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SUPPLEMENT
TO
DENKI READERS

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COMPILED BY

DENKI-GAKKO
THE INSTITUTE OF ELECTRICAL AND MECHANICAL TECHNOLOGY

1930

CONTENTS

LESSON 1.

ABSTRACTS FROM POPULAR MECHANICS MAGAZINE

(A) TALKING-MOVIE SHOW ON TRAIN

(January 1930)

For the first time talking motion pictures recently were exhibited for the amusement of passengers aboard a running train of the Union Pacific system. The equipment used was that frequently employed in movie theaters exhibiting talking pictures, and, despite the noise made by the train, the experiment was pronounced most successful, the sound effects being clear and distinct to everyone. The windows of the theater car were darkened and a screen was stretched across one end.

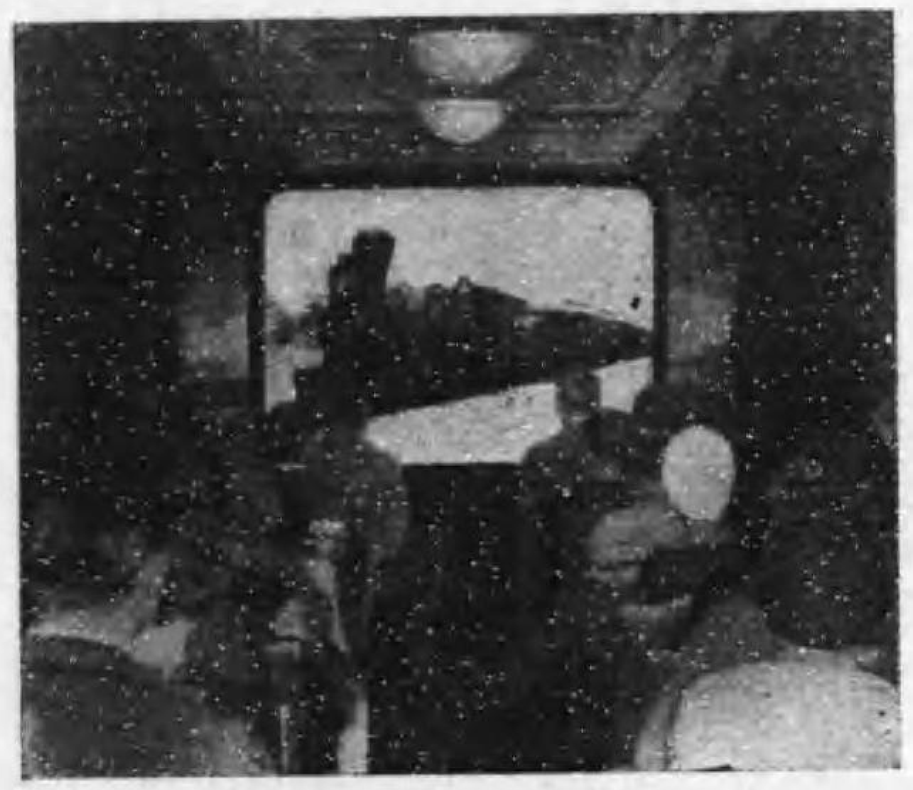

Fig. 1. Talkie on train.

(B) "HUSH-HUSH" LOCOMOTIVE

(March 1930)

England's latest high-speed locomotive, embodying many novel principles of boiler design, including a stream-line effect, recently made its first public appearance and attracted wide-spread attention among railroad officials. It

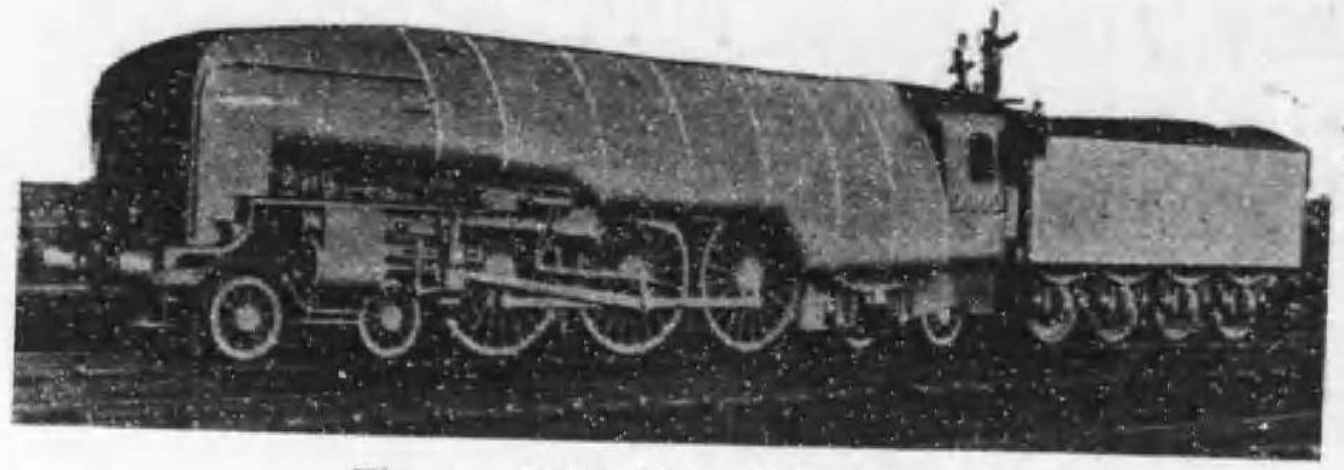

Fig. 2. "Hush-hush" locomotive.

is known as the "hush-hush" engine because of the secrecy surrounding its construction.

(C) ELECTRIC LIGHTS FROZEN IN ICE

(March 1930)

Skaters of the Lake Placid Club in the Adirondacks have enjoyed illuminated night skating this winter through a plan of freezing incandescent electric-light bulbs beneath the surface of the ice. The lights were placed in various artistic patterns, and at night the part of the lake reserved for skating was lighted with the sunken bulbs.

Fig. 3. Lights in ice.

(D) ELECTRIC DEODORIZER

(February 1930)

Destroying the odor of cooking fish, cabbage or onions, and other unpleasant household smells, an electric deodorizer is now on the market. The apparatus, in a

Fig. 4. Deodorizer.

small cabinet resembling a jewel box, may be operated on any alternating-current 100-volt circuit and generates the concentrated and activated form of oxygen known as ozone, quite often noticeable in the atmosphere after a thunderstorm. It clears a room of tobacco smoke and also aids in purifying the air because the ozone tends to kill germs.

" The doors of Wisdom are never shut."—Franklin.

(E) LIGHT RAYS PROLONG REPTILES' LIVES

(February 1930)

Ultraviolet-ray treatments for turtles, crocodiles and other specimens have proved beneficial in preventing sickness among the zoo and aquarium families. Glass that permits the passage of the sun's helpful rays has been used to good advantage over the cages of monkeys and other tropical animals, and where it is not practical to

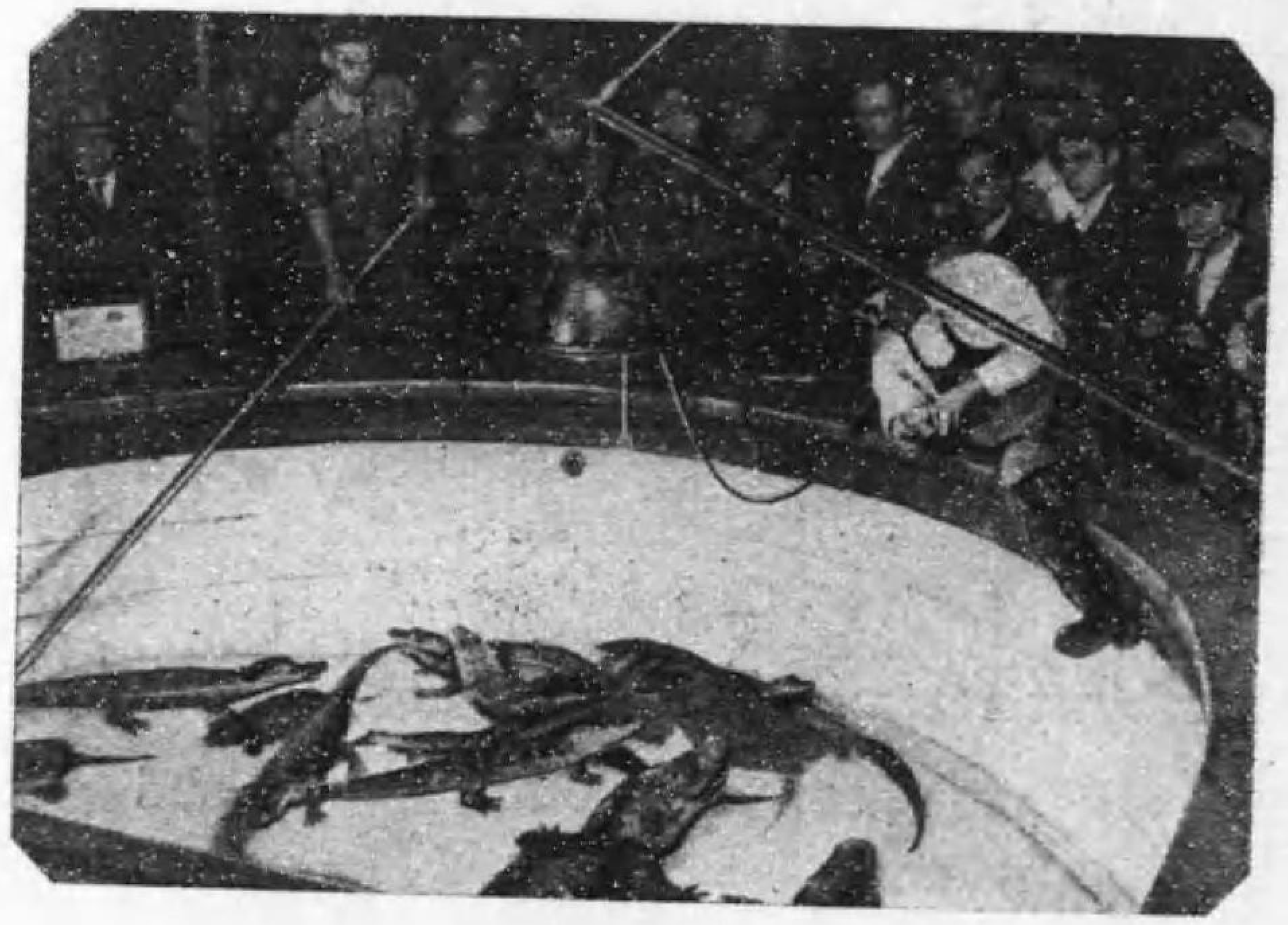

Fig. 5. Zoo reptiles.

employ such glass, special lamps are being sought for the artificial sunlight they produce.

" *The Noblest Question in the World is what Good may I do in it.*"—*Franklin.*

LESSON 2.

FIFTY YEARS

(The Digest, Oct. 1929)

Fig. 6. Edison in 1879.

What Edison produced in the early years of his great activity was more than a lamp—he developed a complete electrical system in its multitudinous details, making it possible for people to *use* the lamp in a practical way as an illuminant that was better, more convenient than its predecessors.

Changes come, as was natural and inevitable. New methods were evolved for production and distribution of electric current. New and better lamps were invented as new minds addressed themselves to the subject. But incandescent lighting as a practical means of furnishing the world with illumination was born just 50 years ago, and all who benefit by it may well pause to join in tribute while whole nations are celebrating *Light's Golden Jubilee.*

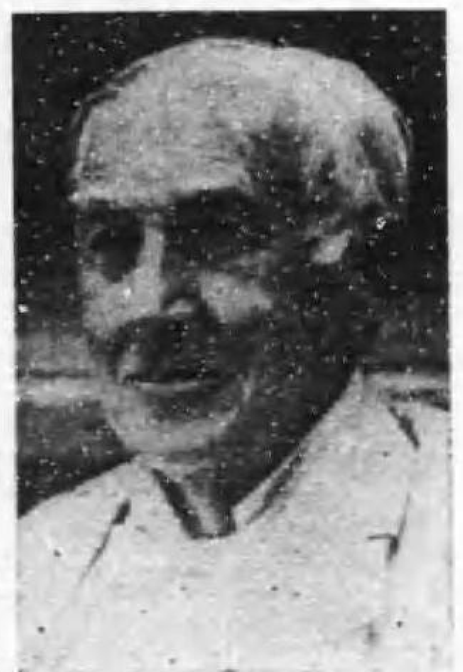

Fig. 7. Edison today.

Happy is the man who plants a tree in youth and sits beneath its spreading branches in ripened age.

LESSON 3.

LEARN A LESSON FROM THOMAS A.

(The Edison Sales Builder, Oct. 1929)

S. E. Kiser

—(1)—

When Thomas Alva Edison
Perceived where something might be done
To speed the world's improvement;
He never listened long to those
Who had objections or were foes
To any hasty movement.

—(2)—

You doubtless know how Thomas A.
Is honored everywhere today,
And why men hail him proudly;
He worked, instead of warming chairs;
The moral is so plain that there's
No need to shout it loudly.

—(3)—

Tomorrow might be soon enough
For other boys to do their stuff,
But Thomas never waited;
He hustled hard, beginning young;
Procrastination was among
The silly things he hated.

—(4)—

If you have planned to start next week
To bring your business to a peak,
Begin today to do it;
For Time's a thief, and prone to steal
Success from those who never feel
Quite ready to "go to it."

" Those who would give up Essential Liberty for a little Temporary Safety deserve neither Liberty nor Safety."

—Franklin.

LESSON 4.

AN ADDRESS ON THE OCCASION OF LIGHT'S GOLDEN JUBILEE IN TOKYO

E. W. Frazar

Many countries are uniting at this time to do honor to one of the World's greatest benefactor, a man born in a most lowly humble state, yet by virtue of intensity of purpose, tremendous hard work and uprightness of character, has been enabled to so develop a heaven-sent gift of invention as to make possible for us many of our modern comforts and efficiency including the telephone, phonograph, motion picture and electric light and power. While authorities may differ as to who actually discovered the first principles underlying these inventions, there can be no doubt that Thomas A. Edison made them real practical possibilities for you and me to enjoy. For this we thank him most sincerely, and join the nations now acclaiming him as one of the World's most honored men. I am very proud to claim him as a fellow countryman, but I am even more proud to feel that I have been privileged to be a personal friend for more than 40 years,

and it is for this reason probably that your Committee has invited me to briefly address you. The many articles written about Mr. Edison and the remarks of famous speakers will have given you his history and accomplishments, but perhaps a few personal or human touches and contacts may be interesting. It was in 1879 just 50 years ago that I first heard of him, I was living in Orange, New Jersey, and one day a man came to town to give a show of juggling, and to attract a crowd he exhibited a queer kind of apparatus which he said was a talking machine, and I well remember what a sensation it created. It was very crude, just some tinfoil wrapped on an iron cylinder mounted on an iron axle with a funnel attached, into which the man spoke: "Mary had a little lamb." On turning the handle backwards, the same words came out in a funny squeaky voice. I asked the man if he had invented it, but he said: "No, it was made by a Mr. Thomas Edison." Everybody was interested in such a curiosity, but no one dreamed that it had any practical value.

About two years after this, my father told me Mr. Edison had just bought a friend's house in West Orange, and he was going to call upon him. This opened up an intimate friendship, and my father and mother often exchanged visits with Mr. and Mrs. Edison, giving me the chance to meet them. My father became greatly interested in Mr. Edison's development of the electric light, and urged him to sell a plant to Japan where my father had started business in 1866; so a small lighting plant was installed in the Emperor's Palace about 1883. Prof. Fujioka took great interest in this development of electricity, and negotiated with my father's firm for a plant to be set up in Tokyo. After some negotiation, he went to New York City to see Mr. Edison's factory then established in Goerick St. I remember very well seeing a good deal of Prof. Fujioka, and accompanied him in many of his visits to various factories, and I especially remember going to Newark, New Jersey, to see the place where Mr. Edison was making his incandescent lamps. They were using bamboo filaments, having found it to be the best material for the purpose. Mr. Edison had experimented with all kinds of material, thread, paper, plants fibres, and on trying a piece of bamboo, obtained excellent results. He did not know, however, how to get supplies, and asked my father to help. Frazar & Co. found the best quality came from Kyoto, and soon large quantities were imported. It came in pieces about the size of a small chop stick about 12 inches long.

They were called bamboo splints and prepared the machinery into long and very thin slivers which were bent into a horseshoe shape put into holders made of carbon, and then placed in a furnace and carbonized. These bamboo filaments were used several years, being ultimately replaced by a kind of composite wire made of tungsten.

In 1885, Prof. Fujioka placed an order with my father's firm for what was considered in those days a very large plant. The boiler was of the internal-tube pattern. The engine was a horizontal single-cylinder type, and the dynamo was known as the three-wire municipal design, 220 volts and 100 horsepower. It was brought to Tokyo, erected in Kojimachi opposite the rear entrance of the Imperial Palace, and became the start of the Tokyo Electric Light Company.

Having witnessed the manufacture and test of this plant in New York, it was most interesting for me to be invited some three years ago to attend the opening ceremony of the power house set up in Nagoya by the Tokyo Electric Power Company. The dynamo and engine this time was 35,000 horsepower, showing what enormous advance Japan had made in electric machinery in 40 years.

When I graduated from Stevens Institute of Technology at Hoboken, New Jersey, in 1890, I entered the laboratory of Mr. Edison at Orange, New Jersey, and worked for some time as an assistant in the galvanometer room, witnessing many most interesting experiments. I also worked for a time in the phonograph department and witnessed the original experiments in making moving pictures. I came to Japan in 1896 to take charge of Frazar & Co.'s Electric & Engineering Department, and in this way have had an intimate connection with the development of Electricity in Japan.

As a member of the Society called the Edison Pioneers now taking a part in the celebration being held at Mr. Ford's place in Dearborn, I wanted very much to attend but business reasons prevented, so I am glad to be given the privilege of joining with you, and I thank you most heartily. I could tell you many stories about Mr. Edison in the laboratory and in his house—how modest, how kind to all his employers—what a wonderful brain he has, and how hard he has always worked, but there is not time, so I will close by saying that from my personal knowledge and contact, I feel he is justly entitled to all the praise and honor being shown him all over the world, and I know he will be especially gratified to

know Japan is taking so active a part, for he has always been very fond of Japan and the Japanese people.

AUTOMATICALLY CONTROLLED HYDROELECTRIC PLANT

(General Electric Calendar, 1930)

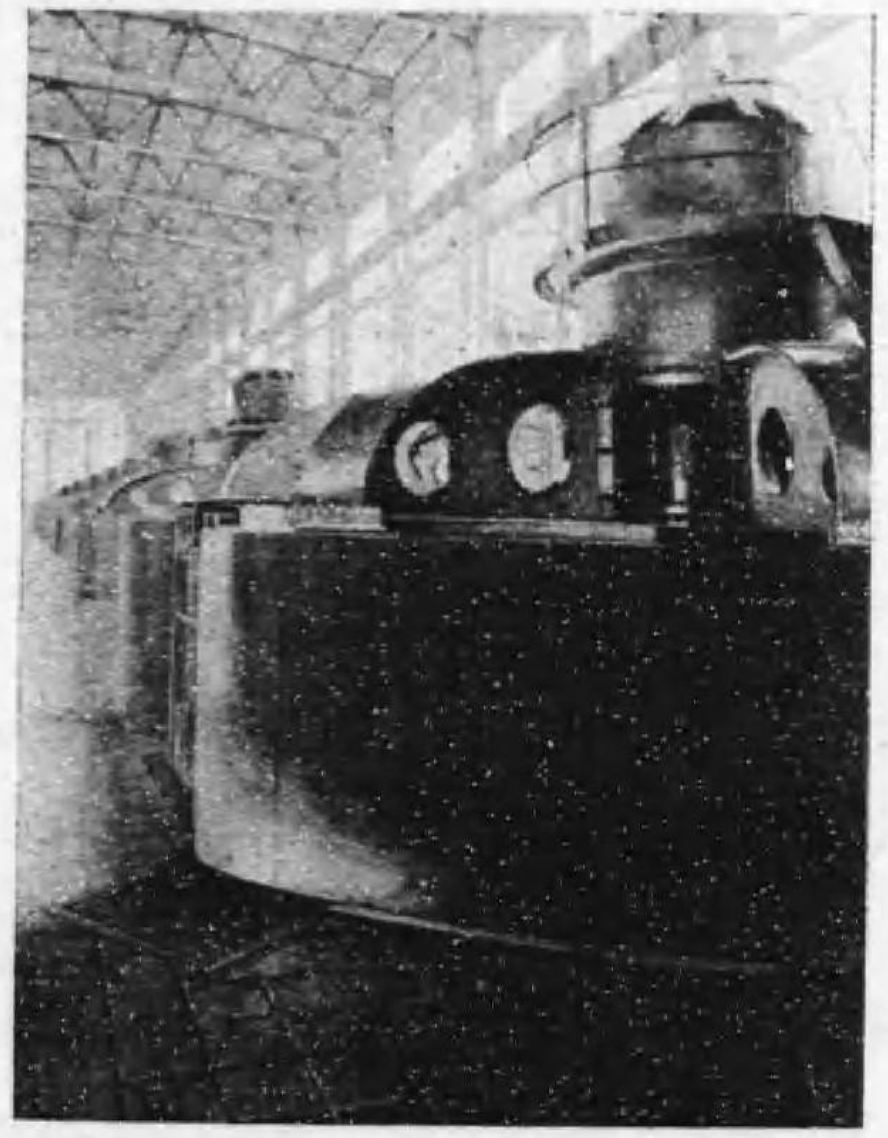

Fig. 8.

Huge generators, driven by water power or steam, supply the electrical needs of great communities.

LESSON 5.

LIGHT'S GOLDEN JUBILEE

(The Electrician, Jan. 3, 1930)

We have written so much about the unfair way in which Sir Joseph Swan's work was ignored by those responsible for the organisation of the recent celebration of "Light's Golden Jubilee" that we are glad to read in our Canadian contemporary, "Electrical News and Engineering," quite the fairest statement about the incandescent lamp invention that has yet been made public on the other side of the Atlantic. It points out that Edison and Swan both invented a carbon-filament lamp, Swan's being the first, and then goes on to show that while Swan was the pioneer, Edison was the commercialist, a view which is largely borne out by the facts as we know them. It must have acquired no small amount of moral courage for a paper published on the American continent to champion so unpopular a cause. Congratulations to our Canadian friends on their share in doing justice to the memory of a great British inventor.

LESSON 6.

CLAIMS OF GOEBEL TO PRIORITY OF THE ELECTRIC-LAMP INVENTION

(The Electrician, Jan. 17, 1930)

A Brussels correspondent, M. Lionel Calisch, calls our attention to the claims of Heinrich Goebel to be regarded as the real inventor of the electric incandescent lamp. He sends a cutting from the Austrian "Radio Amateur" for December, 1929, comprising an article by Dr. H. Beckman, in which Goebel's work is briefly described and a priority of a quarter of a century over Swan and Edison is claimed for him. The following particulars are given by Dr. Beckman:—

Goebel was born on April 20th, 1818, at Springe, near Hanover; went with his wife and children to America in 1848, and set up in business as an optician, mechanic and clockmaker. In the year 1854 he constructed an efficient incandescent lamp, closely resembling that of Edison 25 years later. Goebel's lamp consisted of a glass tube into which platinum wire was smelted to conduct the current into the interior of the glass cylinder. To this platinum wire was attached a filament consisting of a bamboo thread (as in Edison's lamp), which was brought to a glow by the electric current. A good vacuum was necessary, and this Goebel had already learnt to secure, while he lived at Springe, in connection with the making of barometers. He smelted to the lamp a glass tube about a metre in length, filled the tube with mercury and plunged it into a bowl containing mercury. When placed upright the flow of the mercury checked the atmospheric pressure, thus securing the vacuum in the lamp. Between 1855 and 1860 Goebel regularly exhibited his lamp in the evenings in the squares and streets of New York. The time was not ripe, however, for the sale and use of the lamp because a satisfactory supply of current was not available. Goebel died in 1893 in New York, and the Elektrotechnische Gesellschaft, Hanover, has erected a tablet to his memory, describing him as the inventor of the electric glow lamp, on the house in which he was born. The inscription reads:— "Hier wurde der erfinder der elektrischen glühlampe Heinrich Goebel am 20 April 1818 geboren."

Fig. 9. Tablet placed on Goebel's birthplace.

Our Brussels correspondent suggests that we should conduct an investigation of the claims of Goebel and "let us know the real inventor of the incandescent lamp." But, interesting as the subject undoubtedly is, we regret that we have neither the time nor the facilities for such an inquiry, nor would the result be decisive in any case. Probably a further search would reveal others on whose behalf claims could be maintained, for most inventions are the fruit of a long series of experiment by numerous investigators. There is no doubt that Swan and Edison are entitled to the credit of producing commercially successful lamps, though, as in the case of Adams and Le Verrier, the joint discoverers of the planet Neptune, their respective countrymen may never see eye to eye in regard to their respective merits. If Goebel preceded them, he was, like many another pioneer, unlucky in being ahead of his time, but in the interests of truth his name should not be forgotten among the "prophets of the dawn."

The world's heroes of the past have come from the fields of politics, government and war. Thomas Alva Edison is the first hero from the field of industry.—The Edison Sales Builder.

LESSON 7.

ENGINEERING ACHIEVEMENTS

(Westinghouse International, March 1930)

H. W. Cope

Electrical engineering still growing rapidly, rarely pauses for reminiscence ; a habit of industries and people whose glory lies behind them. Recently, however, historical celebrations have turned men's eyes briefly to the past ; to Brush, and his arc lighting ; to Edison, whose practical incandescent lamp laid the foundation stone of an industry ; to Westinghouse, whose alternating current made electricity for all purposes universally available.

We may wonder what aspect of our 1929 achievements would most impress an engineer of the 'nineties, brought suddenly from that remote antiquity of thirty years ago. Most conspicuous would be the fabulous size of turbine generators, transformers and circuit-breakers. Less obvious, but perhaps quite as impressive, would be the high modern efficiencies—the work of a generation of designers in chipping away the barrier of losses between their product and perfection, a barrier now sometimes less than one-half per cent. Amazing too would be the shrink-

age of physical bulk brought about by high speed, ventilation and new materials ; marked by such powerful pygmies as the 1,250 hp., 3,600 rpm. motor that could be put under a kitchen table. Beside these developments whose origin he had witnessed, he would see others whose very principles are new, like the De-ion circuit-breaker, the lightning investigations, and the new porous block arresters. Then too are the human attributes—of voice, of hearing, of sight and touch—which have been acquired by electricity in the wake of radio and its kindred tubes.

But perhaps none of these things would strike our visitor from the past so vehemently as the change which has occurred in the main objective. In his day, the making and distribution of power was the great problem. That problem solved, the focus of attention now shifts to wider use, better adaptation to the needs of industry, and such are preponderantly the achievements which follow.

High in airplanines or deep in mines, handling gossamer silk, blocks of steel, driving ships and railroads and street cars, heating massive castings or a spoonful of water for a dentist's spray, aiding the labor of the family laundress ; assisting the diagnosis of the heart specialist, electricity is doing what has not been done before. Man realizes, sometimes dimly, the promise of electricity. It is the opportunity of today's engineers to make that promise good.

ELECTRIC AIDS TO HOUSEKEEPING

(General Electric Calendar, 1930)

Fig. 10.

Electricity, which has taken over the hard tasks of industry, also makes home works easy and contributes to domestic health and comfort.

LESSON 8.

AN ELECTRICALLY HEATED DENTAL SPRAY

(Westinghouse International, March 1930)

Only too often, a careless dentist shoots water too hot or too cold on a sensitive tooth, causing needless pain to the patient. Electrical engineering has not thought even this problem beneath its attention, and has easily solved it with the same little thermostat originally invented for flat-irons.

A new dental syringe keeps water exactly warm enough always on tap. Formerly the dentist gaged the water's temperature by squirting it on the back of his hand—a hand whose sensitiveness is not likely to be that of the other man's mouth.

To fix the water at the desired temperature, a built-in thermostat in the bottom of the 4.5 by 3 inch metal reservoir controls the 60-watt, 110-volt, 60-cycle heater in the walls of the tank. Water comes from the city mains.

The average cost for electric power is about the same as for burning a 40-watt lamp—less than half a cent an hour at ordinary rates. If the unit stands idle and no water withdrawn, the heater cycle approximates ten minutes on and ten minutes off, or less than a quarter of a cent's worth of electricity hourly.

Several features appeal directly to dentists. By a twist of the small lever on the reservoir, cold city water (usually about 60 deg. F.) is by-passed to the mouth syringe to hurry the cooling of a wax impression. The jet from the spray nozzle is easily adjustable to suit the office water pressure. Even a very weak city pressure is sufficient, since with the average water pressure of 40 to 50 pounds per square inch, the same syringe could throw a jet 40 feet. The long-forked handle, resembling a telephone hook, is thrown far to the left when the spray is in use, allowing water to flow. At other times the forked holder is thrown to the right. This cuts the water off the rubberized hose, preventing any chance of the hose's bursting during the dentist's absence and flooding the office.

Human sensibilities to heat are extremely exacting, and it is very complimentary to the thermostat that it is suitable for such delicate duty. It is only one example, however, of a very wide range of duties in which the Spencer thermostat is replacing guess-work with knowledge.

LESSON 9.

MANY INGENIOUS DEVICES USE THE ELECTRIC EYE

(Westinghouse International, March 1930)

Long merely an exhibition novelty, the photo-electric cell is now the brain of many commercial devices. A very practical use is in promoting efficient combustion in boiler plants. The appearance of the flue gases passing up the stack is a very fair gage of the fireman's skill, and of the sufficiency of the air supply.

From a lamp on one side, a ray of light passes right through the stack and its flue gases to a photo-electric cell on the other side. The opacity of the gases is measured by the amount of light that gets through, and is indicated on a meter in the fireroom. Several installations have made it clear that knowledge of what the chimney is doing tends to intelligent firing, and actually results in a nearly clear stack.

A most useful application of the light relay's visual ability is the control of factory lighting. As daylight waxes and wanes, shop lights are turned on and off by the daylight itself. The worker's speed and the quality of product depends largely on adequate lighting. With this control, which responds more accurately to the varying need for artificial light than can human judgment, larger lamps, burning only when needed, can be used to give better factory illumination without increasing the monthly power bill. In long aisles, light control units at intervals can turn on and off the banks of lamps in their particular region. In one installation, two adjacent areas, each of 8,000 watts were controlled, one by the daylight relay, the other by the whims of the workers. With apparently adequate light in both, the hand-controlled section used two and one-third times as much power as the area under daylight control during the three-month test.

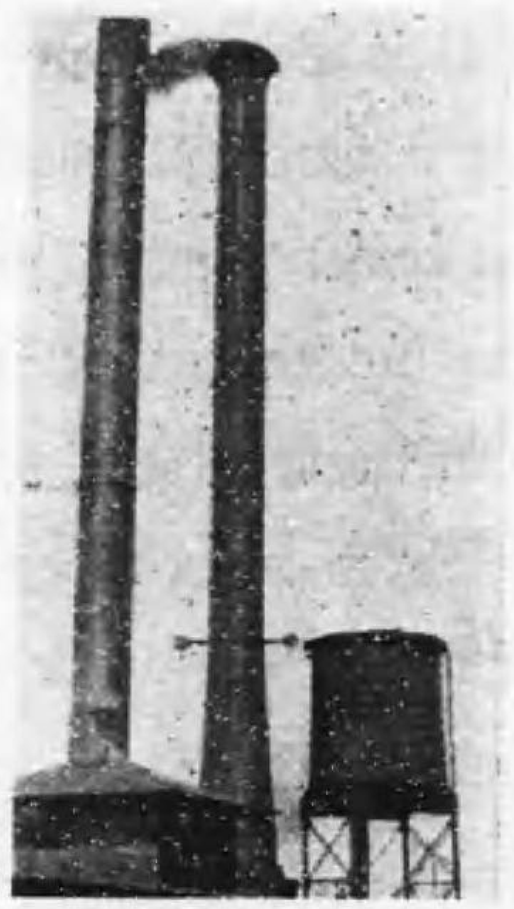

Fig. 11. Electric device telling the condition of stack gas.

The " electric eye " is the vital part of many other ingenious devices, a few of which follow: sheets of paper flying past the fixed stare of the " eye " are accurately counted at the rate of 60 sheets a second; suspicious smoke from electric machinery turns on fire-smothering gas before material damage occurs; defective pieces are sorted from a moving production line by their

own defects, and doors of automatic elevators hold themselves open as long as passengers are getting on or off.

THE MOST POWERFUL ALL-ELECTRIC MERCHANT SHIP

(The Electrician, Jan. 3, 1930)

Outboard profile of the new Dollar electric liner now building for round-the-world service. Her displacement is over 32,000 tons and her electric motors will develop 26,500 H.P.

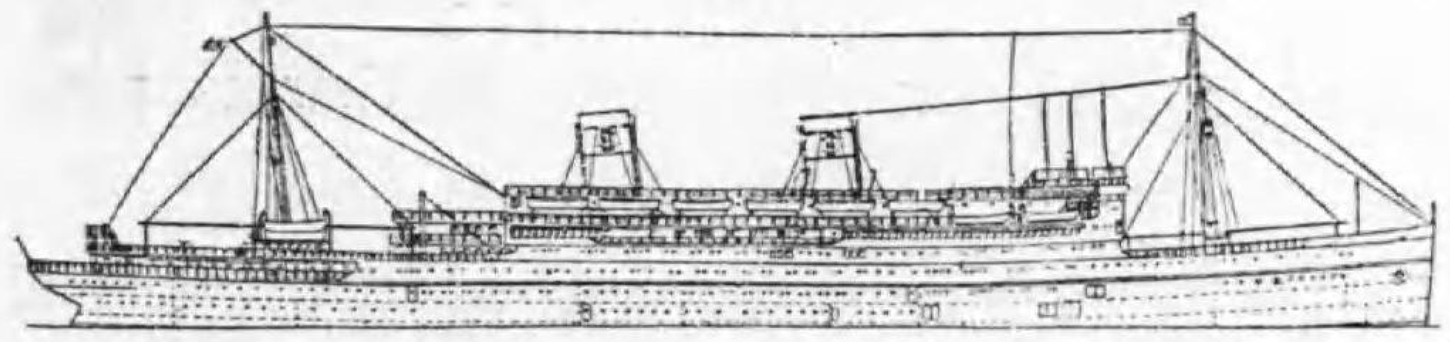

Fig. 12. New electric liner.

LESSON 10.

AN AUTOMATIC CAR-PARKING MACHINE

(Westinghouse International, March 1930)

The parking of automobiles has seemed a pressing problem without an answer. The long search for an open spot beside the curb, the tedious walk back to the actual destination, is one known to every motorist. Traffic crawls snail-like through streets whose clear width has been cut in half. Traffic police vainly try to enforce limited-time parking.

Parking lots usually offer no protection from the weather and their location depends on the chance existence of empty ground. Cars must be left unlocked so as to be moved about in the jam, and the charges must cover the expense of cashiers and drivers.

The new parking machine uses vertical, not horizontal space; many cars can be stored in the ground area of a two-car garage. It is possible to build them so that no attendants whatever are necessary, and no one has access to the car while in storage. It can be built as a part of a building, or on vacant ground, and, in any event, will presumably be enclosed from the weather. The motorist

drivers his car onto a platform, and gets a check, either from an attendant, or by pulling a lever. The car is automatically whisked upward out of sight, and an empty platform appears at ground level, ready for another car. When the motorist is ready to leave, he presents his check either to one attendant, or to a machine, presses a button and his car is delivered to him at ground level almost immediately, without any of the ordinary vexatious garage delays, and without the chance of its having been damaged in his absence.

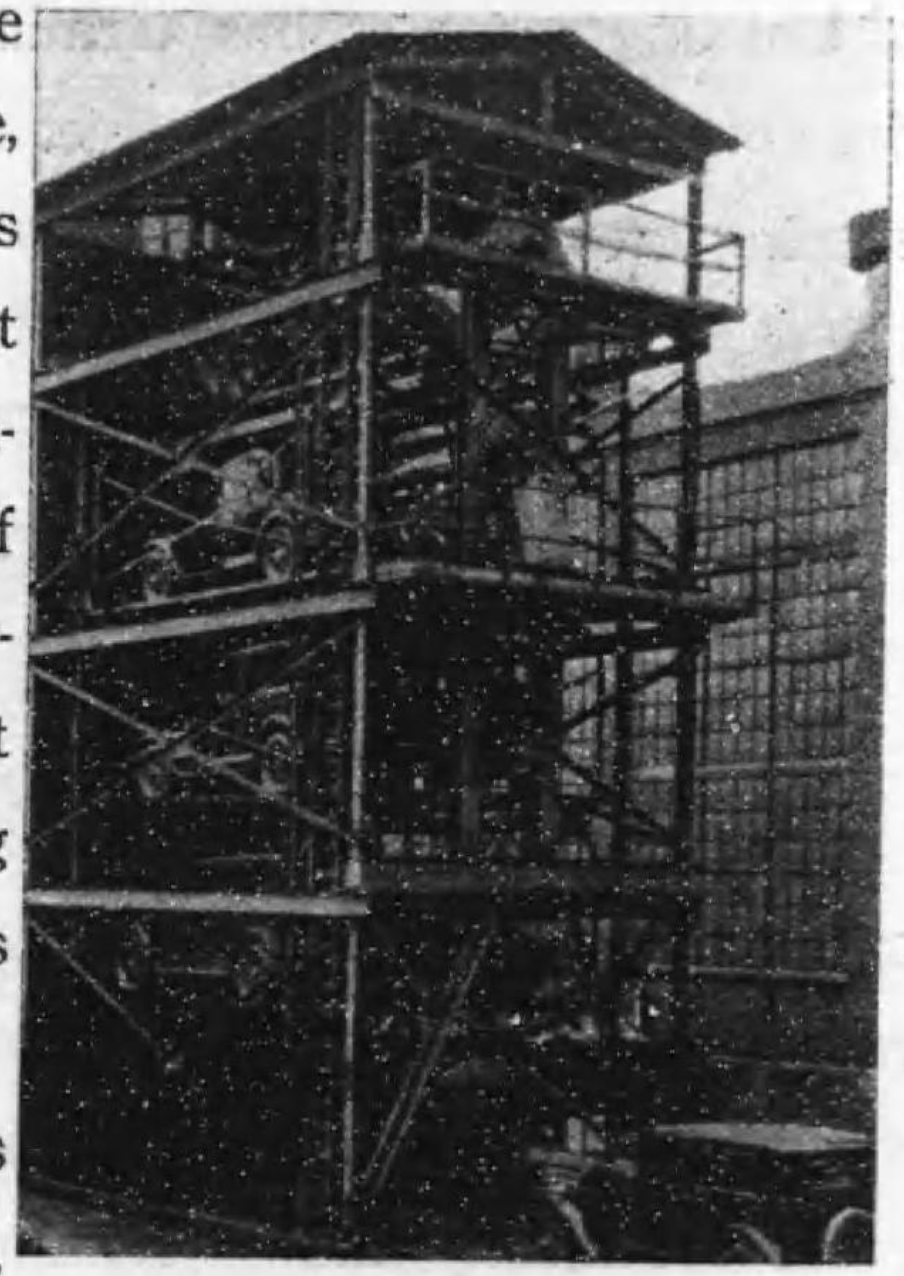

Fig. 13. Car-parking device.

The general principle is that of a Ferris wheel, except that in place of the wheel, there is an endless chain running over sprockets at top and bottom. The machine is, of course, stationary except when a car is being put in or taken out.

The small machine in the picture, built at East Pittsburgh, holds eight cars. The walls which would ordinarily enclose it have besn omitted, to make its operation easily seen.

The new device seems a hopeful solution of several problems beside that of the parking of private automobiles—perhaps also in the matters of cruising taxicabs, of standing space at bus terminals, conceivably even of the downtown storage of street cars to accommodate the evening crowds.

MOVIE CAMERA AND PROJECTOR COMBINED

(Advertisement, Electrical World)

Your eyes focus on and take a sharp, clear picture of only one small portion of an object at a time. The surroundings of this small portion at the instant of focus are blurred and hazy. So your eyes, to see all clearly, must continually move, continually change focus—take moving pictures of an ever-changing scene. In addition, they "develop" these pictures on their "film," the retina, and then "project" them on the "screen," the visual nerve fibres of the brain.

LESSON 11.

ABSTRACTS FROM THE ELECTRICIAN

(A) HISTORICAL PIECES OF APPARATUS

(Nov. 22, 1929)

Included in the apparatus exhibited by the Royal Institution at the Science Museum, South Kensington, is the ring with which Michael Faraday discovered in 1831 the laws governing the theories of electrical engineering. This ring, seen in the left-hand picture, will be the central feature of the international commemoration of Faraday's work which is to take place in London in 1931. The right-hand picture is of another Faraday exhibit and shows an experimental electro-magnet.

Fig. 14. Historical ring magnet.

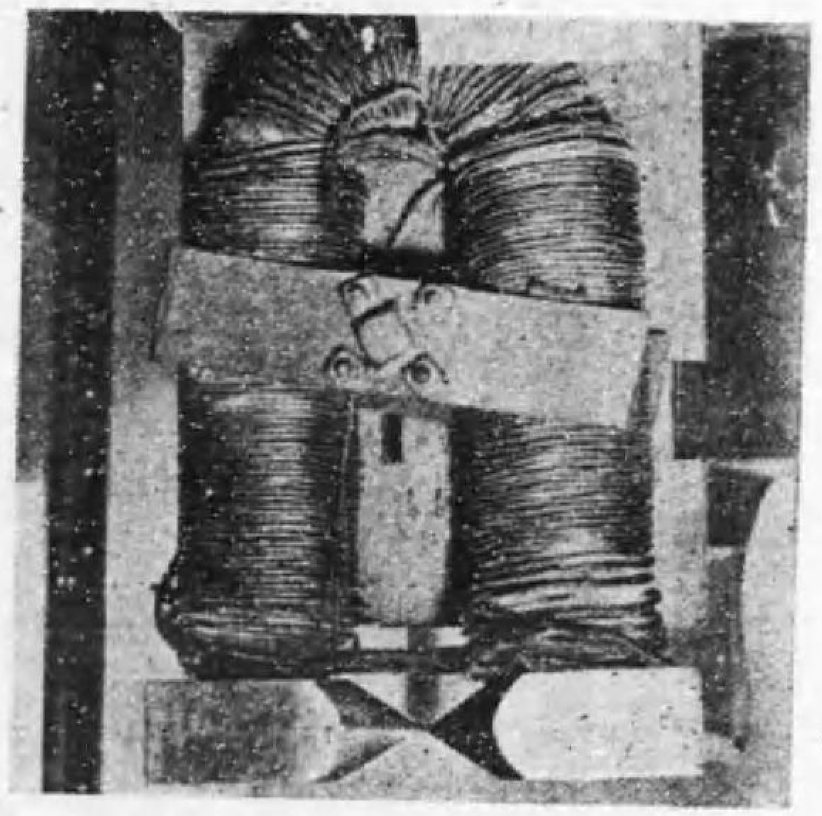

Fig. 15. Experimental electro-magnet.

(B) SHIP-SHORE TELEPHONE SERVICE

Fig. 16. A.T.T. officials talking with "Leviathan."

Officials of the American Telephone and Telegraph Co. and the United States Shipping Line in the offices of the A.T. and T. at New York on the occasion of the inauguration of the ship-shore public telephone service in America. This picture, which is among the first to reach this country, shows Mr. Walter S. Gifford, President of the A.T. and T. in the centre at the head of the table, holding conversation with the Commander of the S. S. "Leviathan" in mid-Atlantic.

KEY-WORDS FOR TELEPHONE

"She was waiting at my lawn."

"Joe took fathers shoe bench out."

LESSON 12.

LETTERS FROM U. S. A.

— A —

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

814 Elicott Square Building, Elicott Square, Buffalo, N. Y.

October 31st, 1929

Mr. S. Katoh,
Denki-Gakko,
2, Nishikicho Nichome, Kanda,
Tokyo, Japan.

Dear Mr. Katoh:

It is always a pleasure to us to extend such courtesies as are possible. We, and I personally, appreciate the sentiments contained in your letter.

There is an international meeting about to occur in Tokyo, I believe, which will be attended by Mr. F. C. Hanker, head of our General Engineering Division in charge of Public Utility Engineering. You may wish to see him while he is in Japan.

Assuring you that it will be a pleasure to communicate with you from time to time.

Sincerely
John S. Henderson,
Central Station Supervisor.

— B —

ELECTRICAL ENGINEERING DEPARTMENT
Johns Hopkins University, Baltimore, Md.

November 25, 1929.

Dear Mr. Katoh,

I was very glad to receive your letter, and to know that you had a safe and pleasant trip home, and had such agreeable recollections of your visit to this country. I was surprised at the number of places you had visited, and should think you would have become all tired out.

Thank you very much for the publications about your school. Your courses are very well laid out, and appear to cover the subjects very thoroughly. I like your method of publishing the lectures, and avoiding the use of text-books. Your experience has evidently been the same as mine, that it is difficult to find a text-book which meets one's particular requirements.

Your paper, "OHM," is very well gotten up, and from the illustrations appears to be very interesting. I was interested in notice, which was in English, about the

work Dr. Tachikawa is doing on utilizing terrestrial heat.

I find your little slide rule most convenient and useful, and it recalls very pleasant memories of your visit.

With best wishes, and hoping to hear from you again,

I am

Most sincerely yours,
R. H. Marvian

(Advertisement, Electrical World)

Increasingly, manufacturers realize that the most convincing word for any product comes from the product itself. When that is so, they are eager to put that product into the prospective buyer's hands, without obligation to buy, and let it speak for itself.

The General Electric Vapor Lamp Company has followed this policy with Cooper Hewitt light for years. And our knowledge, based on experience, that Cooper Hewitt light decreases spoilage, increases production and promotes factory efficiency generally, is invariably corroborated by a trial installation.

LESSON 13.

ELECTRICAL OPEPATORS FOR ELEVATORS

(The Electric Journal, Dec. 1929)

Chas. R. Riker

High speed vertical transportation is an economic necessity in any tall office building. It means that the upper floors can be reached almost as quickly as the lower ones, making them even more desirable. It also permits fewer elevators to handle the same traffic; and every elevator occupies otherwise rentable floor space. Hence speeds of 800 and 900 feet a minute; it is hinted that even higher speeds are not far in the future.

High speed for passenger elevators, however, involves a psychological problem. Curiously enough, this particular problem in psychology can be solved by calculus. The practical results of a group of differential equations can be stated quite simply.

Provided no physical comparison with nearby stationary objects is permitted, speed in itself is not perceptible to any of our senses.

High rates of acceleration and deceleration are, however,

as essential as high speeds. Discomfort during starting and stopping obviously is undesirable. But the differential equations inform us that this discomfort is produced not primarily by high rates of acceleration, but by uneven changes in acceleration. The answer to the problem of comfortable starting and stopping is obvious—a uniform change in acceleration. The general method of solution is obvious; the practical detailed solution is not so simple. Careful design of both motors and control has, however, resulted in not only high speed but also high acceleration, almost without any bodily sensation.

High speed and high acceleration, however, are both most annoying to the eyes. A solid door obviates this difficulty, but introduces another. Both because of the solid door, and also because he is going too fast to read numbers even if there were no doors, the operator cannot depend upon sight to stop the car at the proper floor.

An operator with senses quicker than sight and with correspondingly speedy judgment is necessary for fast and accurate operation. Hence the engineers introduce to us an electrical man. He sits on top of the elevator and makes all the stops. He has collaborators in the pent house. All they need is a signal from a pushbutton telling them where to take the car and a further signal that it is time to start. They then close the doors, start the car and bring it to full speed; slow it down and stop it at the desired floor and open the doors; also signalling the number of the floor for which the doors are opened. The operator is no longer an operator, he or she is merely a guard and information bureau.

So far as the passenger is concerned the modern elevator has all the characteristics of the magic carpet. He enters the car, the doors close, in a few seconds the doors open and he leaves. To none of his senses, not even those special ones developed by aviators, is it apparent that there has been any motion of the car.

SECRET OF THE MACHINE

"We can pull and haul and push and lift and drive,
We can print and plough and weave and heat and light,
We can run and jump and swim and fly and dive,
We can see and hear and count and read and write!"

—*Kipling.*

LESSON 14.

SCIENCE PERFECTS AN IDEAL WINDOW DISPLAY

(Westinghouse International, Jan. 1930)

D. A. Keirn

"Touch this spot", was the legend appearing on the inside of the show window at a recent automobile show on Broadway, New York City, U. S. A. The many persons who followed these simple instructions were astounded as a large motor car mysteriously moved toward them and back again and continued until the hand was removed.

Crowds gathered—various opinions were offered as to the phenomena that mystified so many. People fought among themselves, good naturedly, for the privilege of touching the spot and all eyes were centered on the amazing spectacle before them. Many went inside the show room because, unlike other attention-attracting devices, this one did more than merely draw the passerby to the window—this device called specific attention to the product on display through the passerby, himself, motivating it.

Now let us see just what weird method was employed to cause the hand to move the motor car.

Below the sign, on the inside of the show window, was a small metal-foil disc. From this metallic disc, a thin wire, practically invisible, ran to a small box containing a Grid-Glow Tube Demonstration Set, a new piece of electrical apparatus developed by the Westinghouse Electric Company.

Between this box and the moving motor car, another wire conveyed the motive power to the car. The energy from the hand was sufficient to actuate the apparatus.

Here was a novel device, created and perfected by science, made available for commercial use and demonstrated to be ideal for advertising merchandise of many types.

Displays similar to that of the moving motor car attract the public because, unlike other novelties which draw the passerby, here is one where the onlookers are more than an audience as when watching an ordinary mechanical device or a demonstrator at work. Here the onlookers are actually participants in the show because by the mere touch of a hand, they control the display.

The possibilities of the Grid-Glow demonstration set are practically unlimited. Here is a partial list of ap-

plications:

Starting electric fans.

Lighting electric lamps to light up show windows.

Starting electric toy trains.

Lighting miniature airports.

Lighting colored transparencies (decalcomanias).

Turning on radio receiving set with loud speaker.

Controlling small moving picture projection machine in show window.

Sounding electric bells.

Control of mechanism for release of draperies at unveiling ceremonies.

Ringing alarms or lighting lamps when a hand approaches valuables.

So, Westinghouse has developed its invention, the Grid-Glow Tube, the most sensitive device known to the electrical industry, and with thousands of technical uses. It is available for introducing new products or calling attention to old and to otherwise draw the public not only to the show window where the merchandise is displayed but inside to where it is sold.

LESSON 15.

AMERICA SLOWING DOWN

(The Electrician, Jan. 3, 1930)

Figures relating to the output of electricity in the United States during November are significant. They indicate that although there was a substantial gain over the corresponding month of 1928, the rate of development has slackened. The actual increase is below the figure of normal growth as determined by past experience and reflects the slowing down of industrial activity which has followed the recent Wall Street collapse. Those parts of the country which gave evidence of the greatest increase in industrial activity during the past year now show the largest relative decline. It is in the Middle West, between the Alleghanies and the Missouri, that the recession of activity is most marked, and it is specially noticeable in the centres concerned with the automotive, steel and associated industries. The worst drought ever recorded in the Pacific Coast State of Washington persisted up to the beginning of the winter, and the diminished stream flow restricted the output of hydro-

electric plants, thereby curtailing industrial activity at serval centres where supplementary steam-generating plant was not available.

SOURCE OF ELECTRIC POWER

(General Electric Calendar, 1930)

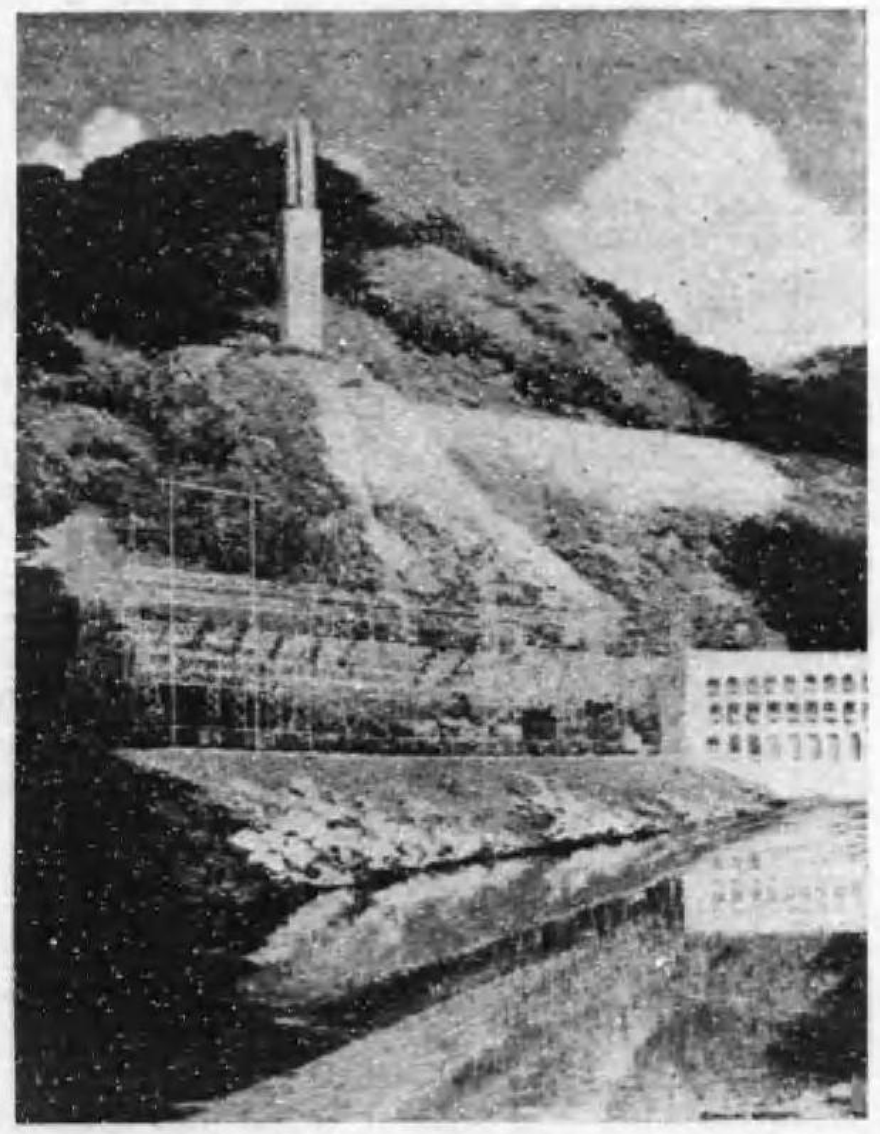

Fig. 17.

Of national economic importance are the great generating stations that convert the energy of falling water into electric power.

LESSON 16.

POWER

(General Electric Review, Nov. 1929)

In turning the pages of a small dictionary on our desk we were struck by the rather pleasing fact that but one word separated Poverty from Power. Poverty was separated from Power by the single word Powder. After noting this fact we found ourselves almost unconsciously humming a verse from Kipling's "Secret of the Machine":

"Do you wish to make the mountains bare their head
And lay their new-cut forests at your feet?
Do you want to turn a river in its bed,
And plant a barren wilderness with wheat?
Shall we pipe aloft and bring you water down
From the never-failing cisterns of the snows,
To work the mills and tramways in your town,
And irrigate your orchards as it flows?
"It is easy! Give us dynamite and drills!
Watch the iron-shouldered rocks lie down and quake
As the thirsty desert-level floods and fills,
And the valley we have dammed becomes a lake!"

The story of our modern world is, indeed, in a great measure the story of how man has used powder, dynamite,

and his own indefatigable energy in eliminating poverty by damming rivers and blasting rocks, not only to plant barren wildernesses with wheat but, more particularly, that we might have power and have it ever more abundantly. The power that we are today generating in our steam and hydroelectric stations throughout the land is, as we see it, the antidote for poverty and has revolutionized our lives economically, socially, and industrially.

In the radical changes that have come about in our mode of doing things during the last fifty years, we believe that our newer and better methods depend more upon the increased use of power than on anything else.

If we confine our remarks to America we can say with certainty that the ever-increasing use of power and the multiplication of its applications in the home, in the office, and in the majority of industries has been the greatest and most potent factor in building up the national wealth.

Great as the changes of the last half-century have been, we believe that our public utilities are going to do more for us in the next ten or fifteen years than they have accomplished in the last fifty years.

Just as the mighty oak springs from the tiny acorn, so have the gigantic American public-utility industries sprung from small beginnings. Thomas A. Edison's small 1,200-horsepower station at Pearl Street in New York City will always be regarded as of historic interest, and may justly be looked upon as one of the nuclei from which sprang this tremendous growth.

How rapid and great this growth has been can, in a measure, be shown by the statement that in 1927, well under half a century after Edison's Pioneer station, central-station service was available to every city in the United States with a population of 5,000 or more; to 97 per cent of all communities between 1,000 and 5,000; to 50 per cent of all communities between 250 and 1,000 people and to 25 per cent of all townships of less than 250 inhabitants.

There are now some 4,400 electric-utility enterprises in the United States alone, serving considerably over twenty-one million customers. It is interesting to note that in the year 1927 of the 75,116,000,000 kilowatt-hours generated, about two-thirds was produced by fuel-burning plants and one-third by water power.

In the year 1928 considerably more than ten billion dollars was invested in the American utility industry and during that same year the gross revenue had reached nearly two billion dollars.

These figures are tremendous, but the rapidity of this

growth is best told by stating that in the last twenty years the equipment for generating power in American central stations has grown from five million horsepower to thirty-six million horsepower.

Of this great total, nineteen million horsepower was sold to manufacturing industries. There are some people who can read sermons in stones. There ought to be many more who can read the economic history of a nation in these figures. Every industrial worker in America has over 4½ horsepower at his disposal, and thus, the American workman has become to a far greater extent the director of mechanical energy than the exerter of muscle power. It is this simple fact that has given to the American factory that increase in both quality and quantity of production that has astonished and perplexed the world.

We regard the American public-utility industry as the very life blood of the country, energizing and vitalizing every section where its thin red streaks of civilization are spread. The electric transmission lines are to a country just what the blood vessels and nerves are to the human body. They energize, they vitalize, they give life where no life could be without them.

The mighty expansion of the public-utility business today assures the prosperity of the future in a degree that, if it had been told to our fathers, would have outshone their brightest visions of Utopia.

The early history of American public utilities was of a turbulent nature. It was permeated with useless and wasteful competition and harassed by uncertainties. There was no government control in the early days. We doubt if history anywhere holds a better example of success and prosperity as the first fruits of coöperation between producer and consumer than is shown in the case of public-utility growth.

Order displaced chaos as each state of the Union, one after the other, recognized electric service as essential to the prosperity and growth of the commonwealth and decreed that wasteful and destructive competition should give way to a form of state-regulated monopoly. So quickly and so thoroughly was recognized the wisdom of protecting the consumer, without undue hindrance to pioneer developments, that today we find public-service commissions established in every state in the Union with the single exception of Delaware.

This economic theory that has been developed in America to govern the regulation of public utilities embraces in its present scope electricity, water supply,

gas, street railway, bus, express, telegraph and telephone companies. In general, the theory is this: that in exchange for the exclusive right to serve a particular territory and to make use of such public property as streets and roads, etc., the state assumes the right to supervise and regulate the rates charged as well as to dictate the standard of service to be rendered.

The results achieved under this far-seeing policy are well described in the following paragraph taken from the new (14th edition) *Encyclopedia Britannica:*

"It is under this general form of state regulation of private enterprise that the electric-utility industry of the United States has made its extraordinary record of growth during the present century, to a point where the country uses nearly as much electricity as all the rest of the world."

How well engineering developments, research, and able management have served the country is admirably shown by quoting a paragraph from a recent United States Geological Survey Report.

"In 1927 the operators of the public-utilities power plants performed the remarkable feat of generating 2½ billion more kilowatt-hours of electricity with the use of 150,000 tons less of fuel than in the previous year."

We can add to this statement the fact that in the year

1928 the average domestic rate for electric energy for the entire country was 15 per cent less than for the year 1913, and that electric energy was the only item in the government cost-of-living list to show a decrease when compared with pre-war averages.

We have quoted some figures from an article by E. W. Rice, Jr., appearing in this issue and some from other sources to show the magnitude and the rapidity of growth of the American public-utility business. We could have quoted many more statistics but figures after a time become wearisome.

The public utilities, like many other things American, have become giants. America in the past learned much from other countries and be it said to her credit that she has made the full use of what she learned. It sometimes seems to us that the world now has much to learn from America, and especially the all-important fact that big business is good business.

There are some, we know, who lament the fact that the public-utility business is big and prosperous. There are some people who always seem to fear anything big. The great paradox about American business that the world at large should heed to-day is that all those agencies of American commercial life that were feared a quarter

of a century ago because of their bigness have developed, through the guidance of wise regulation, to be those factors that have built up the national wealth and at the same time raised the standard of living for the workingman and led to the most equitable distribution of wealth to be found in any country of the world.

Dollars are not filthy things as some have imagined. They are in reality only the tokens of work done in the past and opportunities intelligently taken. The man in the street, the consumer and the workingman in the shop have the same privileges as that mythical figure, "The Magnate," to share in the prosperity of big business.

It is the large corporations and our stock exchanges that have given the tinker and tailor, the soldier and sailor an opportunity to share in the national wealth. In the future, the man who is nothing but a critic and the person who does nothing but grumble will be poor; but the person who has sufficient energy and intelligence to work and to save and to invest his savings wisely in America's great business institutions will not be poor.

There is only one word between Poverty and Power—that is Powder. We take the privilege of coming a new synonym for powder—Energetic Intelligence.

LESSON 17.

THE ALTERNATING CURRENT

(Charles Proteus Steinmetz)

John Winthrop Hammona

In electrical engineering, alternating current is one of the two kinds of electrical current in every-day practical use. The other kind is direct current.

The difference between the two is very distinct. Direct current flows continually in the same direction. Thus it can be measured in amperes (the ampere being the unit for measuring the flow of an electric current), and its action can be calculated numerically in a simple manner.

But alternating current does not flow continuously in the same direction. As its names implies, it alternates, flowing first in one direction, then reversing and flowing in the opposite direction, then reversing again and flowing in the original direction, and so back and forth, back and forth, usually 120 times every second. In certain applications of electricity, however, alternating currents are made to alternate not merely 120 times per second but thousands and thousands of times per second.

The alternating action was thus described by Dr. Steinmetz: "The current rises from zero to a maximum;

then decreases again to nothing, reverses and rises to a maximum in the opposite direction; decreases to zero, again reverses and rises to a maximum in the first direction—and so on."

No wonder mathematicians were baffled by the peculiar nature of this mysterious force! And in dealing with it thirty years ago they were hampered by an imperfect understanding of the mathematical principles involved. Alternating current was particularly baffling in that, unlike direct current, it has no value and on direction. Its value continually changes, and so does its direction.

"Thus," says Dr. Steinmetz, in his explanation of this problem, "in all calculations with alternating current, instead of a simple mechanical value of the direct current theory, the investigator had to use a complicated function of time to represent the alternating current. The theory of alternating-current apparatus thereby became so complicated that the investigator never got very far.

"True, practical electricians had been building and operating alternating-current machines, and they secured, for practical use, a numerical value for the alternating current by means of an ammeter (an instrument for measuring in amperes the strength of an electric current). But you could not make any calculations with it."

LESSON 18.

PROFESSOR AND ENGINEER (I)

(Charles Proteus Steinmetz)

John Winthrop Hammond

The newly completed Steinmetz's house presents an imposing example of architecture of the Elizabethan period. It is built of ornamental red brick, with high-peaked gables and a substantial dark wood finish, and has commodious, attractive rooms. The general plan is in keeping with the suggestions of Dr. Steinmetz and embraces a large, hospitable entrance-hall, broad stairs with heavy, wide banisters, and certain touches particularly adapted to the convenience of the owner.

Chief of these is an office-room and museum, opening out of the entrance-hall at the extreme rear, and reached through an anteroom. There Dr. Steinmetz had his desk, on one side of which was a large swivel arm-chair, for the special accommodation of visitors; while on the other side stood a low bench, suggesting a leg-rest, with a cushion, on which the doctor placed himself, knees on the cushion, elbows on the desk—his favorite attitude when in conversation with any one who came to see him.

At one elbow stood a large bowl, the cover of which he would raise after a few moments, to reach in and take a long, thin cigar, which he would slowly light and contentedly smoke throughout the discussion.

This room was large; and more than half the space was occupied by half a dozen glass-inclosed shelves, which stood in rows with aisles between them, and which reached clear to the ceiling. These contained eventually a miscellaneous assortment of odd treasures, the hobbies of a scientific collector extending over the better part of a lifetime.

In a corner of one case were incandescent lamps of all sizes, even up to the largest. On another shelf were to be seen tray upon tray of geological specimens, iron ores and minerals of all sorts. Another contained a large display of Indian flint arrow-heads, including some excellent specimens. There were also collections of curious smooth stones and pebbles, sea-shells, old note-books, hour-glasses, and many other objects. There was a ladder, on wheels, which the doctor used to get at the upper shelves of this museum.

LESSON 19.

PROFESSOR AND ENGINEER (II)

(Charles Proteus Steinmetz)

John Winthrop Hammond

The first time that Dr. Steinmetz attended a student play at the old Van Curler Opera-house, he caused a thrill among the student body by appearing in one of the boxes attired in a gray flannel shirt beneath an ordinary sack-coat. The students were greatly fascinated by this. It struck them as absolutely characteristic. Nobody but "Steiny" would have done it; and nobody but he would have done it as a perfectly natural, ordinary practice.

"In short," as the 'Union Alumni Monthly' puts it, "the boys took him to their heart, and he entered fully into the life of the college."

In the lecture-room he was inclined to set a pretty stiff pace for his classes. He was wonderfully stimulating as a lecturer, but he frequently talked far over the heads of the students. The reason for this was twofold. He never quite realized the limitations of the student mind. With all his sympathy and kindly interest in individual

members of his classes, he always imagined that young men could absorb more than was to be expected. In addition to this, he was apt to feel stirred to a high pitch of enthusiasm within himself as he got up into the upper levels of the grand field of electrical engineering, and so would unconsciously leave his admiring, but bewildered, classes far behind.

Nevertheless, he was a successful class-room lecturer and exceedingly popular with his students. At first the college boys found his high-pitched voice and his marked accent a trifle difficult to follow, but this reaction did not last. He possessed a remarkably clear diction; and he invariably unfolded his subject in a spirited and entertaining manner, so that even a technical lecture, as he handled it, was decidedly effective.

As a result, his classes gained a vivid impression of the broad background of this subject, securing a sound conception of the fundamentals. Even though sometimes left floundering by the ultra-technical exposition to which they had listened, the students of Dr. Steinmetz carried away with them a realization that electrical engineering was a vast and tremendous field, a profession of unimaginable possibilities, in which no man with ambition and opportunity could feel restricted.

LESSON 20.

CLOSE OF WORLD ENGINEERING CONGRESS IN TOKYO

(Journal of A. I. E. E., Jan. 1930)

The closing sessions of the World Engineering Congress and the Tokyo Sectional Meeting of the World Power Conference were held in Parliament House, Tokyo, Thursday, November 7th, 1929.

Twenty-six countries were represented. About 500 delegates and guests from foreign countries were in attendance, about one-half of whom were from the United States; the total attendance exceeded one thousand. About 800 papers were presented at the sessions of the Engineering Congress and approximately 150 at the Power Conference. A large proportion of the 240 Japanese members of the A. I. E. E. were in attendance with the addition of about 30 foreign members.

The Japanese engineers were untiring in their efforts to make the visit of the foreign engineers and guests both profitable from a professional standpoint and enjoyable socially. The general sentiment of the visitors was

expressed in a resolution unanimously adopted at the final session of the Congress, Nov. 7th, highly commending the officers, committees, and others concerned, for the effective manner in which the Congress had been planned and conducted, both professionally and socially.

The Transactions of the Congress will be published in book form but will not be available for several months; in the meantime pamphlet copies of all the papers that could be printed in advance will be on file in the Engineering Societies Library, New York. Correspondence regarding the availability of separate copies of the Congress papers may be addressed to Mr. Maurice Holland, Secretary of the American Committee, 33 West 39th Street, New York; similarly, inquiries regarding the Power Conference papers may be addressed to O. C. Merrill, Chairman, American National Committee of the Conference, 917, 15th Street, N. W., Washington, D. C.

At the final session of the Congress the following resolutions were adopted upon the recommendation of the Resolutions Committee:

RESOLUTION NO. 1

Be It Resolved that the Delegates of the Various Nations be requested to explore the situation, with a view to ascertaining the opinion, in their own Countries, as to the advisability and practicability of bringing forward for action some plan aiming at World Engineering Federation:

And that this subject should have a place allotted to it at the next World Engineering Congress.

RESOLUTION NO. 2

Whereas it is understood that the Netherlands Royal Institute of Engineers is willing to take the lead in the investigation of certain irrigation questions of international importance.

Be It Resolved that this congress favors an international investigation, to be carried on under the auspices of said Institute, Division Netherlands East India, for report to the next World Engineering Congress on the following question:

What subsidies, direct or indirect, are paid by various governments to secure the construction of large irrigation and flood control and drainage works and with what justification?

RESOLUTION NO. 3

Be It Resolved that the attention of Engineering Society in the various countries participating in this Congress be directed to the importance of a full understanding of

hydrostatic uplift, internal stresses and other factors affecting the safety of dams, and that the American Society of Civil Engineers be requested to invite the coöperation of the committee on Dams of the International Navigation Congress, also the World Power Conference and the Engineering Organizations of the other countries represented at this Congress, in a study of this problem.

* * * * *

The daily press of Japan, both Japanese and English, devoted an unusually large amount of space to the Congress day by day, many of the papers being printed each day in full or in abstract.

In its leading editorial on Nov. 8th, the Japan *Advertiser* said in part:

The reader who has skimmed the daily summaries of the proceeding of the World Engineering Congress and the sectional meeting of the World Power Conference must have asked himself if there is anything in the material life of man which does not come within the vast net of the modern engineer. * * * * The discussions on scientific management and rationalization showed how engineers are being aroused to the social consequences of the progress of their science. The exchange of views on this subject by engineers from old countries where labor is superabundant and where its too rapid displacement by machines may be the greater of two evils, and new countries where labor is relatively scarce was a feature of the conference.

One of the acts of the Congress was the appointment of a preparatory committee to consider the formation of a world federation of engineers. Such an organization would develop professional spirit and in this way would form and clarify professional opinion on those large questions. But the engineers, true to their engrossing tasks, were chiefly engaged in the pooling of knowledge —the expression par excellence of the professional spirit —and the merest glance through the daily reports shows what a rich and varied field they cultivated. The great experiment of holding this gathering in Japan has been fully justified.

TRADITIONAL INDUSTRY OF JAPAN

(Industrial Japan)

Even the Japanese themselves are often negligent of the traditional industries that thrived before the Restoration. However, some of them are interesting and noteworthy when their substance is examined or their future prospect considered.

LESSON 21.

DOCTOR SHIBUSAWA ELECTED AN HONORARY MEMBER

(Journal of A. I. E. E., Jan. 1930)

At a special meeting of the Institute held November 7th in Parliament House, Tokyo, Japan, Doctor Motoji Shibusawa, Dean of Engineering at the Tokyo Imperial University, was installed as an Honorary Member of the American Institute of Electrical Engineers.

The meeting, which was attended by a large number of members of the Institute of Electrical Engineers of Japan and of the American Institute, was presided over by Past-President Frank B. Jewett of New York, who stated that the Constitution of the Institute provides that honorary membership may be conferred upon those who have rendered acknowledged eminent service to electrical engineering, and only upon the unanimous vote of all the members of the governing body. There are at present only eleven men, including Doctor Shibusawa, who have been thus honored. The election of this distinguished Japanese engineer occurred on August 6, 1929 in New

York and this special meeting for the purpose of publicly announcing the matter had been arranged because of the presence in Tokyo of a large number of American electrical engineers in attendance at the World Engineering Congress.

Past-President R. F. Schuchardt, outlined the achievements of Doctor Shibusawa and presented the Certificate of Honorary Membership to him. Doctor Shibusawa was born in Saitama Prefecture, Japan, on October 25, 1876. He received his technical education at the Imperial University of Tokyo, being graduated from the Department of Electrical Engineering in 1900. He continued his studies in Europe and America.

He was appointed an Electrical Engineer of the Electrotechnical Laboratory of the Department of Communications in 1906, and in 1909 was appointed to the additional post of Engineer of the Imperial Railway Board.

In 1919 he was appointed Engineer-in-Chief, Bureau of Electricity, Ministry of Communications and in 1919 he also took the additional post of Professor of the Tokyo Imperial University, to which latter post he was definitely transferred in 1924.

He was appointed Dean of the Faculty of Engineering, Tokyo Imperial University, in 1929, and received the

degree of "Kogakuhakushi" (Doctor of Engineering) in 1911. He was elected President of the Institute of Electrical Engineering of Japan in 1924, and has held the post of President of the Japanese Electrotechnical Committee since 1921. He has been a member of the American Institute of Electrical Engineers since 1905. Doctor Shibusawa has contributed largely to the technial literature of Japan.

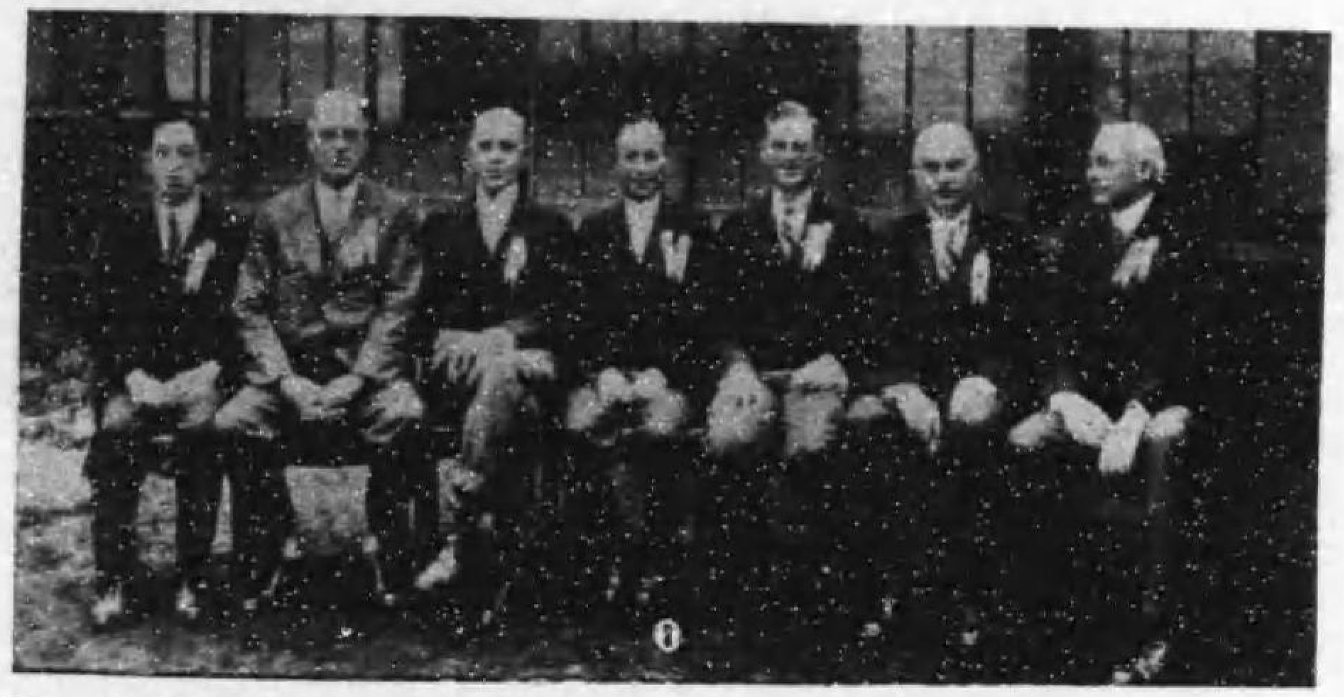

Fig. 18. Left to right: Dr. Niwa, Prof. Lincoln, Dr. Jewett, Dr. Shibusawa, Mr. Schuchardt, Prof. Jackson, Mr. Hutchinson.

Others on the platform were President Yamamoto, of the Institute of Electrical Engineers of Japan, Past-Presidents D. C. Jackson and P. M. Lincoln, National Secretary, F. L. Hutchinson, and Elmer A. Sperry, Charter Member of the American Institute.

Doctor Shibusawa responded with an address in which he expressed high appreciation of the great honor that had been conferred upon him.

LESSON 22.

FIRST AWARD OF LAMME MEDAL

(Westinghouse International, Nov. 1929)

The first presentation of the Lamme Medal, created by provisions in the will of the late Benjamin G. Lamme, noted electrical scientist and chief engineer of the Westinghouse Electric Company, was awarded to Allan Bertram Field, a prominent English inventor.

Pathfinders of North America's great electrical industry gathered in convention at Swampscott, Mass., U. S. A. at the Annual Convention of the American Institute of Electrical Engineers, witnessed the presentation in the evening of June 26, 1929.

The Lamme medal annually is given for meritorious achievement in the design of electrical machinery; the recipient being chosen by the Lamme-Medal Committee of the American Institute of Electrical Engineers.

The specific accomplishment for which Mr. Field received the medal was "The Mathematical and Experimental Investigation of Eddy-Current Losses in Large Slot-Wound Conductors in Electrical Machinery."

Mr. Field received his early education in England, but much of his work was done in the United States. He attended the Finsbury Technical College, St. John's College, Cambridge, England, and the University of London.

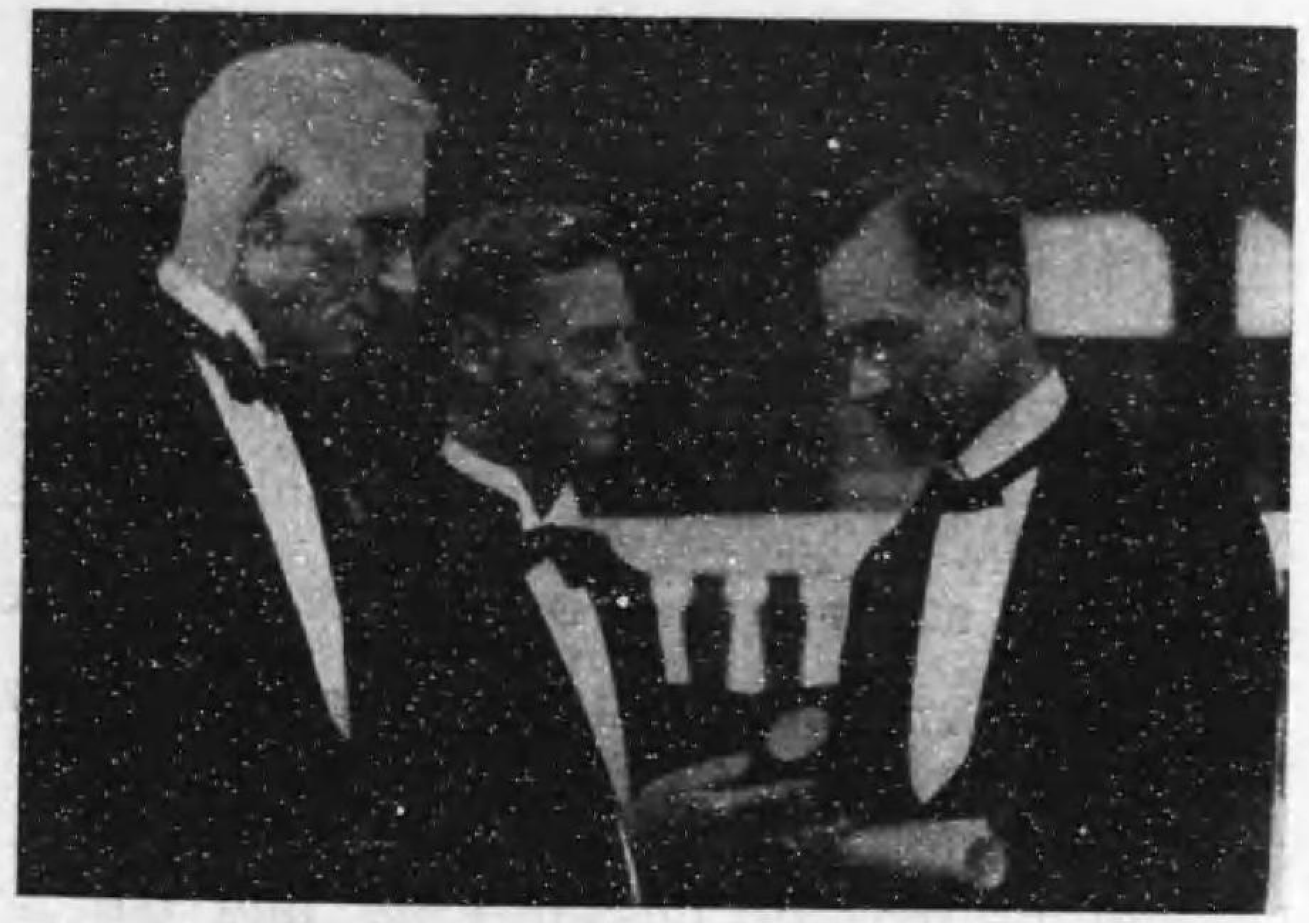

Fig. 19. Left to right: Mr. Scott, an honorary member of A.I.E.E. Mr. Schuchardt, the President of A.I.E.E. Mr. Field, the recipient of the medal.

In 1902, Mr. Field came to the United States and worked for various electrical companies before joining Westinghouse in 1909. While with Westinghouse, he began his most important work, among which was the solution of problems relating to turbine-generator design which has been followed since then throughout the Westinghouse organization.

Since 1914, Mr. Field has lived in England. Formerly, he was a consulting engineer and professor of mechanical engineering at Manchester University. In 1917, he joined a large British electric company of which he is now consulting engineer.

Benjamin G. Lamme, donor of the medal which bears his name, was the type of man who would be expected to promote the advancement of science even after his death. He was an intense delver into the reason for things. Very soon after joining the Westinghouse Company in 1889, he took up design work and did not relinquish his interest in inventions during his career. He was accredited with 162 patents most of which have been put to practical use. Mr. Lamme was identified with the installation of the Niagara Falls, U. S. A., generators, at that time the largest in the world.

"The engineer views hopefully the hitherto unattainable."

—*Lamme.*

LESSON 23.

ENGINEERING BY ANALYSIS

(Electrical Engineering Papers)

B. G. Lamme

The early engineering in any field is usually of the "cut-and-try" kind, followed later by the refinements of more highly trained specialists. A comparatively recent development in industrial and manufacturing engineering is the analytical engineer. By this is meant the engineer who translates facts into relationships, formulæ and figures, and eventually retranslates them into other facts. The analytical engineer in this sense does not mean the mere user of figures and formulæ. He starts with fundamental principles and laws from which he then draws his conclusions, the applications of which are made directly to the final product without intermediate experimentation. The analytical engineer has led the way to new and more difficult fields of endeavor and many of our most rapid advances have been made under his guidance.

Electrical engineering is one of the youngest of the engineering lines of endeavor, but its "cut-and-try" period was of comparatively short duration. The coming of the analytical engineer was almost coincident with the rise of electrical engineering as a business. This branch of engineering deals with more or less obscure phenomena, of which there are only indirect evidences in many cases. Many of them can only be grasped or handled by those who have considerable analytical and mathematical ability. In consequence, even comparatively early in the work, the highly technical engineer was a necessity. Probably in no other branch of engineering, since its first development, has there been as large percentage of men, having high technical training, engaged in the work; and as a consequence, in no other lines of engineering has there been as rapid growth as in the electrical.

Coincidentally with the growth of electrical engineering, there have been rapid advances in the older and better established lines of engineering, especially in those which have been rather intimately associated with the electrical industry. The steam turbine which now dominates the field of steam prime movers, received its greatest impetus in connection with electrical work, and its present high development may be said to be the product of the analytical engineer. Water-wheel development has also made

great advances under much the same conditions.

One characteristic of the analytical engineer of the present time, especially in electrical work, is that he is very often working far ahead of his available data. He is obliged to plot his existing data and experience and then extrapolate for the new points which he finds necessary in his work. He is thus working in the unknown to a greater or less extent, but his ability to analyze and correlate very often leads him to be fairly certain of his results.

It is this ability to work with confidence in comparatively unknown fields, which has produced such astonishing results in electrical engineering.

The analytical engineer of to-day, whether electrical or otherwise, must forsee, through his analysis of data and practice, what the trend of future practice will be. If his analysis shows him that certain lines of development are scientifically more consistent than other lines, he will naturally tend to work along what he considers to be the correct direction. If he sees that certain practices are fundamentally wrong and represent only makeshift conditions, or merely commercial expediency, he will naturally feel that such practices eventually will be replaced. He must weigh both theoretical and practical conditions in determining which direction to work.

With the true analytical engineer there will be no standardization of practice unless such practice has good fundamental reasons back of it. His tendency is rather toward standardization according to certain scientific principles and limitations than by practices which have insufficient basis. The latest standardization rules of the American Institute of Electrical Engineers represent an attempt along this line, and it is a pretty safe prediction that the basic features of these new rules will be retained for many years to come.

Analytical engineering, of a very advanced kind is represented by the modern research and testing departments and laboratories of the big engineering concerns who do electrical and other manufacturing. Much of the technical data, which the designing, developing and manufacturing departments require, is a direct product of such departments. No progressive industrial establishment of the present time can get along without extensive research departments. Recently Congress has approved of a large Naval Laboratory for research and experimental work, in line with other engineering and industrial organizations.

A good example of modern electrical design work of a

highly analytical character, is the present turbo-generator. The present huge-capacity high-speed machines are almost beyond the dreams of ten years ago. These machines are almost entirely the product of the analytical designing engineer. In these machines nearly all previous developments and experience in other lines of apparatus have counted for little. New methods, new materials, new practices and new limitations have been established in these machines, and for these reasons, the turbo-generator engineer has been compelled to work ahead of his data and experience much of the time. For example: the twenty thousand kilowatt, 1,800 r. p. m., 60-cycle, turbo generator was undertaken when the ten-thousand-kilowatt machine of the same speed and frequency was the nearest size from which to obtain data, and this smaller-size unit had already been carried up to what were considered as the permissible limits, in many ways. In such case the designer had to overstep his data and limits, and depend largely upon analysis.

Another good example of analytical engineering is the induction motor. While such motors possibly could have been developed by cut-and-try methods, at great expense and with many failures, yet the present advanced status of this type of apparatus can be considered only as the product of the analyst. The production of cage-wound induction motors with good starting torque, suitable for general purposes, was the result of analysis, not experi ment.

* * * * *

As the competent electrical designing engineer must necessarily be an analyst, obviously analytical ability, in the broad sense, must be one of his foremost characteristics. He should also have a certain amount of mathematical ability and training. In general, skill in the ordinary mathematics, such as in algebra and analytical trigonometry is of more use than a mere working knowledge of the higher mathematics. There are certain lines of work in which the higher mathematics are, of course, very valuable and necessary. These, however, represent a relatively small percent of the total field. The young engineer should not become unduly impressed with the idea that ability to use extremely complicated mathematics is the prime requisite. He should, however, recognize that without mathematical aptitude of any sort, he is very greatly handicapped. The "handy man" with mathematics appears to have a decided advantage over others, in practical work.

The engineer who can develop a mental picture or a

"physical conception" of what is going on in a machine, in distinction from a purely mathematical conception, appears to have a very considerable advantage over his fellows. The man with both the physical conception and with good mathematical ability will probably go further in analysis than any of the others.

OVER HUNDRED FLOODLIGHTS

(Popular Mechanics, Feb. 1930)

As a part of a decorative scheme for the Edison exposition held in Cincinnati, Ohio, a total of 127 floodlights for outdoor illumination were installed in one great bank, all the lights operating simultaneously. When all were lighted they drew a total of 82,000 watts, the equivalent of 110 horsepower. The framework for the unit extended into the air thirty-six feet.

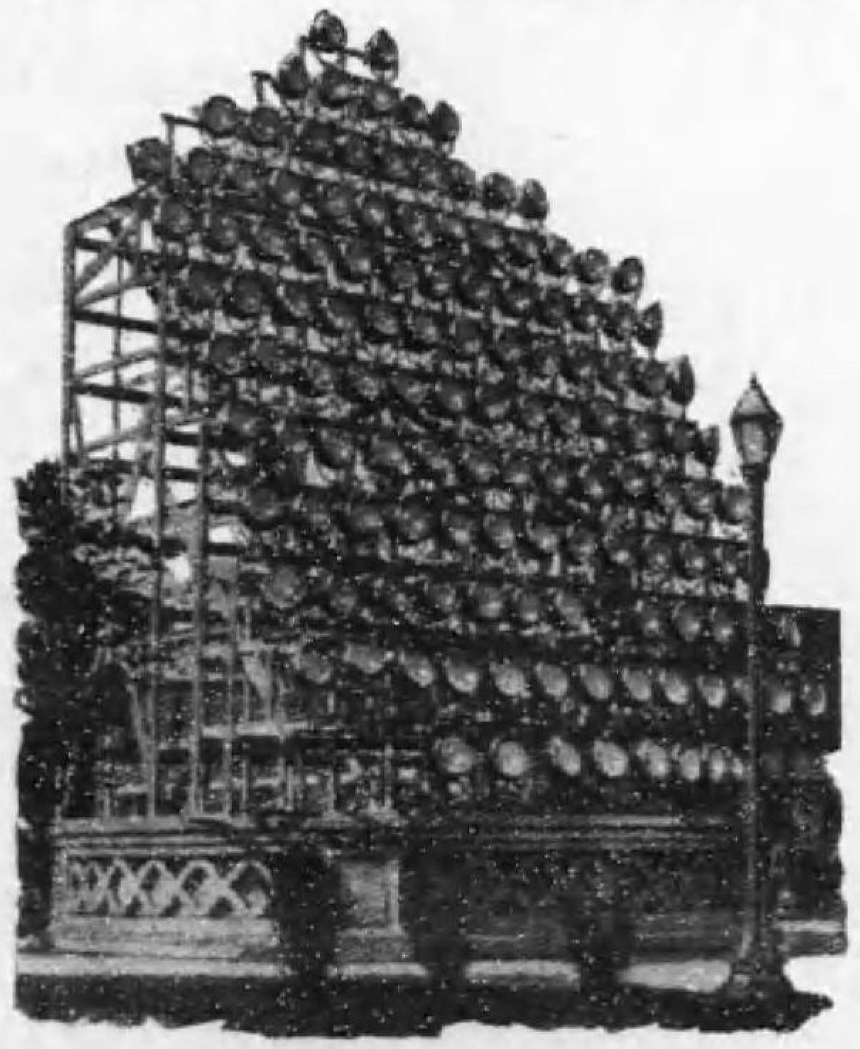

Fig. 20. Cincinnati floodlights.

LESSON 24.

INDUSTRY OF JAPAN

(Industrial Japan)

The area of Japan is small and her population dense. She is even over-populated.

Education, however, prevails and the people are smart and dexterous with their fingers. So, Japan is not wanting in industrial labour, either in quality or in quantity.

However, they have only one or two generations of training for the modern industries, and they are smaller in stature compared with Western people.

Consequently, when they are put to manipulate machines designed and made for Europeans and Americans they are often unable to show an equal efficiency. But there are cases where even greater efficiency is shown by gradually modifying the machinery to fit their use.

Before the Meiji Restoration the modern industrial system was unknown in Japan, and no labour question arose.

But then with the introduction of Western civilization there came the industrial system of the West, bringing in its wake many questions one after another in quick

and sudden succession socially and industrially.

Especially the World War enabled us to make an epoch-making expansion in our industry, and the labour questions became more and more serious with modernistic tendencies.

THE PATH OF ELECTRICAL SERVICE

(General Electric Calendar, 1930)

Fig. 21.

Across mountain and plain, transmission lines bring electric energy for every industrial and domestic need of countryside and city.

LESSON 25.

INDUSTRIAL TRANSITION IN JAPAN

(The Industrial Transition in Japan)

Maurice Holland

In her industries, her social life, her amusements, her press and publications—transition is the key-note of life in present-day Japan. Impelled by the forces of industrial research—that magic wand of applied science—Japan is passing through an industrial metamorphosis which is reflected in all phases of her life.

A few years ago she was suffering from an attack of industrial indigestion. Chronic symptoms developed after successive attempts to bolt German, English, French and American methods, advisers, and products, wholly unsuited to her economic requirements and domestic conditions. Tempting but unsuitable merchandise was introduced by salesmen doing "missionary work"; the industrial digestive tract was clogged; assimilation was slow.

No longer is Japan dependent upon an imported technology. Thirty thousand engineers are enrolled in the membership of her national engineering societies. That single fact is some indication of the phenomenal industrial growth which can absorb so large a number of technical

men. Young Japanese engineers, recent graduates of Japanese universities, are gradually taking over the administration and technical control of industrial processes and manufacturing methods. These engineers occupy important positions in the electrical, chemical, aeronautical, silk, and even the fisheries industries.

Tracing the evolution of industrial technology in representative industries from the agencies of pure science research through those of applied or industrial research, one is impressed by the genius for organization, the skill in method and technique, and the diversity of the application of science to the technical problems of industry.

In fisheries technology Japan leads the world. The high degree of perfection of scientific process in this field of industry is attested by the success of pearl-culture operations in that country. In the larger field of the fisheries industry as a whole Japan has been eminently successful in the integration of research agencies with industrial operation.

The development of civil aviation in Japan offered an interesting field of investigation. Civil aviation, one of the newest industries—in which science is in the marking, and where processes are in a state of flux, was compared with fisheries, one of the oldest industries, until but recently steeped in tradition and hampered by prejudice.

The whole range of industry is represented in research laboratories for fuel, nitrogen, pottery, iron and steel, electro-technics, brewing, aeronautics, silk, and sericulture. Of the ninety research institutions listed by the Department of Commerce and Industry twenty-three are supported by the National Treasury and include the National Institute of Physical and Chemical Research, Imperial Combustibles Research Laboratory, Tokyo and Osaka Industrial Research Laboratories, Imperial Sericulture Experimental Stations and others. Forty-four research institutes are supported by Prefectures and Municipalities while twenty-three are attached to private concerns in industry. Technical and semi-technical industries are rapidly taking the lead from agriculture in the race for economic supremacy.

The transition from hand labor to mass production, from oxen as a vehicle of power to high-tension transmission lines, from jinrikishas to motor cars, represents the pace in the present-day industrial development of Japan and foreshadows an economic advance of great significance to the western world.

LESSON 26.

GENERAL IMPRESSIONS ON RESEARCH IN JAPAN

(The Industrial Transition in Japan)

Maurice Holland

One of the inherent weaknesses of the organization of research in Japan is the wide gap between the agencies of pure science, or academic research, and those of applied science operating in the industry. Except in the electrical, the chemical, and other highly technical industries, very few research laboratories are supported by individual concerns.

There appear to be three reasons for the present situation in research organization. First, there is a too generous subsidy appropriated by the Imperial Government for national research institutes, extending in some instances to agencies which should manifestly be supported by the industry. The incentive for the establishment of private agencies, due to industrial competition, has been to a large extent removed by the influence of Government regulation of industry through the Department of Commerce and Industry. Although the officials of the Government seem to realize that the ideal to be attained is a gradual reduction of Government subsidy, and an effort to place the research organizations on a self-sustaining basis, there is little or no concerted movement towards the realization of such an ideal. The average industrial executive of Japan is not sold on the research idea. He is, in general, intent upon production and dividends.

A second reason for the present situation is the absence of a national clearing house or central agency for the promotion or stimulation of research in the industries themselves. Obviously this task should be undertaken by a division of the National Research Council of Japan. Some discussion of this proposal during my visit may result in carrying such a project through to realization. Some national agency to interpret the technical problems of industry in terms of the research on the one hand, and to influence the program of academic research in such a direction as to be helpful in the solution of industrial problems, on the other, is of vital importance as a remedy for the present situation.

One important factor which has hindered the progress of research in Japan is the large number of scientific and research workers who have received their training abroad, particularly in the scientific centers of Germany, England, and France. In almost every instance, men trained in

Germany occupying important positions in research institutes or universities will use not only German methods and technique, but insist upon using German apparatus and instruments, and even publish the results of their investigations in the German language. The same thing is true of men who have received advanced scientific training in England, France, or America.

The Japanese people possess one fundamental quality necessary for success in research—an inquiring mind and a hunger for knowledge. No opportunity is lost by any Japanese in any station of life to come in contact with foreigners and to acquire as much new knowledge as the opportunity affords. Great care is taken to make a detailed record of newly acquired facts, and little time is lost in their application. The similarity between the national organization of research in Japan and the German system does not end here. There is in Japanese research workers that same thorough, painstaking patience in method and also the same skill and deftness in technique which have characterized the preeminent position of the Germans in research.

Modern science itself is less than fifty years old in Japan. Its industrial application, through research, is just beginning to bear fruit. The full harvest will be ready for reaping within the next few years.

In general, the trend of research in Japan is towards an economical utilization of natural resources under refinement of industrial processes, the substitution of cheaper materials, and the mass-production of articles which can be sold at home and abroad, rather than an organized effort to produce original processes or technique through scientific research.

Considering the relative amount of funds (including Government subsidy) expended on research, the number of research institutes, their housing, equipment, personnel, and organization, I should place Japan in the fourth position in the organization of industrial research among the industrial nations of the world.

FREQUENCY-CONVERTER INSTALLATIONS

(Advertisement, General Electric Review)

The most economical use of prime movers often requires an interchange of power. Hence, the important place occupied by the frequency converter in the continued growth and interconnection of power and transmission systems.

The General Electric Company has frequency converters in successful operation up to 40,000 kW capacity.

LESSON 27.

EFFECTS OF ELECTRIC SHOCK

(Journal of A. I. E. E., Jan. 1930)

By W. B. Kouwenhoven and Orthello R. Langworthy

General. The first death from contact with an electric circuit occurred in France in 1879. As the use of electricity has become prevalent, the number of accidents has increased. In the United States approximately 50 per cent of the accidents are fatal and the death rate from electricity is 0.9 per 100,000 population.

In the case of an electric accident, there are five factors that are of importance; namely, (1) the voltage of the circuit; (2) the current that flows through the body; (3) the duration of the contact; (4) the type of circuit, direct or alternating, and the frequency; and (5) the points on the body where contact is made with the circuit.

Voltage. It is a well recognized fact that high-voltage circuits are dangerous. Low voltages also are dangerous and especially so when the victim's contact with the circuit is good. Recent data seem to indicate an increase in the number of deaths caused by contact with low-voltage circuits used in residences. No authentic record has been found, however, of a death on a 110-volt d-c. circuit.

On high-voltage circuits the victim is often thrown away from the conductors by the severe contraction of the muscles, but on low-voltage circuits it is often impossible to let go. It is interesting to note that approximately one-third of the fatal accidents reported occur on low-voltage circuits.

Current. The current that will flow in any given case depends not only upon the system voltage but also upon the resistance offered by the body. This lies mainly in the skin, which when in a dry state has a resistance of from 40,000 to 100,000 ohms per sq. cm. In a thoroughly wet condition, however, the resistance of the skin contact falls as low as 1000 ohms per sq. cm.

The sensation produced by an alternating current of 15 to 20 milliamperes is extremely painful and a current of 100 milliamperes may cause death. Therefore, it is evident that if the skin of the victim is wet, 110-volt a-c. circuits are dangerous.

The resistance of the body decreases also if contact is made with the circuit for any length of time. In our tests, if the animal was allowed to remain in the circuit for any length of time, the current increased from 5 to 10 per cent.

Duration of Contact. The possibility of successful resuscitation decreases rapidly as the time of contact with the circuit increases. The higher the voltage of the circuit, the shorter the time that a man can remain in contact with it and still be resuscitated.

Type of Circuit. Low-voltage a-c. systems of commercial frequency are more dangerous than continuous-current circuits of the same voltage. A continuous current produces electrolysis of the body fluids and some strong contractions of the muscles. Alternating current, on the other hand, produces no electrolysis but a very severe contraction of the muscles.

Position of the Electrodes. If the contact of the body with the circuit occurs at points so located that the current does not pass through any vital organ, as a rule no permanent damage will result.

Experimental Study. The purpose of this investigation was to determine the effect of electric shock upon the central nervous system, to study the behavior of shocked animals, to ascertain if possible the cause of deaths due to respiratory failure, and to find how many cases of delayed deaths are the result of demonstrable lesions in the central nervous system.

Rats were chosen because they are easy to transport and inexpensive. The heart of the rat also recovers spontaneously from the uncoordinated contractions called fibrilation, produced by the passage of the current. No deaths in these tests were due to heart failure.

The effect on rats of alternating 60-cycle and continuous currents at constant potentials of 110, 220, 500 and 1,000 volts for varying lengths of time was studied. The authors felt that the changes in the nerve cells could be seen especially clearly if the animal was resuscitated after the shock and allowed to live several days. This procedure was carried out; the rat was then killed and the central nervous system examined at once. Attention was confined mainly to a study of the effects produced by the electric current on the spinal cord and brain.

* * * * * *

Conclusions

The following conclusions are drawn from the investigation:

1. The 110- and 200-volt a-c. circuits are more dangerous to rats than the corresponding d-c. circuits.

2. A d-c. circuit of 1,000 volts is more dangerous to rats than the corresponding alternating voltage.

3. A large rat can withstand a greater shock than a

small one and still survive.

4. The contraction of the body musculature is greater on an alternating voltage than on a d-c. circuit.

5. In many cases the alternating-current experiments are characterized by paralysis of the hind legs caused by hemorrhages in the spinal cord.

6. The three different positions of the electrodes investigated produced similar abnormalities.

7. A severe electric shock probably produces changes in the nervous system that are incompatible with life.

8. The death of the rats that could not be resuscitated was due in every case to respiratory failure.

9. The death of rats that lived for only a few hours after the shock was found to be caused by hemorrhages in thg brain.

10. The injuries are not directly proportional to the amount of current that passes through the body. Not only is the initial voltage of importance, but the duration of the contact and the size of the animal also.

It must be kept in mind that these results cannot be applied directly to men or to other animals.

LESSON 28.

LANGUAGE QUESTION

(Industrial Japan)

There is a great difficulty and handicap that confronts the Japanese race—nationally as well as internationally. It is the question of the language. To be sure, the Japanese language has its own merits; it sounds clear and musical, and its literature is full of interest. And the Japanese characters proper, the syllabary, consist of only 50 simple letters. But in the written language we mix Chinese characters with the Japanese syllabary, thus creating a complexity and inconvenience in writing and reading it.

That Japan, though one of the foremost countries of the world, is comparatively little known is no doubt due to her geographical isolation, but no less to her linguistic isolation. If all our researches, experiments, and opinions, etc., on science and industry were published in an international language, the world would be greatly benefited by them. Without using such a medium of expression, our conceptions and achievements, inasmuch as they are expressed in our own language alone, must necessarily remain a closed book to the outside world.

Japan has adopted the metric system ahead of England or U. S. A. Being capable of such a drastic decision as that, it may be possible for Japan to reform her language. However, in such an old country as Japan, though it were for the sake of general advancement and for the mutual understanding of the world, to revise or reform the language will be a formidable task.

WORLD'S LARGEST ELECTRIC LAMP

(Journal of A. I. E. E., Dec. 1928)

The world's largest lamp, a monster 50,000-watt experimental bulb built recently is like a radio tube in apperance. At the top of the bulb, a radiator made of metal fins carries off intense heat generated by the tungsten filament at 5,500 deg. fahr. The bulb is filled with nitrogen gas, whose circulation cools it and carries upward into the radiator evaporated or thrown-off tungsten particles from the filament, thus preventing blackening of the walls.

LESSON 29.

A LETTER TO HIS SON

Robert Lee

You must study to be frank with the worlds. Frankness is the child of honesty and courage. Say just what you mean to do, on every occasion, and take it for granted you mean to do right. If a friend asks a favor, you should grant it, if it is reasonable; if not, tell him plainly why you cannot, you would wrong him and wrong yourself by equivocation of any kind.

Never do a wrong to make a friend or keep one; the man who requires you to do so is dearly purchased at a sacrifice. Deal kindly, but firmly, with all your classmates; you will find it the policy which wears the best. Above all, do not appear to others what you are not.

If you have any fault to find with any one, tell him not others, of what you complain; there is no more dangerous experiment than that of undertaking to be one thing before a man's face and another behind his back. We should live, act, and say nothing to the injury of any one. It is not only best as a matter of principle, but it is the path to peace and honor.

In regard to duty, let me, in conclusion of this hasty letter, inform you that nearly a hundred years ago there was a day of remarkable gloom and darkness,—still known as "the dark day",—a day when the light of the sun was slowly extinguished as if by an eclipse. The Legislature of Connecticut was in session, and as its members saw the unexpected and unaccountable darkness coming on, they shared in the general awe and terror. It was supposed by many that the last day—the day of judgement—had come. Some one, in the consternation of the hour, moved an adjournment.

Then there arose an old Puritan legislator, Davenport, of Stanford, and said that, if the last day had come, he desired to be found at his place doing his duty, and therefore moved that candles be brought in, so that the House could proceed with its duty.

There was quiteness in that man's mind, the quiteness of heavenly wisdom and inflexible willingness to obey present duty. Duty, then, is the sublimest word in our language. Do your duty in all things like the old Puritan. You cannot do more; you should never wish to do less. Never let your mother or me wear *one* gray hair for any lack of duty on your part.

LESSON 30.

GETTYSBURG ADDRESS

(The Elson Readers, Book Eight)

Abraham Lincoln

Fourscore and seven years ago our fathers brought forth on this continent a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.

Now we are engaged in a great civil war; testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

But, in a larger sense, we cannot dedicate—we cannot consecrate—we cannot hallow—this ground. The brave men, living and dead, who struggled here have consecrated it far above our poor power to add or detract. The world will little note, nor long remember, what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the

unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain—that this nation, under God, shall have a new birth of freedom—and that government of the people, by the people, for the people, shall not perish from the earth.

STAR-HEAT MEASURED BY ELECTRICITY

A thermometer so delicate that it can measure the heat from stars is a recent application of electricity to scientific research, according to Doctor Henry Norris Russell, noted astronomer, in *Scientific American*.

Stars invisible to the naked eye are found in a powerful telescope, which concentrates the starlight over the measuring device. The rays are carried through a small window into an exhausted receiver and fall upon a thermocouple. This consists of a junction of two tiny wires of different metals which, if heated, sets flowing a minute electric current through a sensitive galvanometer.

The wires of the thermocouple are one one-thousandth of an inch in diameter, and the whole unit weighs less than one six-hundredth of a grain. The heat from Betelguese, which sends us more than any other star, raises the temperature of the thermocouple by about one-sixtieth of one degree, but so sensitive is the galvanometer that the infinitesimal current set up causes the recording spot of light to swing through 18 inches.

Studies with the electric thermometer have already proved of value to astronomers, says Doctor Russell. More than 100 stars have been measured, and experiments thus far indicate that the apparent brightness of a star may have little or nothing to do with its heat, since much of the heat may be radiated in waves invisible as light.

— THE END —

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