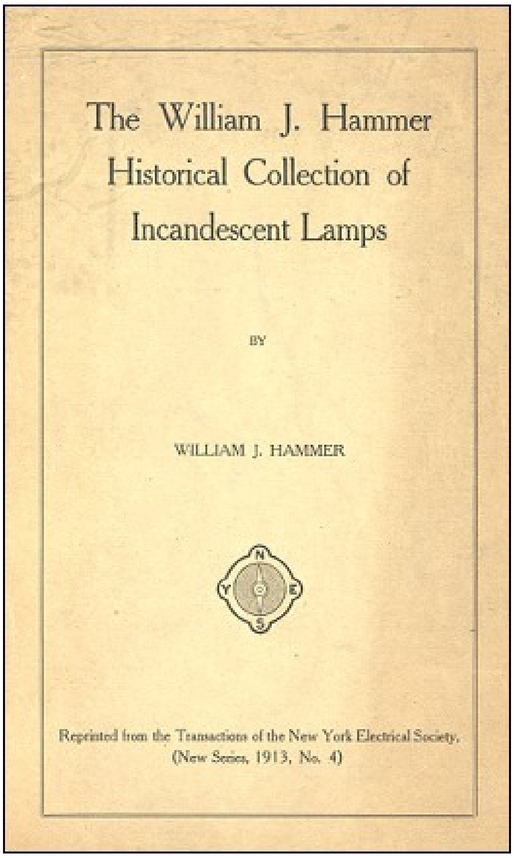
THE WILLIAM J. HAMMER HISTORICAL COLLECTION OF INCANDESCENT ELECTRIC LAMPS*

By William J. Hammer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It will be impossible for me to do even scant justice to the history of the incandescent electric lamp in the brief period assigned to me to address you in this evening. The informal remarks, for I have no notes, which I shall make to you this evening will be largely confined to the "History of an Art," which you will be able to inspect later on the tenth floor of this building in the headquarters of the American Institute of Electrical Engineers. I have been engaged upon this work for about 34 years. I trust that when we later arrive upstairs, you will not hesitate to ask any questions and I will endeavor to answer them to the best of my ability.

It seems essential at the outset of my remarks upon this collection to say at least something regarding the genesis of the incandescent electric lamp. While Mr. Thomas Alva Edison is universally recognized as the father of the commercial incandescent electric lamp, it is nevertheless a fact that there were incandescent electric lamps made long before Mr. Edison's time; yes, even before he was born.

In the year 1810 Sir Humphrey Davy, in the Royal Institution in London, with his famous battery of 2,000 cells and his pieces of willow charcoal, formed a 4-inch electric bow or "arc" and this experiment laid the foundation for all subsequent "arc" lighting systems. It is interesting to note that he was also the founder of incandescent electric lighting, as he at this early period made both platinum and carbon incandescent by means of his famous battery. After describing his experiments with the arc light, he says, "And a platinum wire 1/30 of an inch in thickness and 18 inches long, placed in circuit between the bars of copper, instantly became red hot, then white hot, and the brilliancy of the light was insupportable to the eye."

The first English patent on the incandescent electric lamp was that of De Moleyns in 1841. He proposed to sprinkle finely divided carbon or graphite over the surface of an incandescent platinum wire.

Mr. J. W. Starr, a young man from Cincinnati, Ohio, a protege of the well known philanthropist Peabody, in 1845 took out a patent, through his English attorney, King, in whose name the patent appears, for a lamp consisting of a strip of graphite in a Torricellian vacuum. It is very interesting to note that in the year of his death 1847 (the very year, by the way, in which Mr. Edison was born) Starr had the privilege of exhibiting before the immortal Faraday a chandelier, or electrolier, of 26 of these lamps, representing the 26 states which constituted the Union at that time.

In 1858 Gardner and Blossom took out the first American patent in this field, it being for a platinum lamp to be used for a railway signal lamp. One of these lamps may be seen today in the Patent Office Museum at Washington, D.C.

Many men subsequently contributed to the Art, among those of an early period being Konn, Kosloff, Bouliguine, Lodyguine, Changy, Staite, Fontaine, Draper, Adams, Watson, Farmer, Roberts, Sawyer, Maxim, and others; and it is but right that we should keep these names green in our memory because their work was work of importance, even though it did not directly result in the establishment of the commercial incandescent electric lamp.

There were inherent defects in all of these lamps; they were nearly all separable lamps. Some burned in the open air,, and others were sealed by glass or porcelain plates and, if exhausted, probably possessed only a Torricellian vacuum. Torricelli discovered that mercury in a glass tube at sea level would stand at a height Of 30 inches when a glass tube so filled was inverted and stood upright in a vessel of mercury. Starr and others utilized a tube 6 or 8 inches longer than this, filling the entire tube with mercury, so that when the tube was inverted, as already described, the mercury would fall until it reached the height of 30 inches, leaving a Torricellian vacuum above this vacuous space being utilized by some of the early inventors for their electric lamps.

The early platinum lamps were very limited in their possibilities; for if platinum is brought up to over 3 to 4 candles, its melting point is reached and it softens like butter. Edison's first lamp was a platinum lamp, but he alloyed iridium with the platinum, as had been done by Staite before him and the use of which bad been still earlier suggested by Petrie. Edison found that by gradually heating the wire by means of an electric current, then allowing it to cool, and reheating and cooling it again many times, he was enabled to drive out the hydrogen gas which was occluded in the pores of the metal, and the metal became exceedingly dense and so hard that the sharpest file would not affect it. It was like a new metal, and a spiral coil, which had a radiating surface of 3 sq. in., could be raised to from 30 to 35 candle-power without melting. A thermostatic wire placed in the center of this spiral was attached to a short-circuiting lever, so that an excess of current sent through the spiral would heat and expand this thermostatic wire, allowing its lever to touch a contact which short-circuited the spiral. As soon as the spiral had cooled, sufficiently, the thermostatic wire would lift the lever, thus throwing the spiral back into circuit again. This lamp was known as Edison's platinum-iridium thermostatic regulating lamp.

In this early work of Mr. Edison's of 1877-1878, he not only employed platinum in the form of wire and foil and alloyed it with various metals, but he did considerable work with various metallic oxides and you will note among his early lamps his oxide of zirconium lamp; another lamp shows a platinum wire coated with titanium oxide.

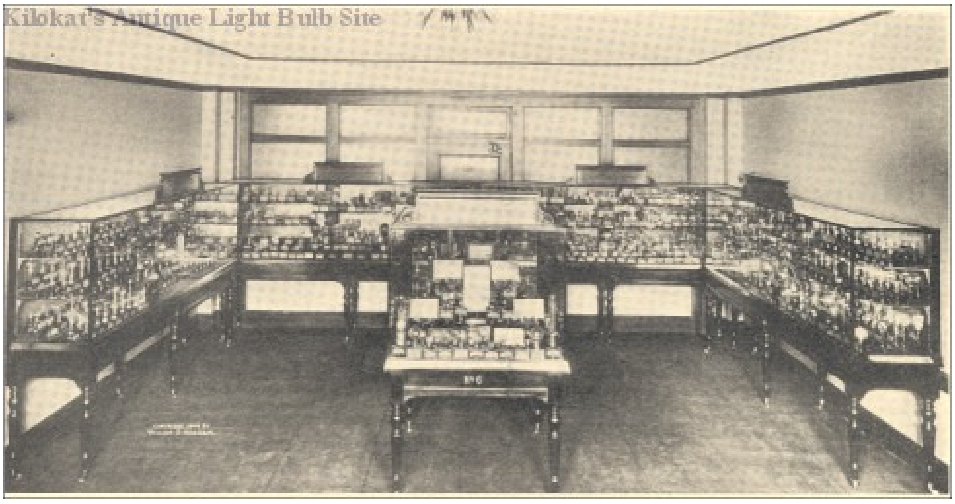

Fig. 1-General View of Incandescent Lamp Collection.
Click on picture to enlarge

In 1879 Edison's famous "paper horse shoe" lamp appeared, this being his first thoroughly commercial lamp, and of which 700 or 800 were installed in the Edison laboratory and workshops, dwelling houses and through the streets at Menlo Park, N. J. The filament of this lamp was cut out of a piece of bristol board, which in carbonizing shrunk about one-third, in size. Lamp filaments were also made of thread rolled in tar; also from graphite and of many kinds of vegetable fibers, such as manila, hemp, bast, jute, bamboo, etc.

You will observe that the historical incandescent lamp collection is contained in five cases, four of which are ten feet in length. They are of plate glass with glass shelves and with mirrors at the back. In addition to these four cases, there is a fifth in the center, which is four feet square. The brass plates on the cases are numbered from 1 to 5 and give the periods of the Art covered by the lamps contained in each case and the names of certain of the inventors.

The square case No. 1 contains the earliest steps in the work of Mr. Edison, as well as that of Swan, Lane Fox, Maxim, Sawyer, Latimer, Changy, Crookes, Rogers, Gatchouse, British Electric, Nothomb, Siemens & Halske, Siemens Brothers, Mueller, Gerard, Greinert & Fredrich, Swinburne, Cruto, Bernstein, Akester, Kurtzgen, Boehm and others. These particular lamps have been isolated in this case as they constitute the foundation of the Art as represented by the entire collection shown in the room. They have been set apart just as one observes is the case in visiting the Louvre in Paris or the Uffizzi Gallery in Florence, where there is a special room containing a few pictures of the greatest masters- pictures of which we have heard all our lives. In this manner we are duly impressed by these famous works of Art, whereas if they were scattered throughout the entire Gallery we would not receive the same impression.

I would call your attention to a lamp in Case 1, invented by an English butcher by the name of Rogers. In 1881-1882, in association with Mr. Edward H. Johnson, I had the pleasure of establishing the first central station for incandescent electric lighting in the world at 57 Holborn Viaduct, London, England (started up January 12, 1882). Rogers hired a place a few doors away from the station and fitted up an exhibition of his system of incandescent, electric lighting. In the basement he hung a number of large copper spheres about 18 inches in diameter, inside of which were placed smaller spheres. From these spheres, which were connected to the dynamo machine, fine wires were run to the individual lamps in various parts of the room. He explained to me with great earnestness that he had made one of the most wonderful electrical discoveries ever made, namely, that if electricity from the dynamo were permitted to spread itself over the surface of these copper spheres, it increased enormously in efficiency, and he was thus able to get from "two to three lamps per horse-power more" than Mr. Edison did. He not only believed this, but made certain investors believe it, although the system naturally did not last very long.

Edison's various platinum wire and foil lamps and his oxide of zirconium lamp, may be seen in this case and also his earliest steps in the paper and vegetable fiber filaments, and bamboo and graphite filament lamps, including the first lamp ever made in the pear shape, which form is now practically universal.

For many years Mr. Edison used bamboo for his filaments. There are said to be some three thousand varieties of bamboo, of which about 400 are of some particular use, the rest being largely weeds. He found in a certain hilly district of Japan a variety of bamboo called "Madake" bamboo, and discovered that when the outer calcareous surface and the inner pithy fibers were removed, he obtained in the center one of the most perfect cellular structures known, which produced a carbon filament of great strength and high resistance. I have explained to you that early inventors did not succeed in making a commercial carbon filament lamp, which was because the early lamps utilized either plates or rods of carbon of exceedingly low resistance, ranging from somewhat less than 1 ohm up to 4 or 5 ohms. Edison's carbon filament lamp had a resistance of 140 ohms hot and more than twice that cold. Possessing such a high resistance filament, he was enabled to connect his lamps across the electrical conductors like rungs in a ladder, and the higher the resistance of the filament, the more lamps he could place in parallel or multiple before the external resistance approached the low internal resistance of the armature, and naturally the greater the saving of copper in the distributing system.

Among the early carbon lamps shown in Case No. 1 are many of low resistance and, frequently a number of these were connected in series and the sets of series lamps being then connected in parallel or multiple. Mr. Edison aimed from the very first to make each of his lamps an independent, self-contained unit, con-

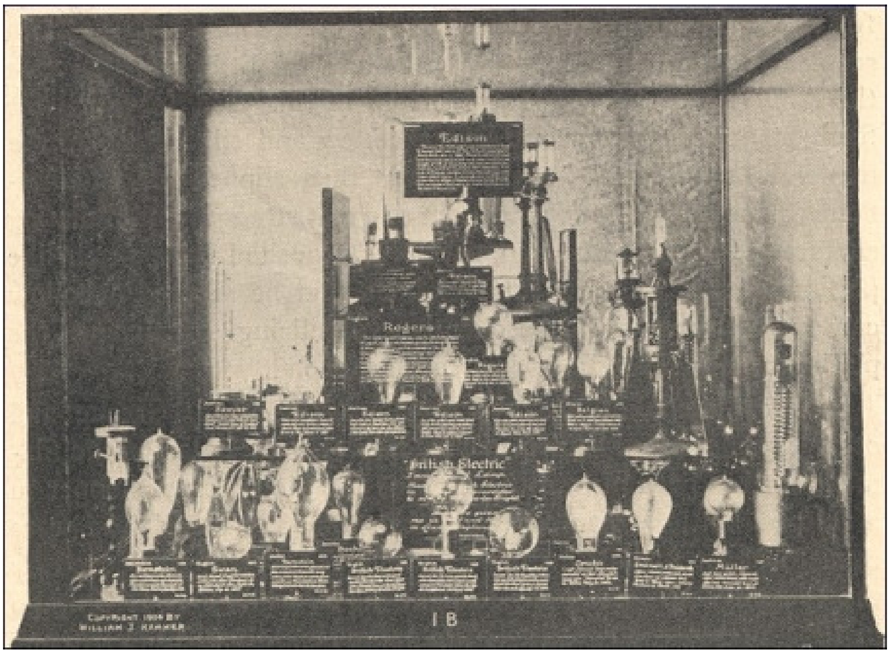

Fig. 2-Case 1, Showing Original Types of incandescent Lamps.

sisting of a high resistance filament of carbon hermetically sealed in an all-glass receptacle with platinum leading-in wires. I wish to call your particular attention to what seems to me an extraordinary fact, namely, that in 1879 the Edison carbon filament lamp was perfected and from that time until the present day, a period of 34 years, it has stood without a single salient feature eliminated or added.

Case No. 2 is devoted entirely to the work of Mr. Edison on the carbon filament lamp, and supplements the fundamental steps in his work as shown in Case No. 1. I believe that there is not a single important step in the work of Mr. Edison missing in this record, which embraces about 350 lamps.

Cases Nos. 3 and 4 represent the Art under the workers contemporaneous with Mr. Edison all over the world, the lamps being grouped chronologically. Among them are a number of Diehl's induction lamps for use with alternating current. In these lamps a secondary coil is placed inside the lamp and connected to the filament, the primary coil being wound on the outside of the globe, or the globe inserted in such a coil. This interesting lamp, for which the early development of the alternating current system seemed to promise great things, has left but little impress upon the Art. Bernstein lamps are shown in this case, in which the filaments are made by braiding a cotton and silk cover over a mandrel or wire; this covering was then slipped off and carbonized, forming a hollow filament of great strength and radiating surface. In the Cruto lamp, carbon is deposited upon a hair-like platinum wire. The inventor claimed that he secured a hollow carbon filament by subsequently volatilizing or fusing the platinum and leaving a hollow carbon tube.

Stopper lamps of the Westinghouse, Packard, Greene and other types are also shown in this case. In these lamps the filament stem is ground into the neck of the globe like a stopper in a cologne bottle. Bitumen and other compounds and lead were used to assist in holding the vacuum. This lamp was used by the 'Westinghouse Company to light the World's Fair at Chicago in 1893 and was so constructed to get around the Edison patents.

It was supposed that this stopper lamp was absolutely new at that time, but in Case No. 2, will be found several forms of stopper lamps which Mr. Edison made as far back as 1880.

In Case No. 4, in addition to the standard types of lamps, will be found special classes of regulating lamps, signal lamps, sign lamps, Christmas tree and novelty lamps, etc. I am indebted to the Federal Sign System (Electric) of Chicago, for a neat initial sign, here shown, in which each letter is made of an incandescent lamp containing a number of filaments in series.

In the center of the case is a most interesting lamp and socket, for it was used by the speaker in the first electric sign which was ever made and which he constructed in December, 1881 and hung up in the Crystal Palace in London, England. It flashed the name "Edison" by means of a huge lever spring switch. The speaker also had the honor of constructing the first two 'motor driven flasher" signs, which are now so universal, the signs having been constructed in 1883 and placed by him on top of the Edison Pavilion at the International Health Exposition in Berlin, the name "Edison" being flashed letter by letter and as a whole. Other forms of sign lamps are shown in which the letters are enameled or etched on the outside of the globe. Another form designed by the speaker consists of a phosphorescent flashing lamp, in which phosphorescent material containing a trace of radium is combined with a vehicle which I have used for various purposes since 1902. This material is coated on the under side of a lettered round glass disc forming a transparent sign which is held by clips above the lamp. The lamp itself is flashed frequently and the phosphorescent sign stimulated by the operation of a thermostat in the lamp base.

The next group of lamps in this case are the regulating lamps. Here may be seen the Ries regulating socket, which employs a choke coil or single-coil transformer or reactance coil, and the Wirt "Dimalite" lamp regulator, employing resistance wire embedded in artificial stone. Also, the Johnson "Anylite" employing a coil of resistance wire in sections, and other types of lamps in which two or more filaments are operated in series or parallel or separately by turning a key or the socket or by pulling a cord, such, for instance. as the "Duplex," Phelps, Hylo, Trilight, Dublglow, Economical, etc. Among these is shown a lamp designed by the speaker in 1880, in which two or more filaments could be placed in parallel or series, by turning a switch. I also designed a lamp in 1880 in which a number of filaments of 8, 10, 16, 20, 30, and 50 candle-power were placed in one globe, and by means of a commutator on the base of the lamp, could be regulated up and down without employing any external resistance by merely switching the current from one filament to the other. Various forms of silvered reflecting and signal lamps are shown and you will observe one which is very badly worn which I made as far back as 1880 at Menlo Park.

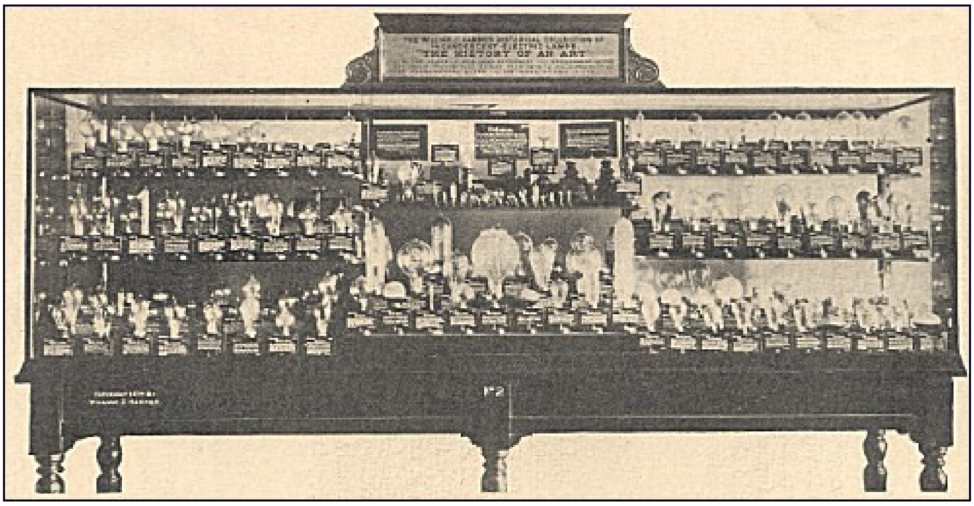

Fig. 3-Case 2, Showing Stages of Development of the Edison Incandescent Lamp
Click on picture to enlarge

About 12 years ago a number of companies were making what were called "tipless" or "downward" lamps. Various types of these are shown in the collection. At that time it was thought that getting rid of the tip on the globe was new, but you will observe in Case No. 1 that many of the early workers, such as Lane-Fox, British Electric Company, Rogers, Mueller and others made lamps which were exhausted and scaled off at the bottom or side and were therefore tipless. The first colored incandescent lamp ever made is shown in Case No. 4 and the first ground glass, opal lamp and the first etched lamp in Case No. 1.

An interesting regulating lamp is that of Thompson, of Philadelphia. In this lamp a solenoid is placed on the inside of the lamp itself and this solenoid, in one case, Operates a pair of springs and in the other case, a number of carbon rollers, which place more or less of the carbon filament in circuit as the potential varies. This lamp is absolutely impracticable, but it is, an interesting illustration of the efforts made to lessen breakage and blackening of the globes due to bad regulation.

Case No. 5 illustrates the most recent developments in the Art, as it passed beyond the carbon filament and reached the stage of the perfected metallic oxide and metal filament lamps. The Nernst lamp is shown in its various developments both here and abroad from the early stages up to the present time. Also the tantalum, osmium, dicarbide of silicon, titanium carbide, helion, and many types of American and foreign tungsten lamps.

The tungsten lamp represents the survival of the fittest and, although its efficiency is so great that one might say that there is little excuse for the existence' of the other types of lamps today, who will say that we shall not later find out something about carbon, of which today we have no knowledge. The late Professor Rowland once remarked that the Steinway grand piano was a comparatively simple piece of mechanism compared to the iron atom, and the same thing might be said regarding carbon, the constitution of which we know comparatively little of today. In the early days of the development of the Edison lamp, the gas people feared that gas was about to be wiped out of existence, and some of you may recall the great panic in gas stocks which followed the advent of the Edison incandescent lamp at Menlo Park. The Welsbach mantle came along later, and while it was practically a failure at first, it was enormously increased in efficiency and improved in color by the addition of a small percentage of oxide of cerium to the oxide of thorium, of which the Welsbach mantle is largely constituted. This saved the gas situation and we may see the same thing occur in the case of the carbon filament lamp and perhaps other lamps.

One of the things which is certain to be perfected in the future, and I believe in the near future, in "cold light." In Case No. 5 I have arranged a section devoted to this subject, largely utilizing lamps and tubes borrowed from my little laboratory, which point toward "cold light". Among these is a lamp consisting of a tube with a stop cock in the center and a glass bulb at each end. In 1902 while visiting the late Prof. Curie, who, with Madam Curie, discovered radium, he drew a sketch on the blackboard of this lamp and suggested that I make one of them. If the gaseous emanation from radium is placed in one bulb and this bulb is then immersed in liquid air, the emanation is condensed; when the stop cock is then opened, it passes over into the bulb at the other end of the tube and stimulates the phosphorescent sulphide of zinc contained therein, which is thereby caused to give such a brilliant light as to enable fine print to be read some distance away.

A cathode ray lamp is also shown in which the negatively charged corpuscles of hydrogen gas are caused to bombard a disc coated with phosphorescent or fluorescent material, moving at a speed of approximately 70,000 miles a second, by means of which one may read a book at a considerable distance away.

Forms of Moore tubes are shown and also an interesting Moore gas lamp which operates at an efficiency of about one-fourth watt per candle. Unfortunately this efficiency soon falls to five or six watts per candle and the lamp does not last over 200 hours. Two tubes containing Neon gas are also shown. Who will say that we shall not find some efficient way to vibrate, oscillate or in some way energize a gas so that it will make an efficient transformer for electrical energy and produce an efficient cold light? I have now in my laboratory a tube filled with a gas which, on stimulation by a flash of current supplied by an induction coil, becomes quite brilliantly phosphorescent, the light persisting after the current is shut off for half an hour or thereabouts.

Forms of Edison tungstate of calcium lamps are shown which give considerable light when connected to an induction coil. A vacuum tube lamp made by Mr. W. S. Andrews, of Schenectady, is shown, in which a sheet of metal is coated with tungstate of calcium and phosphorescent sulphide of zinc. This also gives a considerable amount of light when connected to an induction coil.

I have made many mixtures, of radium with sulphide of zinc sulphide of calcium, willamite, etc., utilizing these in the forms of powdered mixtures and combined with vehicles of various kinds. I was the first to make these in 1902, and they have been extensively used since for watch and clock dials, etc. I also made a lamp in 1903, which was exhibited in the St. Louis Exhibition in 1904 and is shown in the case, which glows constantly in the dark. I have since made much better ones.

The energy efficiency of the original carbon filament incandescent lamp was about 0.43 of 1 per cent.; that of the tungsten lamp is somewhat over 1 per cent. (about three times that of carbon) and there is probably no incandescent lamp that has all energy efficiency as high as 2 per cent. On the other hand, the light of the fire fly and the "pyrophorus noctilucus" have an efficiency of 96.5 per cent., as shown by measurements made by Professors Langley and Very with the bolometer and by Coblentz with the thermopile. We shall without doubt ultimately learn how these various creatures expend their energy and produce vibrations that come within less than one octave of the total spectrum of vibrations and which affect us as light. In all of our illuminants today, most of the energy is dissipated in long heat waves, so that what we must strive to reach is the goal of "cold light."

Now, just one word before I close regarding the formation of this collection. I was one of Mr. Edison's early laboratory assistants at Menlo Park, N. J., entering his employ in December, 1879

For a considerable period I had charge of the tests and records on the Edison lamp and subsequently became the electrician of the first Edison lamp factory. In the early days platinum was worth $7.00 an ounce; today it is worth about $45.00 an ounce. It was customary to throw the old lamps into a barrel to be smashed in order to recover the platinum, and in endeavoring to rescue lamps representing fundamental steps in the Art, I met with difficulty, being frequently told that the lamp I wanted had half a dollar's worth or perhaps two dollars' worth of platinum in it. But I would appeal to Mr. Edison or his very able associates Mr. Charles Batchelor or Mr. Francis R. Upton, and was finally allowed to form the nucleus of this collection, over which I have, metaphorically speaking, "sweat blood" for 34 years. About eight years of this time I have spent in various visits to Europe, and I have not hesitated to camp on the trail of any man who had a lamp that I wanted. As a result, I believe the collection does not lack an important link.

Some 24 years ago I tried to interest a number of gentlemen. Among them Mr. Henry Villard and Mr. Edison, in the establishment of an engineering and technical museum in New York City, in which engineers and inventors could place their models and records and have then safe-guarded, but I found, however, that there was too much inertia in this matter and I made up my mind that I would endeavor to carry to fruition the work of completing this collection, hoping that it would encourage others to make similar collections forming priceless records of the inception, development and perfection of other Arts and perhaps ultimately result in the establishment of a great engineering and technical museum where collections of this nature could be exhibited where they would not only be of great interest to the general public, but of great educational value to the student as well as stimulating and instructive to the engineer, the inventor, the manufacturer, the patent attorney and the historian. If my work assists in any way in securing this desirable end, I shall feel well repaid for my efforts.

I thank you for your courteous attention and I hope that some time in the future I may be able to supplement this informal address in a lecture upon the Incandescent Electric Lamp which will be to some extent at least commensurate with the importance of the Art and the time and attention I have devoted to it and to its history.

"THE HISTORY OF AN ART."
The William J. Hammer Historical Collection of Incandescent Electric Lamps as set up in the Engineering Societies' Building, 29 West 39th Street, New York City, in 1913.

[Rear Cover, click on picture to enlarge 2mb]

*A lecture delivered at the 317th Meeting of the New York Electrical Society, held February 17, 1913, in the Engineering Societies Building, New York. The magnificent collection of incandescent electric lamps formed by Mr. Hammer during the past thirty-four years, and comprising over 1,000 specimens, has been secured by the Association of Edison Illuminating Companies and is appropriately housed in a room in the Engineering Societies Building, New York. The lamps are skillfully arranged in five large glass cases for convenient inspection by visitors, each lamp being accompanied by a descriptive card.

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