the return current can be reproduced in the laboratory by using a resistance in the surge generator equal to that computed for the surge impedance of the stroke.

HKN Regions Reorganized

John E. Lagerstrom
Vice President

The 1962 Assembled Convention in Chicago took action to approve the selection of two new National Directors from the newly-created Western Region of the Association. Thus the Board of Directors now has two representatives for each of four geographical regions of the country. The establishment of these regions is the responsibility of the Board of Directors, and as Eta Kappa Nu grows it is necessary to provide appropriate representation for the Chapters in the deliberations of the Board. The latest action of the Board in this regard has been to divide the former Western Region into two regions, giving the geographical distribution shown on the map.

The Eastern Region remains as it was, including those Chapters east of the western boundary of Pennsylvania, extended. Including Cooper Union which was installed this year, this region contains 34 collegiate Chapters.

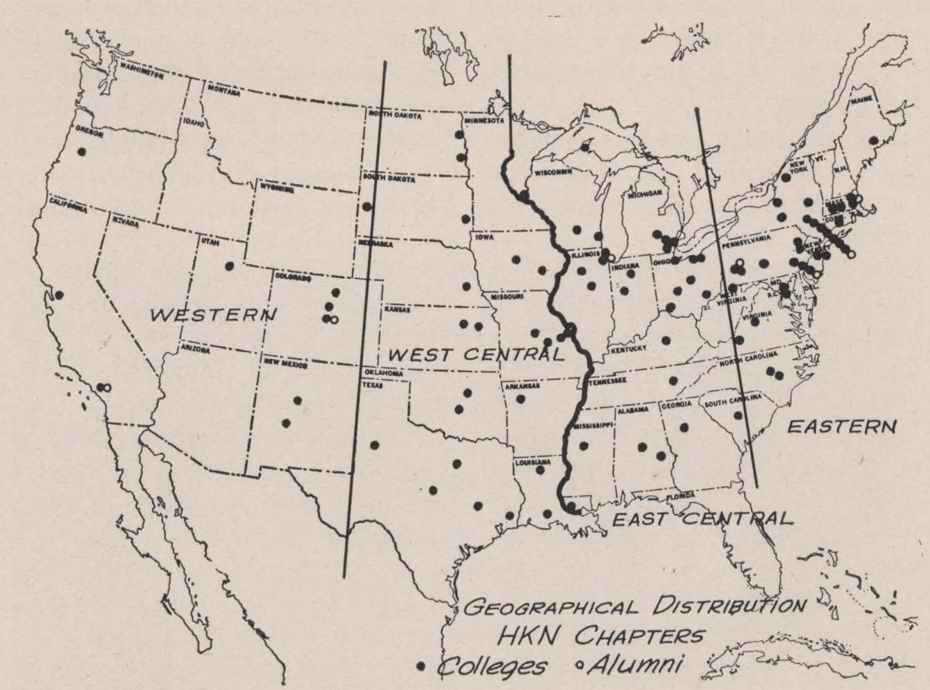
The former Central Region will now be known as the East Central Region, and its western boundary will be the Mississippi River, extended north to Canada. This region, including new Chapters at Toledo and Fenn, will include 29 Chapters.

A new region has been created between the Mississippi River and the eastern boundary of New Mexico, extended, to be known as the West Central Region. In this region a new Chapter has been installed at St. Louis to bring the number to 22.

That portion of the country west of the eastern boundary of New Mexico and including Hawaii and Alaska will now be known as the Western Region. As soon as the new Chapter is installed at Hawaii this region will contain 11 Chapters. The total number of Chapters by the end of this academic year will, therefore, be 96. The estimated membership will be about 41,000.

Of particular interest in this new distribution is the potential for growth of the Association. It is the feeling of the Board that the new Western Region has, by far, the greatest potential for growth. During his term as a National Director, Prof. Ferris W. Norris of the U. of Nebraska prepared a report for the Board analyzing where new Chapters of HKN might reasonably be expected to be established in the near future. Prof. Norris obtained a complete list of accredited E.E. departments, and he also obtained data showing the number of juniors and seniors in each of them. Assuming that there should be available at least 20 prospective members to petition for a charter, he reported that in 1960 there were 28 schools ready to start a new Chapter if they wished to do so. Of this number, 11 schools have either been installed or they are in the process of election to membership and will be installed before the year is over. This leaves 17 prospects, and of this number 10 are in the new Western Region. Should these schools choose to petition for Chapters, and there is reason to believe they will, then the Western Region can be expected to grow to a stature comparable with the other three regions. Having Directors in this region who are familiar with the prospects will enhance the probabilities that they will become new Chapters.

We are, right now, in a period of rapid growth. In the first ten years of our history there were established ten Chapters. In the period 1954-1963 there have been established 40 Chapters. In addition to the ten prospects mentioned above, there are twenty other schools on the accredited list who may grow sufficiently in the next decade to be ready for Chapters. We should be ready when the time comes to welcome them into membership in our Association.



Electrical Industries of America — II

Westinghouse

This is the story of Westinghouse. Its first chapters were written 75 years ago by George Westinghouse, whose foresight and engineering genius exerted a decisive influence on the future of the electric power industry in the United States. The tradition of technological leadership which he established has been vigorously preserved and strengthened by the employees of Westinghouse Electric Corporation, whose efforts today, as in the past 75 years, are devoted to the technical and economic progress of the United States and its people.

Seventy-Five Years Ago . . . .

George Westinghouse launched a new business venture. He leased a building in downtown Pittsburgh, hired 200 employees, and started production of a newly invented transformer.

This undertaking by the young inventor established the foundation for the Westinghouse Electric Corporation of today. Sales for the first year amounted to $172,000, not enough to prevent operations at a loss, but the following year—1887—the firm recorded its first profit.

The company grew vigorously. Within four years, the original group of 200 employees exapnded to a force of 3,000. Annual sales climbed to $4,000,000. A total of 13 products were manufactured, all of which were advertised on a penny postcard.

Today Westinghouse has nearly 110,000 employees and annual sales of nearly $2,000,000,000. The company makes some 300,000 variations of 8,000 basic products at 61 manufacturing plants and 44 manufacturing and repair (service) plants throughout the United States.

Era of Modern Power

Many impressive benefits flowed from the achievements of George Westinghouse. The very type of electric current used throughout the United States today—alternating current—was pioneered by the inventor himself.

Before the development of a-c power, direct current had been in vogue. But direct current because of its low voltage could only be sent short distances. George Westinghouse envisioned a method of transmission that would give electricity the equivalent of "seven league boots," enabling it to stride long distances to remote communities.

On the night of March 20, 1886, a crowd gathered in the town square of Great Barrington, Mass. They had come to see the success or failure of Westinghouse's first practical trial of alternating current. Suddenly the town's darkened buildings grew bright with light.

By November of that year, the first commercial installation of alternating current had been placed in service at a department store in Buffalo, N. Y. George Westinghouse had brought the nation to the threshold of modern electric power.

By championing the cause of alternating current, however, he had touched off a stormy public controversy. But the issue was settled beyond a doubt when he dramatically demonstrated the application of alternating current by lighting the World Columbian Exposition at Chicago in 1893.

Among his other accomplishments are: the railroad air brake; the polyphase electric motor; the meter for measuring electric current consumption; and the application of a steam turbine which today produces nearly four-fifths of our total electricity and which powers the navies and many of the merchant fleets of the world. During his lifetime, he was credited with 361 patents.

Company Highlights

One of the largest electrical equipment manufacturers in the world, Westinghouse has sold over $16.6 billion worth of products and services in the past ten years. Sales for 161 totalled $1.9 billion and assets, $1.5 billion. Net income for the same period was $45 million.

Of the company's 25,000 suppliers, 22,500 employ fewer than 500 people. To illustrate the interdependence of American business enterprises—both large and small—Westinghouse under its contract with the U. S. Atomic Energy Commission, was assisted by more than 3,000 subcontractors in its work on the nuclear reactor for the USS Nautilus, the world's first atomic submarine.

The Westinghouse Electric International Company distributes Westinghouse products overseas both through company representatives and independent local distributors. At the end of 1961 there were more than 350 such distributors and sales representatives throughout the free world. To work more closely with its European licensees in the development and manufacture of atomic plants for Western Europe, the International Company has formed a new subsidiary, the Westinghouse International Atomic Power Company, Limited, in Geneva, Switzerland.

The Westinghouse Broadcasting Company, a subsidiary, operates television stations in Boston, Baltimore, Cleveland, Pittsburgh and San Francisco; and radio stations in Boston, Chicago, Pittsburgh, Fort Wayne, Ind., and Portland, Oregon.

Power for Productivity

Another contribution of significance to the United States economy is the extent to which Westinghouse power equipment has contributed to the growth of the nation's capacity for the production of electrical energy.

Each year Westinghouse manufactures literally millions of kilowatts of potential power in the form of turbine-generators. These range in capacity up to giant units capable of providing enough electric power to serve the residential needs of one million people. One such unit, another Westinghouse first, is the recent sale of a single shaft turbine generator, largest of its kind in the world. Rated at 400,000 kilowatts, the unit is for installation in the Hudson generating station of Public Service Electric and Gas Company.

Steam turbines for ship propulsion also represent a major contribution by Westinghouse. The company built propulsion plants for 329 naval vessels and 595 cargo ships and tankers during World War II. All 25 Essex-class aircraft carriers were powered by Westinghouse.

For many years Westinghouse has produced transformers that have set new records for maximum ratings.

In the field of extra high-voltage transmission, Westinghouse will provide the engineering and equipment for the nation's first commercial 500-kv transmission system to be undertaken by the Virginia Electric and Power Compnay. This 350-mile transmission loop project will cost approximately $45 million. In addition, Westinghouse will build two 500-mw turbine generators to supply the system's power.

At Apple Grove, West Virginia, Westinghouse engineers are working with the American Electric Power System to determine the economic and technical feasibility of transmitting power at 750-kv or higher.

Still another significant contribution is the Point Loma sea water desalting plant built by Westinghouse for the Office of Saline Water, U. S. Department of the Interior. The plant will supply a million gallons of ultrapure fresh water per day from the ocean by a flash evaporator process, for use in the city of San Diego's regular water supply.

Westinghouse is now proposing giant "water-kilowatt factories" capable of producing 150 million gallons of fresh water per day while generating 880-mv of electricity.

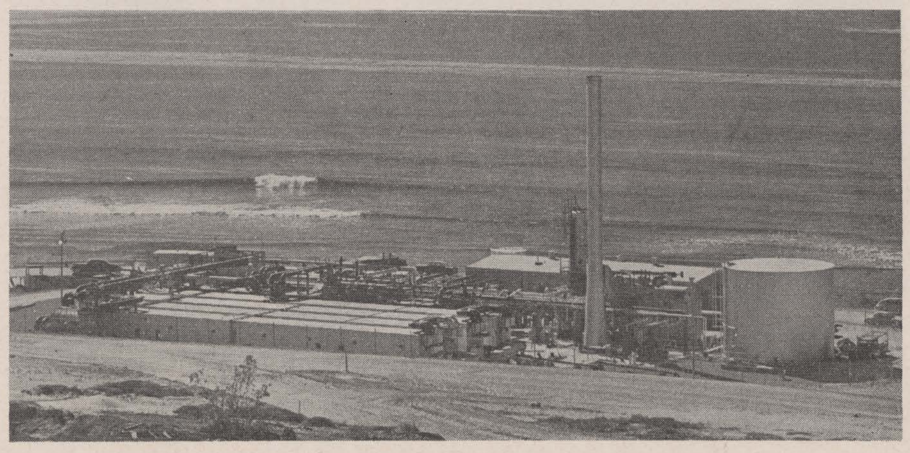
Products

Huge generators, transformers, and motors, though an important part of the company's product line, represent only three of the thousands of Westinghouse products, which are organized into eight principal groups: Electric Utility and Marine, Industrial, Construction, Consumer, Electronic Components and Specialty Products, Defnese and Space, Air Conditioning, and Atomic.

The Industrial Group and the Electric Utility and Marine Group together manufacture a vast variety of equipment for generating, transmitting and distributing electrical energy, and for other industrial purposes. Into this group fall such products as motors, transformers, circuit breakers, gas turbines, flash evaporators, meters, high voltage bus duct, computers, marine diesel propulsion equipment, railway traction equipment, rectifiers, and welders.

The Electronic Components and Specialty Products Group manufacture transistors, rectifiers, electronic tubes, molecular electronic components, ceramic insulators, soft magnetic materials, stainless steels, superconducting wire, thermoelectric generators, insulating varnishes, and a host of other specialty products.

Included in the Construction group are elevators and electric stairways which transport millions of persons a day in buildings throughout the country. Of the elevators sold today, virtually all of them are



Sea water desalting plant at Point Loma, California, produces 1,000,000 gallons per day.

arranged for passenger operation. The Pan American skyscraper now under construction in midtown Manhattan will have 65 elevators and 21 electric stairways made by Westinghouse. Six of these elevator cars will be the fastest in the world, capable of traveling more than 1,600 feet per minute.

Westinghouse also produces a complete line of home appliances, including entertainment products such as radios, television receivers, and stereophonic, high-fidelity, radio-phonograph combinations. Under a $6,000,000 contract, largest of its kind, the company is equipping a 4,500-home Maryland suburb with 20,000 air conditioning, kitchen, and laundry units.

Among the company's many new consumer products is a coin-operated, automatic dry cleaner for self-service laundries. Completely self-contained, the unit will service eight pounds of clothes. A portable greenhouse with thermostatically controlled heat for germinating seedlings has also been announced. Recently introduced is another new consumer product—a water cooler with a thermoelectric cooling system.

Defense

Westinghouse emphasis on research and development has brought dramatic advances in land, sea, air, and space power for national defense.

The handling and launching systems that make it possible to fire the Navy's Polaris missile from submarines were developed by Westinghouse. Westinghouse is developing the first integrated shipboard radar and armament control system to be produced for the Navy by a single company.

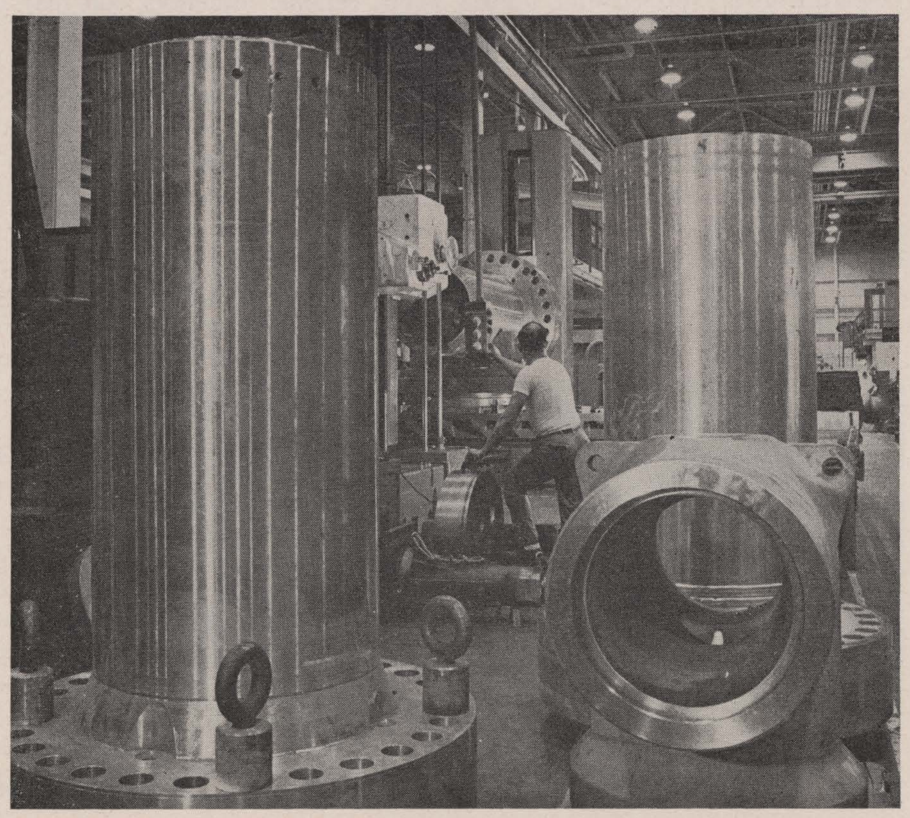
In cooperation with the Air Force, Westinghouse has developed a three-dimensional radar which improves the ability of control centers to track aircraft and missiles. Radar previously indicated only direction and distance. Three-dimensional radar also determines altitude, and performs all three tasks simultaneously.

A target-seeking radar system developed by the company for the F4H-1 Navy interceptor demonstrated its effectiveness by enabling the aircraft to cut its in-flight fueling time in half, thereby capturing the prized Bendix Trophy in a coast-to-coast speed run. The U. S. Air Force recently unveiled another Westinghouse achievement. It was a compact communications receiver about the size of two packs of cigarettes that demonstrated the feasibility of building complex military electronics systems with functional molecular electronic blocks. Westinghouse designed and is now producing the world's first airborne brushless and oil-cooled generator which is being used on aircraft such as the Boeing 707, the B-58, and the B-52.

Advanced imaging systems using infrared, ultraviolet, and visible light rays are under development at Westinghouse to expand the "vision" of man in the interests of science and national defense. Westinghouse is developing a low-light-level electron imaging system that will permit military pilots to "see" moving ground targets at night.

In the field of thermoelectricity, Westinghouse has developed for the Navy a five-kilowatt thermoelectric generator, and a smaller thermoelectric generator capable of producing militarily useful amounts of power yet light enough to be carried by one man.

Among other Westinghouse defense activities are: the flight stability system for the X-15; Astor torpedo, a new weapon system designed to destroy enemy submarines and surface vessels from great distances; the aircraft electric power system for the B-52H bomber; the terminal guidance systems for the Air Force surface-to-air Bomarc and Bomarc-B missiles; ground and shipborne radar equipment employing new concepts for greater effectiveness; a vast variety of communications equipment for the Air Force, Army and Navy; military applications of microwave and sensing tubes, molecular electronic and semiconductor devices, and nuclear components.



Huge "canned" motors and pumps are used to handle coolants and radioactive materials in nuclear reactors.

Space

Company scientists and engineers are working on many advanced space projects involving electronics and propulsion. These efforts include molecular electronics and the application of nuclear power in space. Under a subcontract with Aerojet General Corporation, Westinghouse is responsible for the nuclear portion of the first phase development of the NERVA rocket engine. The project is under the direction of the Space Nuclear Propulsion Office, a joint facility of the Atomic Energy Commission and National Aeronautic and Space Administration.

Under a contract with NASA, Westinghouse will construct and build the S-52 spacecraft for the cooperative international space program being conducted by the United Kingdom and the United States. The spacecraft will conduct experiments on the upper ionosphere, the vertical distribution of ozone in the atmosphere, and measurement of micrometeoroid size and quantity.

Westinghouse scientists have developed an imaging system for using ultraviolet light to communicate over great distances in space. It will extend the range of space communications up to 50 times that of present means of transmission. The company is producing an ultraviolet imaging tube, the Uvicon, which promises to provide a new view of the universe.

Westinghouse scientists and engineers are at work on many other space projects among which are: the feasibility of thermoelectric power generation and cooling for flight vehicles; specially designed and explosion-proof electrical equipment for a new Saturn launch complex at Cape Canaveral; special fabrics that are flexible enough to be launched into orbit in a small package where they can be inflated and will soon become rigid in the space environment; and advanced version of a recently-demonstrated nuclear thermoelectric power system which uses the spontaneous decay of a radioisotope to produce heat which is converted into electricity by thermoelectric principles; a NASA contract for the most powerful arc heater ever built which will simulate the extreme conditions of re-entry; a study contract for a solar power system for orbiting satellites for the USAF; a major subcontract for a generator and control unit for the Dynasoar; and concentrated effort in the area of materials for space use.

Atomic Power

In 1937 Westinghouse engineers built the first industrial atom smasher and began probing the secrets of a new and virtually unexplored field. Eleven years later the company formed an atomic power division and subsequently—under government contract—began tackling the job of harnessing this new and little understood type of power. In 1953, a Westinghouse-designed reactor began operation in an Idaho desert. It was the world's first atomic power plant to produce substantial amounts of usable power.

From this historic project came the atomic engine which today drives the U. S. Navy's submarine Nautilus. Westinghouse also developed the reactor for the atomic submarine, USS Skate. During August, 1958, the Nautilus and the Skate drew world-wide attention with the first transpolar voyages under the arctic ice pack. The Skipjack, which established a world's speed and diving record for submarines during her maiden voyage, and the George Washington, which is the first to be equipped to fire the Polaris missile, also have reactors designed and developed at the Bettis atomic power laboratory. The company is also providing nuclear propulsion plants for the cruiser Long Beach, first nuclear surface ship, and an eight-reactor plant for the aircraft carrier Enterprise, the world's largest nuclear ship.

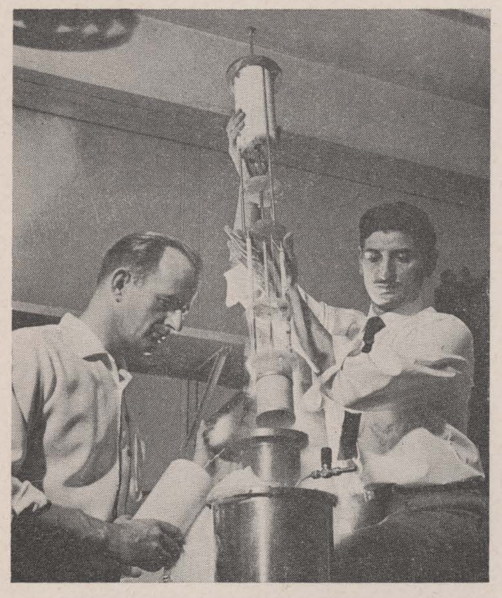
The nuclear portion of Shippingport, and the reactors for the naval nuclear propulsion projects were designed and developed by Westinghouse under the direction of, and in technical cooperation with, the Naval Reactors Branch of the U. S. Atomic Energy Commission at the Bettis atomic power laboratory which Westinghouse operates for the Commission.

Placed in operation in August, 1957, the Westinghouse Reactor Evaluation Center is used for testing various arrangements of fuel, moderator, and control rods to determine the most satisfactory design of nuclear reactor cores.

In addition to the NERVA contract, Westinghouse is pursuing research and development of nuclear technology for space applications in its astronuclear laboratory at Large, Pa.

Research and Development

In the history of Westinghouse, one finds this unique and significant fact: George Westinghouse established his first electrical research laboratory at Great Barrington even before he founded the company itself. This emphasis on research has continued. Today the Westinghouse research laboratories are located on a 100-acre site in Churchill Borough 10 miles east of downtown Pittsburgh. The facilities at the site are being expanded to create a research and development center unique in American industry. With the two additional buildings now being completed at the center, about 1,750 scientists, engineers and supporting personnel will occupy a total of 712,000 square feet of space with 450 scientific laboratories.



Cryogenic research produced a one-pound superconducting magnet equal to a 40,000-pound iron-core magnet.

Complementing the corporate research program, various divisions in the company conduct research in their own specialized facilities where close contact with design groups will permit rapid use of the results of pure research.

The company's long-range program in research and development has maintained for its position of leadership in the field of thermoelectricity. Long a laboratory curiosity, the thermoelectric effect has been applied by Westinghouse scientists towards the development of a simple, efficient, reliable source of power. For the Air Research and Development Command, the company has developed a 100-watt thermoelectric generator capable of powering electronic installations in remote areas of the world. Another thermoelectric project undertaken by the company was the construction of an experimental 5,000-watt generator for the U. S. Navy Bureau of Ships. Westinghouse is also developing for the Bureau of Ships an experimental three-purpose thermoelectric air conditioner, space heater and refrigerator to test thermoelectricity for shipboard refrigeration and air conditioning.

It was announced in September, 1961, that Westinghouse scientists had achieved one of the most sought-after goals of modern science—development of the first super-strength superconducting magnet. The size of a doughnut and weighing a pound, the Westinghouse super magnet creates a magnetic field as strong as that of a conventional iron-core magnet weighing 40,000 pounds.

As early as 1919, researchers at the lamp division laboratories were investigating uranium as a possible lamp filament. Although this metal was subsequently discarded as filament material, these men became proficient in making highly purified uranium, and for years provided the only known source of supply.

Then in 1942 they were asked to produce uranium not in pounds, but in tons. It was a formidable task, but they succeeded. This uranium went into the world's first atomic pile—the critical experiment, conducted in 1942 under the stands at the University of Chicago's Stagg Field, which eventually led to the atomic bomb.

A major breakthrough was achieved by Westinghouse scientists with the development of a revolutionary process for growing germanium in thin, flat continuous strips—a form ideally suited for use in finished semiconductor devices. A recent advancement in solid state materials by Westinghouse was the development of a technique for growing nearperfect crystals of silicon that can be used for semiconductor devices without the time-consuming slicing, grinding and polishing that is usually necessary. These germanium and silicon strips and other solid state materials are important to the development of an exciting new concept known as molecular electronics. Under this concept, a single crystal of solid material performs several electrical functions which now require individual components in an electronic circuit.

Under investigation by Westinghouse scientists is the generation of electrical power by the power generation principle of the future–magnetohydrodynamics. In MHD generators, a moving stream of ionized conducting gas, called a plasma, replaces the moving copper conductors of a conventional generator.

A recntly-announced development by company scientists in the field of optical radiation is a new kind of optical maser. The optical maser is man's newest light-producing device. It produces high monochromatic, narrow, brilliant beams of light from various materials, such as a ruby crystal, that has considerable future potential for such uses as welding, micromachining, communication, and warfare.

The company's total cost of research and engineering which includes the services of 8,000 scientists and engineers is better than $200,000,000 on an annual basis or over ten cents for every dollar of sales—one of the highest figures in American industry.

Employees

The success of Westinghouse depends in large part of the skills and talents of over 100,000 employees.

Individual employees have provided a continuous source of new ideas, methods and inventions. Under a company suggestion system in effect for half a century, cash awards are made to persons submitting proposals that are adopted. In recent years, these awards have totaled considerably more than $200,000 annually. In 1961, more than 10,000 employees were paid a total of $271,346. Since 1927, when company-wide records were first kept, the company has paid over $3 million in cash awards for ideas.

The first retirement plan was adopted in 1915 and a group life insurance plan was initiated in 1920. Over the years Westinghouse has continually expanded and improved its employee insurance and pension program. Today an insurance plan for all employees is supported entirely by company contributions. In 1961 benefits were paid in 79,000 cases involving sickness or death of employees, and hospitalization of employees or their dependents. Westinghouse employees are now covered by group life insurance totaling more than $1 billion.

The cost to the company of providing employee benefits in 1961—including vacations and holidays with pay, employee insurance, pensions, Social Security taxes, unemployment compensation, workmen's compensation, suggestion awards and employee discounts for Westinghouse products—averaged more than $88 a month for each Westinghouse man and woman. Based on 1961 total assets, the company has invested an average of more than $14,750 for each employee's job. In some of the company's newer plants, the average investment per employee approaches $25,000. The company's average hourly rate for employees at the end of 1961 was 16 per cent higher than that of the electrical manufacturing industry as a whole.

By special arrangement with 25 universities in major plant cities, all Westinghouse employees are given the opportunity to continue their education. More than 12,000 employees have taken courses for credit, 647 have received their Master of Science degree, and 40 their Doctor of Philosophy degree. Some company plants in large cities have a plan by which outstanding high school graduates can obtain a technical education at the local university while continuing their work.

Westinghouse provides a training program called the Graduate Student Course for young college graduates employed each year. At the Westinghouse Educational Center, near Pittsburgh, these men attend classes in engineering, sales, manufacturing, and other phases of the company's business. To supplement classroom training, graduate students are required to complete work assignments in various company divisions throughout the country. Altogether, 22,500 graduates have participated in this program.

In addition, the Westinghouse Educational Foundation, which is supported by the Corporation, sponsors the nationally famous Science Talent Search among high school seniors. Selected from an original field of 25,000 entrants, 40 national winners are sent to Washington, D. C., each March to compete for awards worth a total of $34,250. Since the program began 21 years ago, more than $312,000 in the form of Westinghouse scholarships has been awarded to hundreds of young scientists.

Each year the Foundation also sponsors ten George Westinghouse scholarships at the Carnegie Institute of Technology, Pittsburgh, Pa. These scholarships are valued at $4,800 each. Altogether, Westinghouse and the Westinghouse Educational Foundation (established in 1944) maintain 138 scholarships, 3 fellowships and 9 professorships. These Foundation grants and others in the field of employee educational support totaled more than one million dollars in 1961.

Alumni Notes

Three HKN members were recently graduated from the U. S. Air Force Squadron Officers School at the Air-University, Maxwell Air Force Base, Alabama. They include Captain **James R. Matthes, Rho;** Captain **Keith G. Dailey, Beta-Epsilon;** and Captain **Joe A. Howard, Beta-Psi.** Captain Howard was named a distinguished graduate.

Army Reserve 1st Lt. **Thomas P. Donaher, Gamma-Gamma '56,** and Army 2nd Lt. **Ronald O. Reynolds, Gamma-Beta '61,** recently completed the microwave radio officer course at The Signal School, Fort Monmouth, New Jersey.

Major **Marshall E. Neal, Beta-Psi '48G,** was recently graduated from the United States Air Force Command and Staff College at the Air University, Maxwell Air Force Base, Alabama. This is a nine-month course of intermediate-level professional military education for Air Force career officers. Major Neal has been assigned to Sandia Base, Albuquerque, New Mexico.

William C. Jakes, Jr., Beta-Tau '48G, was among thirteen Northwestern University alumni to receive merit awards from the Northwestern Alumni Association this spring. His award was presented "in recognition of worthy achievement" in his work as project engineer, leading scientific and technical teams for Bell Telephone Laboratories participating in "Project Echo," the communications-via-satellite experiment. Brother Jakes was the first man to make a live phone call that was bounced off a space balloon, and believes the experiment will lead to transatlantic satellite telephoning within the next decade. He has recently received an honorary degree from Iowa Wesleyan College.

Albert E. Doles, Beta-Kappa '56, has been elected a vice president and member of the board of directors of Eberline Instrument Corporation, Sante Fe, New Mexico. Brother Doles, who was technical director, will have primary responsibility for all technical phases of the company's nuclear instrumentation engineering and production, radiochemistry, and radiological health services. He recently worked as the nuclear instrumentation member of the start-up team at the Enrico Fermi Atomic Power Plant, Newport, Michigan.

J. W. Emling, Lambda '25, has been appointed executive director of the Transmission Systems Engineering Division of Bell Telephone Laboratories. Brother Emling has been with AT & T since 1925, and with Bell Laboratories since 1934. His work has included the fields of underwater acoustics, transmission and field engineering on power line carrier, and systems engineering studies in the field of engineering economy. One of his responsibilities included transmission engineering of the transatlantic telephone cable.

Outstanding Young Electrical Engineers Honored

The HKN award for the Outstanding Young Electrical Engineer for 1962 was presented at a banquet at the Hotel Governor Clinton, New York City, on January 28. The recipient was James T. Duane, Manager, Aircraft Motor and Generator Product Engineering, General Electric Company. An Honorable Mention was awarded to Francis A. Gicca, Technical Director, Special Programs, Missile and Space Division, Raytheon Company. The award has been given annually since 1936.

Mr. Duane's response, "Opportunities in Engineering," will appear in the next issue of the Bridge.

The evening was highlighted by an address by Dr. Albert C. Hall, Vice President and General Manager, space Systems Division, of the Martin Company, on "The Real Challenge in Aero-Space Engineering."

HKN National President John A. M. Lyon (left) congratulates James T. Duane, Outstanding Young Electrical Engineer of 1962, on his award. Francis A. Gicca, winner of the Honorable Mention award, looks on. Duane's name will be added to those of previous winners inscribed on the brass bowl, which is displayed at IEEE headquarters in New York.

Responsibilities of Scientific and Technological Institutions In Today's World

Martin A. Elliott
Vice President for Academic Affairs
Illinois Institute of Technology

With a title this broad, I will consider responsibilities in only three senses—in a practical sense, in a philosophical sense, and in an idealistic sense.

The scientific and technological institute is in a unique position to discharge its responsibilities in both the practical and philosophical senses. In the idealistic sense it can discharge its responsibility by being a strong voice in what must be a chorus of strong voices from all segments of society.

The Practical Responsibility

In today's world science and technology occupy a central role. Their rapid advancement of knowledge and of its application has been both a benefit as well as a burden to mankind. A benefit because it has increased life expectancy, leisure time, so-called "creature comforts" and standard of living. A burden, because its advances can also be applied to the development of sophisticated weapons of destruction with the attendant burdens of an arms race and of the tensions in the world of today.

Ideally the practical responsibility of the scientific and technological institute should be to educate people in these areas so that the benefits of science and technology could be disseminated throughout the world and made available to all mankind. Although this should be our basic practical responsibility, unfortunately we

A paper presented at the luncheon at the HKN Assembled Convention, November 16, 1962.

cannot view it in this altruistic context. As realists we must accept the fact that considerations of national security dictate that we maintain leadership in science and technology. This means that increasing numbers of individuals must be educated in these fields.

The importance of scientific and technical education in the future security of the United States has been succinctly stated in a report of the National Science Foundation entitled "Education and Professional Employment in the U.S.S.R." This report stated, "Soviet leaders firmly believe that the competition between capitalistic democracies and the Communist world will be decided in the field of science and technology. This provides the rationale for their own emphasis on engineering and the sciences in their professional training programs.

"If we take the Communist threat in international politics seriously, as we must, the issue of America's adequacy in engineering and scientific education—in quantitative as well as qualitative terms—becomes of central importance.

"There must be no misunderstanding or underestimation of the Soviet scientific and technical manpower buildup. It has become the principal source of Communist strength."

The seriousness of Russia's intentions is clear. They are graduating each year about twice as many individuals in the fields of engineering, science and applied science as are graduated in the United States. This fact takes on added significance when it is realized that the total number of graduates in all fields in Russia is only half that in the United States.

Aside from any competition with Russia it has been pointed out for many years that we will need increasing numbers of scientists and engineers for research, both basic and applied; for teaching at all levels; and for insuring our continued technological advance. Again aside from any consideration of competition with Russia—how are we meeting these needs? Our enrollments in science and the number of baccalaureate degrees in science have been increasing progressively each year. In fact we are ahead of Russia in the number of graduates in physical and biological sciences — 35,700 U. S. graduates in 1958 compared with 21,000 USSR graduates in 1959. Despite all of this we should continue to strive for even greater increases in the number of individuals receiving scientific education. But our critical problem in enrollments and graduates is not in scientific fields but in the field of engineering. Without minimizing the importance of supplying the need for scientists I would nevertheless like to direct attention to warnings that signal the development of a more pressing problem—supplying the need for engineers.

In the four years prior to 1961, total engineering enrollments have decreased by 7.8%, and undergraduate engineering enrollments have decreased by 14%. In this same period total degree-credit enrollments have increased by 26.7%. In the two years prior to 1961, decreased engineering enrollments have resulted in a 5.3% decrease in undergraduate engineering degrees. Here then is a real problem in technical education—a decrease in the total number of engineers being educated in the face of an estimated 45% increase in the number of engineers needed in the next 10 years. The chances of meeting this need are slim because the estimated needs are 48,000 engineers per year for the next decade as compared with an estimated 37,000 engineers to be graduated per year in this same period. Once again, aside from any comparison with Russia, we must graduate more engineers if we are to continue to lead in technology. On the slightly brighter side of engineering education, in the same 4-year period of declining undergraduate enrollments, candidates for the master's degree increased about 39% and for the Doctor's degree, about 88%. Since graduate enrollments are only about 17% of total enrollments, these substantial increases, although heartening, were not enough to offset the downward trend in undergraduate enrollments.

What are the reasons for the decline in the interest of students in engineering? Two of the more important reasons coming from a survey of 150 deans of engineering are:

1. Increased interest of qualified students in other fields of science. This is borne out by the increased enrollments in physical and other sciences in a period of declining engineering enrollment. This increased interest stems from the greater emphasis that is being placed on science, particularly in those areas such as space and nuclear technology where scientists and engineers are working together at the frontiers of knowledge.

2. Concerns over the rigors and demands of engineering education. Students choosing science in preference to engineering for this reason are in for a rude awakening. Both science and engineering education today demand excellent preparation and hard work. These disciplines are not for the dilettante.

In my opinion, one of the major reasons for decreasing interest in engineering is a complete lack of understanding of what today's engineering really is. I believe there is a widespread, popular misconception that engineering involves rule of thumb, cut and try, empirical procedures based on experience accumulated over the years. Nothing could be farther from the truth. The intellectual skills—creativity and intuition—used by the engineer are identical to those used by the scientist. The scientist applies these skills in discovering new knowledge. The engineer applies these same skills in using the knowledge discovered by the scientist to provide things that people need and want. In doing this, the engineer must conceive and visualize in its entirety the product, process or system that he is designing. He must then select the scientific and engineering disciplines pertinent to the design and know how to apply these in their most sophisticated form. The engineer's activity parallels that of the scientist whose creativity and intuition help him visualize and chart his paths of advance into the unknown and whose scientific ability helps him interpret what he has found.

We must convey this message of parallelism between engineering and science. We must convey the message that the same inherent intellectual skills are essential in both engineers and scientists and that the same level of sophistication in the application of these skills is required in both fields. We must convey the message that engineering curricula today recognize these facts. The choice of the individual then narrows to his preference for working in a field where knowledge is applied or in one where knowledge is discovered.

The scientific and technological institution is in a unique position and has the responsibility to encourage more individuals to enter the fields of science and engineering. It also has the responsibility to see that the distinction between science and engineering is made clear and understood. Individuals in a free society can then make an intelligent choice between these fields and certainly this should help in maintaining a proper balance. This we must do because our competitors satisfy their requirements by fiat. Although scientific and technological institutions are in a unique position to discharge these practical responsibilities, the cudgel must also be taken up by individuals, other educational institutions, industry and government.

The Philosophical Responsibility

A world, whose present and future is inextricably linked with the explosion in scientific and technological advance, suggests the philosophical responsibility of a scientific and technological institute. With science and technology as the strong, central motivating force in today's world, it seems particularly appropriate to structure a university with science and technology as the central core but with strong interaction with liberal arts and humanities. With this structure the liberal arts and humanities will be concerned not only with the cultural aspects of their respective disciplines but also with communications science, with the impact of science and technology on man and society and with the problems of metropolitan centers. In these areas the linguist, the anthropologist, the social scientist, the political scientist, and the economist, will be working with the engineer, the mathematician and the physical scientist. In this context the liberal arts and humanities will contribute to the advance of science and technology and also to the solution of social and economic problems created by this advance.

With such an institutional structure and philosophy we will educate men and women who will be cognizant of the impact of science and technology on society, who will anticipate the problems before they arise and who will be competent to plan courses of action to meet these problems. This breadth of education and competence will be engendered not only in the scientist and technologist but just as importantly in the arts and humanities students. This then should contribute significantly to the merging of the two cultures referred to by C. P. Snow who characterizes them as follows: "Literary intellectuals at one pole—at the other, scientists and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension — sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding." By its acceptance of its philosophical role as outlined above, the scientific and technological institute can contribute significantly to improving this understanding and to unifying the two cultures referred to by Snow.

The Idealistic Responsibility

The practical and philosophical responsibilities of the scientific and technological institutions have been discussed in terms of tangible results expected. The idealistic responsibility is broader, more intangible and must be discussed qualitatively. To me the idealistic responsibility of the scientific and technological institute is to address itself to the basic question of "National Purpose and Education." This is not a unique responsibility but one which is shared with society as a whole.

Fundamental to our national goals and national purpose is the perpetuation of a free society. With this in mind we can recall what Epictetus said almost 1900 years ago, "Only the educated are free." Thus, education must be accorded a pre-eminent position in relation to the attainment of our national goals. Have we accorded education this pre-eminent position? The answer is—no. And until we do accord it the position it deserves, we will continue to be caught temporarily off-balance not only in science and technology, but in other areas as well.

Of course we have been making progress. Teachers' salaries are being increased—albeit too slowly. Belated, intensive education in science and mathematics is being provided for primary and secondary school teachers. Graduate work is being encouraged and graduate students are being given an incentive to enter teaching in higher education. Basic research in universities is being expanded. These and many other signs of progress, too numerous to mention here, are all to the good. But if education had occupied its proper position in our society, and in the minds of our citizens, teachers and college professors would not have had to subsidize the educational system; we would not have allowed theorists to tamper with the substance of the educational process—substituting method for course content and pleasurable experience for plain, unadulterated hard work; we would not have a shortage of competent teachers because their stature in society and the necessary economic incentives would have been assured.

There are signs that education is climbing slowly toward the heights that it must eventually reach in our society. The rate of climb will be commensurate with our progress in recognizing the importance of education and our willingness to adjust our sense of values. Will we give the same recognition to students of high academic ability as we give to those of high athletic ability? Will we regard the teacher as a kindly old Mr. Chips instead of a dynamic force for betterment whose contributions and competence are recognized by adequate compensation and position? These are but two examples of the many soul-searching questions that we must ask in gaining perspective on our sense of values.

In asking these questions we must have a clear understanding of what we mean by education in the broadest sense. A statement that expresses the true significance of education was contained in a report of the President's Science Advisory Committee on Education for the Age of Science, "We ought not speak of our educational tasks solely in terms of buildings or budgets or curricula. These, indeed, are necessary means to an end. But we must think of the end itself. The end is clear: to introduce the growing child, the youth, and the adult to the best and most essential elements of the intellectual and cultural experience of previous generations; to do this in such a way that we stimulate curiosity and encourage each individual to look forward, not backward, to develop his own talents to the maximum and to continue this development throughout his life." "To continue this development throughout life"—to have the capability and desire for continued self-education—this is the basic objective of education. Education must not be confused with training. In a changing world training rapidly becomes obsolete. True education is self-perpetuating and the educated citizen is the informed citizen capable of contributing to progress in his society and capable of understanding and critically evaluating the implications of his contributions and of the contributions of others.

The scientific and technological institutions, along with leaders in all segments of society, must accept the responsibility for seeing that education plays a dominant role in realizing our national potential and national goals. A faint flicker of general awareness of the vital role of education is beginning to emerge. We must fan this flame by word and deed and by all other means at our disposal until it becomes axiomatic that brains are our greatest resource and that educated brains are the underpinnings of our free, dynamic society. Then we will be able to expand the observation made by Epictetus from "Only the educated are free" to "Education perpetuates freedom for all mankind."

Real and Imaginary . . .
(Continued from Page 2)

And men two centuries and a half
Trod in the footsteps of that calf.
A hundred thousand men were led
By one calf near three centuries dead.

For men are prone to go it blind,
Along the calf-paths of the mind,
And work away from sun to sun
To do what other men have done.

They follow in the beaten track,
And out and in, and forth and back,
And still their devious course pursue,
To keep the path that others do.

They keep the path a sacred groove
Along which all their lives they move,
But how wise are you, in this behalf?
Do you follow that primeval calf?

—Author Unknown

Chapter Activities

BETA-TAU CHAPTER, Northwestern University—initiated ten new members at its Fall Quarter initiation ceremony held November 18, 1962. Following the initiation ceremony, a banquet jointly sponsored by HKN, Tau Beta Pi, and Pi Tau Sigma honor societies was given for the new initiates of these three societies. At this banquet, the societies were privileged to hear Professor Raymond Kliphardt of the Northwestern Engineering Sciences Department speak on his recent experiences while teaching in the Sudan. Colorful slides of this African country were also shown. All who heard Professor Kliphardt learned much of the culture of the Sudanese.

One other large project was undertaken by HKN this quarter. At Northwestern this year, a series of convocations are required of all freshmen in the Technological Institute. The purpose of these convocations is to give the new freshmen an insight into the field of engineering and a look at the various branches of engineering. On November 13 and 14, the EE department hosted 276 freshmen for this convocation. The entire program was prepared and executed by HKN in conjunction with the joint student branch of AIEE-IRE. These two electrical engineering societies had the privilege of being the only Tech student societies permitted to completely plan and run one of these convocations. Through a short discussion of the nature of electrical engineering and extensive lab tours, we hoped to give all Tech freshmen a better idea of current trends in electrical engineering.

GAMMA-ALPHA CHAPTER, Manhattan College—The annual Engineering Career Day at Manhattan on Sunday, December 2, owes its electrical engineering exhibits to the chapter. In order to stimulate interest in engineering among high school students, the members and initiates of HKN worked to improve the quality of the exhibits in the laboratories. As their projects, a number of Fall pledges were assigned the development of suitable demonstrations to be used for this and similar occasions.

The Fall semester included, as usual, the six-week initiation period in which aspiring members worked on projects for the repair and improvement of the electrical engineering laboratory facilities. The smoker and the induction dinner were again the highlights of this period.

Other chapters may be interested in the insignia Gamma-Alpha has been requiring eligible students to wear prior to acceptance as members. On a standard 3x5 index card a replica of the HKN key is drawn in black ink with the student's name and class printed along the border. The card is then covered with a plastic sheet (or laminated) and a safety pin is attached to the reverse side. This insignia is easily produced, durable, and involves little, if any, cost.

GAMMA-BETA CHAPTER, Northeastern University — has completed its fall consideration series. Membership in HKN is regarded as a high honor and the chapter takes great care to get to know each of the considerates as an individual so that the character and attitude of each potential member may be evaluated.

At Recognition night the prospective pledges were given insight into the history of HKN nationally as well as the development of our own Gamma-Beta chapter. Then Dr. David Cook of the Northeastern University Testing and Counseling Center gave an interesting and informative lecture on India followed by slides of his recent Indian trip and a question and answer period.

The chapter offered a free tutoring service to those students who had to take conditional examinations in electrical engineering subjects. An interesting display Freshman Night welcomed the freshmen to the University and gave them the opportunity to learn something about both electrical engineering and HKN. A chapel service was sponsored by the chapter in the Northeastern University Bacon Memorial chapel with the membership attending as a group.

A plaque representing Gamma-Beta chapter is hanging in the University Commons as part of the university-wide move to beautify the Commons. The chapter has also set up displays in the library and Richard's Hall to inform the student body of the nature and aims of HKN and Gamma-Beta chapter. A synopsis of EE graduate school information was distributed to the upperclassmen which included admission requirements, available financial aid, degrees offered, etc., for all universities and colleges offering graduate work in EE.

GAMMA-ZETA CHAPTER, Michigan State University—Being unsatisfied with past results, the members of Gamma-Zeta introduced a pledge interview to augment the smoker. Each student eligible for membership was personally interviewed by several active members on an informal basis. The interview enabled the prospective members to become fully aware of the significance and functions of HKN. This was done before any commitment was required of them or the chapter concerning future membership. The interview also provided actives with an opportunity to get to know the future members. The excellent group of new initiates indicates the interview was well worth while. With the entire College of Engineering at MSU now under one roof, plans are being initiated by Gamma-Zeta to establish an information service to provide answers to questions of engineering majors during registration week.

GAMMA-THETA CHAPTER, Missouri School of Mines and Metallurgy—is continuing once again to make available the "Initiation Slides" to all new HKN members. These slides have replaced the old "Light Boxes" made by Gamma-Theta for the new chapters, a few years ago. Any chapter desiring a set of slides is asked to write us for information.

For the nominal fee of fifty cents, any EE student is protected from accidental damage to the EE laboratory equipment through the Gamma-Theta Lab Insurance program. This is a great service to the students and continues to be a good source of income to the chapter. We urge all chapters to consider such a program and will gladly furnish information and sample policies upon request.

The annual "Engineer's Day" for high school students was recently held on campus by the school in an effort to counteract the decreasing engineering enrollment found in most engineering schools. HKN set up demonstrations in all the EE labs for the prospective students to observe, and furnished guided tours of the EE facilities. Many students from the area schools were on hand for the occasion.

GAMMA-LAMBDA CHAPTER, Columbia University—in cooperation with the Columbia University Placement Office presented a placement orientation meeting for the upperclassmen of the School of Engineering. The topics discussed included the importance of campus interviews and the opportunities available to engineering students. Also presented was a survey of the positions offered last year to graduating seniors.

In order to acquaint the E.E. students with the summer employment situation, the chapter conducted a survey among seniors and graduate students in the department who worked

Delta-Chi Installed at Cooper Union

Berthold Sheffield

The scene was the historic grounds of the Cooper Union for the Advancement of Science and Art in New York. The occasion—the proceedings to install HKN'S newest chapter, Delta-Chi, on the brisk, wintry evening of 19 December 1962. It was a profound gathering, with the president of Cooper Union, Dr. Richard F. Humphreys, and other dignitaries, expectant inductees and invited guests. The induction team included the HKN National President, John A. M. Lyon, HKN Director Willard B. Groth, Professor (and HKN faculty adviser) Ernest W. Starr, and Professor Sidney Epstein, both of Cooper Union. Among the guests were Cooper Union's Professor H. F. Roemmele, and two past national presidents of HKN, Larry Dwon and Roger Wilkinson. The New York Alumni Chapter of HKN was represented by Berthold Sheffield.

The ceremony began promptly at 8 P.M. The words of the ritual took on a very special meaning. Clearly Peter Cooper's aims parallelled the requirements of membership in HKN. This historic building had been the scene of many eminent gatherings.

Here Abraham Lincoln had delivered his Cooper Union address which he later said "made me President;" twelve other U. S. Presidents and many other national figures have addressed eager audiences.

The inductees of Delta-Chi appeared fully cognizant of the honor of this occasion. They had demonstrated to HKN that they possess the three basic qualifications of a successful engineer: A good supply of common sense to utilize their basic background; a capacity and willingness to work hard; a congenial nature, and the ability to work harmoniously with their fellows. Each inductee vowed individually to continue to cultivate these qualifications, and to remember above all that we are not just "living," but "living with others."

The induction ended with personal congratulations to each inductee by President Humphreys of Cooper Union and by HKN's National President John A. M. Lyon, and other representatives of the College and of the New York Alumni Chapter of HKN. During the hospitality period there were reminiscences of the grand founder, the venerable Peter Cooper, the modest self-made business leader whose Cooper Union became "a polytechnic school of the most thorough character and the highest order, based as nearly as possible upon the model of the L'Ecole Centrale at Paris," as he had wished.

Peter Cooper had passed away in 1883, nearly 80 years before this HKN induction. The traditions of his career have left indelible marks in many fields. In Cooper Union, there is the free College for gifted young men and women; the famous Great Hall where the Cooper Union Forum lectures and concerts are still being held after over a century, and still with no admission charge; and the Cooper Union Museum.

Peter Cooper had acquired great wealth by perfecting the manufacture first of glue, and later of iron. He had supported and financed new business ventures including the then brand-new communications business. He was the first president, in 1855, of the American Telegraph Co., which in 4 years is reported to have controlled all the telegraph lines along the Atlantic seaboard. His life and work are an inspiring example to all HKN members.

in industry during the summer. Plans for the future include contacting alumni to determine the opportunities for summer and permanent employment in their respective companies.

GAMMA-MU CHAPTER, A & M College of Texas—held its annual fall smoker on October 25, and 20 new members were initiated on November 29. Following the initiation, a banquet was held honoring the new members. The guest speaker for the evening was Mr. James W. Martin of Texas Research and Electronics Inc., Dallas, Texas.

On November 13, the chapter assisted the student branch of AIEE-IRE in the presentation of the annual Freshman Open House. Following a presentation by Professor A. J. Druce emphasizing the broad education needed by the engineer, the freshmen were shown several demonstrations and experiments familiarizing them with the work they will be doing in their later studies.

Gamma-Mu members also made available their services to the Electrical Engineering Department for the Century Study Convocation held November 16. The Alumni were invited back to the campus for conclusion of the Century Study Council and an open house of their departments held on this date.

GAMMA-XI CHAPTER, University of Maryland—began its fall semester activities by offering slide rule instructions to all interested students. The Chapter then distributed a questionnaire to all senior electrical engineering students concerning their summer employment. The results of this inquiry will be compiled as a guide to juniors interested in obtaining similar positions.

The Gamma-Xi Chapter has initiated a program to aid seniors in the difficult task of choosing between several employment opportunities. The alumni of HKN were asked to furnish information concerning their present employer. From this information a list of graduates and the companies employing them will be made available to seniors. Hence, in addition to communicating with a company's personnel office, it will be possible for a prospective graduate to contact a University of Maryland alumnus, and thus obtain a better idea of the opportunities offered by that company.

The Gamma-Xi Chapter is trying to encourage alumni members to take an active interest in Chapter events by publishing a newsletter informing them of Chapter activities and of present happenings in the E.E. Department, and by urging them to purchase a life subscription to the **BRIDGE**. (Bless you!—Editor)

The highlight of the Fall Semester activities was the initiation of fourteen pledges at the Annual Fall Banquet.

CHAPTER DIRECTORY

Chapter	*Name of School and Faculty Advisor*	*Chartered*
Alpha	University of Illinois, James P. Neal	1904
Beta	Purdue University, E. M. Sabbagh, L. A. Kramer	1913
Gamma	Ohio State University, Curt A. Levis	1907
Delta	Illinois Institute of Technology, Elton Jones	1909
Epsilon	Penna. State University, Clifford Holt, Jr.	1909
Zeta	Case Institute of Tech., Jerome Meisel	1910
Theta	University of Wisconsin, Donald W. Novotny	1910
Iota	University of Missouri, Rex Waid	1911
Kappa	Cornell University, Robert Osborn	1912
Lambda	University of Pennsylvania, Octavio Salati	1913
Mu	University of California, G. L. Turin	1915
Nu	Iowa State College, John Lagerstrom	1916
Xi	Auburn University, D. O. Noneaker	1920
Omicron	University of Minnesota, Donald Anderson	1920
Pi	Oregon State College, John Engle	1921
Rho	University of Colorado, L. Robert Branch	1922
Sigma	Carnegie Inst. of Tech., P. L. Smith	1922
Tau	University of Cincinnati, Carl H. Osterbrock	1923
Upsilon	University of S. California, Willard Rusch	1925
Phi	Union College, Inactive	1926
Chi	Lehigh University, Joseph Teno	1926
Psi	University of Texas, E. C. Lowenberg	1928
Omega	Oklahoma State University, Robert M. Penn	1930
Beta-Alpha	Drexel Inst. of Tech., H. H. Sun, W. A. Holland	1935
Beta-Beta	Polytechnic Inst. of Brooklyn, J. J. Bongiorno	1936
Beta-Gamma	Michigan Tech., Walter T. Anderson	1936
Beta-Delta	University of Pittsburgh, Richard O'Shea	1937
Beta-Epsilon	University of Michigan, J. A. M. Lyon	1937
Beta-Zeta	New York University, Robert Cotellessa	1938
Beta-Eta	North Carolina State College, A. R. Eckels	1938
Beta-Theta	Massachusetts Inst. of Tech., John Tucker	1939
Beta-Iota	State University of Iowa, Richard W. Kelly	1939
Beta-Kappa	Kansas State University, R. M. Kerchner	1939
Beta-Lambda	Virginia Polytechnic Inst., Paul E. Gray	1940
Beta-Mu	Georgia Inst. of Tech., Frank Nottingham	1941
Beta-Nu	Rensselaer Polytechnic Inst., Charles Close	1942
Beta-Xi	University of Oklahoma, T. H. Puckett	1942
Beta-Omicron	Marquette University, J. K. Sedivy	1945
Beta-Pi	The City College of New York, L. Echtman	1946
Beta-Rho	West Virginia University, E. C. Jones	1947
Beta-Sigma	University of Detroit, George Chute	1947
Beta-Tau	Northwestern Technological Inst., James Van Ness	1948
Beta-Upsilon	University of Kentucky, Lyle Bach	1948
Beta-Phi	University of Tennessee, G. W. Hoffman	1948
Beta-Chi	South Dakota School of Mines & Tech., C. W. Cox	1949
Beta-Psi	University of Nebraska, Ralph Ibata	1949
Beta-Omega	University of Connecticut, Vinton B. Haas	1949
Gamma-Alpha	Manhattan College, Bro. B. Joseph, FSO	1950
Gamma-Beta	Northeastern University, Laurence F. Cleveland	1950
Gamma-Gamma	Clarkson College of Tech., Donald Shurtleff	1950
Gamma-Delta	Worchester Polytechnic Inst., Russell Krackhardt	1950
Gamma-Epsilon	Rutgers University, J. R. Rankin	1950
Gamma-Zeta	Michigan State University, Herman Koenig	1951
Gamma-Eta	Syracuse University, John Brule	1951
Gamma-Theta	Missouri School of Mines & Met., Leland Long	1952
Gamma-Iota	University of Kansas, William Smith	1952
Gamma-Kappa	Newark College of Engineering, R. Anderson	1953
Gamma-Lambda	Columbia University, Thomas E. Stern	1955
Gamma-Mu	Texas A. & M., John S. Denison	1955
Gamma-Nu	Texas Technological College, Charles E. Houston	1956
Gamma-Xi	University of Maryland, Prof. Glock	1957
Gamma-Omicron	Southern Methodist University, Prof. Schmalling	1957
Gamma-Pi	University of Virginia, William J. Gilpin	1957
Gamma-Rho	South Dakota State College, William Gamble	1957
Gamma-Sigma	University of Utah, Paul O. Berrett	1958
Gamma-Tau	North Dakota State University, Donald E. Peterson	1958
Gamma-Upsilon	Johns Hopkins University, Willis Gore	1958
Gamma-Phi	University of Arkansas, Bryan Webb, Sr.	1959
Gamma-Chi	New Mexico State University, Harold Brown	1959
Gamma-Psi	Lafayette College, Albert P. Powell	1959
Gamma-Omega	Mississippi State University, Sidney Scarborough	1959
Delta-Alpha	Wayne State University, R. O. Sather	1960
Delta-Beta	Lamar State College of Tech, Robert Carlin	1960
Delta-Gamma	Louisiana Polytechnic Inst., Richard M. Steere	1960
Delta-Delta	University of Denver, H. D'Angelo	1960
Delta-Epsilon	Ohio University, Joseph E. Essman	1960
Delta-Zeta	Washington University, R. J. Koopman	1960
Delta-Eta	University of Massachusetts, John Fitzgerald	1960
Delta-Theta	Pratt Institute, Haroun Mahrous	1961
Delta-Iota	Louisiana State University, R. T. Nethken	1961
Delta-Kappa	University of Maine, Walter W. Turner	1961
Delta-Lambda	Duke University, James T. McKeel	1961
Delta-Mu	Villanova University, Joseph J. Hicks	1961
Delta-Nu	University of Alabama, Russell E. Lueg	1962
Delta-Xi	Air Force Inst. of Tech., J. H. Johnson	1962
Delta-Omicron	University of New Mexico, Donald C. Thorne	1962
Delta-Pi	Colorado State University, William Gunther	1962
Delta-Rho	University of North Dakota, John D. Dixon	1962
Delta-Sigma	University of Notre Dame, Lawrence F. Stauder	1962
Delta-Tau	Univ. of Southwestern Louisiana, W. Hansen Hall	1962
Delta-Upsilon	Bradley University, Richard L. Gonzales	1962
Delta-Phi	University of South Carolina, Hubert Noland	1962
Delta-Chi	Cooper Union, E. L. Starr	1962

Alumni Chapters and Presidents	*Chartered*
Boston, Bruce D. Wedlock, MIT, Cambridge, Mass.	1947
Chicago, Joseph Agosta, Commonwealth Edison, 1319 S. First Ave., Maywood, Ill.	1920
Cleveland	1920
Denver, R. Morgan Wilson, G-E Co., 650 17th St., Denver, Colo.	1938
Los Angeles, Tom Rothwell, 13223 S. Wilton Pl., Gardena, Calif.	1923
Milwaukee	1915
New York, Anthony Gabrielle, AEP Service Corp., 2 Broadway, NYC	1910
Philadelphia, Dr. H. H. Sun, Drexel Inst. of Tech., Phila.	1908
Pittsburgh, J. E. Rupp, Union Switch & Signal, Swissvale, Pa.	1908
San Francisco	1925
Schenectady	1913
Washington	1936

GAMMA-RHO CHAPTER, South Dakota State College—participated in a freshman orientation meeting at the beginning of the year. Working with the other engineering societies of the school, the chairman introduced to the freshmen the society and its activities. The freshmen interested in electrical engineering were taken on a tour of the electrical labs. Members of the chapter also served as guides for the EE department on parents day Oct. 27. The parents on campus that day were shown the laboratories and classrooms of the department.

A coffee hour for the eligible pledges was held so that the members might get acquainted with them. The pledges will be voted in and initiated at a later date.

Gamma-Rho was represented by 3 members at the National Electronics Conference in Chicago Oct. 8, 9, and 10.

DELTA-EPSILON CHAPTER, Ohio University—held its organization meeting early in September, and elected Joseph Essman to the position of faculty advisor for the coming year. Mr. Essman, a recent graduate of Ohio University, is an instructor of high standing in communication engineering.

Meetings held in October were for the election of eight new members who are currently working on a pledge project for the display case in the engineering building. Projects of the actives this semester have been the continuation of planning for a better testing system for engineering students, the sponsoring of the annual Engineer's Smoker, and sending a delegate to the HKN convention in Chicago.

The initiation banquet was December 3, with Dr. Sanford of the Physics Department as the guest speaker.

DELTA-ETA CHAPTER, University of Massachusetts – On December 15, the Delta-Eta Chapter proudly welcomed thirteen new members into the chapter. After the initiation ceremonies, a banquet was held for the new members and their dates.

All of the new members have completed the additional pledge requirements set by this chapter. These consist of passing a test on the constitution and chapter by-laws, and of writing a constructive essay on any of the following topics: a) evaluation of the Electrical Engineering curriculum and/or the department; b) the relationship between students and faculty; c) the need for better interclass relations. These essays, with the author's name removed, are read by the head of the Electrical Engineering Department. In the past these essays have been influential in the department's policy making.

This year the Delta-Eta Chapter is showing films about twice a month on technical subjects and current engineering accomplishments. Some of these films are shown at the request of the instructors in conjunction with their class work.

The Chapter will also take an active part in the setting up of projects and in the running of the Open House held in the Spring by the Engineering Department.

DELTA-IOTA CHAPTER, Louisiana State University—An organizational meeting was held in September to set up committees and analyze the chapter and its potential for the coming year. The first item on the chapter's agenda consisted in inviting new members into the organization.

A Smoker was held on November 1 in the E.E. building. Professor Ambrose Ramsey, an alumnus of HKN, gave a talk on the advantages and history of the fraternity. Following the smoker invitations were sent out to prospective members and 14 students accepted membership into Delta-Iota Chapter. One of the new pledges, Jerry Huckaby, has recently distinguished himself by being elected President of the College of Engineering here at LSU. The by-laws of Delta-Iota chapter provide that a faculty member should be initiated each year and this year our selection is Professor Marion B. Reed.

DELTA-THETA CHAPTER, Pratt Institute—Our fall pledge class was composed of six undergraduates. The initiation will be held December 1, 1962 in the Pratt Student Union. Prof. Payne of the general studies department is expected to be our speaker. Other notables attending will be Dean Cook of the engineering school and Dr. Marhous of the electrical engineering department.

Pledges were required to submit biographies of some of the outstanding figures of science, particularly of electricity and electronics. There was also an informal quiz on the constitution of Eta Kappa Nu.

Ideas for future projects consist of a tutoring service, a display in the lobby of the engineering school, a course evaluation service, and a series of talks and films given of campus by members of private industry.

At present we are simply discussing the above as possibilities, having recently completed the writing of our by-laws.

DELTA-SIGMA CHAPTER, University of Notre Dame—sponsored a Graduate School Seminar in which six Ph.D.'s in the E.E. department talked to students interested in graduate school. Each professor spoke primarily of the requirements, fellowships available, advantages and disadvantages of his alma mater; Indiana, Wisconsin, M.I.T., and Stanford were represented. After all of the talks, the students were free to ask questions. The event was well attended and was agreed upon by the students to be helpful.

On Nov. 18 Delta-Sigma held the Initiation Banquet. Dr. N. R. Gay, the Dean of Engineering, gave a short talk and laughingly said that perhaps he should have had the foresight years ago to take up electrical instead of mechanical engineering. Reverend Fr. W. O. Hegge of the Theology department at N.D. was the principal speaker. Father Hegge spoke on "Christian Love." After the formal part of the banquet the students and faculty members were free to mingle informally. The professional members initiated are Mr. Noel Kindt, Mr. Frederick Mowle, Dr. James Massey, and Mr. Arthur Quigley.