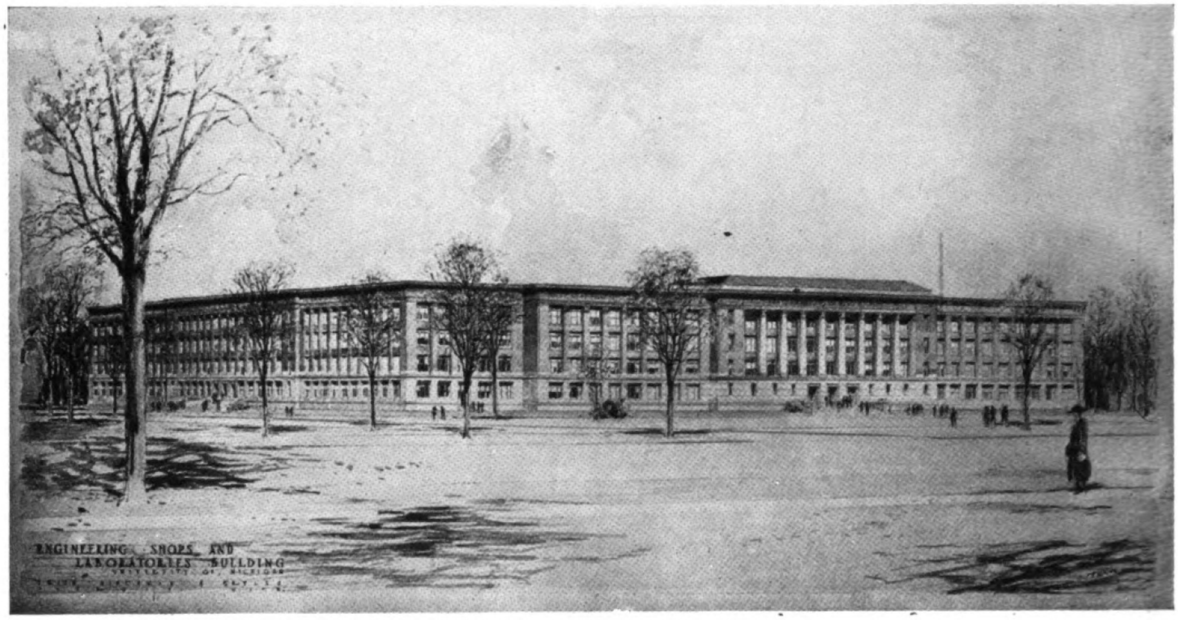


An Architect's Sketch of the New Engineering Building

In 1926 plans were drawn for a large new building to house all of the shops and laboratories. As pictured, the building was to extend down to South University St. and across Church St. to Forest Ave. The main entrance is shown facing Church St. The present East Engineering Building is the central portion of the side along East University Ave. (the left side in the sketch).

Michigan's Electrical Pioneers

DR. BENJAMIN F. BAILEY
Head of Department of Electrical Engineering

During the past 60 years two events have had a tremendous influence upon the progress of civilization—I refer to the World War and to the development of the applications of electricity. I need hardly elaborate upon the fact that of the two the latter has had the more far reaching consequences.

In 1875 electricity had only two important applications—the mariner's compass and telegraphy. The next 25 years saw the invention and application of the telephone, electric lighting, electric power, X-rays and radio. These have so transformed our civilization that it is impossible for younger people to realize the changes that have taken place, despite the fact that all this has occurred within the memory of many living men. Without these developments we should have no telephones, electric light and power, X-rays or radio, and, in addition, our present tall buildings, our automobiles, our airplanes and various other commonplace developments would have been impossible.

In this development two Michigan men, Charles F. Brush and John W. Langley, played important parts and it seems fitting that the MICHIGAN TECHNIC should publish a permanent record of their achievements.

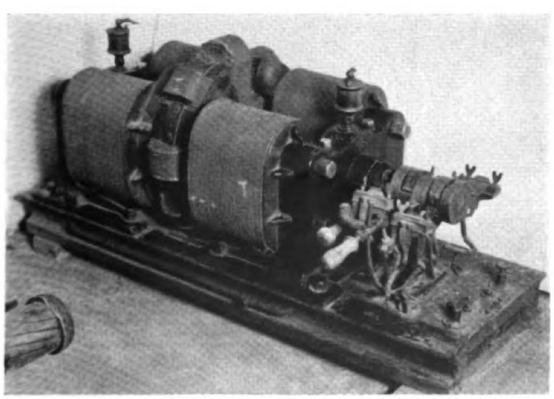
In 1875 engineers were beginning to consider the possibility of electric lighting. The electric arc had been known for a number of years and even incandescent lamps in a very crude form had been invented but not developed commercially. The great obstacle to electric lighting was the so-called "subdivision of the electric light." Arc lamps had been used commercially in the operation of lighthouses but always with one electric generator supplying the current to one lamp. Nobody knew how to devise a system such that a number of lamps could be supplied by one generator and any one of them could be turned on or off without interfering in any way with the others. The problem seems simple to us but at that time many eminent physicists believed that a solution was impossible.

As is usually the case when many men turn their attention to a problem, a way was found; in fact, in this case, two solutions were proposed. One was to regulate the dynamo supplying the current in such a way that the two conductors leading from it would be kept at a constant difference of potential. If this could be done each lighting unit could be designed for this potential and could then be connected across the wires without interferring with the other units. This method is now in almost universal use.

About 1875 another solution was proposed, namely, that the dynamo should be so regulated that the current would remain constant but the voltage would be caused to vary, depending upon how many lamps were inserted in the circuit. This is a constant current system in contrast to the other which is a constant potential system. At the time mentioned this seemed a suitable solution, and, in fact, it was widely used until comparatively recent years. The two men in whom we are interested in this article both contributed to its development. This system was particularly applicable to arc lighting and the Brush arc system was developed and was in commercial use as early as 1878, whereas the first real central station operated on the constant potential system was started in New York City by Thomas Edison in 1882.

In 1875 John W. Langley had just been appointed Professor of Chemistry and Physics in the University of Michigan. He was 34 years of age at the time and had graduated from the University in 1861. Later he studied in the Medical School of the University and received an honorable M.D. After graduating he had been an Acting Assistant Surgeon in the U.S. Navy, Assistant Professor of Physics at the United States Naval Academy and Professor of Chemistry in the Western University of Pennsylvania. Charles F. Brush was 8 years younger than Langley and graduated from the University in 1869. These two men apparently first met in 1875 and our story really starts from that meeting.

When these two men met in Ann Arbor in 1875 Dr. Langley had become interested in arc lighting and had apparently formulated some opinions as to the best methods to be used in making it practicable. He talked this work over with Mr. Brush and apparently it was this conversation which started Brush upon his distinguished career. Langley always claimed that he should have received a great deal more credit than he did for his part in the development of the series arc lighting system. At this late date it is obviously impossible to formulate any accurate opinion as to the justice of these claims.



The Brush Generator

The Langley Generator

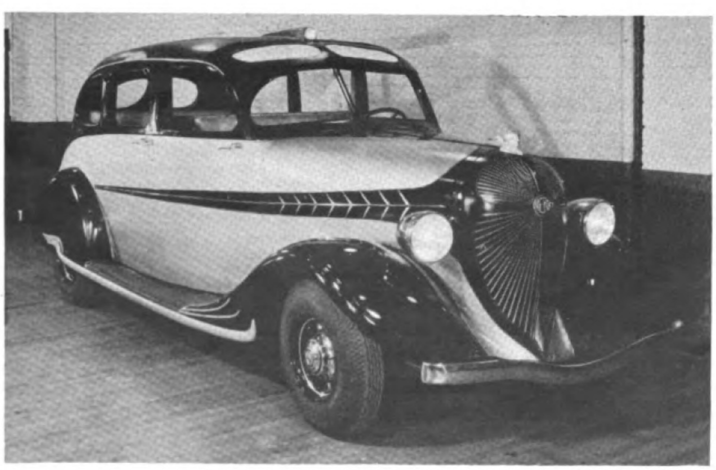
The problem which Brush and Langley attempted to solve involved many difficulties some of which they undoubtedly did not appreciate when they started work. The greatest difficulty is the fact that the carbon arc is inherently unstable. In the case of an ordinary resistor, such as an iron wire or an incandescent lamp, if we wish to get more current we must apply more voltage. With the electric arc, however, the larger the current the less voltage is needed so that if we attempt to supply an arc at a constant potential either the current will immediately rise to an enormous value or the arc will go out. The difficulty was cleverly solved by so designing the generator that the larger the current the lower the voltage; thus matching the characteristics of the generator with those of the arc. Both the Langley and the Brush generators were of the series wound type. If we drive such a generator at a constant speed and gradually increase the current taken from it by decreasing the external resistance, the voltage and current will at first rise together and nearly in proportion to one another. As we increase the current, however, the voltage rises more and more slowly and finally if the current is made large enough the voltage decreases. Ultimately it will become zero when the external resistance is zero. By making a machine with enough internal reaction this current, even on short circuit, can be limited to a safe value and by operating the machine with a comparatively low resistance in circuit we can obtain the desired characteristics, mainly that the voltage of the machine decreases with increased current. In this way the combination of the arc light and the generator can be made stable. If the current tends to increase in the arc the voltage of the generator decreases and checks the tendency, and on the other hand if the current in the arc tends to decrease, the voltage of the generator rises and prevents the arc from extinguishing itself. Whether this clever solution was due to Brush or to Langley or to someone else is not clear from the records available.

The design of the mechanism of the arc lamp presented many difficulties and there is no doubt that Brush contributed more than any other man to its design and invention. The requirements are not easily met. The two carbon rods must be in contact when the lamp is extinguished, otherwise current could not pass over the gap to start the arc, the voltage being insufficient to cause the current to jump through even a very short air gap. When the arc is in normal operation the carbons should be kept a constant distance apart. If this distance varies the light will flicker. The carbons must be automatically fed toward one another since they burn away at the rate of about one inch per hour. In case it should happen that the lamp is kept burning until all of the carbon is consumed it is necessary to provide some automatic method of short circuiting the carbons in order to prevent all of the lamps in the circuit from being extinguished. Brush was apparently the first inventor to develop a simple and successful method of accomplishing all these objects.

It has been pointed out that Brush used a generator which tended by inherent regulation to keep the current constant. He made the regulation still better, however, by shunting the series field of his generator with a rheostat consisting of a pile of carbon blocks. These were pressed together by the plunger of a solenoid whose winding was inserted in the main circuit. If the current tended to rise slightly the pressure exerted on the blocks increased, more current was diverted from the field and the voltage of the generator was reduced, thus preventing any appreciable increase of current.

It must be remembered that all this work was done at a time when very little was known about electricity. Even suitable measuring instruments were not available. The best current measuring device, for example, was the so-called tangent galvonometer. This consisted merely of a compass needle in the center of a coil of wire, the current being proportional to the tangent of the angle by which the needle was deflected. To overcome all the inherent difficulties at such a time and with such meager equipment was a very brilliant accomplishment. The accompanying cut shows the appearance of the Brush generator.

The Brush system was commercially introduced in New York City in 1878 and was an important factor in electric lighting for many years thereafter. This system was, however, ultimately superseded by the constant potential system. There were several reasons for this. Gradually, incandescent lamps were improved until they were equal or superior to the arc in efficiency. Also it was found impossible or impracticable to make arcs giving a small amount of light such as is necessary in house lighting. A standard arc, for example, gives about 2,000 candle power which is entirely too much for many purposes. A third difficulty lay in the fact that the current used was about 10 amperes and each arc required about 50 volts. Since the arcs were operated in series, 100 arc lamps required about 5,000 volts. On account of insulation difficulties it was found impracticable to go much farther than this. The maximum output of an arc generator was therefore only about 50 kilowatts. Today generators of 50,000 kilowatts and larger are common. We can faintly imagine the added complication and cost that would result if we attempted to replace each of our 50,000 kilowatt units with 1000 Brush arc machines. Moreover, great difficulties were encountered in attempting to operate motors on constant current systems. Suitable motors were produced and used but it was necessary to equip them with mechanical governors. They were constantly



Automotive Industries

SOMETHING NEW IN TAXICABS

A transparent roof inset for sight-seeing, air seat and back cushions, an interior finish of silver and black bakelite, and concealed lights in the radiator shell giving the effect of illuminated grill bars are features of this new taxicab design which has been copyrighted by Hal Holtom of Detroit.

far less simple than constant potential motors which are inherently self-governing.

After the successful introduction of the arc system Brush turned his attention to the storage battery. Up to that time the lead plates of the storage battery had been formed by repeatedly charging and discharging a battery consisting of plain lead plates in a solution of sulphuric acid. Ultimately a layer of sponge lead was formed on one plate and one of lead peroxide on the other. Brush conceived the idea of the pasted plate in which the active material was spread upon perforated lead plates. This process made possible a much cheaper and lighter battery and is in universal use today.

Brush's work received wide recognition. He became a Chevalier of the Legion of Honor in France in 1881 and received the Rumford Medal in 1899. He also received many honorary degrees, including the degree of LL.D. from Western Reserve University in 1900 and the degree of Doctor of Science from the University of Michigan in 1912.

The University possesses two of the early dynamos built by Dr. Langley. The first and larger one he apparently built with his own hands in 1876. It was designed for a current of 18 to 20 amperes. Our former Associate Dean, Professor George W. Patterson, who knew Dr. Langley well, left the following note regarding this machine:

"An interesting feature of this machine is the commutating brush arrangement. The brushes were made of spring brass, as carbon brushes had not been invented. The commutator is of the spiral type with one end of each commutator segment about opposite the other end of the adjoining segment. To keep down sparking a second brush was put on which trailed behind the main brush and was left to break the circuit when the commutator segment pulled away from the main brush. To reduce arcing at the second brush, it was connected to the main brush through a small resistance which cut down the current before it was broken. The brushes were adjustable for the best commutation. This machine is practically complete as it now stands, and would require only minor repairs to put it in operation."

At the time this machine was built Dr. Langley claimed that it was the largest arc light generator in the world. No other could supply more than one arc light while this could supply two. The appearance of the machine is shown in the accompanying cut.

The second machine was built by an Ann Arbor company in 1877. In it, however, the commutator is not of the spiral type and only single brushes are used. It is a source of regret that the writer has not been able to obtain more detailed information regarding just what Dr. Langley did. In 1892 Dr. Langley left the University and became Professor of Electrical Engineering in the Case School of Applied Science where he developed one of the very early departments of electrical engineering. In 1892 this University conferred upon him the honorary degree of Ph.D.

Considerable material has been published relative to the work of Mr. Brush but apparently the work of Dr. Langley was unnoticed at the time, at least no printed record seems to be available. Dr. Langley lived in Ann Arbor for several years after his retirement and was quite well known to some of us. What little is said here is the result of conversations between Dr. Langley and the writer.

It is hoped that these brief notes may serve to preserve in permanent form some of the impressions of men now living who have had personal contact with these two distinguished scientists and inventors. They are gone but their accomplishments will live forever.

IN MEMORIAM
Arthur Will, '36E

The death of Art Will on March 8 was a disturbing loss to the Engineering school, the Michigan Technic, and to those of us who were his friends at the University of Michigan. After struggling valiantly for six weeks against the effects of a ruptured appendix, Art succumbed to the illness. His cheerful disposition and friendliness made of him a fine companion, while his intelligent capacity for knowledge and his industrious nature combined to make him one of the most promising students of the school. His scholastic record was one of which to be justly proud.

Entering here in the fall of 1932, he soon distinguished himself as an outstanding member of his class. He was widely known even outside of his class, and a member of Phi Eta Sigma. This was but a stepping stone to his future accomplishments. He became a member of Triangles Junior Honorary Society, and Articles Editor of the Michigan Technic. His characteristic efficiency was extended into the realms of the Glider Club of which he was an outstanding member. He was also the holder of a student's pilot license. Had he lived he would have become the Managing Editor of the Michigan Technic for the coming year, the highest position on the staff.

As we write these lines, a feeling of emptiness overwhelms us. He was a young man who had wonderful promise of success in engineering; one whose memory will be sincerely cherished by his friends at the University, and it will be a long time before another such a one comes to take his place in the hearts of those who knew him.