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HISTORIC LIGHTING 1900-1950

FIFTY YEARS OF TECHNOLOGICAL ADVANCEMENTS AND STYLISTIC INNOVATIONS IN LIGHTING SYSTEMS

by

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Historic Lighting 1900-1950: Fifty Years of Technological Advancements and Stylistic Innovations in Lighting Systems

Part I. Technological Advancements

Illustrations

Introduction

This compilation of information serves as a reference for American domestic interior lighting of the early twentieth century. The time span of 1900-1950 that was chosen addresses the group of structures that are now becoming eligible for the National Register of Historic Places and the issues associated with historic lighting systems are discussed into two parts. Part One discusses the technological developments of lighting systems and the repair and maintenance of these historic systems. Part two gives stylistic history in both the architect designed context, and the vernacular context. Vernacular designs refer to those adapted from architect designed structures to different regions of the country using regional materials and cultural influences in the designs that often served to meld different elements together that an architect would not have otherwise used.

The topics addressed are limited to interior residential lighting systems, and do not address exterior lighting issues. Commercial lighting issues are also left for another project, although the lamp developments are mentioned to give a reference point as to the comparative technological advancements of the time. Power source development is also outside the scope of this project, although the first successful dynamos were produced in the 1880s.

When addressing the issue of historic residential lighting systems, there are many factors intertwined within this problem. The development of the lamp types, the luminaire designers who adapted and manipulated this medium into an art form, wiring and electricity, construction of wires and insulation, switching methods and how to make the system safe for residential use have to be considered. From the standpoint of events in the timeline of technology, aesthetic and social change, and how those things are interrelated, there is much to be gained from studying the various aspects of this complex issue. Looking at the four main parts of this issue consisting of the lamp, wiring, luminaire, and style, each of these elements influence one another from different angles and points in time. Looking at the timeline grid, one can observe how certain changes in one aspect of the industry affected the other three parts and how some things were occurring simultaneously.

From the time of Edison's first commercially viable electric lamp in 1879, designers of interior spaces have exploited this medium to create different ambiances within an interior. For the preservationist trying to recreate not only the look of an interior but the ambiance created by the lighting, this will be a valuable reference guide for both preservation professionals, and private homeowners interested in the restoration and preservation of their residences.

The period in American architectural history regarding Victorian interiors and lighting have been well documented and are therefore not documented here. However, the lighting effects of gas lighting have a direct bearing on how the early electric lamps were designed, and what the approximation of light should be. Gas lighting approximated the amount of light that would come from a candle and early electric lamps tried to imitate this as well. It was believed that too much light into the eyes was damaging to them. When the higher powered tungsten filament electric lamps were developed, they received some criticism because of the harsh light levels through the clear glass. Once the technology was developed that made these lamps brighter, the mood of the room became more stark and contrasting because of the long shadows cast by the unshielded lamp that put the entire room setting in an unflattering position. The use of color and reflective surfaces in the room also affected how the electric lamp was perceived. During the gas lighting era, wallcoverings were designed with shiny backgrounds and bright colors to help reflect light off the walls to help illuminate the room. Once the brighter lamps were developed, this reflective quality became too much for the comfort level of sight in a room, so experiments were conducted to determine how color, light and reflective surfaces interacted, so that interior finishes could be selected that would compensate for the problem of reflective glare. Another major contributing factor was the luminaire shades had not been designed to conceal the lamp until that point in time. Designers had to start developing luminaire styles that would redirect the light out of the eyes, tone down the harshness, and bring the room back to an intimate candle lit mood. The use of stained glass and fabric shades also helped to alleviate the problem.

The reason these topics are divided and then brought together in this manner is that stylistic changes influenced how lighting systems were designed and implemented, and the reverse was also true. As an example to illustrate this point, the architectural taste changed dramatically in the 1920s with the advent of the Art Deco style. Lighting became a backdrop to the room, being concealed behind cornices, and hidden in torchieres. This was made possible in part by the development of better wiring insulations and concealed systems that could be run into more awkward positions to put a built-in luminaire in a more decorative position. The results of the tests using color and reflective surfaces also helped to maximize the effects created by this new decorative approach to lighting. Luminaires no longer played a prominent role within a room as clutter was out and the streamlined look was in. The reverse is also true, in that technology influenced style. The lamp developments that created brighter lighting, forced (or allowed, depending on your point of view) designers to compensate for this as previously discussed in the shade designs.

Chapter One, the Development and Technology of the Lamp, discusses lamp development of the incandescent and electric discharge lamps. This topic was selected first because in order to understand the mechanical support system needs and the aesthetics of style, color and reflective surface use, it is important to know how these different lamps affected these other factors. This information is crucial if a house is to receive a museum quality restoration and the appropriate luminaires and lamp types should be installed. It is also important to note that the technical term of lamp refers to what is commonly known as a light bulb in vernacular terminology.

For a test model, a house that was built in 1906 shall be used for discussion. The preservation professional or the homeowner would have the choice of obtaining two types of reproduction lamps available at the time when the house was built. First, the carbon filament lamps that Thomas Edison perfected, or the tungsten filament lamps with clear glass for the luminaires. If they were trying to obtain the historic lighting effects for the house, the lumens output of each of these reproduction lamps need to be considered, as they do not equate with the output of today's lamps. A paint analysis of the original colors will also help determine which of the two lamps to use. If the colors are light or bright, the lower powered carbon filament lamps should be considered, and if the colors are very dark and non-reflective, then the tungsten filaments might be more appropriate. If historic wallpaper is present, this can also be examined to determine its reflective qualities, and subsequently what the effects of these two types of lighting will have on the room. It is important to bear in mind that what people were used to for evening lighting 100 years ago, is nothing like what we are accustomed to today. Creating an historic appearance to a room has to include the approximation of what the lighting levels would have been. The designs of the historic luminaires that either had the lamp exposed or concealed under the shade would also influence these decisions as glare is a problem. Besides those issues, the design aesthetic of the house should be considered as well. If the luminaires that would be appropriate to the house do not have shades that shield and redirect the light out of the eyes, the lower powered carbon filament lamps would be more appropriate. The lower levels of lighting also create a more intimate mood, so the use of the space will also determine which lamps to use. For instance, the kitchen is usually a place of work, so the higher-powered tungsten filaments might be a better choice for this room, as it was a more utilitarian space and the lower powered carbon filament lamps would be more appropriate for intimate conversation in the front parlor. This may seem confusing trying to consider and sort out all these factors, but using the rule of thumb, use the lower powered lamps in a bright room and higher powered lamps in a dark non-reflective room, unless the function of the room demands the reverse, such as a light kitchen, and a dark parlor.

Chapter Two discusses the development and technology of residential wiring systems. In the 1906 house, if it retains the original wiring system, what would be expected to find when replacing a luminaire or a switch? The wiring type and insulation in the luminaire may be different than what is concealed in the walls. What concealed wiring system would be found if an attic was inspected for wiring? There were five different types of insulation materials available at the time, and four different types of concealed wiring systems that were being installed. Safer more efficient methods had be developed to harness this wonderful, but dangerous invention for humankind. Depending on what type of insulation was employed, and what type of concealed wiring system was present, an educated guess could be made as to whether the original owner of the house was wealthy enough to be on the cutting edge of technology as newly developed systems were more costly to install than the older versions. Better insulation materials were developed in the early 1900s as scientists began to understand electricity, its properties and behavioral characteristics. The types of insulation on the wiring for the house may also differ from the types of wiring insulations found on historic luminaires. For example, interior wiring may have rubber insulation on it, but the luminaire may have corded fiber insulation on its wires. Besides that issue, the switching systems and the power source locations for the lamps may be different or unsafe as well, and should be examined by a competent electrician.

Chapter Three, Maintenance and Retrofit of Historic Wiring Systems can be a complicated and dangerous task. What many people who have been electrocuted by these systems failed to realize, is that when these systems were installed, they did not meet today's codes for safe wiring practices. Many circuits installed to code became overloaded, as more products were produced that depended on electricity to run. More convenience outlets were added through one central circuit within the room (usually from the ceiling luminaire location) that would overload the circuit if too many things were turned on in the room at once. Besides the overloading of the circuits, historic wiring insulation materials were very susceptible to breakdown with excessive heat. Overloading the circuits with too many outlets could breach the insulation. The person trying to service the system could be electrocuted because of melted insulation on an exposed wire. For these reasons, insulation types have been identified in this project. The concealed wiring systems including the now illegal methods (such as the Carter System), the National Electric Code changes to protect the consumer (not that they were always adhered to by unscrupulous electricians), and the various hazards associated with servicing these systems have also been addressed. For aesthetic purposes, reproduction switching systems are now being produced that function to modern code standards, but retain their historic appearance. Frequently, visible components such as knife switches will be left in place as conversation pieces, but taken out of service for safety reasons.

The repair and restoration of historic luminaires is often an expensive undertaking. The inspection and steps to take to have them refurbished, and their care and maintenance are also addressed. The components of the luminaire should be examined for signs of wear, especially at the grommets where the wiring comes through the ceiling canopy (or the base of a portable luminaire) and at the base of the socket where the lamp screws in. Over time, the changing of burned out lamps can loosen the socket base, and it can break free from the luminaire and begin to twist with the lamp as it is turned. If the insulation is old, dried out or cracked, this can create a dangerous situation for a fire to start from crossing bare wires. Sockets themselves can also wear out and cause problems. If the luminaire is in solid condition and does not need any cosmetic repairs, the internal workings should be replaced for safety considerations. These usually consist of the wiring, sockets and any turn-key switches that may be on the luminaire itself. When in doubt, remember that original historic luminaires are always worth restoring.

Other mechanical components such as fuse boxes and knife switches are often not up to code and their safety needs have to be met as well.

Part Two begins with Chapter Four, Stylistic History of Luminaires and Prominent Designers discussing the stylistic history of lighting luminaires or fixtures as they are commonly known as today. The term *fixture* was popularized by the vernacular producers of lighting products. Chapters four and five are less technical and give more information regarding style and how the designers interpreted the relevant architectural style of each period. It is commonly believed that the designs of lighting usually followed the elements of a particular architectural style, but who is to say that architectural elements weren't inspired by a lighting design first?

Another sub topic within this section addressed is for the serious collector of historic lighting luminaires. Some of the prominent designers of the period were included with biographical sketches and photographic portraits, as they humanize their work by putting a face to a famous name. Each one of the people chosen made a significant contribution to the world of lighting design and their influence is still being copied by reproduction artists today. Included in this portion are the trademarks used on their respective products so that the serious preservation enthusiasts and collectors can be sure of what they are buying from an antique vendor.

It is important to have some knowledge of architectural history to select the appropriately styled luminaires for a residence. Many historic structures have had their lighting luminaires altered over time, or completely removed. This begs the question, what was there, and what would look appropriate for this interior? The factors of style and the task of the room need to be considered. For instance, a crystal chandelier might be appropriate in a Colonial Revival home, but not hanging in the middle of the kitchen. Fortunately, the style of luminaires emulated the architectural styles of the structures making them easy to research. To illustrate how to possibly track down a luminaire, take the example house that was built in 1906. There were five main architectural styles during this fifty year period including the Arts and Crafts Movement, American Beaux Arts, Edwardian, the eclectic late American Victorian, and the last gasp of Art Nouveau styles being produced in America in 1906. If it was a later period house, such as an example from 1930, the choices would be limited to Art Deco and the Modern Movement. By the process of elimination using the illustrations of architectural styles, that could easily be determined. Another example of lighting found in an interior before restoration might include a beautiful atomic age ceiling luminaire (a round flat ceiling mount luminaire with a broad glass circular shade in the shape of a low mushroom cloud, maybe with some designs on it of the galaxy or stars) from the 1940s would be inappropriate in the 1906 example house. Another example that would reveal a glaring error in luminaire choice would be an Art Nouveau luminaire that has plant-like arms terminating in orchid petal glass shades in a modern sharply rectilinear glass and steel Miës van der Rohe residence.

Chapter Five addresses the vernacular interpretation of architecture and lighting. As stated before, the term vernacular refers to the adaptation of an architectural style to regional materials and cultural influences. The same applies to luminaire designs. This chapter would be most useful to the private homeowner, as architect designed structures (usually for wealthy clients who could afford a "pure" design) are usually museum pieces researched by preservation professionals. The vernacular designs appealed primarily to the middle class, which is the price range that most enthusiasts today can reasonably afford to restore. Designer lighting refers to those luminaires designed by prominent designers in a "pure" interpretation of the architectural style of the period. Vernacular lighting designs refer to those luminaires designed for mass production and were marketed to people of middle class status through mail order catalogs. Designers working for the mass production companies often copied elements of the designer styles, but would often combine other elements of different architectural orders in the design that would not otherwise be present on a designer luminaire.

Rural homes present a challenge of their own in that the Rural Electrification Act would have affected the style of lighting first introduced to the home. Taking the example 1906 house again, if electric lighting wasn't installed in the house until the late 1930s or 1940s, would it be appropriate to select luminaires of that era, or the earlier era that reflects the architectural taste of the residence? To complicate matters further, the Rural Electrification Administration was continued until 1974, so there are homes out there that are completely incongruous between their architecture and lighting styles.

There are numerous illustrations of lighting components, interiors and architectural examples provided to help the reader understand from a visual standpoint what the technical information is pertaining to. The reader should then be able to identify a carbon filament lamp from a tungsten filament lamp, what knob and tube wiring looks like verses surface mount wiring, what a Tiffany lamp looks like in comparison to a Dirk Van Erp lamp, and what luminaire styles are appropriate for different architecturally styled interiors. In addition, there are charts that illustrate the time lines of the lamp technology advancements, residential wiring insulation materials, concealed wiring systems, National Electric Code changes, and stylistic periods for quick reference when dating a building's support systems. An integrated timeline chart is also included so that different aspects of a lighting system can be analyzed for the variables that would be encountered when dealing with a specific house in a given point of this fifty year era. There are also diagrams illustrating wiring systems into the typical room, both for social and task oriented spaces so that when in the attic examining the existing wiring, the lines running from the ceiling to the walls in all different directions all make sense as to why they are there and how it came to be that they were added in that manner.

The main points to remember before undertaking the restoration of an historic lighting system include these main categories of topics that need to be addressed by the preservationist and/or the homeowner. Ideas about what kind of ambiances should be created for each space of the home and how they function need to be considered. A basic knowledge of the issues with retrofitting wiring systems in an historic residence can save the preservationist and the homeowner many headaches by being able to ask intelligent and informed questions of their electricians before work commences on the home. Lastly, the architectural style of the home should be considered when selecting appropriate luminaires.

A lot has been learned from researching this topic and it is appropriate that the time period of 1900-1950 was selected for this in that the electric lamp was examined from its infancy in 1900 to its modern developments by 1950. The historic structures that are now becoming eligible for the National Register of Historic Places can only benefit from the information gathered here for their accurate preservation and rehabilitation. It is my hope that both preservation professionals and homeowners will find it interesting and informative to read.

I. Development and Technology of the Lamp 1900-1950

Introduction

In 1801, Sir Charles Davy embarked on research and experimentation that would change humankind forever. Although the Belgian inventor Jobard was unsuccessful in getting the carbon filament incandescent lamp to work properly in 1838, his ideas were finally perfected in the first commercially viable incandescent electric lamp developed by Thomas Edison in 1879. The discussion of technical developments of the lamp combined with the evolution and design of luminaires will be in chapters four and five. Before the incandescent electric lamp could dominate the market in the late nineteenth and early twentieth centuries it had to contend with stiff competition in the cities from the gas lighting companies. Gas lighting accounted for about 90 percent of the lighting needs, and electric arc street lamps occupied the other 10 percent.[1] Between 1880 and 1890 there were many different competitors working on electric lamp developments and many patents were filed as the race to be first with new improvements was fast and furious. When all the mergers were completed and the patents gained, General Electric contributed 62 ½ percent of the value of the patents, and Westinghouse the other 37 ½ percent.[2] The gas lighting companies fought hard to keep their markets while Edison and his competitors quickly encroached upon their territory. In the end, gas lighting survived for only about forty years before being eclipsed by the incandescent electric lamp. The development of drawn wire tungsten filament lamps sealed the fate of gas lighting because they were brighter, more efficient, and more cost effective.

Besides the development of the incandescent electric lamp, there were other contributing factors to the decline in the popularity of gas lighting. First of all, gas lighting dealt with an open flame, so there was a constant risk of fire. Secondly, there was a considerable amount of smoke associated with burning gas lamps. The resulting

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[1] Keating, Paul W., _Lamps for a Brighter America_, 26.

[2] Ibid., 39.

permeation into the surfaces of the home dirtied and darkened woodwork and discolored wall coverings. Today, restorations of homes (profiled in *Old House Journal* and other magazines) built during this period regularly have to have these deposits removed to reveal the brilliance of the original surfaces. Aside from the aesthetic issues, and the open flame issue, there was the danger of accidentally leaving a gas cock open and asphyxiating on the fumes. In addition, if a gas main ruptured, that could also cause a dangerous situation for an explosion to happen.

By 1925, the components of the incandescent electric lamp were standardized as to size and shape within the industry. The major components of the incandescent lamp consisted of a standardized screw base, pear shaped glass tube filled with gas, the exhaust tube (now in the base), stem press and tube, inner and outer leads and the filament (Fig.1).

The luminous characteristics of the incandescent electric lamp resembled that of candlelight, but on a harsher level. When lit, the carbon element gave off a yellowish glow, that unshielded could make the eyes hurt if looked at too long. These lamps gave off approximately 1/3 the amount of light that a modern 60 watt lamp would give off, but for a world accustomed to candle and gas light, they were startlingly bright.

Incandescent electric lamps were used in both built-in luminaires and portable occasional luminaires. Lighting designers were determined to exploit this new medium in spite of the objections of those preferring lower lighting levels. The designers had to compensate for the low lumens output of each lamp by putting several lamp outlets on a luminaire so an adequate amount of light would be shed in the room. Occasional portable luminaires were strategically placed in rooms to provide additional lighting for task oriented activities, such as reading, playing musical instruments, or sewing. The styles of these portable luminaires often emulated the architectural fashion of the day. By the 1920s, Americans were rejecting the clutter of the Victorian age, and the abundance of portable lighting was no exception. Designers began to use lighting as a backdrop to a

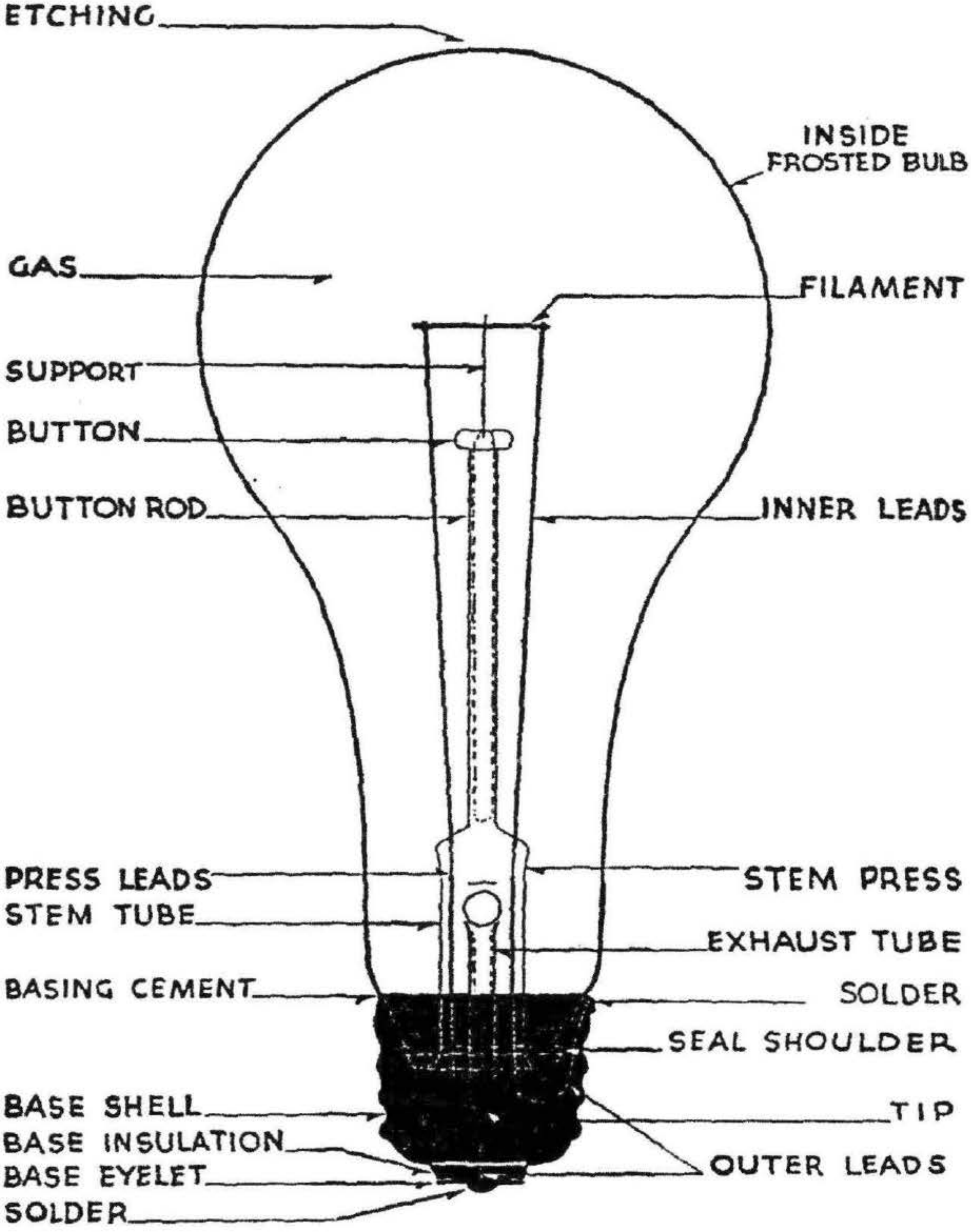

Fig. 1 Diagram of Lamp Components

room in the form of built in luminaires that were concealed, thus adapting to this new aesthetic.

Although wiring systems are not addressed in this chapter, it is important to bear in mind that they had to be adapted for the changes in the lamp types used in the luminaires that drew an ever-increasing amount of power. Additional lines also had to be run to power the convenience outlets. In situations of a retrofit, wires were run from the central ceiling luminaire of the room to the locations of the convenience outlets as a cost saving measure. If too many convenience outlets were added, this could cause a potential fire hazard from an overloaded circuit. If these convenience outlets were not separated into different circuits by an electrician, then that issue would have to be addressed in a retrofit of the wiring system.

If in examining a restoration to a 1906 house a fluorescent luminaire is discovered hanging in the kitchen, referencing the timeline when the fluorescent luminaire was developed for residential use, the conclusion could be drawn that it was not available for residential use until the end of the 1930s. Therefore, it was a later retrofit for the house, and could be removed for a more appropriate luminaire that would have been available in 1906. For practical purposes of today's lighting needs, certain compromises would need to be made in the lamp selection so that an adequate amount of light would be available while working in the kitchen. One way to accomplish this is to purchase modern glass lamps that do not have frosted glass with lower wattages. The most popular version of these are 40 watt ceiling fan lamps. The developments in the technology of the lamp are important to know, as knowledge of the timeline of events will aide in the accurate restoration of a house to a particular period.

The integrated timeline (Fig. 2) that addresses lamp developments, wiring system developments, changes in the National Electric Code and the stylistic changes illustrates how each of these elements worked together to evolve the lighting industry into what it is today. Each change in technology affected how style could be used in the design of the

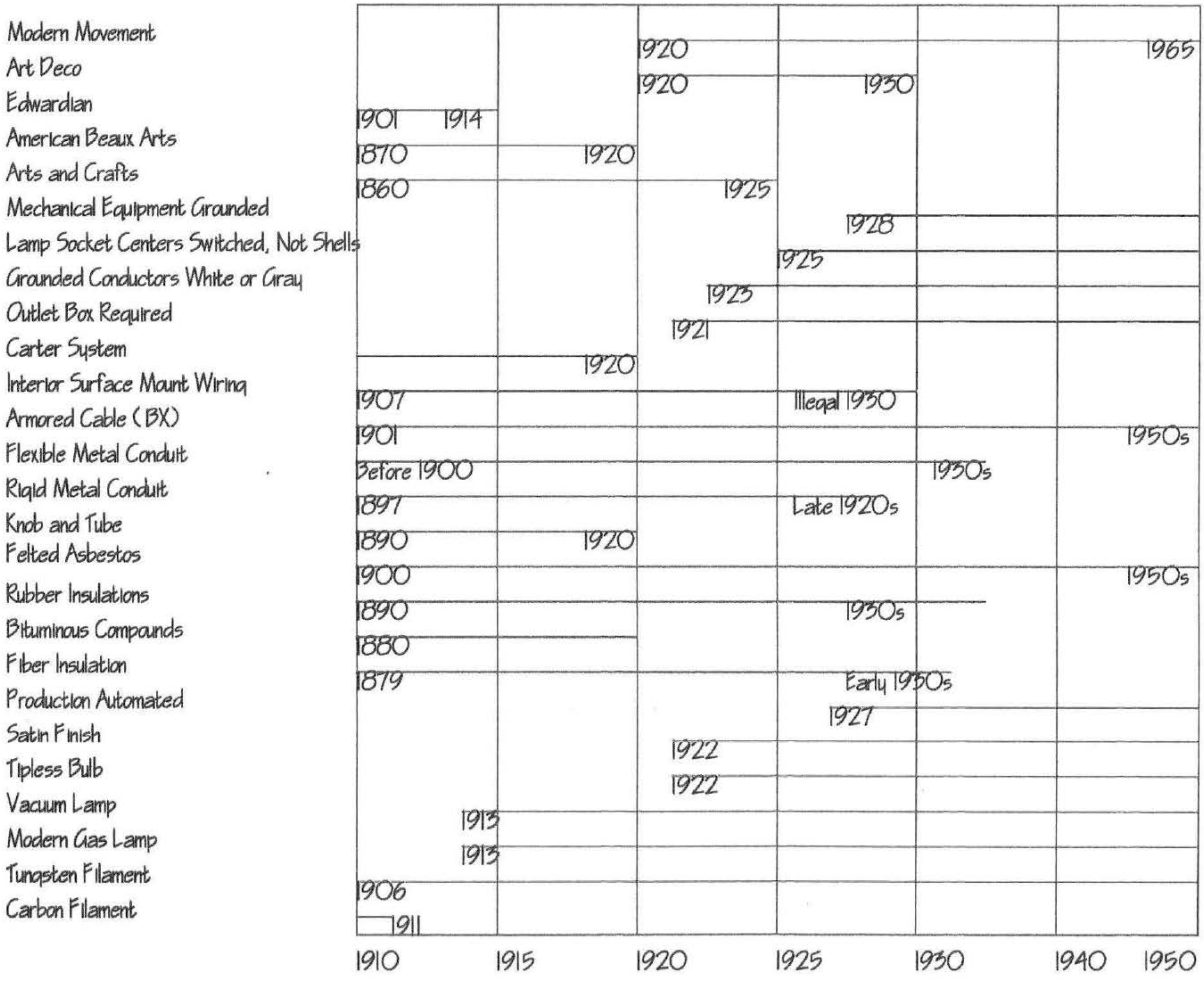
Modern Movement
Art Deco
Edwardian
American Beaux Arts
Arts and Crafts
Mechanical Equipment Grounded
Lamp Socket Centers Switched, Not Shells
Grounded Conductors White or Gray
Outlet Box Required
Carter System
Interior Surface Mount Wiring
Armored Cable (BX)
Flexible Metal Conduit
Rigid Metal Conduit
Knob and Tube
Felted Asbestos
Rubber Insulations
Bituminous Compounds
Fiber Insulation
Production Automated
Satin Finish
Tipless Bulb
Vacuum Lamp
Modern Gas Lamp
Tungsten Filament
Carbon Filament
1920 1965
1920 1930
1901 1914
1870 1920
1860 1925
1928
1925
1923
1921
1920
1907 Illegal 1930
1901 1950s
Before 1900 1930s
1897 Late 1920s
1890 1920
1900 1950s
1890 1930s
1880
1879 Early 1930s
1927
1922
1922
1913
1913
1906
1911
1910 1915 1920 1925 1930 1940 1950

Fig 2

luminaires, and the mechanical components found within. If the lamp technology advancements are looked at separately (Fig. 3) from the other aspects of lighting systems, the presence of commercial lighting types can be observed. These were included to give a reference point as to what was happening in the world of lamp technology outside of residential lighting, even though the topic of commercial lighting is omitted from this collection of information.

Kitchens usually had a central luminaire on the ceiling and additional wall mounted lighting over the sink and stove. Once it was discovered that germs were the cause of the spread of disease, the health and cleanliness of the kitchen and bathroom became an important issue. Lighting levels were increased through luminaire design and the designs of the rooms became more streamlined with the use of smooth white surfaces so that any dirt could be easily seen and cleaned up.

This chapter is important to read first because it explains the use of the lamp technology of each of the decades in question. This will contribute to the understanding of the importance of lighting systems as not only a tool, but as a creation of an historically accurate ambiance for a given space. The types of lamps to choose from to use in a luminaire can be in the back of the mind while deciding on appropriate luminaire types, shade styles, color palettes and reflective surfaces of rooms. The number of portable luminaires for the rooms should also be considered as well for an appropriate amount of task lighting. Stemming from the number of luminaires selected, the wiring system should also be considered as to the power demands of the circuit, and the retrofitting of the wiring system that may need to take place to operate the luminaires safely.

Lamp Technology Advancements

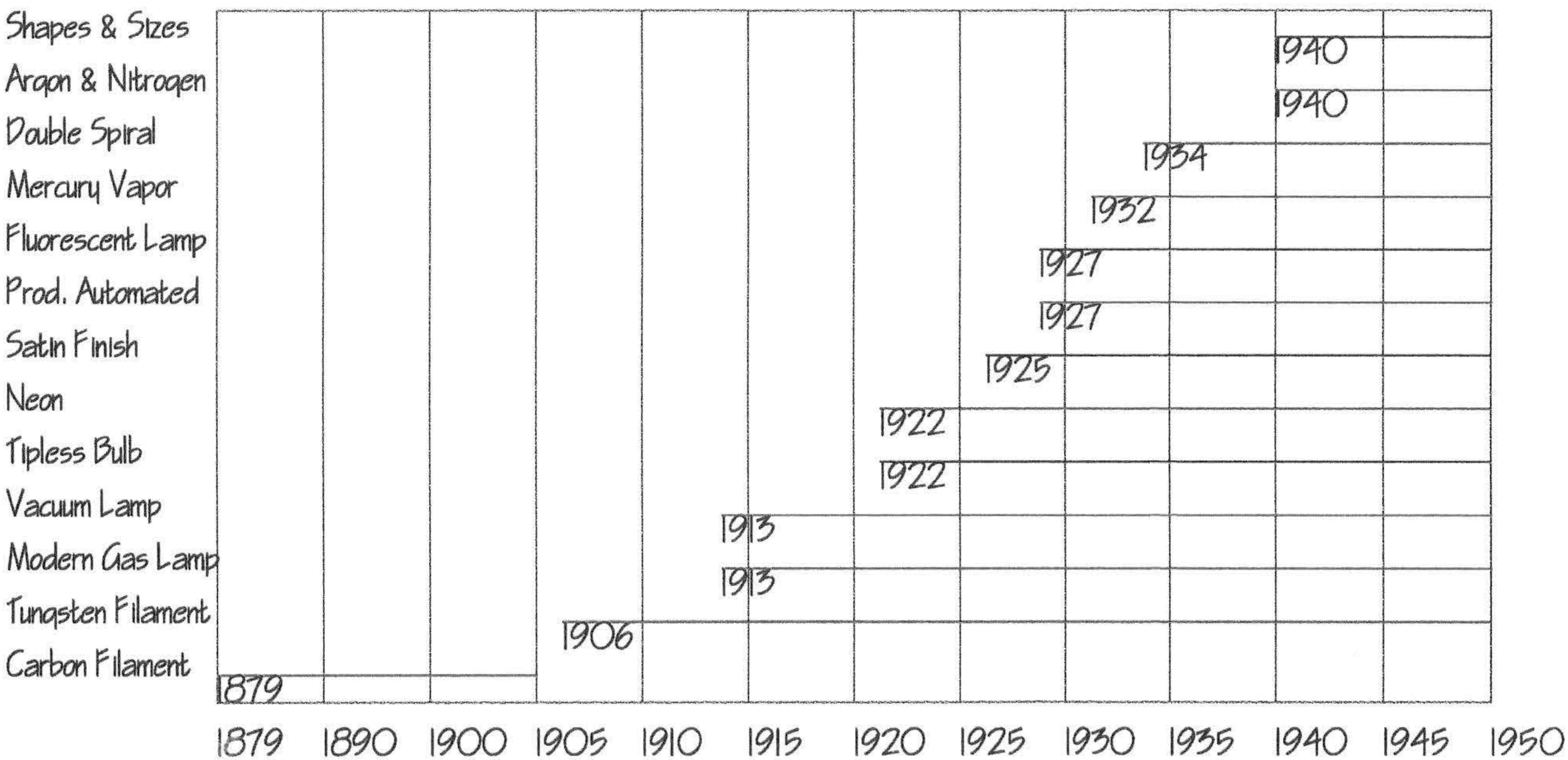

Fig 3

Incandescent Lamp, Carbon Filament

The first person to experiment with the electric arc was Sir Charles Davy in 1801, but the first invention on record of the incandescent lamp was in 1838, by a Belgian man named Jobard. He used a carbon element and a vacuum atmosphere to create the electric lamp. The principle is that the filament is heated until it glows and emits light. He was not successful in dealing with the short length of burning time or the lack of a good vacuum pump. In 1879, Thomas Edison used these same elements with success. His first lamp put out 2.6 lumens per watt[3] (Fig. 4). Today, a 60 watt lamp produces 14.3 lumens per watt. The term lumen refers to the amount of light produced from a source. There were three essential features for an incandescent lamp to work. First, an element material; carbon as it was an inexpensive material compared to tungsten and readily available. Second, was the use of a high-vacuum pump which was slow to be developed and a cumbersome problem to overcome. Lamp production was inhibited largely due to inadequate pumps to remove the air to keep the filament from oxidizing. Sealing the glass around the lead wires was also a problem. The third element was an electrical supply system. The lamp resistance, system voltage, and conductor current were all factors in producing light. During the 1870s, practical dynamos (generators in which both armature and field were electromagnets) were produced making it possible to generate substantial quantities of electricity to power the lamp and many other electrically powered inventions of the time.[4]

The parts in an early incandescent lamp consisted of one or more filaments. The tungsten filament lamps that were developed later had multiple filaments, and were called squirrel cage lamps. The glass bulb had a partial vacuum to keep the filament from oxidizing too rapidly. A foot of lamp glass tube or otherwise called node located at the base of both ends held the filament supports or, in older lamps, the filament. Through the

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[3] IES Lighting Handbook, 6-1.

[4] Friedal, Robert and Paul Israel, Edison's Electric Light-Biography of an Invention, 115-116.

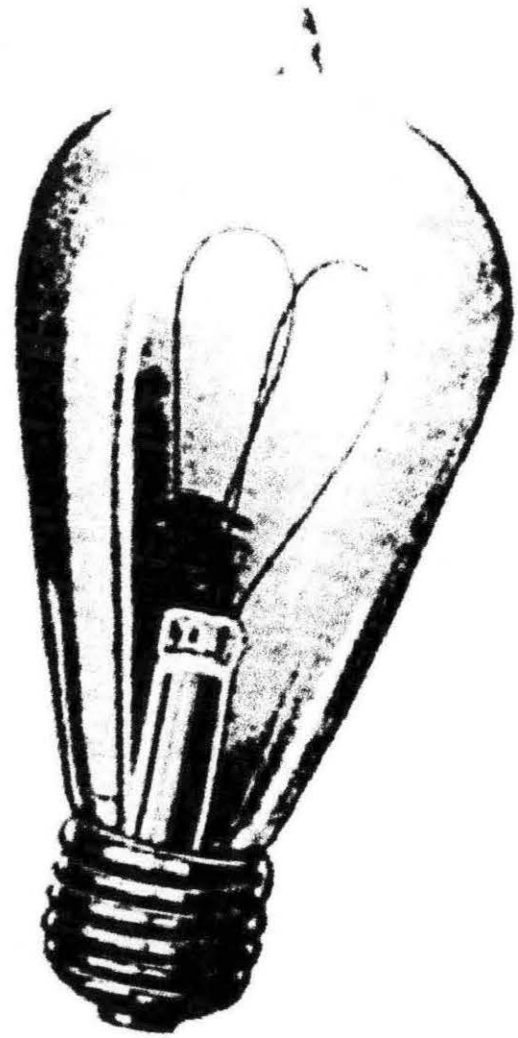

Fig. 4 1905 Carbon Filament Lamp

use of the vacuum pump, air was removed from the bulb after being soldered with glass, and the solder mark was shaped like a small pin at the top of the bulb or at the bottom in the base. The base generally consisted of a metallic band around the bottom of the bulb that fastened the lamp into the socket, and also provided contact with one side of the line. Bases were of the bayonet or screw type. The base contact was a small metallic disk or point at the bottom of the base that provided a connection with the other side of the line. The free gas consisted of rarefied air or, in modern lamps, a gas called argon or krypton that was placed under low pressure.[5] Edison chose carbon as a filament because it has no melting point and vaporizes at 6,510 degrees Fahrenheit, which was above the melting point of tungsten at 6,120 degrees Fahrenheit. Carbon was the only material used for 25 years from 1879 to 1904. Osmium and tantalum were tried and used briefly before tungsten, which was first used in 1907. In 1913, the modern rare gas lamp developed by Langmuir used a spiral filament obtained by winding a wire around a larger wire that was later dissolved in acid.[6] The filament was now more like a ring and was held in place with metallic wires anchored to the central glass tube. The glass bulb shape changed to a pear shape that carries into today's designs. The pump opening was moved to the base instead of the top.

As the production numbers rose on these lamps, the unit costs were reduced, making them cheaper for the consumer. From 1880 to 1887 the cost of a 16-candlepower carbon lamp was $1.00.[7] Using a Consumer Price Index that dates back to 1913 (earlier dates were not available), in today's dollars the cost of the incandescent lamp was roughly $16.00 each (Fig. 5).[8] What is kind of amusing is that the reproduction lamps of the era being produced today cost $10.00-$12.00 each through Rejuvenation in Portland, Oregon.[9] By 1891 there were about 7 ½ million lamps being produced and by 1899 the

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[5] Friedal, Robert and Paul Israel, *Edison's Electric Light-Biography of an Invention*, 116.
[6] Ibid., 116.
[7] Keating, Paul W., *Lamps for a Brighter America*, 39.
[8] U.S. Department of Labor Bureau of Labor Statistics, Consumer Price Index, 1913-2000
[9] Rejuvenation Lighting Catalog, 12th Edition, 48.

Consumer Price Index 1913-1950, 2000

	January	February	March	April	May	June	July	August	September	October	November
1913	9.8	9.8	9.8	9.8	9.7	9.8	9.9	9.9	10.0	10.0	10.1
1914	10.0	9.9	9.9	9.8	9.9	9.9	10.0	10.2	10.2	10.1	10.2
1915	10.1	10.0	9.9	10.0	10.1	10.1	10.1	10.1	10.1	10.2	10.3
1916	10.4	10.4	10.5	10.6	10.7	10.8	10.8	10.9	11.1	11.3	11.5
1917	11.7	12.0	12.0	12.6	12.8	13.0	12.8	13.0	13.3	13.5	13.5
1918	14.0	14.1	14.0	14.2	14.5	14.7	15.1	15.4	15.7	16.0	16.3
1919	16.5	16.2	16.4	16.7	16.9	16.9	17.4	17.7	17.8	18.1	18.5
1920	19.3	19.5	19.7	20.3	20.6	20.9	20.8	20.3	20.0	19.9	19.8
1921	19.0	18.4	18.3	18.1	17.7	17.6	17.7	17.7	17.5	17.5	17.4
1922	16.9	16.9	16.7	16.7	16.7	16.7	16.8	16.6	16.6	16.7	16.8
1923	16.8	16.8	16.8	16.9	16.9	17.0	17.2	17.1	17.2	17.3	17.3
1924	17.3	17.2	17.1	17.0	17.0	17.0	17.1	17.0	17.1	17.2	17.2
1925	17.3	17.2	17.3	17.2	17.3	17.5	17.7	17.7	17.7	17.7	18.0
1926	17.9	17.9	17.8	17.9	17.8	17.7	17.5	17.4	17.5	17.6	17.7
1927	17.5	17.4	17.3	17.3	17.4	17.6	17.3	17.2	17.3	17.4	17.3
1928	17.3	17.1	17.1	17.1	17.2	17.1	17.1	17.1	17.3	17.2	17.2
1929	17.1	17.1	17.0	16.9	17.0	17.1	17.3	17.3	17.3	17.3	17.3
1930	17.1	17.0	16.9	17.0	16.9	16.8	16.6	16.5	16.6	16.5	16.4
1931	15.9	15.7	15.6	15.5	15.3	15.1	15.1	15.1	15.0	14.9	14.7
1932	14.3	14.1	14.0	13.9	13.7	13.6	13.6	13.5	13.4	13.3	13.2
1933	12.9	12.7	12.6	12.6	12.6	12.7	13.1	13.2	13.2	13.2	13.2
1934	13.2	13.3	13.3	13.3	13.3	13.4	13.4	13.4	13.6	13.5	13.5
1935	13.6	13.7	13.7	13.8	13.8	13.7	13.7	13.7	13.7	13.7	13.8
1936	13.8	13.8	13.7	13.7	13.7	13.8	13.9	14.0	14.0	14.0	14.0
1937	14.1	14.1	14.2	14.3	14.4	14.4	14.5	14.5	14.6	14.6	14.5
1938	14.2	14.1	14.1	14.2	14.1	14.1	14.1	14.1	14.1	14.0	14.0
1939	14.0	13.9	13.9	13.8	13.8	13.8	13.8	13.8	14.1	14.0	14.0
1940	13.9	14.0	14.0	14.0	14.0	14.1	14.0	14.0	14.0	14.0	14.0
1941	14.1	14.1	14.2	14.3	14.4	14.7	14.7	14.9	15.1	15.3	15.4
1942	15.7	15.8	16.0	16.1	16.3	16.3	16.4	16.5	16.5	16.7	16.8
1943	16.9	16.9	17.2	17.4	17.5	17.5	17.4	17.3	17.4	17.4	17.4
1944	17.4	17.4	17.4	17.5	17.5	17.6	17.7	17.7	17.7	17.7	17.7
1945	17.8	17.8	17.8	17.8	17.9	18.1	18.1	18.1	18.1	18.1	18.1
1946	18.2	18.1	18.3	18.4	18.5	18.7	19.8	20.2	20.4	20.8	21.3

Fig 5

1947	21.5	21.5	21.9	21.9	21.9	22.0	22.2	22.5	23.0	23.0	23.1
1948	23.7	23.5	23.4	23.8	23.9	24.1	24.4	24.5	24.5	24.4	24.2
1949	24.0	23.8	23.8	23.9	23.8	23.9	23.7	23.8	23.9	23.7	23.8
1950	23.5	23.5	23.6	23.6	23.7	23.8	24.1	24.3	24.4	24.6	24.7
1999	164.3	164.5	165.0	166.2	166.2	166.2	166.7	167.1	167.9	168.2	168.3
2000	168.7	169.7									

Fig 5

How to Use the Consumer Price Index for Escalation

	Example
CPI for current period	136.0
Less CPI for previous period	129.9
Equals index point change	6.1
Divided by previous period CPI	129.9
Equals	0.047
Result multiplied by 100	0.047 x 100
Equals percent change	4.7

Fig. 5

figure leaped to 25 million lamps.[10] Throughout this fifty year time period, incandescent and fluorescent lamps dominated residential electric lighting.

Incandescent Lamp, Tungsten Filament

In 1906, the Illuminating Engineering Society was formed to further the research and development of the electric lamp.[11] If the timeline is examined, the observation of the development of the tungsten wire was simultaneous with this event. The gas filled lamps (either nitrogen or argon) developed in 1913 had gas pressure which retarded the evaporation of the filament.[12] From 1907-1911, the filaments were pressed from metallic tungsten powder and were very fragile. The material was only accepted by the public because the light output was three times the lumens per watt of the carbon filament (Fig. 6). In 1910, a new method of production was developed using drawn tungsten wire that had four times the tensile strength of steel. Vacuum lamps were used until 1913, for lamps less than forty watts. In lamps over forty watts the gas was pressurized to retard evaporation of the filament. The best gas with the lowest heat conductivity was nitrogen. It was relatively inexpensive, readily available, and had a high purity. Argon was discovered to be a better gas, but it was scarce and relatively expensive.

In 1925, a satiny interior bulb finish was introduced to reduce glare from the lamp. In 1927, the entire production of the incandescent lamp was automated.[13] Between 1934 and 1936, the double spiral filament was introduced.[14] The tungsten wire was wound once into a spiral and was coiled again into a second spiral with a larger diameter. Lamps produced in the 1940s used a mix of argon and nitrogen in various proportions depending on the type of lamp. Argon alone ionizes at normal circuit voltages and tends to support arcing between the lamp lead-in wires.

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[10] Ibid., 39.

[11] *IES Handbook*, 6-1.

[12] Ibid., 6-7.

[13] Ferro, M., Cook, M., *Electric Wiring and Lighting in Historic American Buildings*, 28.

[14] Woodhead, E.I., C. Sullivan and G. Gusset, *Lighting Devices in the National Reference Collection Parks Canada*, 74.

Fig. 6 1906 Tungsten Filament Lamp

The technology of the lamp in the 1940s used the same elements as the original tungsten filament lamp. The main component difference consisted of gas in lamps over 40 watts to prevent the rapid evaporation of the filament, thus permitting higher "burning" temperatures and higher efficiency.[15] The lead-in wires conducted the current through the filament on a copper base to the nickel stem press and back to the filament. The stem press was glass and lead-in wires that were sealed airtight. The lead-in wires were a combination of nickel-iron alloy core and copper sleeves. The Dumet wire named for its inventor (a nickel-iron alloy core with a copper sleeve)[16] was substantially the same and had the same coefficient of expansion as glass. The exhaust tube projected beyond the bulb during manufacture. The air was exhausted and the bulb was filled with inert gases. The tube was then sealed off.[17]

By the 1940s, there were many bulb shapes and finishes to choose from. Such features as hard or heat-resisting glass, frosted glass and colors, white bowl lamps, and coated bulb ends were available. Using the coated end bulb in a luminaire would redirect the light upward to give indirect lighting effects. Daylight lamps used blue green glass to absorb red and yellow wavelengths to produce a whiter light. Colored lamps were either outside spray coated or inside coated or enameled. Ceramic glazed glass in natural colors of ruby, blue, green, and amber were also available.[18]

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15 IES Handbook, 6-7.

16 IES Lighting Handbook, 6-4.

17 Ibid., 6-4.

18 Ibid., 6-15.

Electric Discharge Lamps

There are many types of electric discharge lamps that were developed over time for commercial purposes only. Looking at the timeline, the introduction date of 1932 is observed. New wiring insulation types were also being introduced at this time that were much safer and were used for heavy-duty situations. The lamps were commonly referred to as ionization lamps or discharge tubes. Their advantages for modern life included bright light, low energy consumption, low cost, long life span, great adaptability to specialized uses, no maintenance, and a better spectral quality of light.[19]

Carbon arc lamps were first used with commercial success because of their temperature, pressure and voltage capabilities. The electric discharge lamps for commercial lighting applications used mercury, sodium, and neon. They were relatively easy elements to come by and inexpensive to provide. Different metals were used for the electrodes and were often coated with electron-emissive barium or strontium oxide.[20] The electrodes emitted electrons better hot than cold. The enclosed arc emitted light at the instant the discharge began between an electrode acting as a cathode and another acting as an anode.

The cathode is an electrode that emits electrons in a vacuum tube. Hot cathodes include an element heated to incandescence by auxiliary current to promote the emission of electrons. The cold cathode does not have this feature. The pressure indicates the amount of gas in the tube. In a low pressure lamp the pressure is 1/100th that of the atmosphere. The first experiments with electrical discharges in rarefied air date back to the eighteenth century. In 1709, Dr. Hawksbee (an Englishman) used an electrostatic machine to produce a discharge in a tube containing a partial vacuum. In 1768, Canton obtained luminescent compound calcium sulfite base by heating and mixing powdered oyster shells with sulfur. In 1895, the first truly functional apparatus produced Moore's

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[19] Woodhead, E.I., C. Sullivan and G.Gusset, *Lighting Devices in the National Reference Collection, Parks Canada*, 76.
[20] Ibid., 76.

carbonic gas tube.[21]

The tube was in the shape of a large ball that the current passed from one electrode to another through a gas. The free electrons of the current displaced certain electrons in the gas atoms and became ionized. The electrons in the atoms moved to a different energy level or layer by freeing photons and this produced light. In other cases the free electrons moved toward the inner surface of the tube where they could produce light by fluorescence of a coating.[22]

Types of ionization lamps that were developed included the non-fluorescent cold cathode lamp that produced light at low pressure, such as the Moore carbonic gas tube (1895), the Cooper-Hewitt mercury vapor tube (1900), and the cold cathode neon tube (1922). The hot cathode lamp is a low pressure lamp, also produced by Cooper-Hewitt in the form of the mercury vapor lamp (1900) that produced 13 lumens per watt[23], the hot cathode neon tube (1922), and the high pressure mercury vapor lamp (1932). Fluorescent lamps developed with hot cathodes with high pressure mercury vapor became available in 1939 and were improved in 1957. The low pressure lamps had significant performance improvements in 1940, 1948 and 1957.[24]

Neon

After the introduction of the carbon arc lamp, the second type of electric discharge lamp developed was neon lighting during the early part of the Art Deco movement. It was invented by Georges Claude in 1810.[25] It was first used in commercial advertising in 1922. The neon tube was used for promotional lighting of retail establishments. Many retail establishments of the period had residential apartments above them, and the decorative applications of neon lighting sometimes found their way

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21 Woodhead, E.I., C. Sullivan and G. Gusset, *Lighting Devices in the National Reference Collection, Parks Canada*, 76.
22 Ibid., 76.
23 *IES Handbook*, 6-1.
24 Woodhead, E.I., C. Sullivan and G.Gusset, *Lighting Devices in the National Reference Collection, Parks Canada*, 76.
25 Ibid., 77.

into residential applications. The neon placed in the tube produced a red light under low pressure using a cold cathode under high voltage. Neon using a hot cathode was also made available in the same year. The light produced was brilliant and colorful which attracted the attention of potential customers to read the signs outside retail establishments, and entice them to stop and spend their money.

Mercury Vapor

The modern mercury vapor lamp was the third type developed and went on the market around 1932 when the Modern Movement was in full swing for lighting roads and public places. The look was bright, clean and efficient, like the modern household of the 1930s. The lamp had a high pressure hot cathode that produced an intense bluish light. The lamp produced an arc inside the bulb enclosed in another bulb in order to retain heat to work. After 1936 quartz bulbs were used to resist higher temperatures and pressure.[26] The mercury vapor discharge lamp had a higher operating pressure than the sodium vapor lamp with a larger proportion of emitted radiation with longer wavelengths within the visible region of the mercury spectrum. There were four principal wavelengths that resulted in a greenish blue light. This light source appeared to be bluish white to the naked eye. The drawback to this type of lamp was it took several minutes to restart if there was even a momentary lapse of current. This drawback still exists today.

Sodium Vapor

Sodium vapor lamps were the fourth type developed that used a low pressure cold cathode lamps, also introduced around 1932, during the Modern Movement for lighting roads and public monuments. They gave off a bright yellow light, were rather long and were specifically made to resist corrosive action of sodium and intense heat. They had a high luminous efficiency because the wavelength of the monochromatic yellow radiation

[26] Woodhead, E.I., C. Sullivan and G.Gusset, *Lighting Devices in the National Reference Collection, Parks Canada*, 77.

from the discharge was very close to the maximum luminosity in spectrum. Lamps of 50 lumens per watt were in regular use as scientists experimented with lamps that could produce 100 lumens per watt in 1947.[27]

Fluorescent

The fluorescent tube was the last lamp type to be developed in this time period of fifty years. The fluorescent tube used in domestic and commercial lighting gave off light through fluorescence of the coating, generally a white powder covering the inside surface. Fluorescent tubes were used commercially on a large scale by the end of 1927. This development coincided with the development of heavier insulation on wires, and the decline of the Art Deco movement. On April 21, 1938 General Electric announced the introduction of fluorescent lamps as a regular line, and the patent for development of this ground breaking technology was awarded to George Inman in October, 1941.[28] Production soared, and by 1941 the lengths ranged from nine inches to five feet (Fig. 7).

Modern tubes had a hot cathode under low pressure with a white interior coating. A cylindrical glass tube was coated with fluorescent phosphors. The electrode was sealed at each end and after evacuation of the tube a small drop of mercury was added and a volume of neon or argon was introduced at low pressure. There were three to eighteen millimeters of mercury present depending on the lamp. Starting and operation required the use of a transformer and starter, also known as a ballast.[29] The electric discharge lamps used the negative resistance characteristic; operating in a series with a current controlling the ballast starting switch that needed three to four seconds after closing the circuit before the arc struck.[30]

Fluorescent lighting in the home would dominate the market for several years

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27 *IES Handbook*, 6-29.

28 Keating, Paul W., *Lamps for a Brighter America*, 198.

29 Woodhead, E.I., Sullivan, C., Gusset, G., *Lighting Devices in the National Reference Collection, Parks Canada*, 71-77.

30 *IES Handbook*, 6-29.

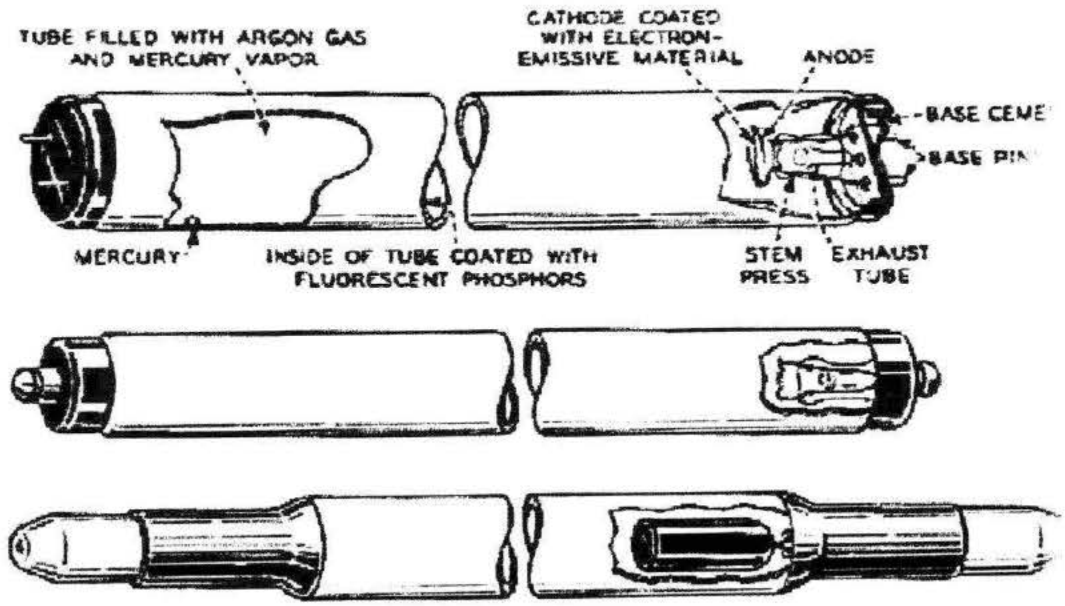

Fig. 7 Fluorescent Tube Lamp

because of its efficient use of energy, and bright lighting characteristics. Kitchens and baths were the primary spaces where fluorescent was used. Under cabinet tubes were installed to eliminate shadows on counters for food preparation, and the bright light in the bathroom helped make it easier to see for grooming in front of the mirror.

Standardization of the Industry

Lamp Bases and Bulb Shapes

The first lamps that were introduced came in different shapes and sizes largely due to the competition among the rival companies. Marketing exacerbated this problem. There were a large variety of bulb shapes including cylindrical tubes, spherical balls, globular forms, flames, and the pear shape most familiar today. Different base screw types for the sockets were problematic when one needed to replace a blown lamp in a luminaire with a non-standardized screw base size (Fig. 8). Until the beginning of the twentieth century, there were many varieties of lamp bases to choose from for the "standard" incandescent lamp. Through standardizing the size and shape of the screw base and relative bulb sizes, companies were able to be more competitive with one another, so that the consumer could use a number of different lamp types in their luminaires. In 1922 a commercially feasible method was developed to make the bulb tipless by employing a hole blown in the stem to exhaust the air out of the lamp.

Lamps were produced with clear glass. The earliest bulbs only produced 1.68 lumens per watt, but by 1911 ductile tungsten gave out 10 lumens per watt.[31] Because of the glare issue, designers compensated quickly for this by elongating the shades on the lamps to filter and diffuse the light away from the eyes. Because of this problem, manufacturers worked on different methods to frost the bulb. They tried silvering, painting, etching with hydrofluoric acid, coating with collodion, and sandblasting.[32] A commercially feasible frosting method wasn't developed until 1925.[33] The bulb became the functional piece of the luminaire that was best reflected and shielded by the decorative design of the luminaire. This is illustrated by the timeline of the development of the lamp and the shapes and sizes that have resulted from technological advancements in the industry (Fig. 9). It was no longer fashionable to show off the lamp as the

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[31] Ferro, M., Cook, M., *Electric Wiring and Lighting in Historic American Buildings*, 28.
[32] Ibid., 28.
[33] Ibid., 28.

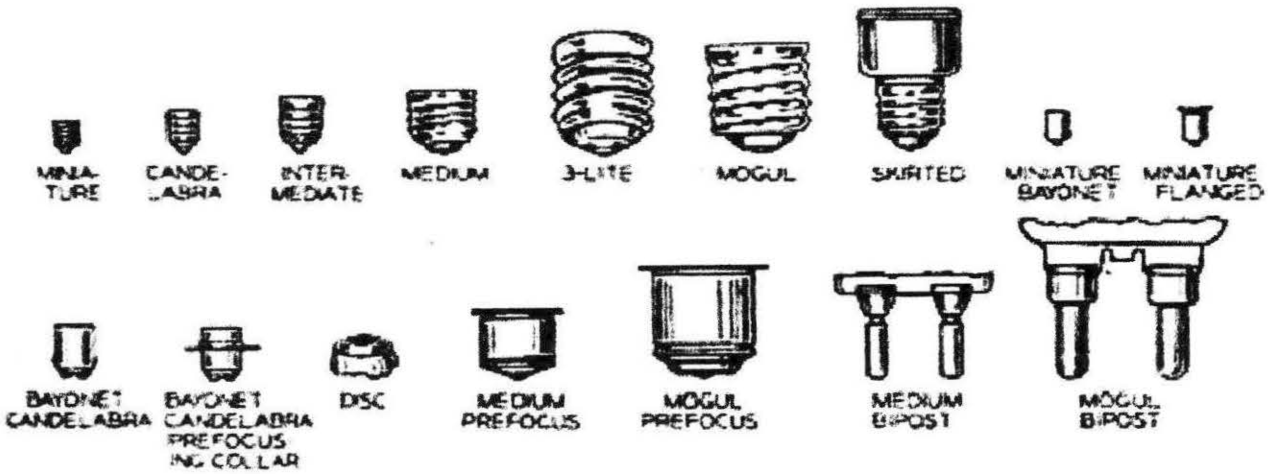

Fig. 8 Common Incandescent Lamp Bases

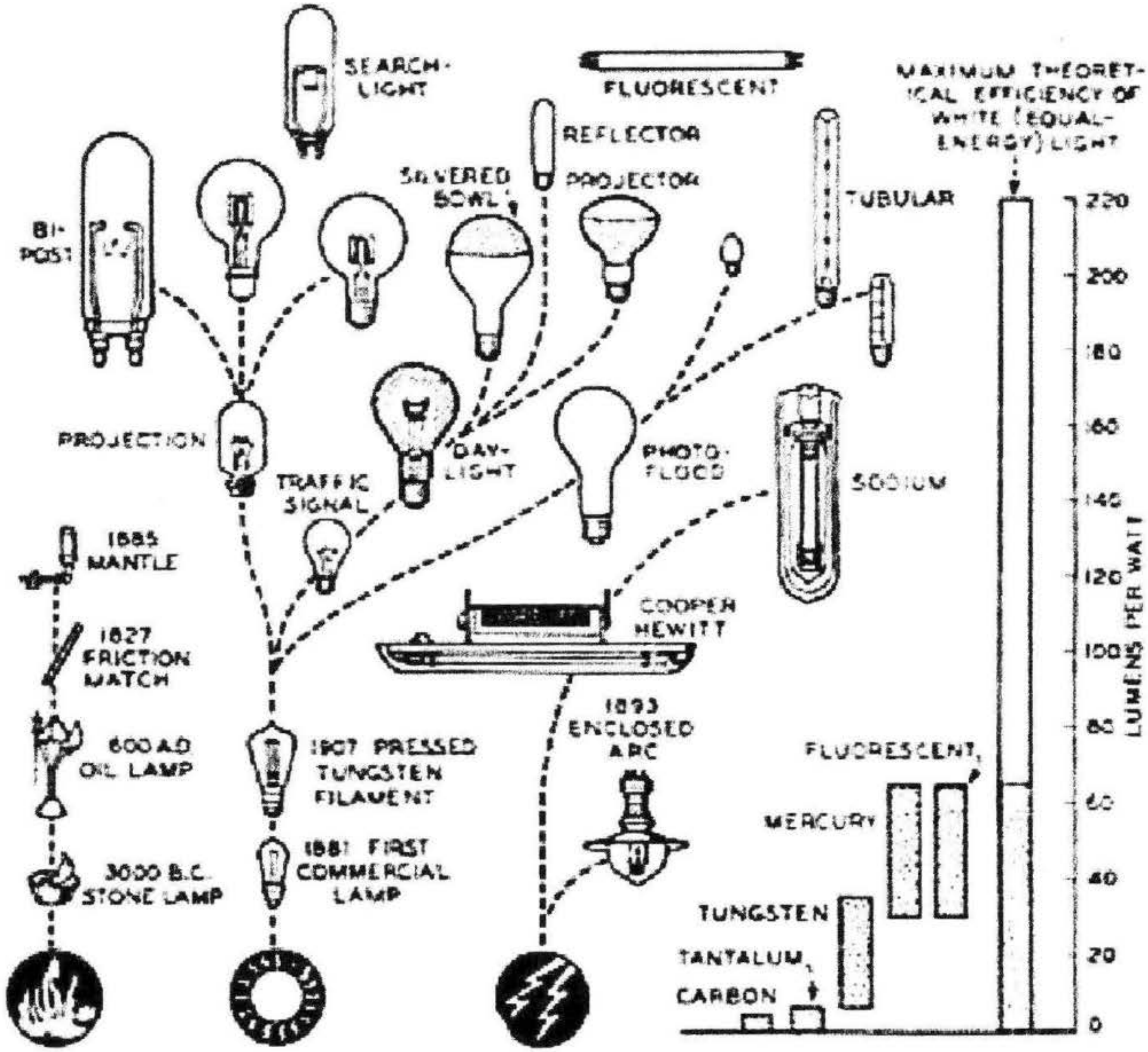

Fig. 9 Combustion, Incandescent, Electric Discharge Lamp History

luminaire designs had eclipsed their importance. By this time, the electric lamp was here to stay. Older luminaires that had the lamp exposed were considered crude and cheap in comparison.

II. Development and Technology of Residential Wiring Systems 1900-1950

Introduction

The following information is to aid the preservation professional and the private homeowner determine approximately how old the existing wiring system is in a structure. This chapter is divided into two parts, the first part addresses the development of insulation materials, and the safety factors figured into their development. The second part discusses the wiring systems, both open and concealed. A knowledge of insulation types and when they were introduced can be helpful when examining a wiring system. Once these systems are observed for insulation type and wiring system type, then using the timeline they can determine how old the wiring system is in the house.

In the following chapter, the issues of a deteriorated wiring system will be addressed. The relative age of the wiring can easily be observed by removing a cover plate from a wall switch and visually examining the insulation on the wires. The safety hazards regarding old wiring are addressed in chapter four, and should be read first before going anywhere near the wiring. It is also important to remember that when a turn of the century house was built, the modern electric lamp and the subsequent appliances that were developed came later than the construction date of the house. Therefore, it is highly probable that the wires for the convenience outlets in a room are going to be wired through the ceiling luminaire and the junction box may have more than the legal limit of eight wires coming out of it. By cross referencing the results of the visual investigation using the timeline with the types of insulation being made during this fifty year period, the relative age of the wiring can be determined.

The National Electric Code was established in 1897 to protect consumers from shoddy wiring practices, and to keep the insurance companies from having to pay out huge sums of money to citizens whose houses burned to the ground because of an electrical problem that could have been prevented. A cumbersome problem for the electric industry was to come up with an effective insulation for wiring conductors that would protect the conductors and insure the integrity of the electrical circuit. Scientists were also learning exactly what the behavior characteristics of electricity were and, through experimentation, began to discover how to harness this new power source.

In addition to the lamp, wiring, switching systems, fuse boxes, knife switches, and a whole host of other necessary components needed to be developed. Many inventors made a fortune during this exciting time in history. When the Great Depression gripped the country, the Rural Electrification Act went into effect to help bring the rest of the country up to modern standards and put people back to work. This program was continued into the early 1970s and was considered to be worth the time and the cost, as those in rural areas could know at a moment's notice on their electric radios (and later televisions) what was happening around the world.

The Rural Electrification Administration was established as an emergency agency on May 11, 1935, to introduce electric service to rural areas not already being served. It was made a continuous agency by the Rural Electrification Act, May 20, 1936. It was then made a permanent agency in the Department of Agriculture by the Pace Act on September 21, 1944. The program was heavily advertised (Fig. 10) and continued until 1973.

The functions of the program were to make low interest self liquidating loans to farmers, farm cooperatives, and utility districts to finance rural electrification projects and improve rural telephone service.[1] Many farms of the time had their own generators for lights that ran on DC power. Once electrification came to their farm, along with telephone service, it made their old systems obsolete so they had to buy AC powered luminaires and lamps. For a poor and starving farm population, this was a considerable hardship during the depression.

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[1] http://www.nara.gov/guide/rg221.html, 1-7.

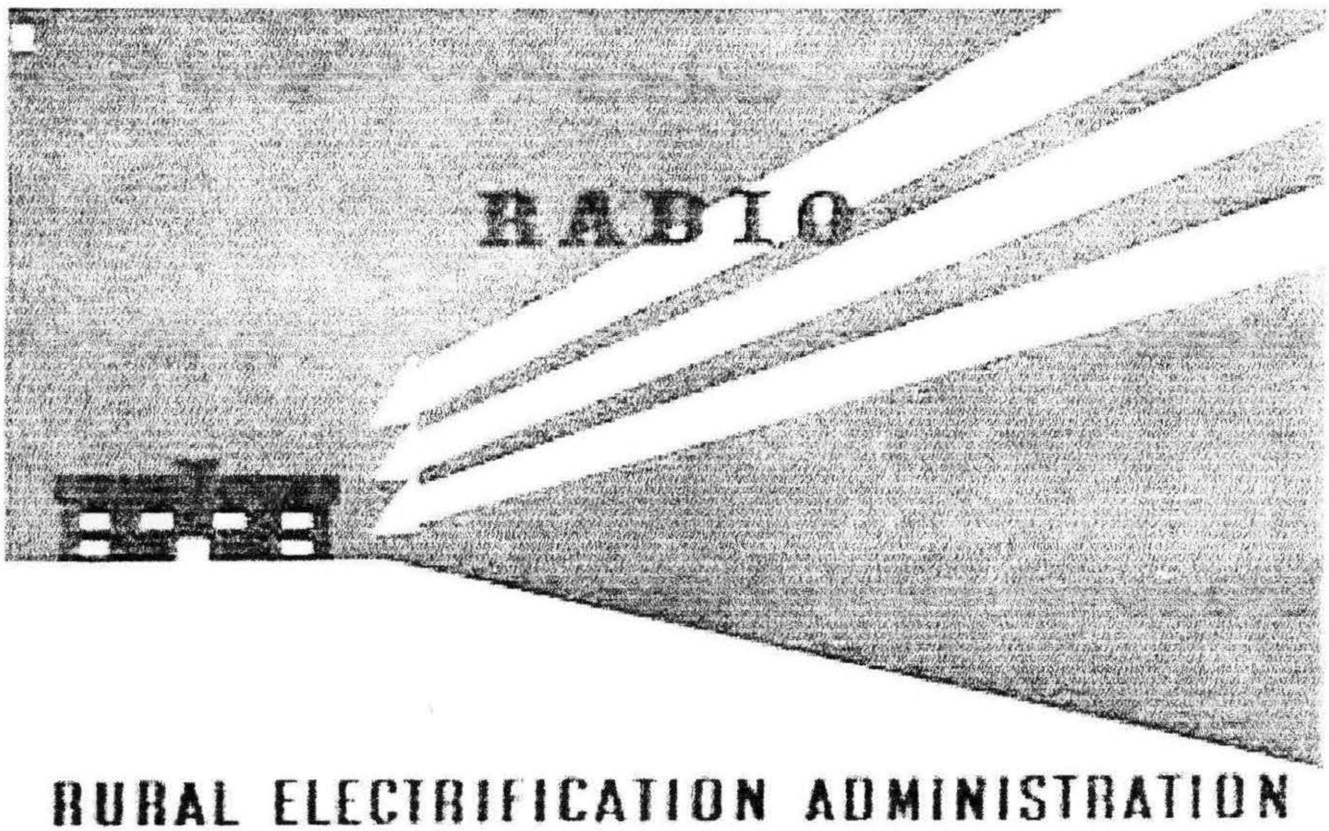

Fig. 10 Lester Beall, Radio, Rural Electrification Administration, 1937, silkscreen

Insulation Materials

Experiments and Failures

Wiring insulation played two critical roles; maintaining the integrity of the electrical circuit while protecting the conductors from damage. Controlling and minimizing the hazards of a potentially dangerous power source were of top priority. During the early days scientists looked for the perfect insulation to deal with the safety issues and a skeptical public. The ideal material had to have a very long life with high and long-lasting dielectric strength with excellent resistance to heat and moisture. Flexibility in use required specialized resistance to ozone and various chemicals. The life of the copper conductors was practically indefinite and the goal was to create an insulation of the same properties. The natural materials or compounds experimented with failed in one or more requirement. No one substance could perform up to the expectations that were set. A compromise had to be made. Insulation had to be tailored to the installation location or it had to employ several methods of insulation in one assembly.[2]

The main problem early wiring designers faced was how to deal with the current going through wire, as most did not have any real knowledge of how electricity behaved under most circumstances. A big problem was heat build up that usually led to the start of a fire, especially if the wires were near anything flammable. There were many ill-fated experiments in the effort to insulate the wires. A method solving the insulation problems through the evolution of material experimentation developed in the early 1880s used strips of cloth saturated with a mixture of natural asphalt, linseed oil, beeswax, and paraffin applied to the wires in situ.[3]

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[2] Ibid., 7.

[3] Ferro, M., Cook, M., _Electric Wiring and Lighting in Historic American Buildings_, 7.

Fiber Compositions

Fibrous wrapped insulation was first tried in 1879. Using the timeline (Fig. 11), the evolution of subsequent materials can be observed. A direct conductor insulation and secondary protective coverings in the forms of fiber braids, tapes and tubes were used. Cellulose was a common base for virtually all types of woven fabric, felted material, paper, yarn, or thread. Rubber insulation was used primarily in interior wiring applications. Fibrous types maintained an important position because of their advantages. They were economical to produce and could withstand high temperatures and were essential as spot insulation joints (where two wires met and were spliced together) and repairs.[4]

Fibrous insulation alone was too hygroscopic (easily saturated with moisture) to be safe and it required treatment with oils, varnishes, gums, or impregnating compounds. These additions reduced the porosity and susceptibility to moisture. They improved the resistance to heat and shrinkage. Asphalt, coal tar, bitumen, natural and synthetic resins, rubber, gutta percha, and linseed oil were all flammable, and not the best choices for insulation.[5]

Insulating varnishes, linseed oil and fossil gum resins were in wide use until the 1920s. They were superseded by heavier duty impregnating compounds of asphalt and paraffin. Both were eventually eclipsed by synthetic resin products. One of the first was Bakelite (phenol and formaldehyde) put into use before 1920, treating paper and felted asbestos insulation. In the early 1930s, the most familiar thermoplastic modern synthetic resins were invented and employed in fibrous insulation. They were waterproof and oil proof. Their characteristics made them superior to earlier mixtures of natural materials. Varnished cloth fabric was a popular insulation for interior wiring. In dry places varnished cambric or empire cloth, linen or cotton muslin was treated with a mixture of

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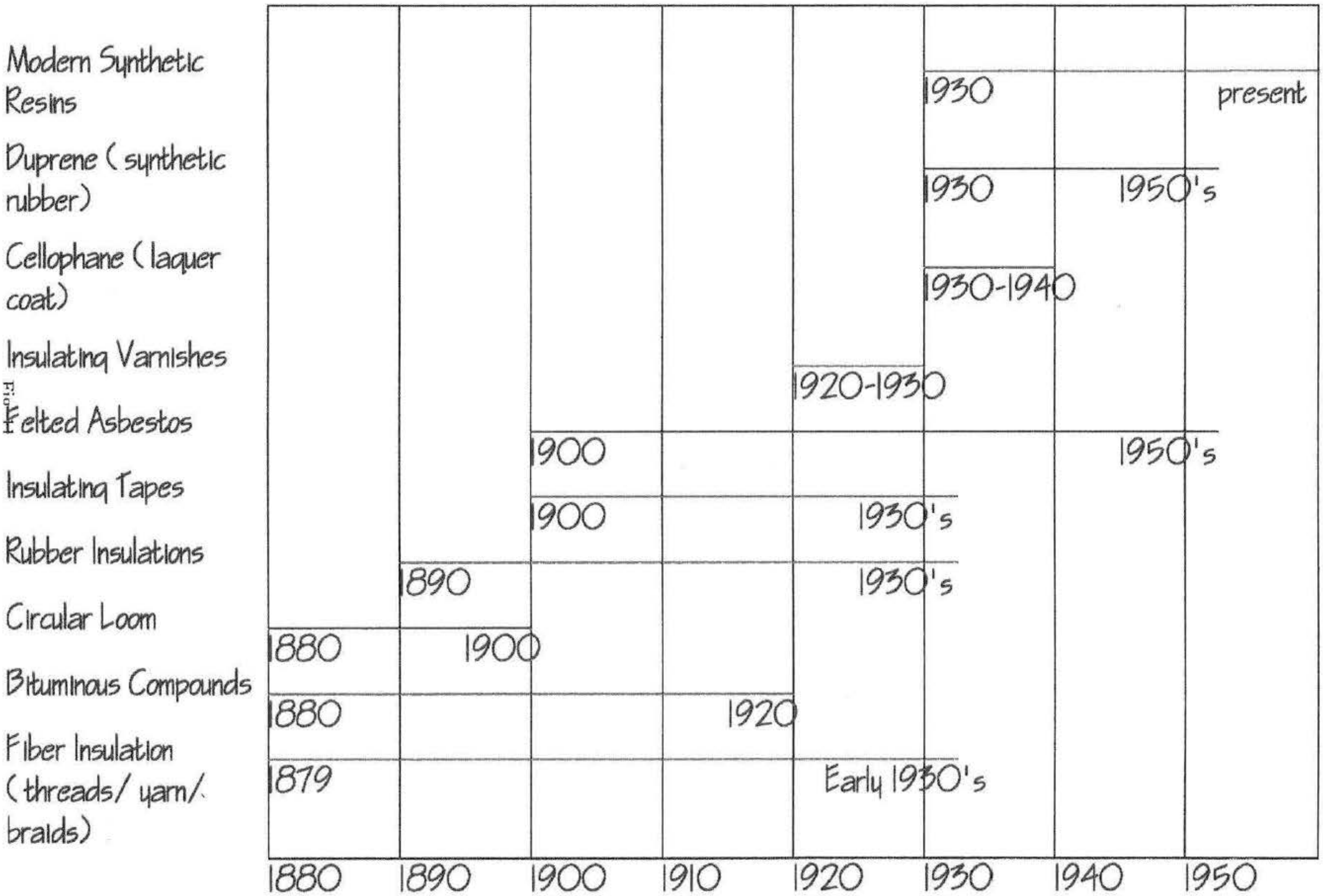
[4] Ferro, M., Cook, M., _Electric Wiring and Lighting in Historic American Buildings_, 8.

[5] Ibid., 8.

Residential Wiring Insulation Materials



boiled linseed oil, resin, and benzene. The treatment was applied by dipping the material in a bath of varnish and baking until dry to oxidize the coating and then repeating this two, three, and four times. The cloth after two to four dippings and bakings had a relatively impermeable surface. It was wrapped around the conductors with several layers of tape with an oil or insulating compound between the layers to provide an extra seal against moisture and more flexibility to the overall assembly. One to two cotton braids were saturated with a moisture resistant compound, or asbestos braids were treated with a fire retardant compound that formed the outer covering.[6] The varnished cloth resisted moisture to some degree but the National Electric Code forbade its use in damp areas without a lead sheath since when it was damp the insulation could act as a conductor. Temporary immersion in water was allowable, but not long term exposure to moisture as it worked the insulating compounds out of the fiber.[7] There was also a tendency for the insulation to dry out and deteriorate in very hot environments. Varnished cloth could withstand heat to 150 degrees Fahrenheit, and rubber could withstand heat to 120 degrees Fahrenheit. Similar types of oiled cloth material coated with oxidized linseed oil and impregnated cloth was treated with oil and asphalt.[8] Varnished cloth was superior to rubber because its breakdown point was at 150 degrees Fahrenheit in comparison to 120 degrees Fahrenheit for the latter. Oiled cloth with oxidized linseed oil and impregnated cloth treated with oil and asphalt were also used. The circular loom was a flexible tubing or duraduct used in difficult situations. A seamless tube of heavy cotton or canvas fabric was treated with an insulating compound rolled in mica dust before it was dried. Mica was an excellent insulator but fragile. It was commonly ground up and used in shellac binder to coat an insulating cloth or paper. Insulating paper was found to be good after treating it to exclude moisture. It had a high temperature limit of 185 degrees Fahrenheit. Its drawbacks were relative inflexibility and

[6] Ferro, M., Cook, M., _Electric Wiring and Lighting in Historic American Buildings_, 7.
[7] Ibid., 7.
[8] Ibid., 7-8.

lower resistance to moisture. Its chief limitations caused it to be used in conjunction with other fibrous materials as outer coverings. Japanese paper made of mulberry pulp was most common. Papers before the 1920s were treated with oxidized linseed oil or linseed oil with asphalt or resin and later synthetic resin products. In the 1930s, cellophane from wood pulp with a lacquer coating for moisture protection was the new insulation in use. Insulating yarns and threads were made into braided yarn using multiple layers for extra protection. The combination of cellophane and yarn insulated the conductors and were used before 1900, to combine two or more conductors in a single cable. There were several types of fibers in the braids. They acted as a final finish to both fiber-insulated and rubber-insulated wires. Cotton impregnated with asphalt was the most common insulation form and it was for more hazardous use. Felted asbestos was however the preferred material for this type of application. Cotton or silk thread spun onto the wire was less frequently used, and it was treated with paraffin or varnish.

Insulating tapes were woven cotton, silk or paper and came in a number of treatments. Varnishes, rubber compounds, or bituminous compounds were common treatments that varied greatly in their quality. Friction tape of the best grade in the early 1900s was made of fabric impregnated with rubber compounds. Many cheaper types were treated with bituminous compounds. Bituminous compounds were used extensively for interior wiring despite their inferior insulating quality. The tapes were supposed to be chosen to be compatible with the insulation of the wire to avoid chemical reactions between them. For example, oils or bituminous compounds applied to a rubber insulated wire would harm the rubber and break it down.[9] Fishing otherwise exposed wire through an existing structure was not a common practice after 1900.

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[9] Ferro, M., Cook, M., _Electric Wiring and Lighting in Historic American Buildings_, 8-9.

Rubber Compounds

Rubber insulation compounds were developed in the early 1890s and became the most widely used interior wiring insulation by 1900. They were known to have a relatively short life span. Early wiring systems used primitive safety precautions. A thoroughly waterproof system was essential and, in that case, rubber made up for its shortcomings. From the 1890s on, rubber and substitutes used had hardly any rubber in them. Pure rubber could not withstand abrasion or high temperatures. It had to be mixed with fillers and had to be vulcanized to be useable. Compounds of 20-40 percent rubber were the standard range.[10]

Pure rubber exposed to the air or sunlight for long periods oxidized back to its original sticky state. The vulcanization slowed this process. Once the high quality 30 percent rubber compound passed the working temperature limit of 140 degrees Fahrenheit, the insulation began to break down. The 120 degrees Fahrenheit code-approved 20 percent rubber insulation reacted the same way to heat in excess of 120 degrees Fahrenheit. Continued slow oxidation over time caused the rubber to become brittle with age. Once the insulation reached a deteriorated state, if it came in contact with insulating oils and bituminous compounds used in other electric system components a hazardous situation could develop.

Unequaled moisture resistance was a vital part of wiring insulation. The expense and deterioration of the insulation prompted the search for natural rubber substitutes in the late 19th century. Gutta percha, a natural gum similar to rubber was too rare to be economical, but was frequently used in expensive compounds into the 1920s. There were no satisfactory cost-effective substitutes developed in the 1920s. Cheaper wire insulation employed vegetable oils such as cottonseed, corn or colza oils that were vulcanized to extend the life of the rubber compounds. Kerite a compound of rubber and oxidized linseed oil was used with other vegetable oils that were vulcanized and used as a rubber

[10] Ferro, M., Cook, M., Electric Wiring and Lighting in Historic American Buildings, 8-9.

substitute. Other formulas using oxidized oils, paraffin, various resins and rubber shoddy, a by-product of old vulcanized rubber, were also developed. These substitutes lowered the cost, but didn't address the deterioration problems. Before the 1920s, molded mineral compositions resembling hard rubber were developed and could withstand double or triple the temperature that rubber could. But they were not appropriate for wire insulation. Not until the 1930s was a successful synthetic rubber produced. The synthetic Duprene had a molecular structure similar to rubber and did not become brittle with age or deteriorate when it came in contact with oil. After World War Two, thermoplastic insulations were developed and were more economical even though rubber insulated wire was still common into the 1950s.

Insulation problems were and are inevitable with accidental damage. Several levels of quality exist in a late 19th century system should have a thorough inspection for defects as there is a long list of possibilities of damage and hazardous problems. Even relatively recent wiring should be inspected. Common to all early systems is deterioration and brittleness through age and oxidation of the materials. Linseed oil and rubber compounds dry out and crack or separate at temperatures exceeding their maximum working temperature. This can instigate or aggravate deterioration causing insulation to fail rapidly after the maximum temperature is passed even once. Overheating from the improper fusing of a circuit to higher capacity than it was designed for could carry exposure to the wiring and mechanical support system components, or a contained fire in a nearby area could also damage the insulation.

Water penetration in poorly maintained buildings can destroy fibrous insulation that was originally placed in permanently dry locations. It can cause a short circuit anywhere deteriorated insulation on active wiring is exposed. Rusting ferrous metal conduits or raceways exposed to moisture can attack rubber insulation. Improper repairs or alterations using incompatible insulations also cause unexpected problems. Accidental damage to insulation such as cuts and abrasions of the wiring can produce hazards. Old rubber insulation left untouched may still retain its integrity even if oxidized, particularly if it's protected by metal armor or conduit. Moving or bending or strain to the wire may cause now fragile rubber to crack, turning a latent problem to an active one. Potential problems seem endless as wiring integrity can be threatened by seemingly insignificant flaws. Minor damage can be very dangerous if near a combustible material. Exposure of bare conductors may result in ignition of nearby materials through overheating, short circuiting or arcing.

Today rubber insulated wire is still made for special uses when extreme flexibility is required and relatively low temperatures are assured. The extra expense of rubber is undesirable for most wiring applications. Rubber withstands more bending and flexing than plastic and is not required in ordinary uses. Thermoplastics superseded rubber insulated wire. Most thermoplastic insulation goes to 140 degrees Fahrenheit without failing. It resists heat, moisture and attack by oils and chemicals. It has a life expectancy of forty years and is desirable for safety and long-term maintenance investment.[11]

Once these insulation types are studied, then it will be easy for the homeowner or the preservation professional to observe the wiring system and determine what insulation type is on the wiring, and what its relative age is. Once that is discovered, then the decision can be made as to whether or not the wiring system needs to be upgraded. The rule of thumb is that if a wiring system is more than forty years old, it should be upgraded because nothing developed up to the present day has been able to perform at maximum efficiency and safety for more than forty years. Some existing wiring can be left in place if its condition meets current codes. These same rules apply to the historic luminaires of the home.

[11] Ferro, M., Cook, M., Electric Wiring and Lighting in Historic American Buildings, 10.

Mechanical Systems

National Electric Code

The National Electric Code was established in 1897 and specified that insulation compounds be 20 percent minimum rubber. Rubber was costly, so there was much insulation made at this minimum level. The grade was not highly regarded despite code approval. It did not match the qualities of compounds of 30 percent, specifically Brazilian rubber. Typical fillers were talc, red or white lead, zinc oxide, chalk, or lamp black with a small amount of sulfur added for the vulcanizing process. To avoid corrosion the copper conductors were covered with sulfur to protect the rubber from chemical attack by copper, and were put through a tinning process before being coated. Rubber compounds applied to wires by extrusion or wrapping were then heated by steam to the sulfur's melting point causing the rubber and sulfur to combine chemically to form a stronger heat resistant material.[12]

The 1907 National Electric Code required rubber insulated wire for wooden molding. This type of system could no longer be used in damp areas. Wooden molding had limited code approval for decades, and was illegal by the 1930s. By the 1920s wooden molding was superseded by metal molding and was virtually obsolete by World War Two. Any wooden molding system in use was now considered hazardous. Homeowners needed to disconnect the system but could leave the moldings in place to retain the character the wood moldings provided.

Mechanical Component Systems Past and Present

In the 1890s concealed wiring systems were first introduced. Using the timeline (Fig. 12), the spans of usage of a particular system can be observed and then translated to the age of the structure in question. The predictions by insurance companies and municipal fire departments theorized that imminent catastrophes were present with

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[12] Ferro, M., Cook, M., *Electric Wiring and Lighting in Historic American Buildings*, 8-9.

Concealed Wiring Systems

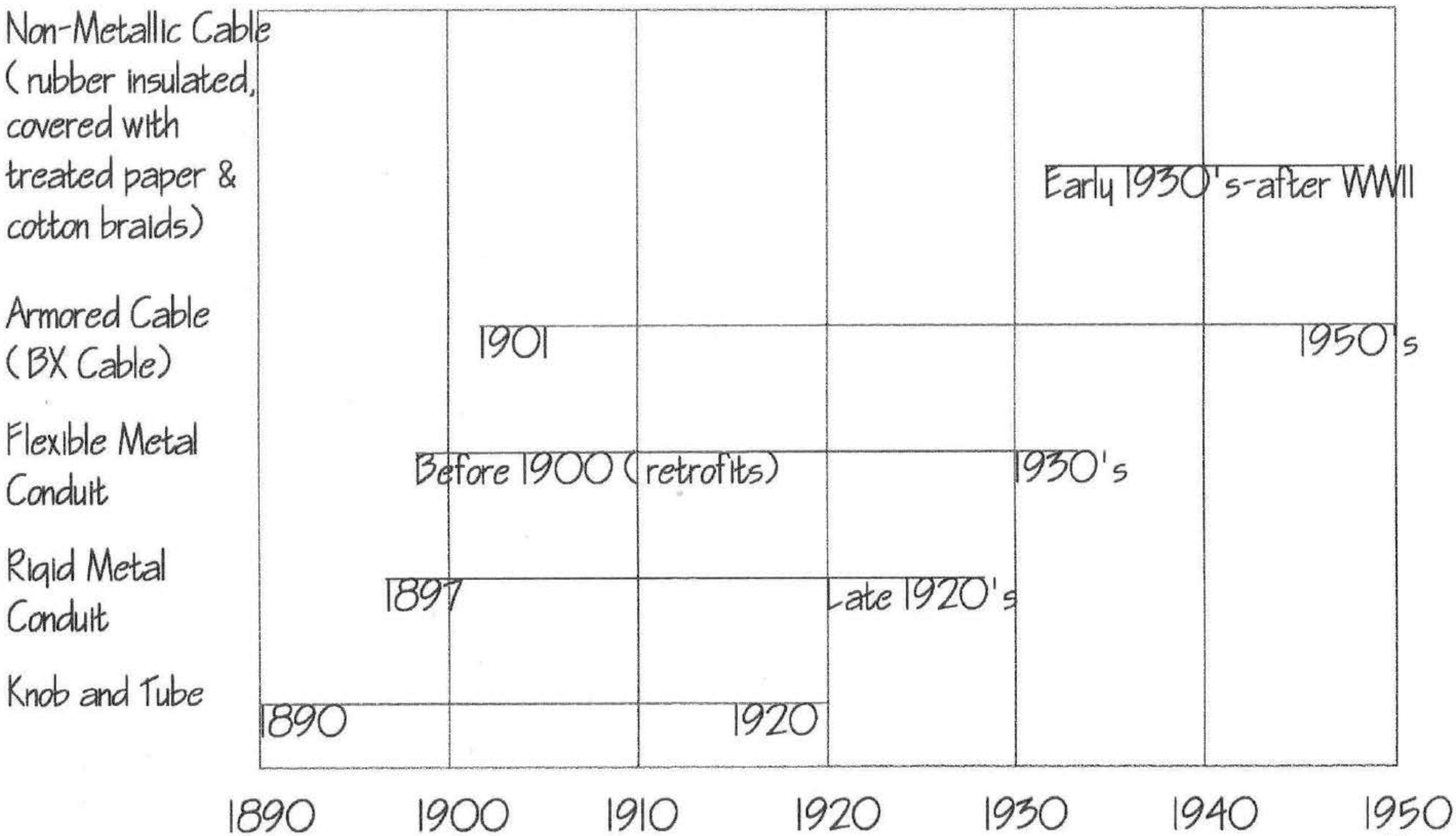

Fig 12

electric wiring.[13] They spearheaded a temporary fight against wiring in buildings and, by 1900, made several wiring systems illegal. Wiring was never cheap, particularly on a retrofit. The search for economy maintained the demand for less costly forms of wiring such as knob and tube long after the dangers were first noted. High-risk wiring situations surround ungrounded knob and tube wiring (Fig. 13). An ungrounded system is waiting for a source to act as a ground, and often it was the person trying to service the system who was not wearing proper protection.

Exposed Open Work

Exposed open work was the most obvious solution for a retrofit for a house built before concealed wiring systems were readily available. The uncertainties of this system made access a necessity. Two basic types were available, the first had wires carried on cleats above the surface of walls or ceilings and the second, a less stark version, had the wires carried inside surface molding.[14] Both types were the least expensive to install.

Wooden Cleats

Open work wooden cleats (Fig. 14) were used in the1880s-1890s. This was declared illegal by 1900, because of their extreme hazardous nature.[15] It was the cheapest form of wiring available. The exposure of the wires led to mechanical damage and short circuits. Wooden cleats had the additional danger of splinters cutting into insulation.

Porcelain Cleats and Knobs

A safer form of open wiring system came into widespread use in the 1880s on high tension circuits and was used in applications where appearance was not a

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[13] Ferro, M., Cook, M., Electric Wiring and Lighting in Historic American Buildings, 11.

[14] Ibid., 11.

[15] Ibid., 11.

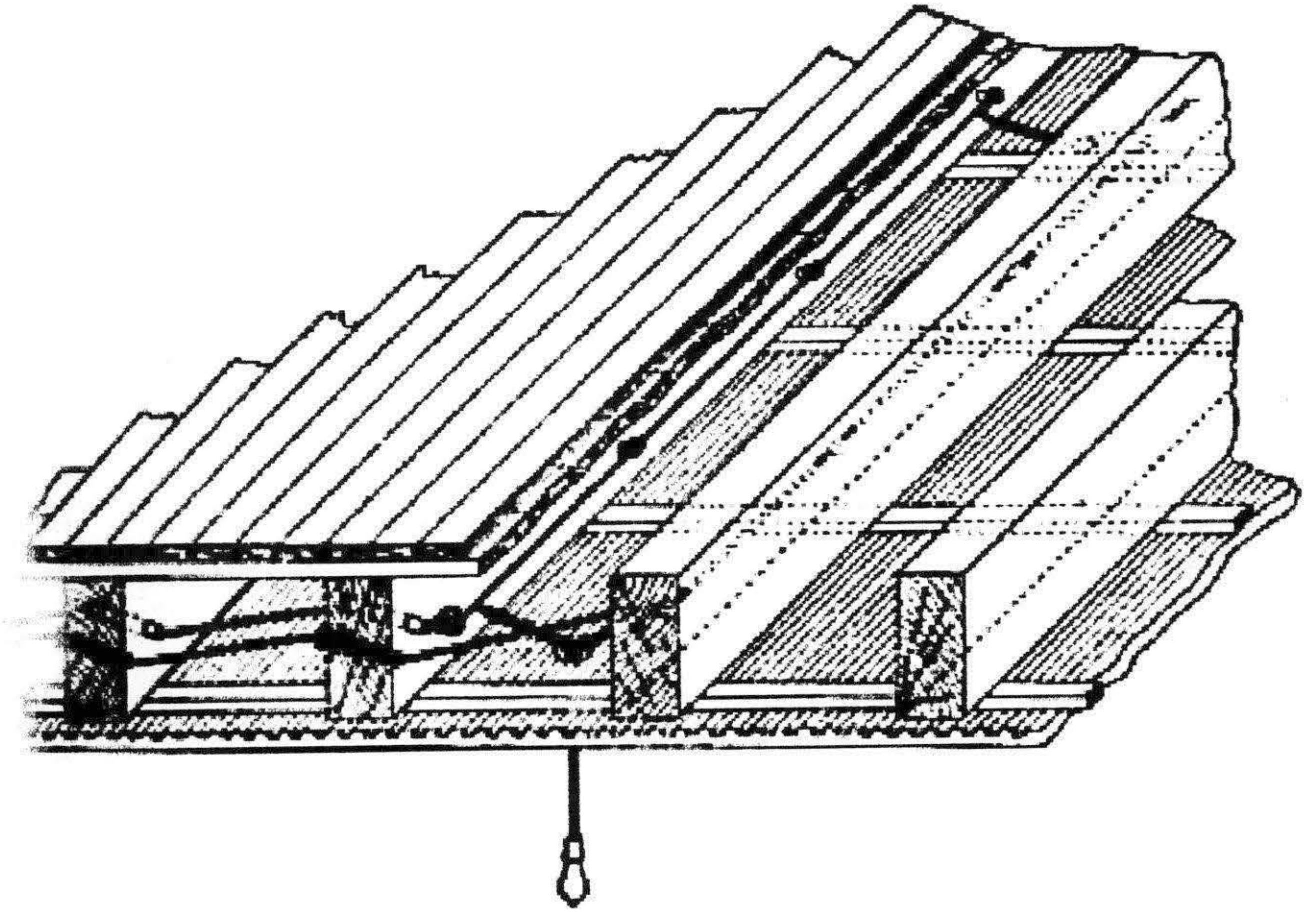
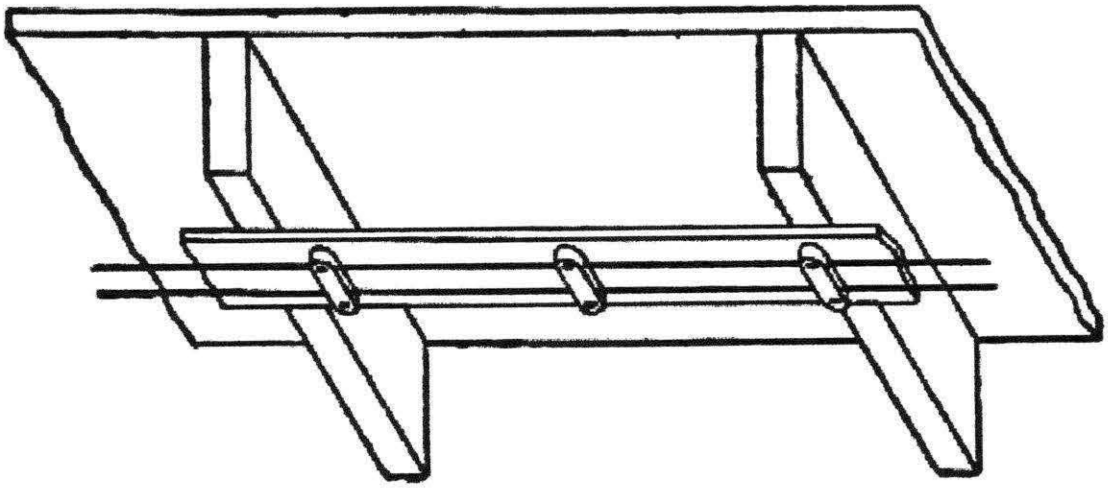
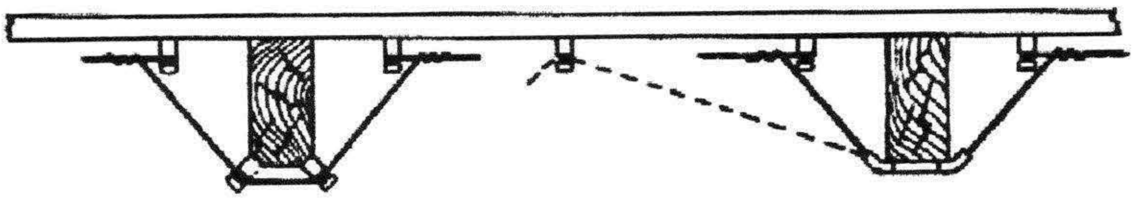


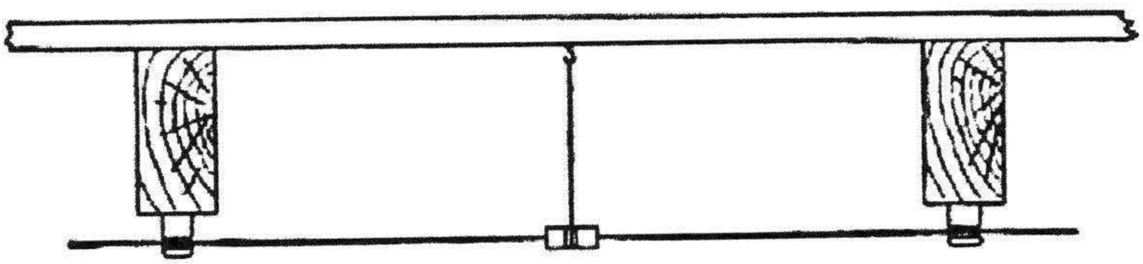
Fig. 13 Knob and Tube Wiring



Insulators Mounted on Running-Board across Wide-Spaced Beams.



Method of Supporting Small Conductors.



Intermediate Support for Conductors between Wide-Spaced Beams.

Fig. 14 Mounting Methods for Conductors

consideration. It was not found in most elegant building interiors. Sections often still exist in basements or attics. Part of knob and tube system's primary use was large commercial or industrial installations. Heavier capacity or frequent change made it necessary for the wiring to be run high up on walls or ceilings to minimize the danger. It cost about half that of rigid concealed conduit. Porcelain knobs were preferred over glass knobs because they were less breakable and less hygroscopic.[16] Knobs or cleats were split to carry two or three small wires (Fig. 15). Low tension circuits had heavier capacity conductors that were kept four to ten inches apart. Supports were required every 4 1/2 feet. It was vital to not let the wires sag into other wires or elements. Wires were required to have rubber insulation and damp locations had to use weatherproof fiber. Insulated wires in hot areas of interior open wiring systems were now only allowed for industrial and agricultural uses.

Surface Molding

Wooden molding concealing wires within was only slightly safer than wooden cleats-being in effect a continuous version of them. They were the most common form of wiring in the earliest period of electric lighting retrofits, or extensions of circuits, and had great popularity in domestic use because of the ease of installation and alteration. The exposed molding was simply run along the surface of walls or ceilings. It had a low initial cost because it was far less expensive than paying an electrician to fish wire through walls.[17] Wood molding concealed the wiring and was aesthetically pleasing. The molding consisted of backing with grooves to hold two or three wires and had a decorative profile similar to ornamental woodwork. Early wiring manuals advised attention be paid to the final appearance of an entire room as the molding was treated as trim. Symmetrically designed walls and ceilings were recommended with the wiring

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[16] Ferro, M., Cook, M., *Electric Wiring and Lighting in Historic American Buildings*, 12.
[17] Ibid., 13.

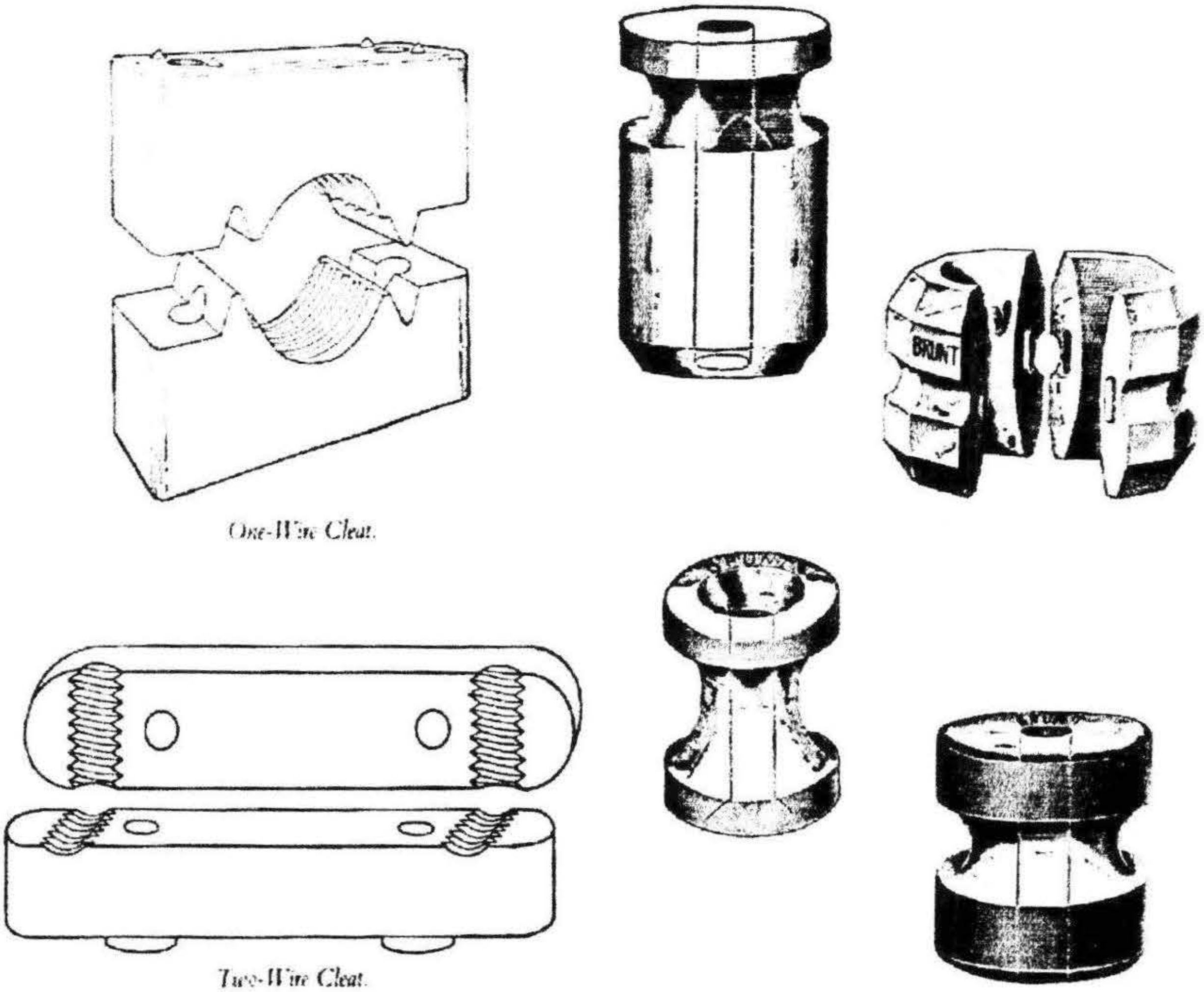

Fig. 15 Porcelain Cleats and Knobs

being laid only where necessary. The rest of the molding was left empty, however a big drawback was that it could be mistaken for decorative molding to drive a nail through to hang a picture. The wiring was conspicuous and consumers demanded the wood molding as camouflage.[18] Other integral problems included the easily crushed or punctured wiring. There was little protection against moisture unless all surfaces were coated. The combustibility of wood combined with overloaded conductors or leakage of current in the presence of moisture could pose a fire hazard. Rodents gnawing through wood and insulation produced similar results. Fire hazards were also aggravated by poor insulation practice. One short cut, used until 1900, had a groove capping and was fastened directly to the wall surface without backing. The situation was more dangerous than normal if the wooden molding or open exposed systems were applied to soft woods instead of code-specified hardwoods. Soft woods were about half the price and were more susceptible to moisture penetration and damage.

Metal Molding

Metal molding was developed in the first decade of the twentieth century but did not have much success until after World War One, when it overtook wooden molding as the preferred system of open work. It was most useful to extend existing circuits, but was not allowed in damp locations and rubber insulated wire was required. It was made of galvanized sheet steel in an oval or rectangular section that could hold two to four wires with separate backing with capping installed. After the 1920s, wire mold was introduced and the capping was crimped on at the factory and the wiring was fished through in the field making it an early form of conduit. It was an easy inexpensive installation-alteration and repairs now could be made with less bulk and more moisture resistance. It featured a two part construction and the nature of the materials used in metal molding meant it was foolproof. The National Electric Code immediately restricted its use to

[18] Ferro, M., Cook, M., Electric Wiring and Lighting in Historic Buildings, 13.

surface wiring to avoid the perception of comparability to conduit, as it would rust at the shear cut edges.[19]

Once these component systems are studied, then it will be easy to determine what the wiring system is in the house being examined. Most of the systems can be observed by surveying the rooms of the dwelling for surface mounted conduit, or looking at the moldings for the partially concealed systems. A trip to the attic and the basement will reveal if knob and tube wiring is present in the dwelling. The wires can also be traced back to the fuse panel to find out if they are still in service. Frequently, during a retrofit of a wiring system, the knob and tube wiring will be left in place, but disconnected from the service panel. This is done to maintain an historical record of the originally wiring system.

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[19] Ferro, M., Cook, M., *Electric Wiring and Lighting in Historic American Buildings*, 14.

III. Maintenance and Retrofit of Historic Lighting Systems

Introduction

This chapter is specifically aimed at those who are about to commence on the maintenance and retrofitting of the wiring system of an historic property. This chapter contains two parts, the wiring system components and the luminaires. Old wiring systems and their mechanical components can be fascinating to look at from the standpoint of trying to figure out what the electrician's thought processes were for installing the system, and the often found mechanical oddities therein. A timeline of the changes in the National Electric Code is also in this chapter for quick reference as to when certain components became mandatory and which ones became illegal to use. This information can be used to cross reference the age of the wiring determined in chapter two to determine which codes were followed by the initial wiring system, or a later retrofit. The same process applies to the luminaire's mechanical components. Before ripping a system apart, some troubleshooting techniques should be examined, especially the safety aspect. Too many do-it-yourselfers have found themselves in the emergency room with electrical burns or worse complications from trying to service their historic systems without adequately preparing for the task.

Another important aspect to consider is the routing of the wiring and which wires are supposedly hot or "neutral" and what the codes were for the time period when the house was built. Some dangerous systems were installed even after they were made illegal. As in any profession, there were always unscrupulous characters in the electrical trades.

By the standards of the National Register of Historic Places, a building is considered historic when it reaches the age of fifty years old. Where the NEC is concerned, the age of the building is not an issue, but the age, condition and legality of the wiring in a building are its issues and concerns.[1] It is important to select an

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[1] Shapiro, David, *Old Electrical Wiring: Maintenance and Retrofit*, 208.

electrician to rewire an historic building who is sensitive to historic character defining elements on both the interior and exterior, and who will make every effort to minimize any damage resulting from fishing wires through the walls.

Historic buildings come with an entire set of complications all their own when a wiring system is to be inspected or upgraded. The electrician needs to be aware of changes in the National Electric Code from the time the building was constructed to the present. An awareness of luminaire parts, restoration, cleaning and maintenance of luminaires should be part of their breadth of knowledge of lighting systems.

Health hazards from unlikely sources can have serious ramifications if they are taken too lightly and safety precautions not adhered to when working on a job. Humans aren't the only creatures that live in historic dwellings and sometimes unpleasant encounters can take place. Added to that risk is the complication of different electricians servicing the system at different times. Each of them had different skill levels, and work ethics, and a property owner never knows for sure what is lurking in the walls. In short, a competent electrician who is knowledgeable and sensitive to historic buildings is essential.

Historic Buildings

National Electric Code and Other Codes

Besides the code regulations of the NEC, there are other codes that deal specifically with historic structures. There are some grandfathering rules regarding existing wiring conditions that are discussed in the BOCA (Building Officials Code Administrators[2]) codes Section 103.0[3] published in 1990. In 1991, the ICBO (International Conference of Building Officials[4]) discussed this same issue in Section 104(f)[5] and concluded that within reason, existing systems can be upgraded. There are more formalized requirements for existing buildings set by the SBCCI (Southern Building Code Congress International[6]) in 1991 that permit the use and upgrade of existing installations, as long as they meet current code standards. Section 101.6 specifically references Special Historic Buildings.[7] In addition to these codes, there are local historic building codes that have been established by the states of California, Georgia, Wisconsin, Connecticut, Hawaii, Indiana, New York, North Carolina, and Pennsylvania.[8] The ICBO publishes a national code for historic structures titled Uniform Code for Building Conservation (UCBC). Section UCBC-4, "Electrical Guidelines," appears on pages 276-291 of the 1992 edition.[9] As of 1998 when this source was published, this code had not been updated. Not only should electrical contractors be familiar with these codes, but homeowners would be well advised to investigate these for themselves to quiz their contractors on their knowledge when they come to bid the job. Anyone can say they are sensitive to the integrity of historic structures, but this would be the acid test to see who is telling the truth.

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2 http://www.arcat.com/builcode.cfm

3 Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 208.

4 http://www.arcat.com/builcode.cfm

5 Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 208.

6 http://www.arcat.com/builcode.cfm

7 Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 209.

8 Ibid., 209.

9 Ibid., 209.

Old, Odd, Unsafe Equipment

When confronted with an antique luminaire, the wiring should be examined thoroughly to make sure it meets current code. This also means examining the internal mechanisms to make sure there is not rotted wire inside that has breached insulation so that the wire can touch the metal and make the entire luminaire hot. Another situation that can be complicated is the presence of wiring in gas lighting pipes that were left from a previous retrofit. The condition of the wiring and the homeowner's comfort level will determine whether the wiring should be removed from the pipes, which are usually made from iron.

Lighting switches are another consideration when rewiring an historic structure. Depending on the age of the building, certain types that are now being made in reproduction styles can replace newer unsightly switches added at later dates. The homeowner wishing to research this can reference *Electric Incandescent Lighting in Residential Interiors: Hardware and Systems, 1890-1910*, by Kevin Kraus.[10] Figures 36-46 illustrate the styles available and their respective dates of introduction to the public. Knife switches reminiscent of the Frankenstein movies can also be found in historic houses built into the 1920s (Fig. 16). Historic fuse boxes can also be a source of consternation as wires come into and out of them from all directions (Fig. 17) or a source of wonder (Fig. 18), if they were well made.

Dating Wiring

The most accurate way to date historic wiring is to investigate the NEC. For quick reference, the NEC timeline chart can be referenced for this information (Fig. 19). As technology developments were implemented, the NEC changed to accommodate those developments. Reading through the NEC can be a daunting task, but here are some highlights to remember. During the 1950s, the NEC specified specific numbers of

[10] Kraus, Kevin, *Electric Incandescent Lighting in Residential Interiors: Hardware and Systems, 1890-1910*, 27-30.

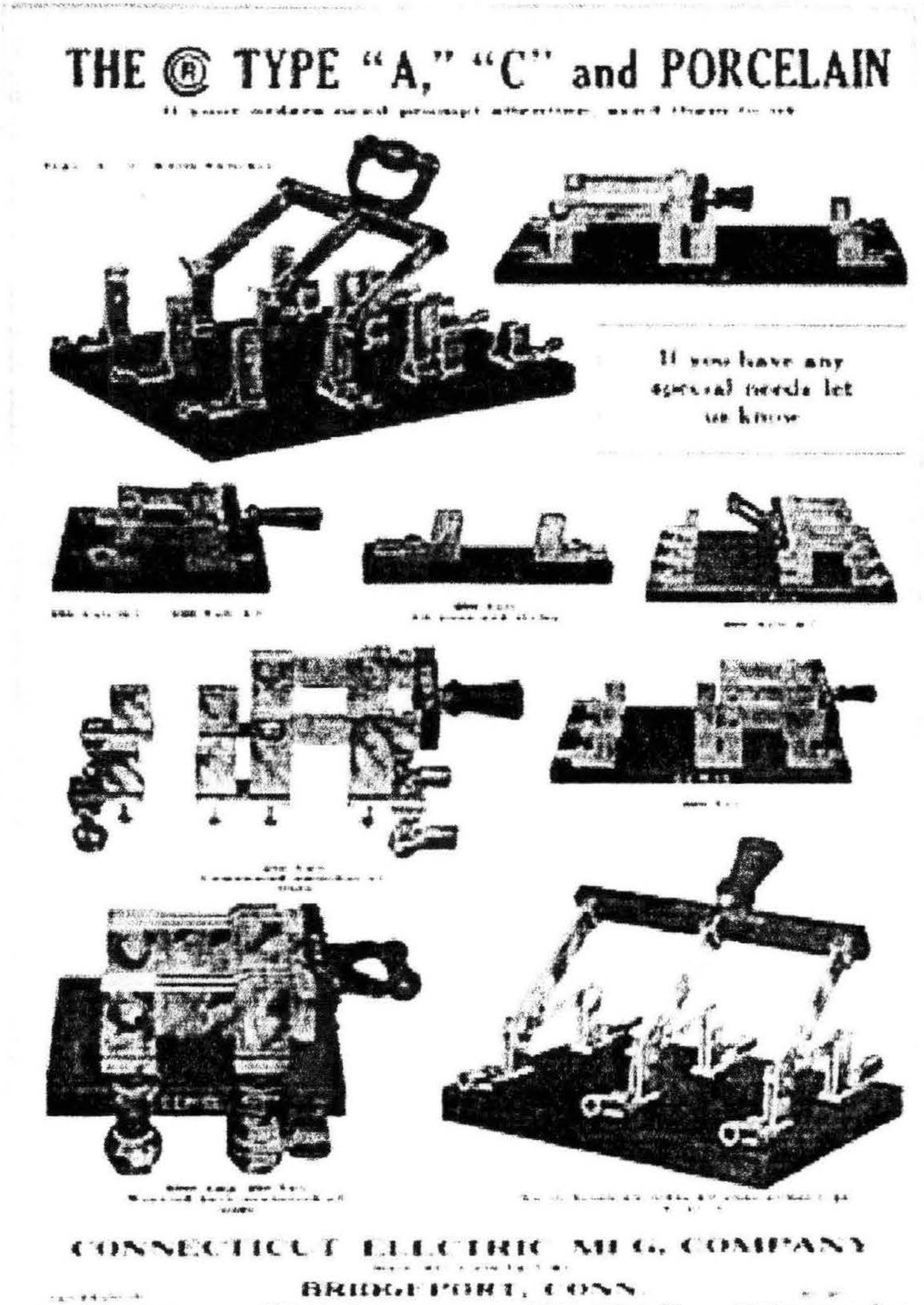


Fig. 16 Knife Switches: Advertisement of
Conneticut Electric Manufacturing Company, November 1918

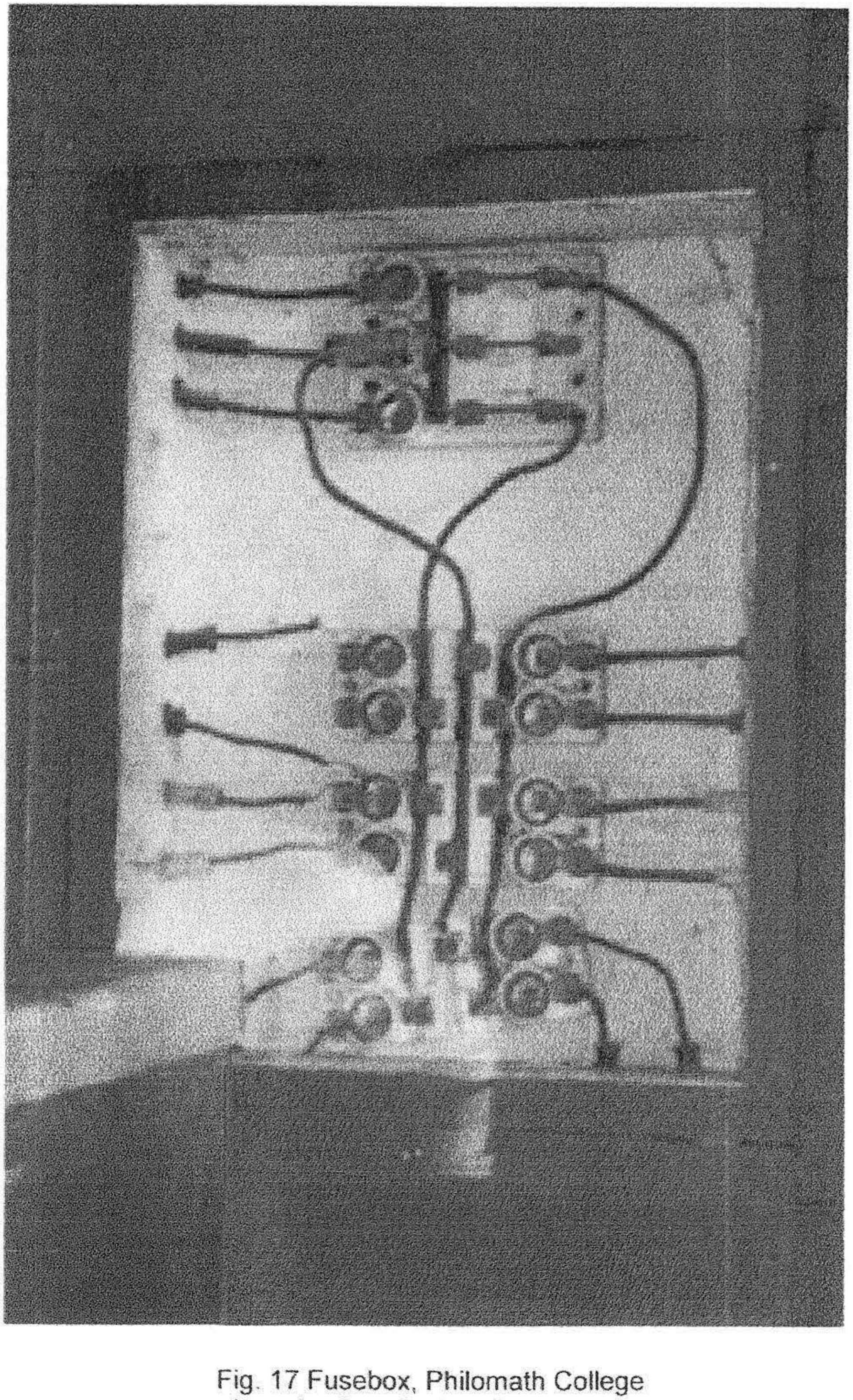


Fig. 17 Fusebox, Philomath College
(note knob and tube wires around
perimeter) 1904

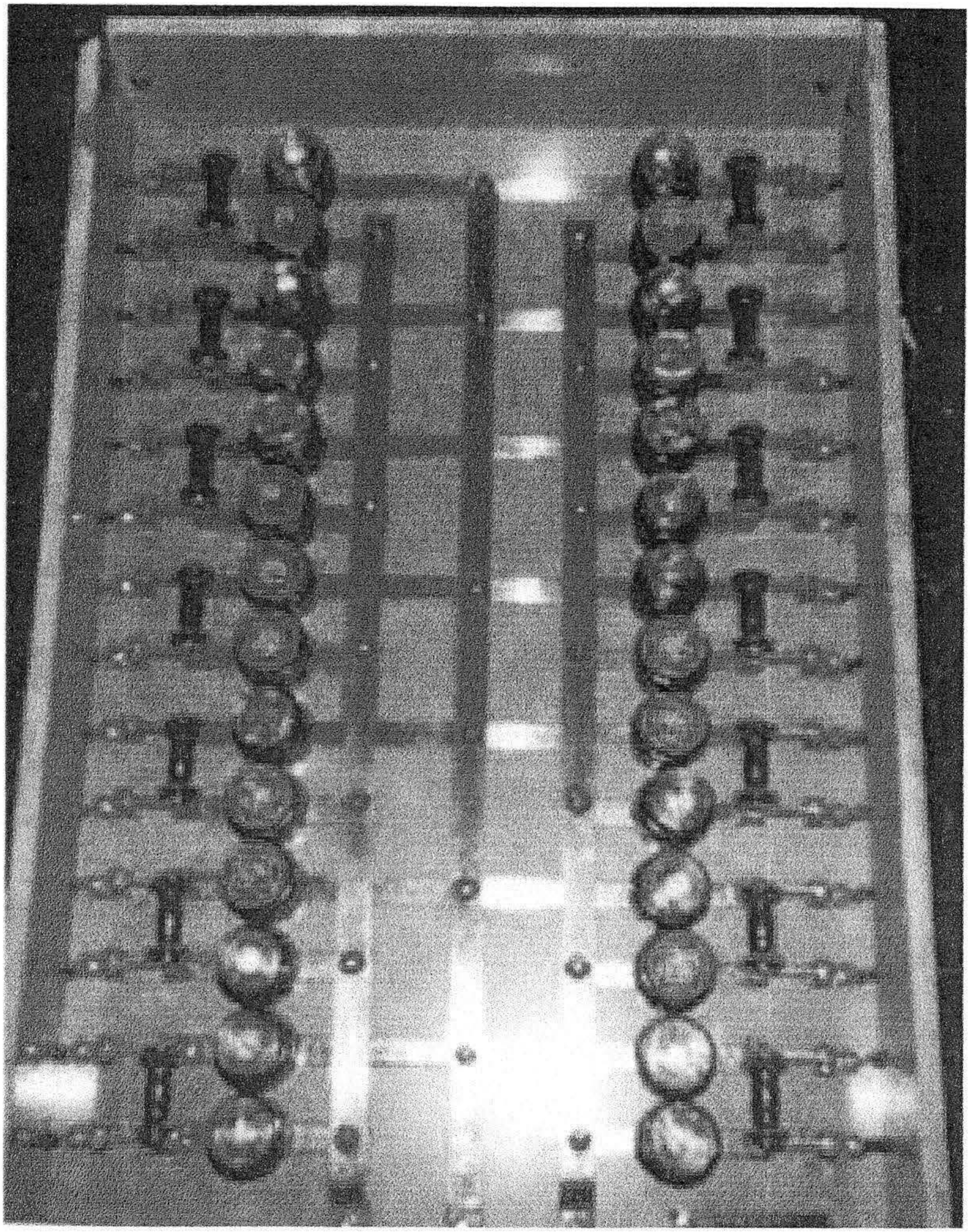
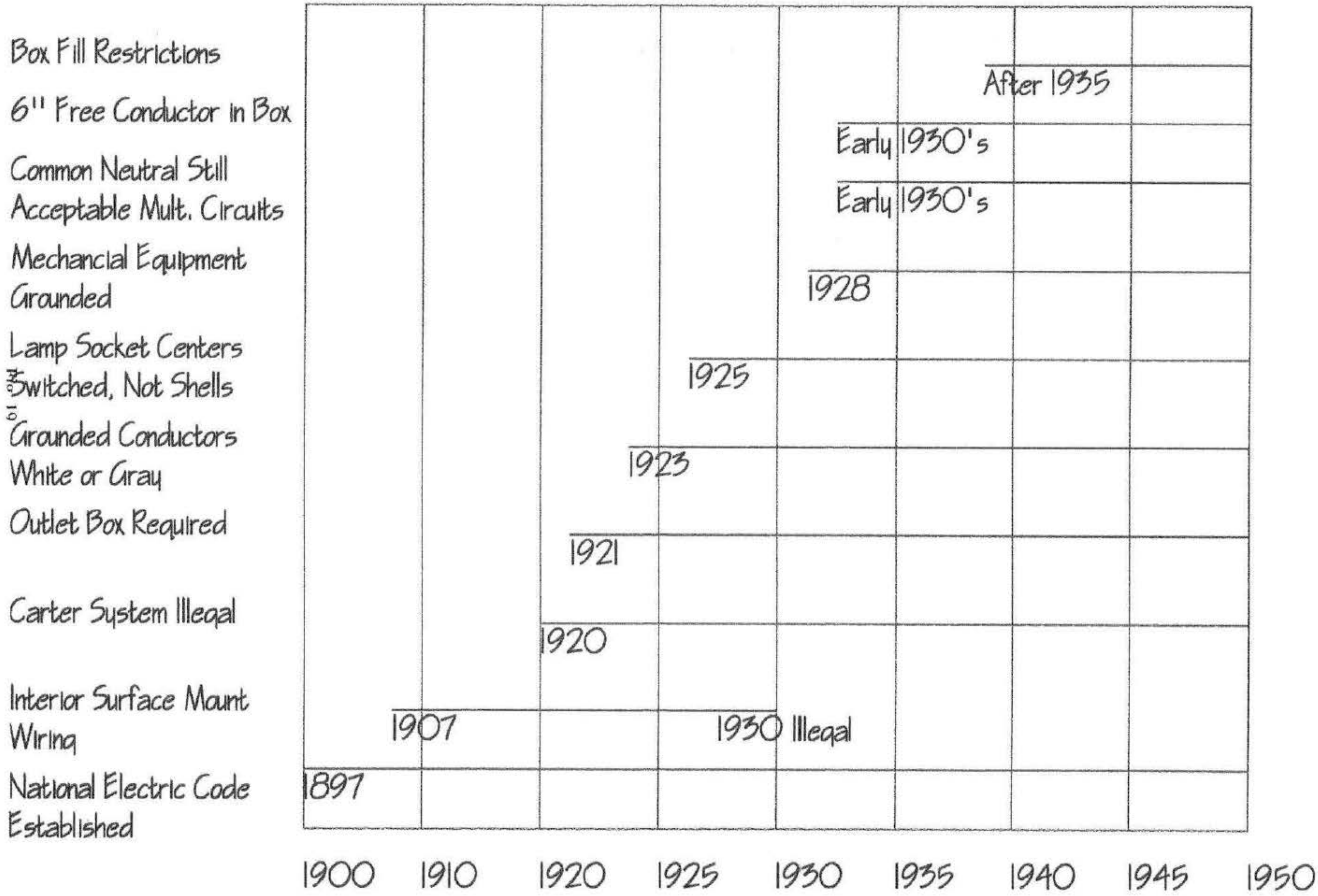


Fig. 18 Fusebox Le Chateau Boutin, Bayfield, Wisconsin c. 1910

National Electric Code Changes



switches, receptacle outlets and hard wired lighting luminaires per room. For example, habitable rooms were to have wall switches to control the overhead lights. Except for a dining room or bedroom, if a room's longer dimension was greater than twice its shorter, that room was to have two lights, regardless of overall room size.[11]

Another source of information predating the 1950s was the 1948 handbook, *The Electricians' Pocket Companion*, that taught the use of open wiring, knob and tube supports, and soldering for connecting conductors. Rubber was the insulation referred to in the manual.[12] It did mention the existence of solderless connectors and thermoplastic insulations. Backing up to the 1920-1937 period, the NEC wrote eighty-nine code changes for electric wiring.

Dates of National Electric Code Changes[13]

Significant changes are illustrated in the diagram of a room (Fig. 20) showing locations of what wiring components may exist in a typical structure built in the mid 1920s. The dates of the changes to the National Electric Code include:

- 1921: Each outlet now required a box, cabinet, rosette, luminaire block, or equivalent in addition to the device itself, except in some cases where knob and tube wiring was used.
- 1923: Grounded conductors now were required to be white or gray
- 1925: Lamp socket center contacts were to be switched, and not the shells
- 1928: Grounding was required for equipment in conductive locations such as basements or in walls containing metal lath, even if the equipment had been fed by knob and tube wiring, conductors in wooden molding, or nonmetallic cable lacking an internal grounding conductor
- The grounding conductor no longer could be soldered to the grounding electrode

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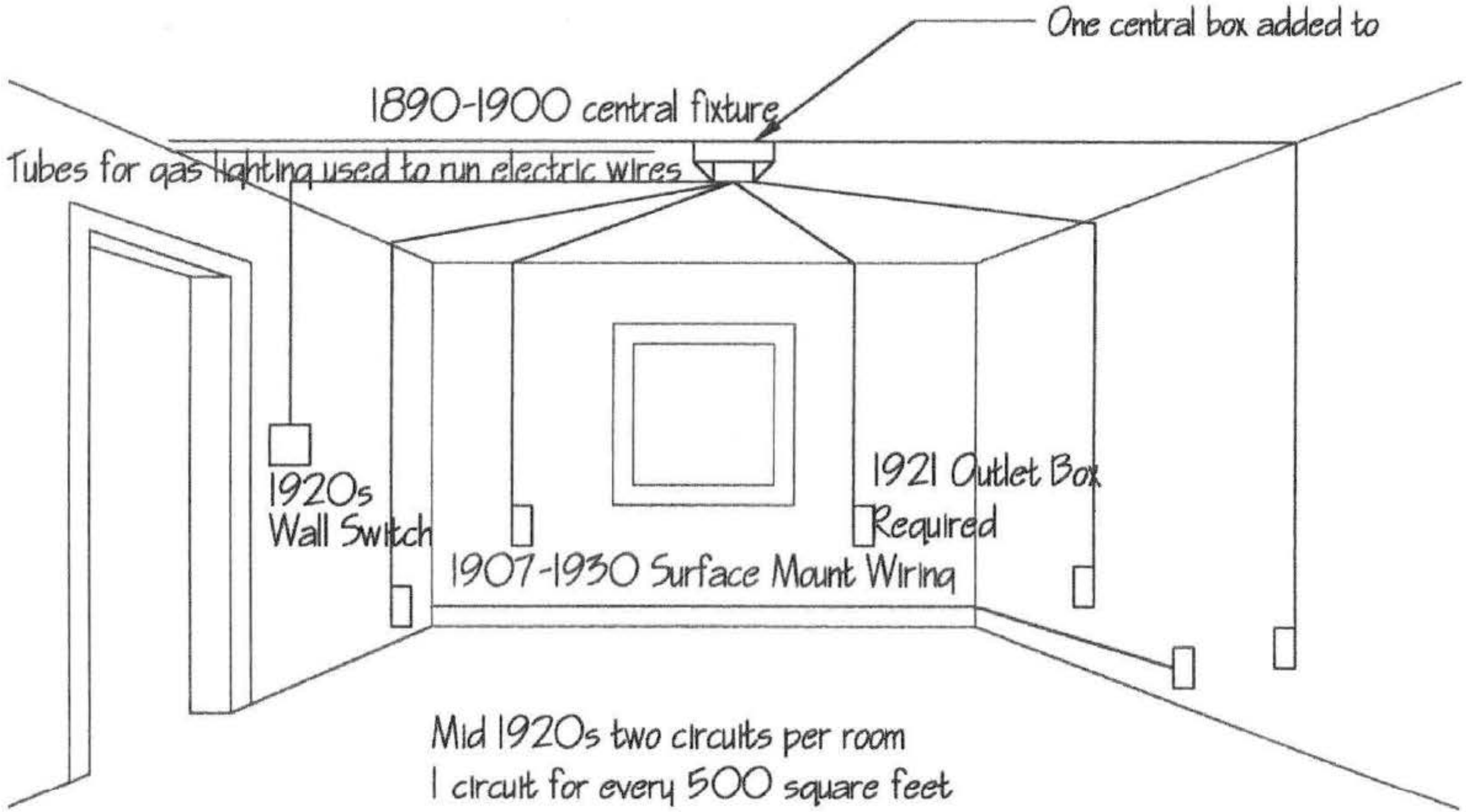
[11] Shapiro, David, *Old Electrical Wiring: Maintenance and Retrofit*, 266.

[12] Ibid., 267-268.

[13] Ibid., 268-272.



One central box added to
1890-1900 central fixture
Tubes for gas lighting used to run electric wires
1920s
Wall Switch
1921 Outlet Box
Required
1907-1930 Surface Mount Wiring
Mid 1920s two circuits per room
1 circuit for every 500 square feet

Fig 20

- Electricians were already required to use white and gray for the grounded conductor. Use of white and gray for other conductors was now made illegal. Switch loops had to have their white conductors reidentified at both ends.
- A new requirement was introduced: where possible, bored holes were to be kept 2 inches away from edges of wooden structural members.
- The NEC required a bare copper ground wire in new nonmetallic cable. In many jurisdictions, though, this simply did not happen.
- The 40% maximum fill rule for conduit was changed from a recommendation to a requirement.
- Early 1930s: A common neutral, appropriately sized, was still acceptable for a number of circuits; they did not have to originate from different busbars.
- There still were no restrictions on box fill.
- The rule requiring six inches of free conductor was introduced.
- After 1935: Locating cutout boxes over tubs and showers was adjudged okay, so long as the enclosures were weatherproof and readily accessible (and their doors were secured with adequate latches)
- Box fill restrictions now were in place; for instance, a maximum of eight #14's were permitted in a 3-1/4" box.

Troubleshooting

Safety

It is very important when dealing with an old electrical system in a house, that one does not assume that the wiring was installed to today's standards and codes. A prime example of this is the use of the "neutral" wire. In modern systems, this wire is white or natural gray, and is not live until you flip a switch. In old wiring systems, the wires can be hot, and one could sustain significant injury if the wire insulation is breached. In old wiring systems, the correct name for this wire is "return conductor."[14] The most important thing to remember is old insulation is the enemy and should be treated with extreme caution. To complicate matters further, in old wiring systems the return conductor may not be white or gray, it may be black like the hot wire.

Before getting near an old electrical system, dress for safety. Wear goggles or safety glasses in case of arcs. Second, put on heavy gloves to protect the hands, and be sure that, when near the wiring, give significant clearance from the wires, as they can electrocute any unprotected part of the body that comes in contact with them. The senses are the best detective to track down problems. Listen for popping or crackling sounds in the wiring, and sniff the air for a burned wiring smell. Go through the house and smell at all the outlets and switches for the odor. It is a very distinct smell, and hard to miss. Charring on the outlets and switches is also an indicator of problems.[15] Turning on lights in the house and watching how the lamp behaves can also be an indicator of problems. If the light flickers, or comes on with low power, the wiring could have a problem. On the other hand, it could be a faulty bulb. This can be tested without significant risk, unless one sticks their finger into the socket. Even though the light switch is in the off position, the wires to that socket can still be live. Also keep in mind, that if the luminaire is older than 1925, the lamp socket could be hot, instead of the button on the bottom of it.

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[14] Shapiro, David, *Old Electrical Wiring: Maintenance and Retrofit*, 11.

[15] Ibid., 12.

Deterioration of Wiring and Wall Switches

Fatigue is often the culprit in deteriorated wiring. The causes of this are usually thermal expansion and contraction over an extended period of time. Insulation becomes dry and brittle, and if the wires are moved to replace receptacles and light switches the insulation can break and create a dangerous situation.

Switches wear out and they are often the most easily remedied troublemakers. Eventually, the spring inside the switch breaks or the contacts pit. However, if the house contains old mercury switches, they are not a likely culprit because they do not draw arcs in the way that snap switches do, nor do they burn contacts or have springs to break.[16]

In some old systems, the electrician would strip away some insulation from the wire in the junction box to attach the switch, and continue the wire to another object instead of terminating the wire on the switch terminal. There are four common problems with this method: if too much insulation was stripped, bare wire in the box can create a safety hazard; if too little insulation was stripped, the terminal screw may not have proper contact with the copper on the switch terminal; if too little insulation was stripped, the wire is often not properly wrapped 2/3 to 3/4 around the screw; and lastly, if this method was used, often the electrician did not leave the required six inches of wire within the box to work on to remove the switch.[17]

Sockets for lamps are also another frequent culprit for wiring problems. Excessive movement of the wiring while changing lamps can weaken the insulation. Contact for the lamp is made through rivets which can corrode or loosen. The switched lead runs to the center of the socket where there is a "button" that can wear down over time or corrode, making for increased resistance. The heat generated by incandescent lamps in the luminaires can cause fatigue on the insulation, causing it to fail. The outlet boxes for lighting in older houses often serve as splicing junctions for other lights on the

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[16] Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 15.
[17] Ibid., 16.

circuit, and the receptacle outlets in the room.[18] When wiring was first used in houses, it was thought to only serve for lighting a room, and not running other things from receptacle outlets. Often the wiring would be run to the outlet box on the ceiling, and a pull chain light was installed as the means for lighting the room. As other electrical devices were invented and receptacles were needed, they were usually spliced in from that one ceiling box in each room and run down the walls. These boxes often became overcrowded with wiring splices, and as the wiring ages and the insulation deteriorates from the heat of the lamp just below it, problems of significant proportions can develop. In the oldest of homes that had gas lighting, sometimes the gas pipes were used to run the wiring, making inspection and diagnosis more difficult.[19]

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[18] Shapiro, David, _Old Electrical Wiring: Maintenance and Retrofit_, 17.
[19] Ibid., 17.

Hazards

Special Risks

Electrical work has inherent dangers including defective or misapplied components that can cut, burn, bruise, poison, stab, twist, gouge, shock, or blind anyone nearby. There are also a considerable number of non electrical hazards to watch for including: dust, plaster in various forms including powder, chunks and slabs, sawdust, termite castings, cockroach castings and eggs, mouse feces, rockwool, asbestos, old newspaper, crumbled wire insulation, nails, tools, former food, sand, stripped cable armor, dead light bulbs, broken glass, pens and pencils, scraps of sheet metal, used tissues, and pieces of brick.[20] Always wear a mask and eye protection when working in attics and crawl spaces. Breathing airborne particulates of these hazards can produce serious lung problems.

Old Work

Dealing with old existing wiring includes the problems associated with dealing with no specifications as to how the wiring was done, and whether the original electrician cut corners employing such methods as the Carter System, or other dangerous or illegal wiring. Also, unscrupulous homeowners can try to blame the current electrician for problems that exist, claiming that the electrician created those problems. Other problems that the electrician can encounter can come from his own crew, such as having someone who is not well experienced in old wiring and the dangers associated with it. Having a bull in the china shop is a bad idea any way you slice it.

Added Threats to Safety with Old Wiring

There are three great threats associated with old wiring. First, old systems are likely to show signs of deterioration, and electrical shorts and dangers are abundant. Second, the longer a system has been in use, the more likely that more than one person

[20] Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 25-26, 339.

worked on it, and their competence levels can vary greatly. Third, old wiring contains things that are not up to code, and can be very dangerous, as specified by NEC standards that may not have been followed when the system was installed or upgraded over time.[21]

Other Dangers Addressed by OSHA Standards

OSHA (Occupational Safety and Health Administration) standards cover problems that can be encountered when working in historic environments. First, lead poisoning from exposure to lead paint can lead to brain damage in infants if they are present in the house that is being repaired. Pneumonia and other respiratory problems can develop from breathing fumes in the air from bird or rodent droppings that create a fungus that develops in the lungs. These respiratory illnesses cause death in 1%-5% of infected people.[22] Lung cancer from exposure to asbestos can happen as well. The risk of exposure comes when asbestos insulation on pipes is being chopped up or removed.

Rational Responses to Health Hazards

When a homeowner is faced with these health hazards, the best course of action is to discuss the problem with the general contractor to make sure they have consulted an industrial hygienist to determine the proper abatement measures for each problem present. Consulting the local Environmental Protection Agency people can also help ease the homeowner's anxiety over these issues, as they can offer practical solutions to these issues.

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[21] Shapiro, David, *Old Electrical Wiring: Maintenance and Retrofit*, 340-341.
[22] Ibid., 344.

Specialized Issues

The Carter System: Recognition and Drawbacks

This system was made illegal in 1920 by the NEC (National Electric Code) but was illegally used long after that. The premise of the system is that the hot and return conductor are alternately switched creating a "lazy neutral"[23] (Fig. 21). What was the purpose of this system? An electrician would add a second switch to a room that was already served by one switch, or install a wall-switched luminaire where a pull chain lamp had been. He would have used the least amount of wiring to save time, and therefore, the wire could be hot on either the hot side, the "neutral" side, or both. In short, polarity goes out the window when this system is encountered.[24]

Recognition of this system can be done by examining the switches in a room. It can be found most often where two or three switches are mounted together in a panel. This is called ganging.[25] This was done to reduce the number of travelers (separate wires for each switch) and one hot and one ground wire could be used for all of them. Inspecting the switches to find out if this is present, look for two or three terminals to be wired together between the switches. If splices are present, or the switches are wired in a daisy chain configuration, then the Carter System is present.[26]

Besides the loss of known polarity in the wiring system, there are other drawbacks with this system. With the current going back and forth between the hot and ground wires, induced current can be developed, creating a heat buildup in the wiring, connectors and electrical boxes. This results in a choking effect on the wiring and creates an undervoltage situation.[27] Another problem that can occur is the exposure to humans of the electromagnetic field of such a wiring system that can create bad health results, even

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[23] Shapiro, David, Old Electrical Wiring: Maintenance and Retrofit, 17

[24] Ibid., 56.

[25] Ibid., 59.

[26] Ibid., 59.

[27] Ibid., 65.

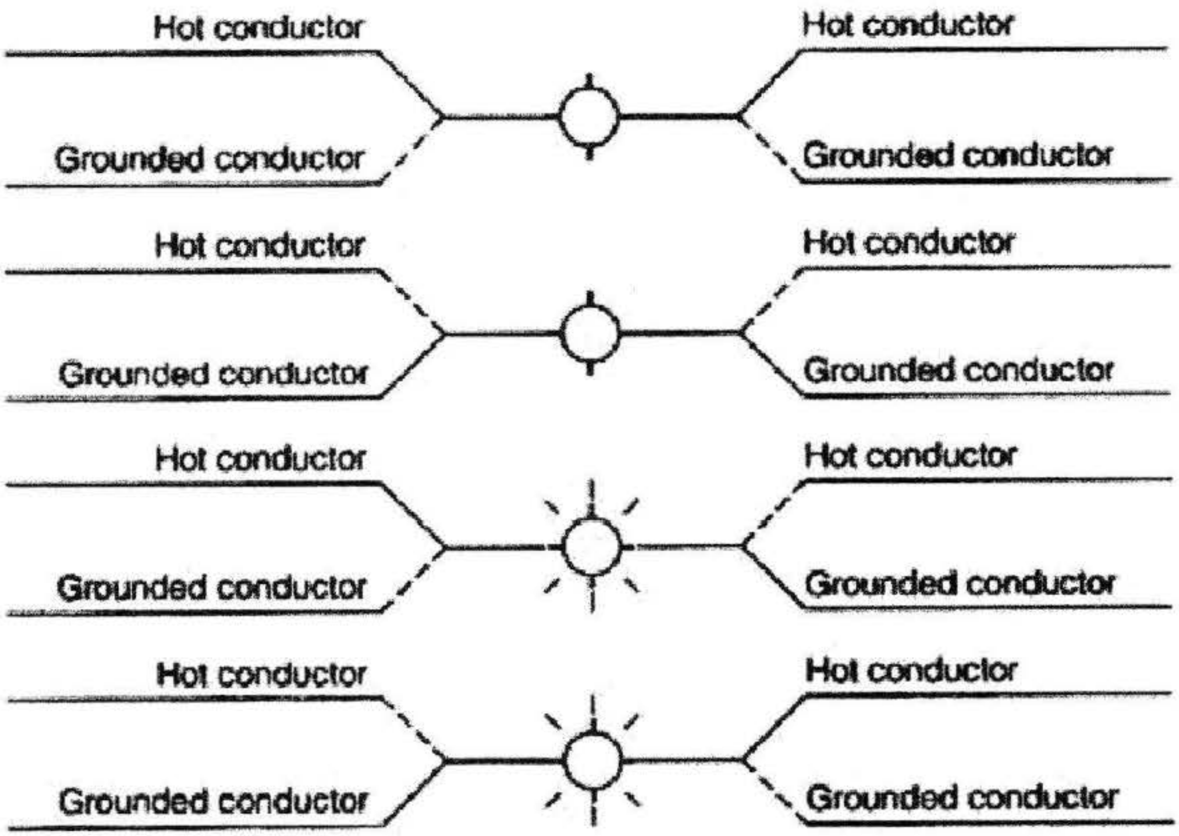

Fig. 21 The Carter System (note the dashed lines indicate current path with light on/off)

cancer, as the room becomes the inductor in the electromagnetic field.[28]

[28] Shapiro, David, _Old Electrical Wiring: Maintenance and Retrofit,_ 65-66.

Luminaire Restoration and Maintenance

Ceiling Luminaire Parts

The termination point of a retrofit of an historic wiring system is the luminaires. If a house has been well cared for over the years, the luminaires may still be intact and functioning. That doesn't necessarily mean they are safe though. The mechanical components should be carefully inspected for signs of wear and possible safety hazards. After going to the trouble and expense of overhauling the entire electrical system of the house to make it safe, it would be a tragedy if the luminaire components were overlooked in the process, resulting in a catastrophic loss from an electrical fire. Before discussing the restoration of luminaires, it is important to have a basic knowledge of the ceiling luminaire parts. If a piece that is needed is missing, the owner of the luminaire would then be able to adequately communicate with a restoration shop as to what part is missing. When looking at the ceiling, the place where the wires come out is called the junction box. If the house was built before 1921 and the wiring system has not been retrofitted at any time, the chances are there will be no junction boxes where the ceiling luminaires are attached. These must be installed first before the luminaire can be put in place. Next, a steel crossbar with steel nipples has to be attached to the junction box to secure the luminaire to the ceiling. Then the decorative part that is placed against the ceiling can be installed. This is called the canopy and from that will either be a chain or a pipe leading to the rest of the luminaire ending at the bulb sockets (Fig. 22).[29] For portable luminaires, the sequence of parts from the base of the lamp include the lamp

[29] Newman, TR., J. Newman and L. Newman, *The Lamp and Lighting Book*, 34.

ixture Elements

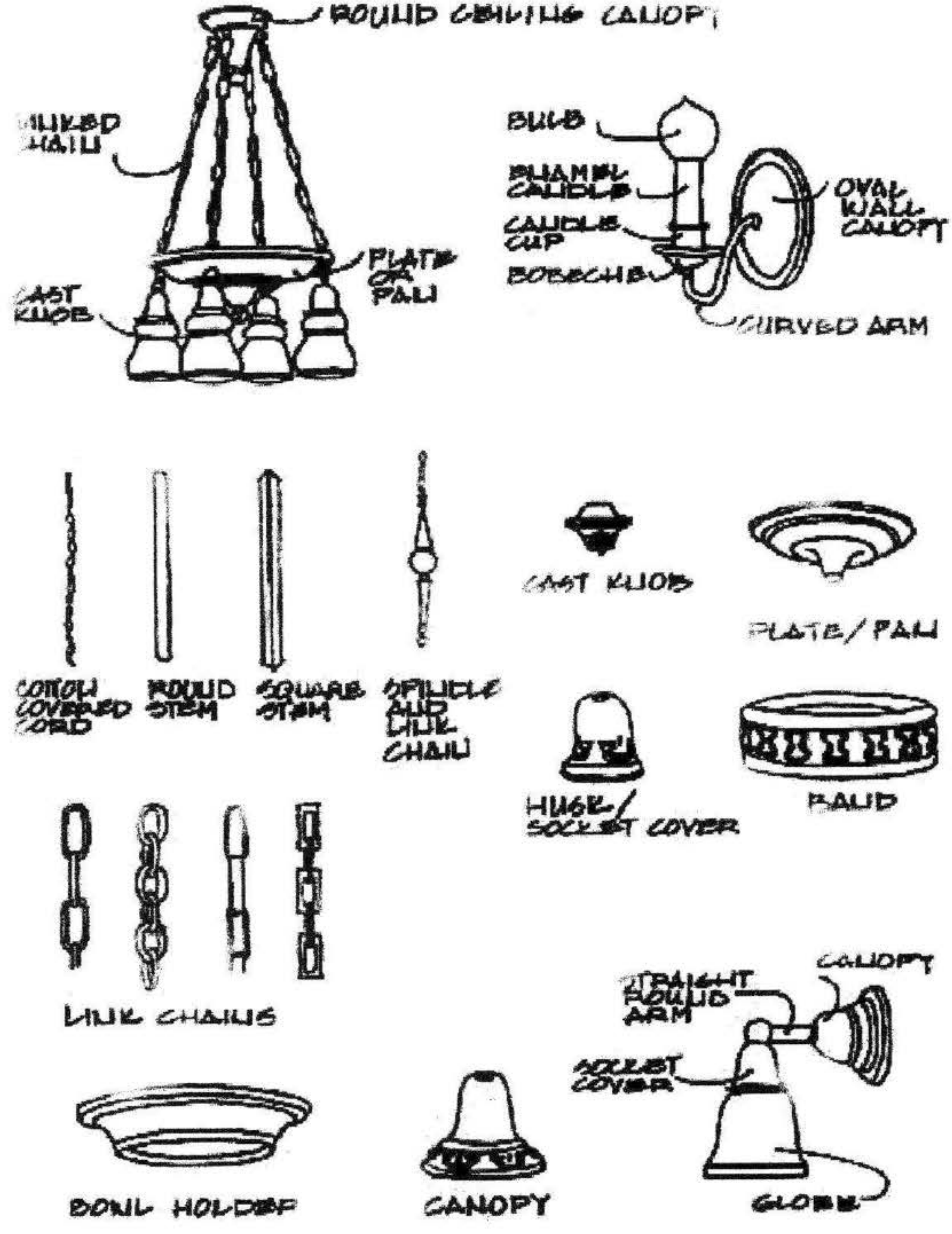

Fig. 22 Luminaire Elements, Canopies, Chains, Bases

cord, the bulb socket, the harp (a curved metal piece that surrounds the bulb) and the finial at the top to secure the lampshade in place.

Restoration

There are now several companies that will restore antique lighting luminaires. The electrical parts in the luminaire should be the first consideration. If the wiring is old enough that the insulation is cracked and compromised, then the luminaire should be rewired. Interior luminaires used cloth covered cords until after World War II when thermoplastic insulations were developed. The condition of the bulb sockets should also be inspected. If they are worn, or if they have turnkeys that are broken, they will need to be replaced as well. If the luminaires in the house are older than 1925, special care should be used when handling the bulb sockets of these luminaires. The National Electric Code specified that after 1925 lamp socket center contacts were to be switched, and not the shells.[30] Often metal parts will be broken or missing, and need replacement.

Cleaning and Maintenance

Different luminaires are made of different kinds of metals, and have different kinds of finishes that react differently to chemicals. Polished unlacquered brass luminaires should be dusted with a soft cloth. They can be cleaned with mild soap and a soft cloth if they've become really grimy. Nonabrasive household brass polish can be used if a bright finish is desired. Polished lacquered brass, matte antique brass, burnished antique brass, brushed brass, mottled brass, antique pewter and gilted luminaires can be cleaned with a damp soft cloth. Use a very mild soap on a damp cloth if the luminaire is really dirty. Never use brass polish on lacquered luminaires as it will damage the lacquer. Polished nickel and brushed nickel can be cleaned with a little household ammonia. Fingerprints from handling or changing bulbs in a brushed nickel luminaire can be easily removed with household ammonia as well. If the metal of the luminaire is green and black, called a verde finish, that can be gently wiped with a soft dry cloth, but only when necessary. Black enamel luminaires are best cleaned with mild soap and water. Repaint any worn or chipped spots as needed as bare metal will soon corrode if exposed to the weather. Mottled copper is finished with wax and should only be dusted with a soft dry cloth. Porcelain luminaires may be cleaned with mild soap and a damp cloth. Polished aluminum luminaires should be dusted with a soft cloth. Non-abrasive household metal polish can be used to shine up any dullness that might develop over time.[31]

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30 Shapiro, David, *Old Electrical Wiring: Maintenance and Retrofit*, 339.

31 *Care Instructions, Rejuvenation Lamp and Luminaire Company*, 1.

IV. Stylistic History of Luminaires and Prominent Designers

Introduction

It is important to note that when dealing with a rehabilitation of an historic structure, some knowledge of art history is indispensable. Therefore, when dealing with different period structures and rooms, a knowledge of what would have typically been there is important to recreate an accurate ambiance for the room. Using the integrated timeline and the stylistic timeline (Fig. 23), one can observe the changes in technology that coincided with the changes in style. For example, in the 1920s, Art Deco became the popular style in architecture and interiors. This was the first major departure from traditions of the past. The demands for streamlined designs affected the use and placement of luminaires. Better wiring insulation types were also being developed that made running the wire in awkward spaces such as lighted cornices possible, as the hot and return conductors could be put into one cable making the work much easier. Also looking at the NEC changes during that decade would be very helpful, as the 1920s were one of the biggest decades of code changes. Once all these factors are identified, then it makes retrofitting the wiring system much easier as the electrician will know what to expect in problem areas. The type of lamps used within the luminaires will also affect the ambiance created (see Chapter One for lamp types) for the period room. This chapter reveals the different major architectural movements being practiced during this time span. The illustrations include the types of luminaires that went with the architectural styles, and the interiors that were created to complement them. The reader can examine the design embellishments of the luminaires and see they emulate the architecture and interiors that surround them.

Not only does this chapter help determine what type of luminaires to use and/or select, it also helps the serious collector determine what to look for when purchasing antique luminaires. There are several manufacturers of reproduction luminaires that now produce quality pieces. That, in turn, to the casual observer makes them hard to tell apart

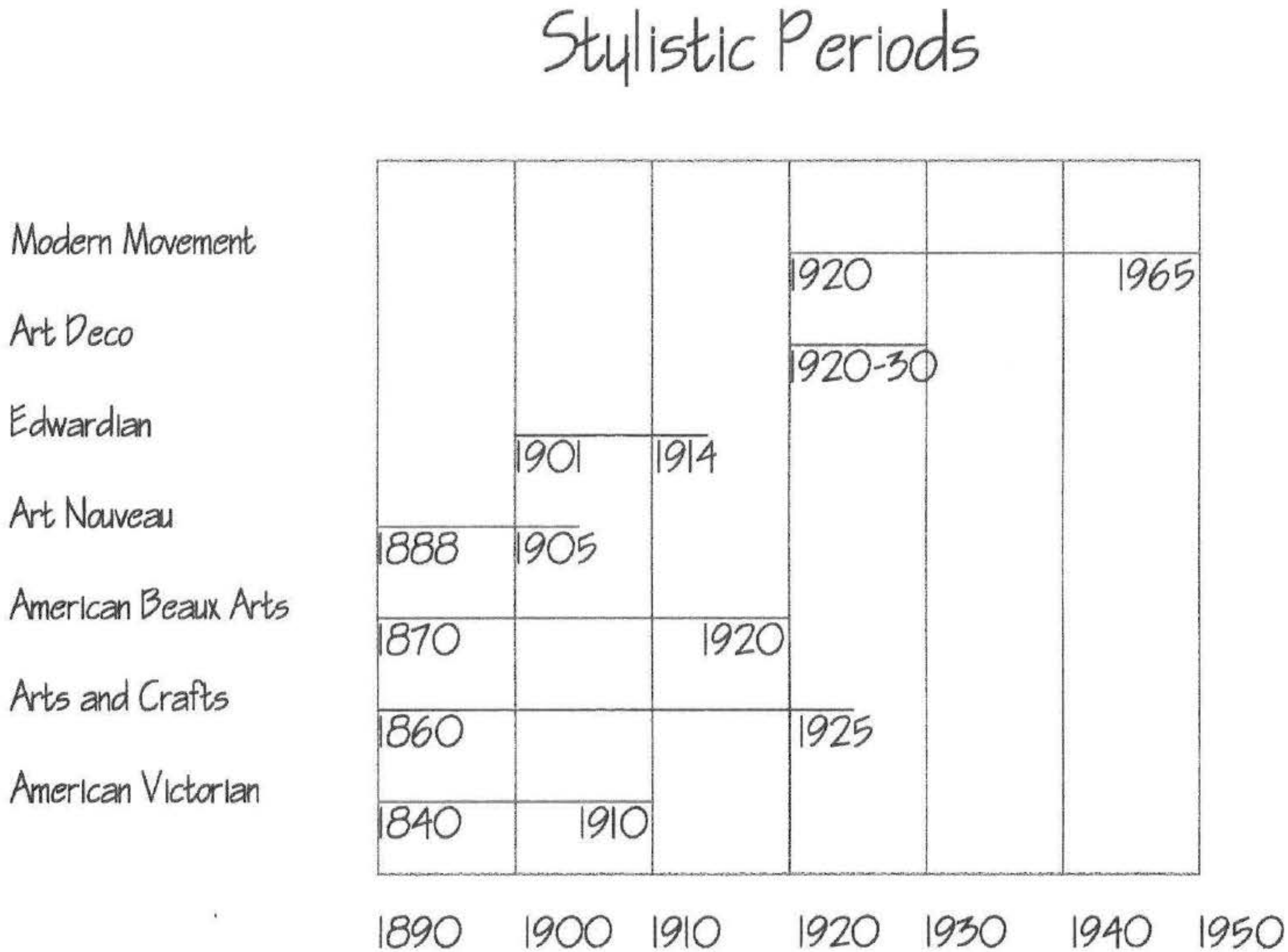
Stylistic Periods
Modern Movement
Art Deco
Edwardian
Art Nouveau
American Beaux Arts
Arts and Crafts
American Victorian
1920
1965
1920-30
1901
1914
1888
1905
1870
1920
1860
1925
1840
1910
1890
1900
1910
1920
1930
1940
1950

Fig 23

from the trademark and hand crafted features of the pieces that are the primary clues to determining an original from a copy. Eight of the most prominent designers of the Arts and Crafts era are featured here, as well as three from the Art Nouveau era. This particular era of design is much more of a challenge to collect unlike Edwardian, Art Deco and the Modern Movement that had many of their designers immigrate to America during the World Wars.

American Victorian 1840-1910

During the second half of the 19th century, architects turned away from Greco-Roman Classicism and began to focus on the revival of medieval and non-classical forms in architecture. Mass production in the industrial revolution created the opportunity to invent many new products, and improve existing ones such as balloon framing, and design oddities such as overhangs, bay windows and towers. Complicated components of wiring systems such as switches and fuse boxes could also be made quickly with mass production lines in place. At least eight distinct architectural styles developed and many subsets were also produced, and to complicate matters more, often several different styles were employed in a single structure. This conglomeration influenced the design of lighting luminaires.

The designs were restricted to combustion sources such as gas mantles until the 1880s, when electric luminaires first began to appear on the market. Many different types of switches were also developed to operate these new lighting luminaires (Fig. 24). The wealthy were the first citizens to have electric lighting. The late 19th century architectural tastes that influenced the lighting luminaires produced were American Queen Anne, Richardsonian Romanesque, Shingle, and Colonial Revival styles. Egyptian and Oriental elements were also incorporated.[1]

Not only were the houses of this era eclectic, they were extremely ornamented, and ostentatious by today's standards, using up to thirteen patterns within a single room. Gas lighting (Fig. 25) was used until the early part of the twentieth century when electric systems were engineered to be more reliable. Ceiling luminaires had multiple lamp ports to create enough light for evening reading. Wall mounted luminaires were also common (note the luminaire mounted on the bookcases in Fig. 25) to provide additional lighting. The lighting effect created by gas lighting approximated candlelight, but was much more convenient to use. The lighting standards in the late nineteenth century called for much

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[1] Calloway, Stephen, and Elizabeth Cromley, *The Elements of Style*, 272-273.

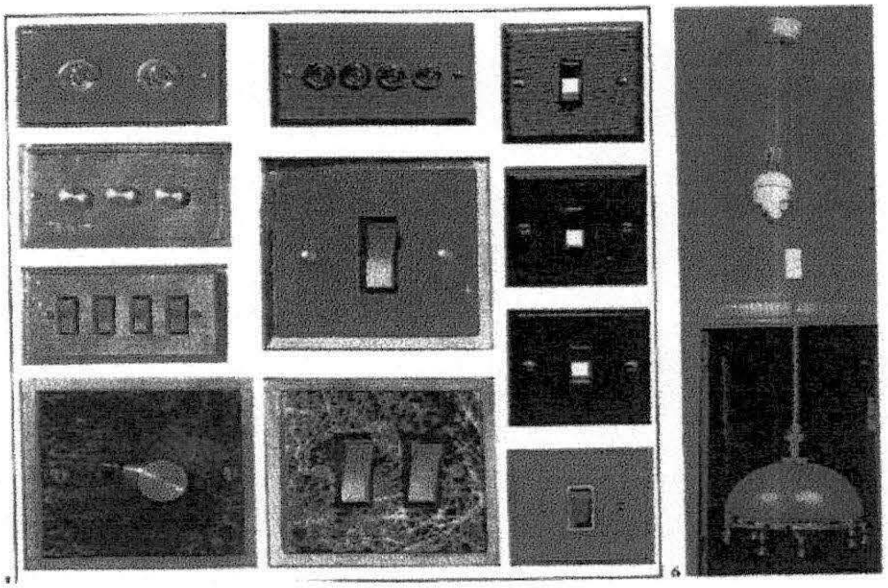

Fig. 24 Selection of reproduction switches

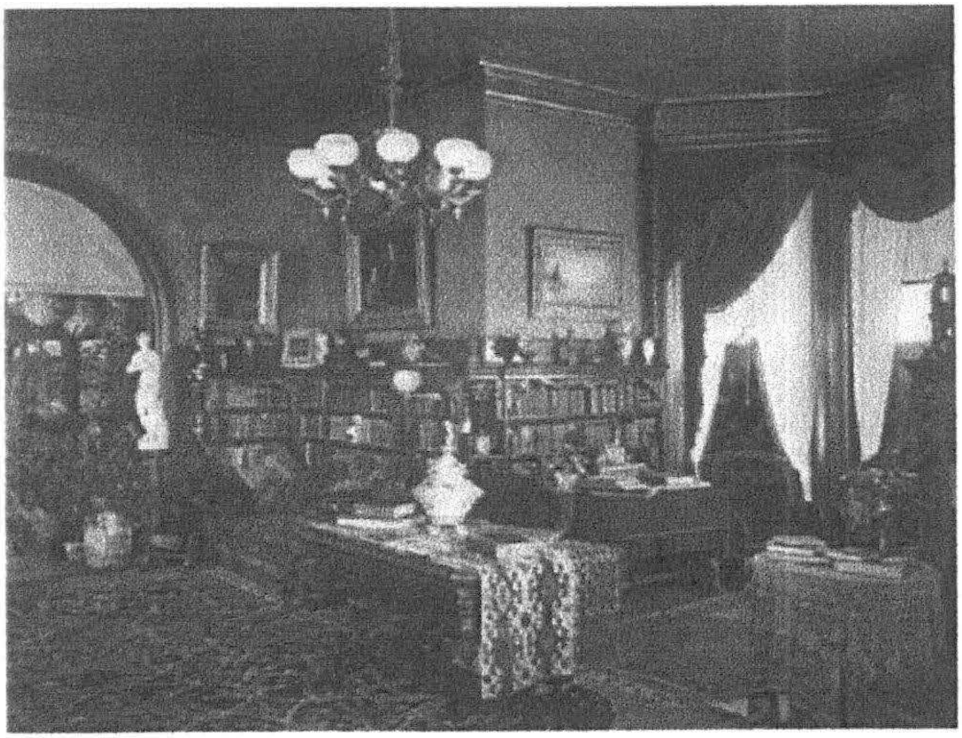

Fig. 25 Victorian Interior, Mark Twain Library, Hartford, Conneticut (note gas fixtures)

lower levels of light than our modern standards. The "doubting Thomases" of society believed that too much light in the eyes was damaging. Using the photograph as an illustration, the nine lamps in the center luminaire would have approximated the light level of nine candles, and the wall bracket lamps would have been one candle each.

As electric lighting became more readily available, many gas luminaires were converted to electric to save on replacement costs. It became safer to light sprawling houses such as this ten bedroom mansion in northern Wisconsin (Fig. 26) as there were no more open flames from gas luminaires to deal with. The foyer in this house features a cross beamed ceiling with an electric lamp at each beam junction. There are approximately 30 lamps in that twelve by ten space. When modern lamps of 60 watts are used, the light levels are blinding in that room. The carbon filament lamps available in 1910 had a much lower candlepower and made the light levels in the room comfortable.

Fig. 26 Le Chateau Boutin, Bayfield, Wisconsin, Queen Anne c. 1910

Arts and Crafts 1860-1925

The Arts and Crafts Movement of the 19th century was the result of the public's grim realization of what industrialization was doing to the natural environment and to the quality of products being produced. John Ruskin (1819-1900) promoted the qualities of medieval architecture and the craft guilds as an example to follow for artisans of the 19th century who rejected mass production of goods. William Morris (1834-1896) championed Ruskin's ideas for honesty of materials and craftsmanship. Morris (Fig. 27) created furniture, carpets, wallpapers and textiles. His work influenced an entire generation of artists who followed his ideas. Charles Rennie Mackintosh was one of those and he brought his ideas to America. Several designers began to create luminaires of extraordinary quality and craftsmanship. Designers such as Elisabeth Eaton Burton, Dirk Van Erp, Charles and Henry Greene, The Roycrofters, Gustav Stickley, Louis Sullivan, and Louis Comfort Tiffany all created some of this century's best designs. It is important to note however that these luminaires that were produced were expensive because of their handmade qualities, and therefore were usually purchased by the wealthy. Vernacular lighting for the average American emulated the character of these designs, but did not have the panache that these designer's work had.[2]

This style enjoyed the longest popularity of any style, in that it lasted sixty-five years. The Modern Movement took second place lasting forty-five years. Consequently, the luminaires designed covered the full time span from the use of candlelight to gas, and then electric luminaires. For the purpose of this investigation, the luminaires studied will be restricted to the twentieth century. Most of the luminaires featured were developed while electric lamps were in their infancy, so their illuminating effects were created for an ambiance that reflected the relative lighting levels of those lamps.

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[2] Calloway, Stephenand Elizabeth Cromley, *The Elements of Style*, 306-307, 332.

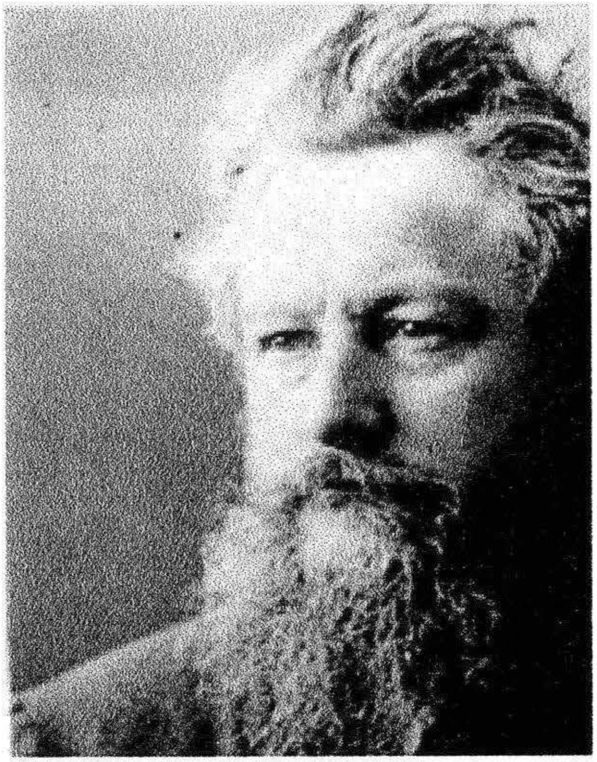

Fig. 27 William Morris c. 1880

Elisabeth Eaton Burton

Elisabeth Eaton Burton was the daughter of a wealthy easterner by the name of Charles Eaton, who patronized the Arts and Crafts movement and opened his own shop in Santa Barbara, California where he produced metal works such as tea screens, jewelry chests and so on. He specialized in using regional materials, and sent fourteen pieces to the 1904 World's Fair in St. Louis, Missouri.[3] Elisabeth followed in her father's footsteps and her work employed bronze in a palette of greens and yellows, and combined other elements such as abalone, melon, and Philippine shells, to produce lamps and sconces in floral forms. Her work embodied the aesthetic of the Arts and Crafts Movement in that she brought nature into her work in the forms of plants and animals. Her hanging lantern (Fig. 28) is a prime example of this. The elongated shade on the luminaire compensates for the glare of the tungsten filament lamps that were being used at the time. Elisabeth was born in Paris in 1869, and was educated in Europe and shared many interests with her father such as landscape architecture, painting and craft work. She opened and operated a studio near her home in Santa Barbara and published a catalog, *Hand Wrought Electric Lamps and Sconces*. She won a gold medal at the Alaska-Yukon Pacific Exposition in 1909 in Seattle for her work in leather and metalwork lighting luminaires.[4]

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[3] Bowman, Leslie, *The Arts and Crafts Movement in California*, 188.
[4] Bowman, Leslie, *The Arts and Crafts Movement in California*, 190.

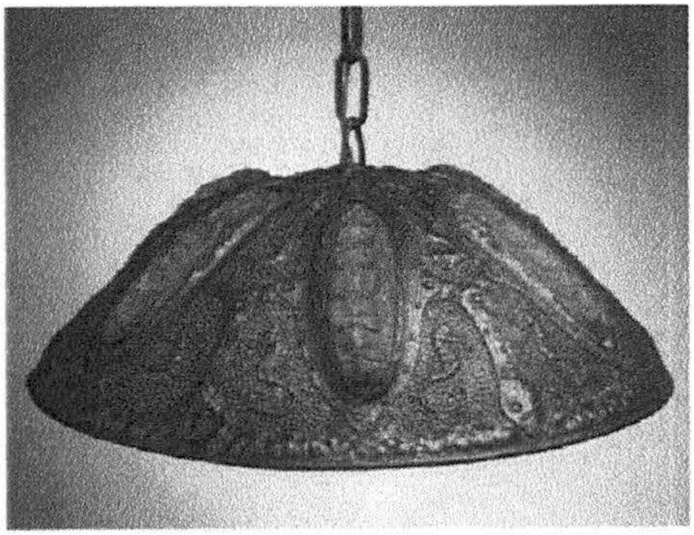

Fig. 28 Hanging electrical fixture c. 1910
Elisabeth Eaton Burton

Dirk Van Erp

Dirk Van Erp opened his copper shop in San Francisco in 1910. He established an artistic identity rather quickly after he submitted twenty-seven pieces to the Alaska-Yukon Pacific Exposition in Seattle in 1909, and won a gold medal. The prices for his work ranged up to sixteen dollars, which was proof enough that hand crafted work was not cheap. He set the artistic and technical standards for hand wrought copper in San Francisco and provided apprenticeships for students. He became a venerated San Francisco institution and his business was operated for sixty-seven years until 1977.

From 1910, when he opened the shop, until his retirement in 1929, he produced a wealth of objects including vases, jardinieres, bowls, boxes, desk sets, bookends, trays, smoking stands and sets, ashtrays, wastebaskets, fireplace screens and paraphernalia, buckets, kettles and other kitchen wares, and lighting luminaires. Nearly all of his lighting luminaires were designed for electricity. The drawn tungsten filament lamps were used in his luminaires, and the effects created with the filtration of light through the mica shades created a warm glow that made for an intimate ambiance in an interior. One of the main principles of the Arts and Crafts movement was to gather the family around the hearth. The use of intimate lighting helped to facilitate this kind of atmosphere.

Dir Van Erp made floor, desk and boudoir luminaires all with mica shades, to hanging ceiling luminaires and wall lights. The output of his shop was staggering in its quantity, and the designs ranged from the mundane to the spectacular.

He is most famous for his table lamps (Fig. 29) which are made in reproduction today. When looking for original pieces of his, look for his trademark (Fig. 30) on the bottom of the lamp. His pieces were of exceptional beauty and the surfaces had patinas in rich blood reds with hints of oranges, golds, browns, and even greens and purples. They were waxed to keep the colors from changing and they stand today unrivaled in American metalwork.[5]

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[5] Bowman, Leslie, *The Arts and Crafts Movement in California*, 146-149.

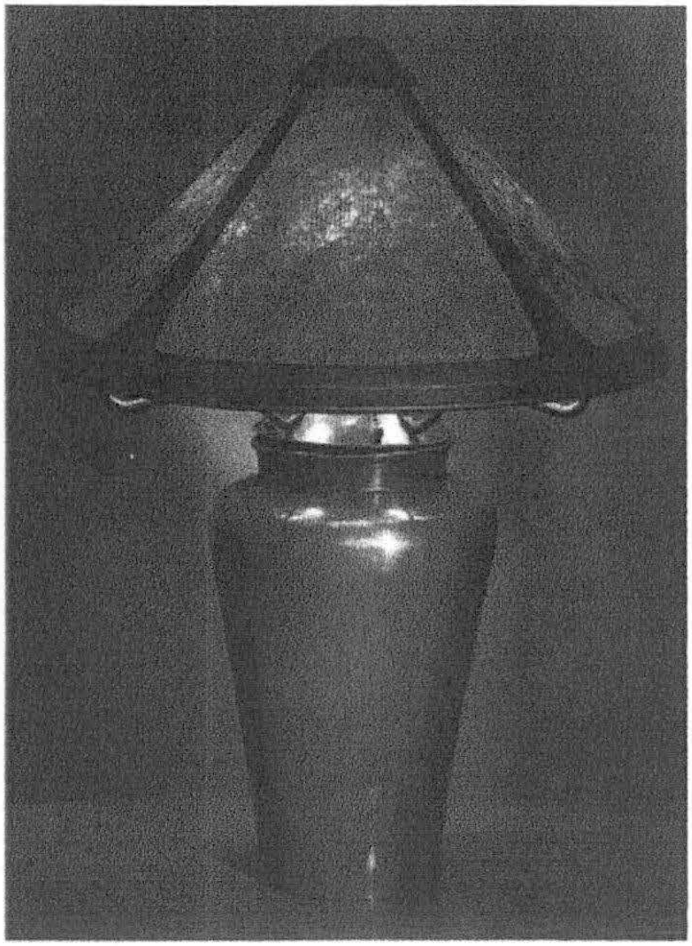

Fig. 29 Table Lamp c.1911-1912 Dirk Van Erp

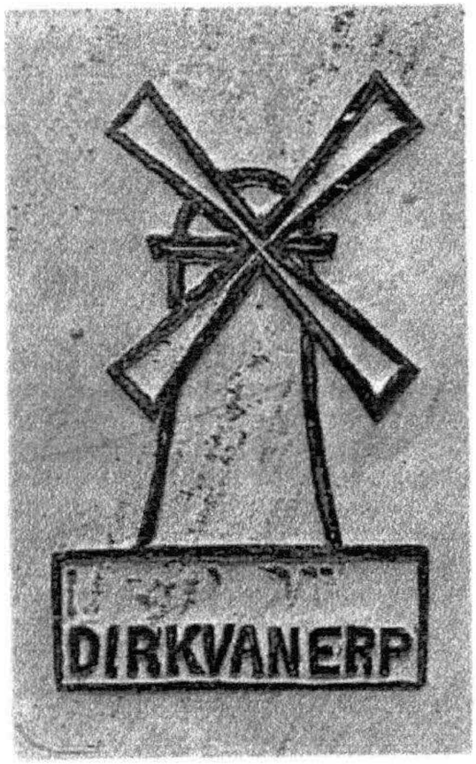

Fig. 30 Dirk Van Erp Trademark

Charles and Henry Greene

Charles and Henry Mather Greene were educated at one of the first Arts and Crafts academies in America, the Manual Training School in St. Louis, Missouri.[6] Upon completion of their education in St. Louis, their architectural training commenced at the Massachusetts Institute of Technology and they graduated in 1891.[7] As they headed west to visit their parents in California, they stopped to see the World's Columbian Exposition in Chicago where they saw the Japanese exhibit and fell in love with the art and design of the Japanese. The elements of the Japanese designs would be incorporated into their work over the next twenty years. They settled in Pasadena, California, a rich and scenic resort for the wealthy. They attracted many distinguished clients and created for them the "ultimate bungalow" which was a sprawling house of 5,000 square feet or more. They controlled the architecture, furnishings and landscape to complete congruous designs that were artistic and cohesive in nature. C.R. Ashbee wrote of Charles' work:

I think C. Sumner Greene's work beautiful; among the best there is in this country. Like {Frank} Lloyd Wright the spell of Japan is on him, he feels the beauty and makes magic out of the horizontal line, but there is in his work more tenderness, more subtlety, more self effacement than in Wright's work. It is more refined and has more repose. Perhaps it loses in strength, perhaps it is California that speaks rather than Illinois, anyway as work it is, so far as the interiors go, more sympathetic to me...
...his workshops...{make}, without exception, the best and most characteristic furniture I have seen in this country...{with} a supreme feeling for the material, quite up to the best of our English craftsmanship.[8]

Charles' lighting designs were always more than just a light luminaire. He experimented with the carbon filament and tungsten filament lamps as they were both available in the early part of his career against various types of stained glass to achieve the desired effects from a particular luminaire he was working on. He was a master at creating mood lighting, such as a lantern softly lit on a terrace that would cast a spell over the evening, and a copper lid design would hint at Japanese influence in the design. Stained glass chandeliers set in the dining room would set a golden hue over the dinner table. The Blacker House featured six-sided lanterns in the living room that had stained

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6 Ibid., 46.

7 Ibid., 46.

8 Bowman, Leslie, _*American Arts and Crafts Virtue in Design*_, 46.

glass panels of the lilies in the pond outside. The open unshielded top allowed the light to be reflected off the ceiling where molded lilies and rippled water in gold leaf were placed. The Gamble house featured luminaires in the living room that employed this kind of indirect lighting treatment (Fig. 31). Charles and Henry (Fig. 32) created innovative designs such as the chandeliers in the Robinson House that could be raised and lowered on a system of weights. The Thorsen House featured recessed lighting in the living room ceiling. Mary Ware, a poor-sighted client, had indirect lighting placed in her living room to spare her the glare of the electric light bulb. The Pratt House features many different light source treatments in the living room; using ceiling luminaires, wall brackets and floor lamps (Fig. 33). This house was built in 1909, before the tungsten filament lamp had frosted glass, so the built-in luminaires on the ceiling and walls all have stained glass shades on them to diffuse the glare of the electric lamp and bring the lighting level down to that of candlelight. The Greene's lighting designs contained three important elements; craftsmanship, motif and romantic allusion.[9] Their architecture also employed elements from Japan, illustrated in many of their famous California "Ultimate Bungalows" such as the Blacker House (Fig. 34) which is a considerable departure from the originators of the Arts and Crafts architectural movement, William Morris and Philip Webb, who designed Red House (Fig. 35) in England. This structure was the first architectural departure from the revival styles of the nineteenth century.

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[9] Smith, Bruce and Alexander Vertikoff, *Greene and Greene Masterworks*, 43.

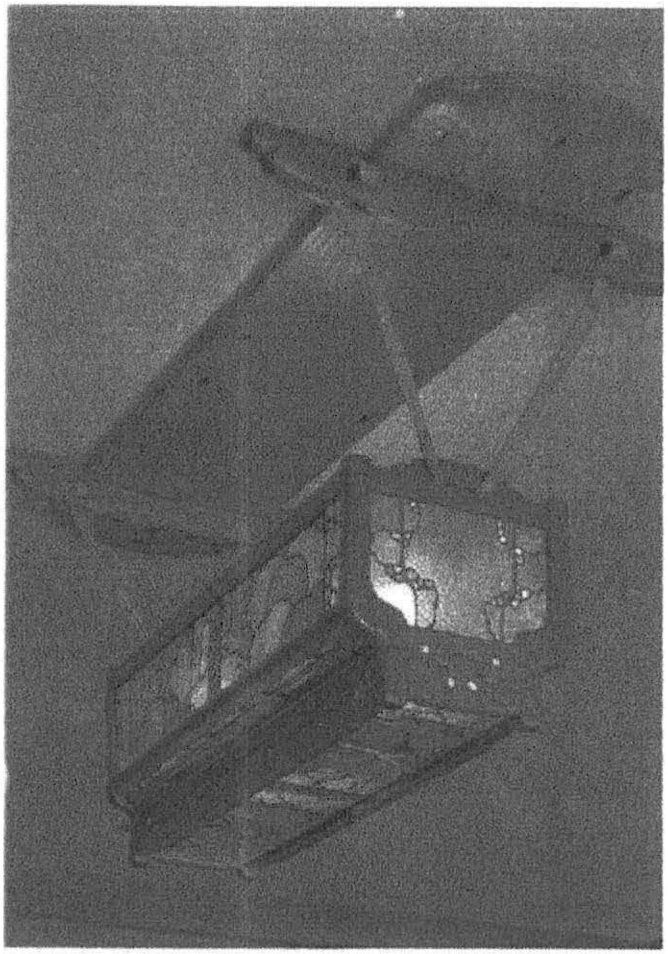

Fig. 31 (above) Living Room Fixture, Gamble House, Charles and Henry Greene, 1908

Charles Greene, 1906

Henry Greene, 1906

Fig. 32 (right) Charles and Henry Greene, 1906

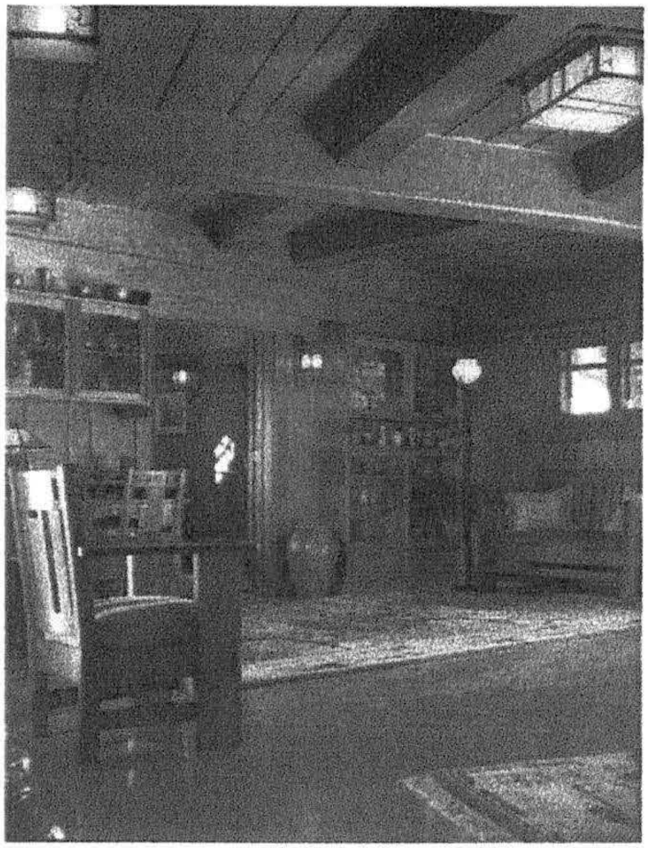

Fig. 33 Living Room, Pratt House,
Charles and Henry Greene, 1909

Fig. 34 The Blacker House, Arts and Crafts, Charles and Henry Greene, 1907

Fig. 35 Red House, the first Arts and Crafts house, Philip Webb, 1859

Charles Rennie Mackintosh

Charles (Fig. 36) was an architect who paid less attention to craft by the modernistic streamlined aesthetic he created in his designs. He championed aesthetic unity in interiors and elevated common objects to the status of art. He was largely ignored by his English contemporaries, but he had an enormous influence in the United States. His interpretations of Arts and Crafts became axioms of the modern movement.

He was born and raised in Glasgow, Scotland and through his education began to integrate designs derived from nature, and stylized them to suit the object, user and site.[10] His bold and creative genius abstracted shapes and motifs into spatial and visual relationships that related little to their vernacular origins. He delighted in optical drama and it overshadowed his concern for craft or construction.

His view of architecture was that it was spatial voids that defined the nature and placement of walls.[11] His furnishings enhanced dimensional character and facilitated human use and comfort. He searched through the influence of Japanese designs for a true non-historical style that was based only on space and a direct use of material. He was a catalyst for his European contemporaries who were also dissatisfied with the state of architecture and design.

Because of his modern ideas, his work was a successful part of the Art Deco movement in the 1920s. His work was referred to as the 'Glasgow Style' and he was a pioneer of Modern austerity. Charles remodeled the home of W.J. Basset-Lowke, 'Derngate' in Northampton in 1917 (Fig. 37).[12] He created decorative and colorful interiors and the project has been seen as a progression in Mackintosh's aesthetic, partly due to the constant involvement of his client, and partly due to his move to London and exposure to new ideas. In the hall of Derngate, Charles created a stepped wooden fireplace that echoed the design he did of the Glasgow School of Art and he repeated the

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[10] Bowman, Leslie, *American Arts and Crafts, Virtue in Design*, 23.

[11] Ibid., 23.

[12] Hillier, Beris and Stephen Escritt, *Art Deco Style*, 149.

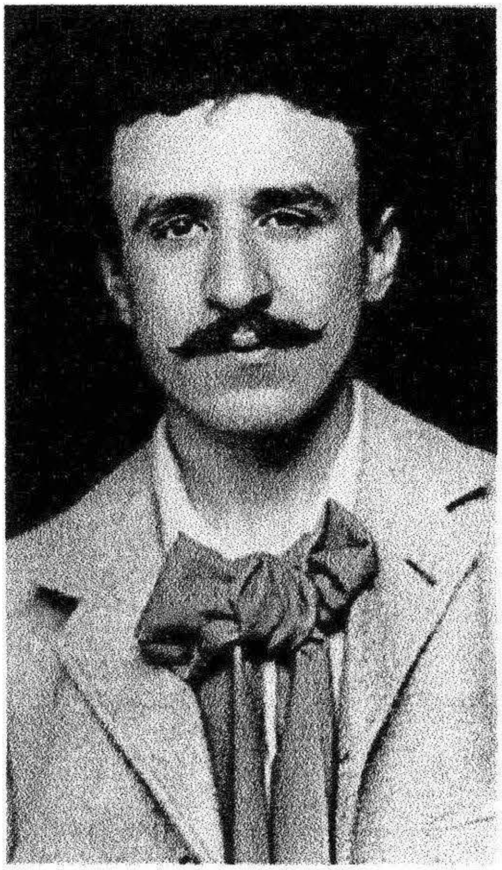

Fig. 36 Charles Rennie Mackintosh, c. 1903

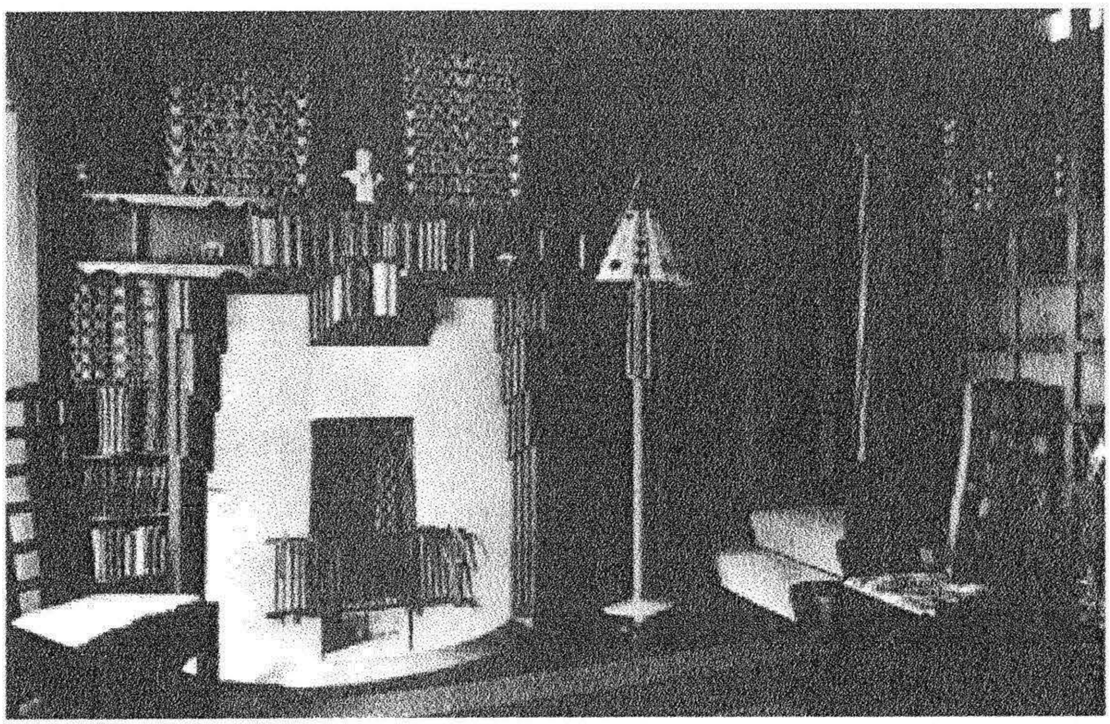

Fig. 37 Derngate Hall, Living Room, Northampton
Charles Rennie Mackintosh, 1916-17

(note lamp shade matches fireplace surround design) triangular motifs of the wall stencils on the lampshade of the floor lamp standing next to it. The drawn wire tungsten filament lamps were being made at this time and added to the bright and colorful ambiance he created. He died of cancer in London in 1928.[13]

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[13] Hillier, Beris and Stephen Escritt, *Art Deco Style*, 232.

Elbert Hubbard and the Roycrofters

The copper shop of the Roycrofters was operated from 1903-1938 in East Aurora, New York. The luminaires produced used the carbon filament, tungsten filament and the modern electric lamps over the thirty-five year period they were in business. Copper was a favorite metal of the Arts and Crafts Movement because it was removed from the elitist association with silver. In 1919, the Roycroft catalog noted that beautiful objects should be owned by people and they should be available as home embellishments and placed within the reach of all.[14]

In 1903, the copper shop was established and became commercially viable for the craft community. In 1908, Karl E. Kipp (US 1882-1954) was placed in charge of the operation. He was from a book binding background and organized his section through planning most of the prototypes for the objects to be produced. He delegated the production to his assistants and targeted the marketing strategies to the middle class. Kipp left in 1911 to form his own firm and returned in 1915. The shop employed up to thirty-five workers and continued uninterrupted production until 1938. The shop also produced hand hammered copper vases, trays, bowls, candlesticks, lighting luminaires, and other objects d'art. Kipp's previous work in the bindery was evident in the copperware designs. The stamped borders emulated the stitching of leather.

Hanging lanterns were produced in the shop and were made of copper with leaded glass. Only nine were produced and they hang in the Roycroft Chapel in East Aurora, New York (Fig. 38). They were strapped to the open beams of the roof trusses of the chapel. The chapel was in actuality a meeting house for the printers.

The 1895 to 1915 period of the company under Elbert Hubbard, Senior (Fig. 39) seems to have the greatest appeal on the collectors market. This time frame encompasses the formation of the print shop in 1895, to Elbert and his wife Alice's tragic deaths in the sinking of the Lusitania on May 7, 1915 by a German U-boat. His son Elbert Hubbard II

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[14] Bowman, Leslie, *American Arts and Crafts, Virtue in Design*, 112.

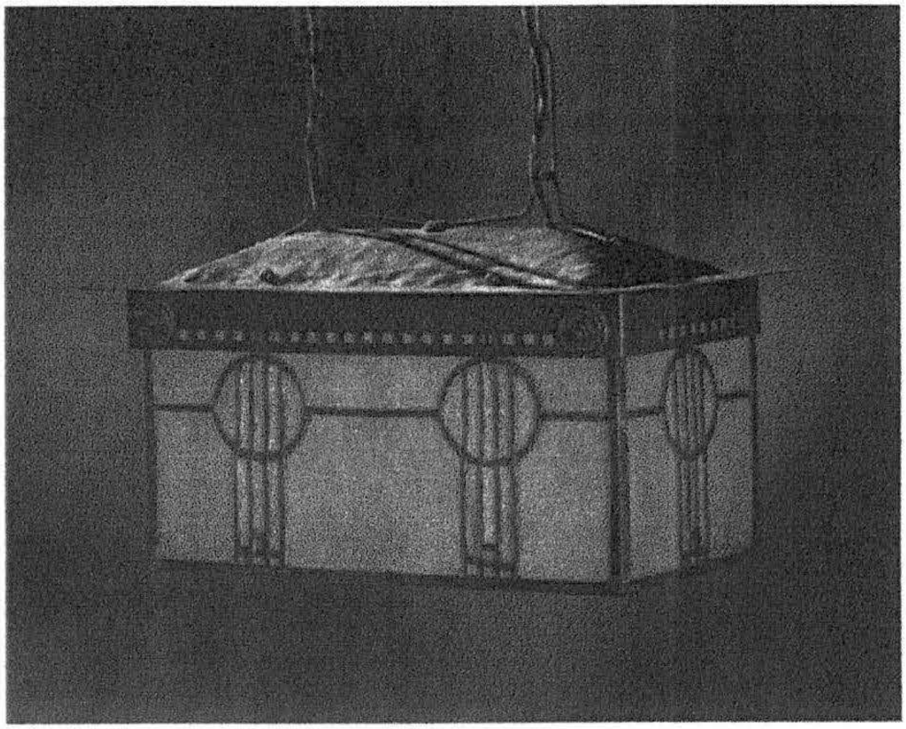

Fig. 38 (above right) Hanging Lantern, Roycroft Chapel
Fig. 39 Elbert Hubbard Sr.

ran the company until 1938 when it finally fell victim to the Great Depression and closed.[15]

[15] Hamilton, Charles F., *Roycroft Collectibles*, 8-11.

Gustav Stickley

Gustav Stickley (Fig. 40) created lamps with hammered copper bases using wicker and silk shades (Fig. 41). He also used materials such as mica, parchment, or art glass in the creation of his lamps. Like his contemporaries, Stickley consistently used muted and warm illuminating techniques to create lighting in the immediate sphere. The tungsten filament electric light was considered glaring when introduced, and this type of luminaire helped approximate the softer glow of candles and gas lights.

Gustav Stickley (1858-1942) was well known as a furniture manufacturer and publisher of the magazine called *The Craftsman*. He started it in 1901, with pictures and descriptions of his house designs. He used the magazine to promote his product line in his ideas of home design. The magazine ceased publication in 1916, but brought forth the movement to have furniture design and house style in the harmony of the new environment. From 1903 to 1912, Stickley offered plans to the public to build the houses from his designs. He drew 240 plans, which was a marketing success with the do-it-yourself builders crowd. Craftsman homes were designed to substitute the luxury of taste for the luxury of costliness. His homes wound up being expensive to execute, so they were only being built for the upper middle classes.[16]

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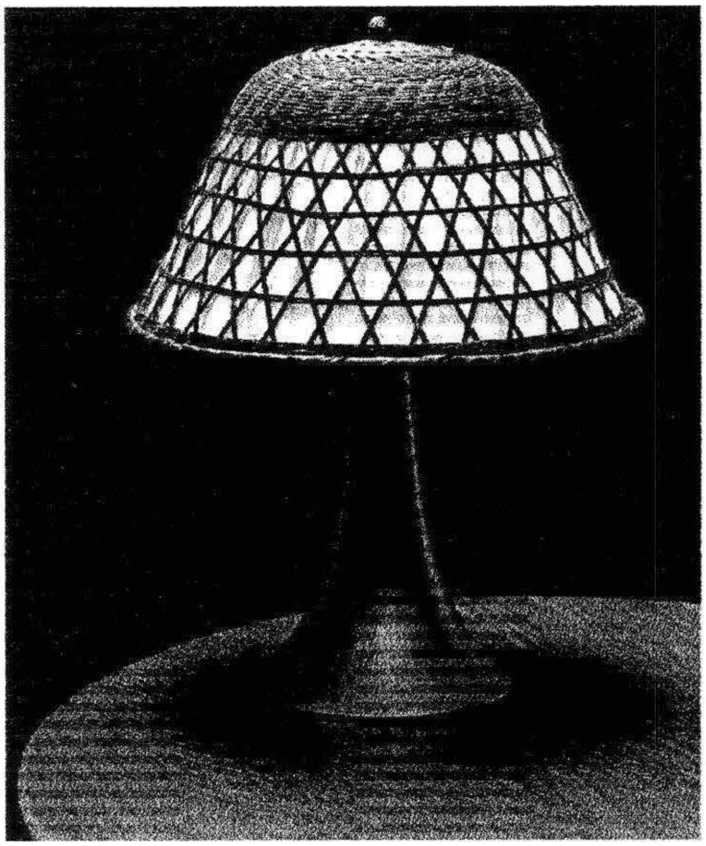
[16] Anscombe, Isabelle, *Arts and Crafts Style*, 149.

Fig. 40 Gustav Stickley, 1905
Fig. 41 Table Lamp, Gustav Stickley, c.1905-10



Louis Sullivan

Louis Sullivan (1856-1924) worked in Chicago as an architect and his specialty was to create ornament from organic outgrowth as a form of the structure. He felt that his motifs should be derived from nature. This philosophy of his was recognizable as an Art Nouveau influence, as that style was a derivative of nature in pure form. Art Nouveau movements were loose, a meandering asymmetry that was absent in his work. He imposed geometric order on the active motifs of the French style. He set up an underlying tension and rhythmically tightened and subsided his designs. He was fascinated by plants and cell growth and he embodied that in his architecture through the use of ornamentation.

He designed the Babson House in Riverside, Illinois in 1907, and created some beautiful and ornate wall sconces for the home that were made of brass and leaded glass (Fig. 42). These probably used the carbon filament lamps initially, as the drawn tungsten filament was not developed for a couple more years. These luminaires gave off a warm, soft glow that appealed to his desire to integrate his work with nature. This commission was the most outstanding of Sullivan's infrequent residential projects. He had a man working for him named George Grant Elmslie (1871-1952) who probably designed the sconces, using Sullivan's ideas. He was Sullivan's chief draftsman from 1893-1909 and he followed Sullivan's theories of geometry integrated with nature.[17]

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[17] Bowman, Leslie, *American Arts and Crafts Virtue in Design*, 121-122.

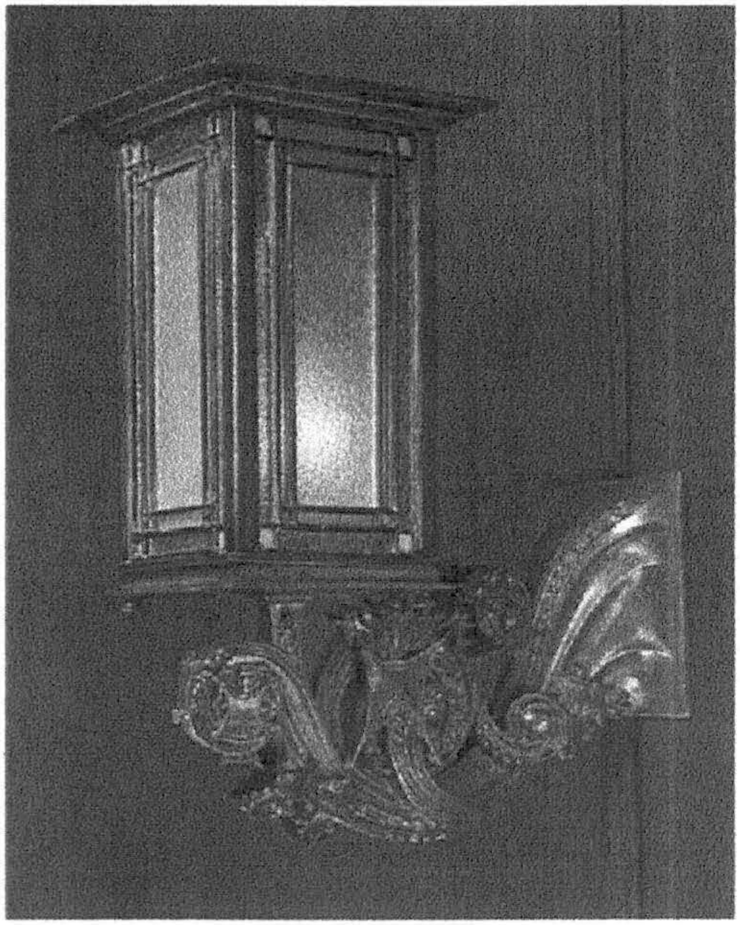

Fig. 42 Wall sconce,
Henry Babson House
Riverside, Illinois, 1907

Louis Comfort Tiffany

Louis Comfort Tiffany (1848-1933) was the son of Charles Tiffany, the owner of New York's Tiffany and Company. He became the acknowledged master of the Art Nouveau style in America. His philosophies of the decorative arts were mainstream Arts and Crafts ideas. He concentrated on the applied arts in the 1870s and he studied medieval stained glass techniques. He tested the artistic possibilities of the medium from the 1870s to the early 1900s. He came closer to John Ruskin's ideas than anyone else. Ruskin wrote, 'a worker should think and the thinker should work.'

He worked to develop "Favrile" glass, which was well suited to vases, windows, lamps and paperweights. He strived to create the iridescent satiny properties that his work was famous for. His favorite tradename (Favrile) for all his art glass was derived from the word meaning "Handmade" in Old English, which was a further reference to the Arts and Crafts methods he employed. He used color variation to define light and shadow, and skillful lead caming to delineate and enhance his designs.[18] While Tiffany was experimenting with his stained glass in the 1870s, Edison was busy working on developing the electric lamp. After 1879 when the carbon filament lamp was introduced, Tiffany was able to broaden his experiments with light and stained glass to create luminaires of extraordinary quality.

He created the Pond Lily lamp (Fig. 43) and produced it from 1900-1902, and it became one of his classics. The drooping lily shade was suspended over a bronze lily pad that had a floating dreamlike quality. The stained glass in the shade was his Favrile glass that created the iridescent qualities he was famous for creating. In 1906, the price for one of these was $400.00.[19] He signed his work (Fig. 44) which today is highly prized on the collector market.

Tiffany (Fig. 45) liked to employ artists with a genuine talent, and young enough

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[18] Anscombe, Isabelle, *American Arts and Crafts*, 218-219.
[19] Ibid., 219.

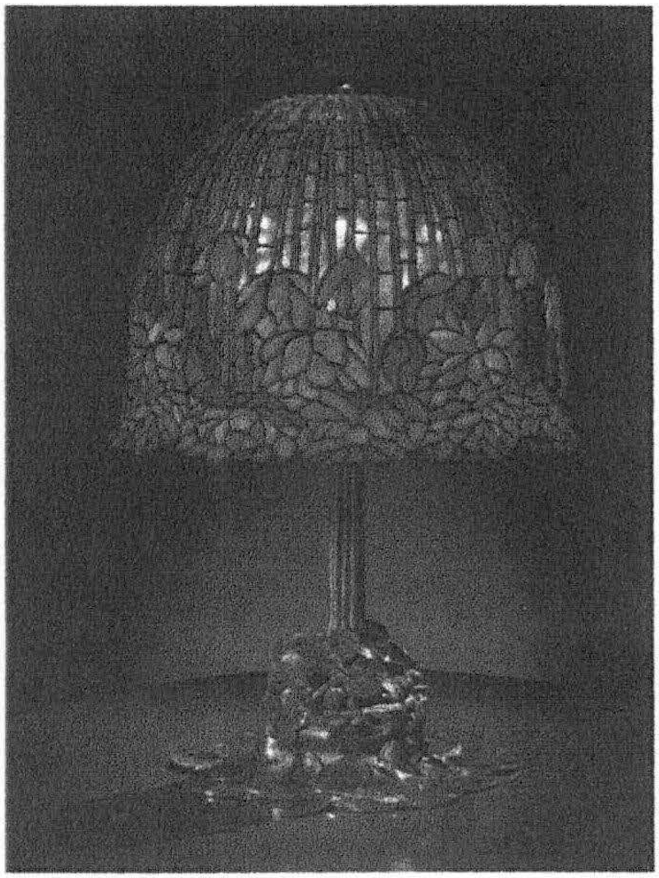
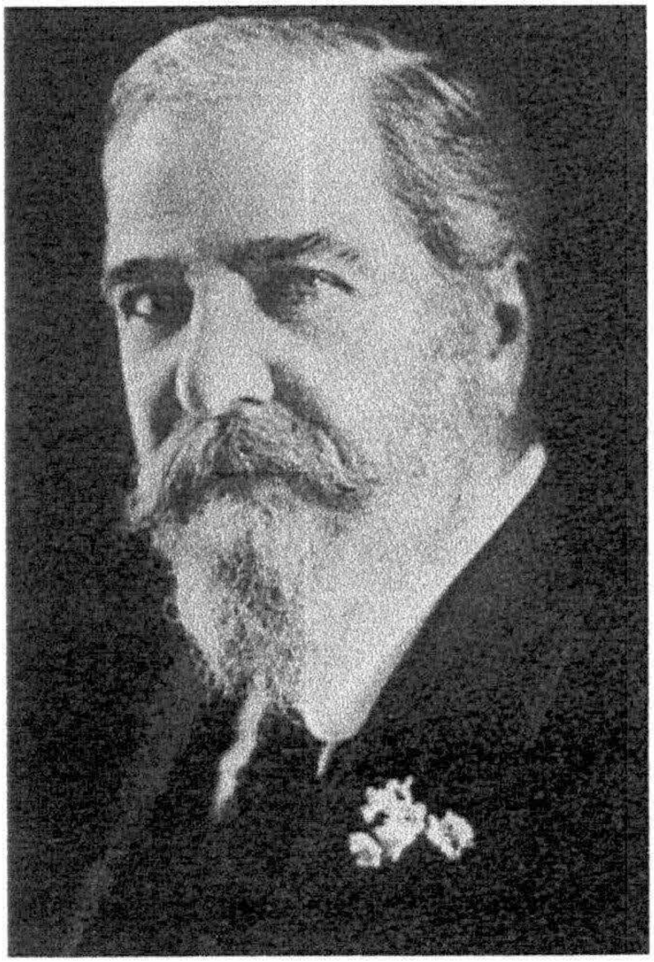


Fig. 43 (left)
Pond Lily Lamp, c.1900-02
Louis Comfort Tiffany

Fig. 44 (below) Louis Comfort Tiffany
Trademark

Fig. 45 (bottom right)
Louis Comfort Tiffany,
c.1910



that they were unspoiled by too much previous training. He gave them every facility to develop along the lines of their abilities or limitations, as long as they fit within his requirements. He never hampered his workers by being dictatorial as to their technique, but he would criticize them sharply if the results showed a lack of precision or application.[20]

[20] Bowman, Leslie, *American Arts and Crafts Virtue in Design*, 124.

American Beaux Arts 1870-1920

The American Beaux Arts movement coincided with the Guilded Age from 1876-1920 and it encompassed a variety of architectural styles drawn from history. During the last quarter of the 19th century, America's economy grew rapidly until it rivaled Europe. Political and financial leaders, who were very aware of the nation's new status, commissioned public architecture to reflect the new found power and prestige of the nation.

At the same time, many private fortunes were being made by such families as the Vanderbilts and the Carnegies. Hundreds of wealthy citizens were building lavish town houses and country estates in which specific motifs were borrowed from European styles. Mansions were built to emulate the French chateaux, Italian palazzi and Elizabethan manor houses. One could speculate that the people who had these built thought of themselves in princely terms.

In a parallel event to these fortunes being established, young academically trained architects were coming out of the École des Beaux Arts in Paris. The first to graduate was Richard Morris Hunt (1827-1895) in 1855, and he made a name for himself in the United States designing homes for the Vanderbilt family (Figs. 46-48). The Winter Garden (Fig. 46) at the Biltmore Estate featured large hanging pendant lamps that borrowed from the designs of the French chateaux built during the Renaissance, but were thoroughly modern in their execution. The Music Room (Fig. 47) at the Breakers was decorated in the Renaissance Revival style and the chandeliers copied this style, but again were fully electric. The estate was finished in 1895, and was furnished with the carbon filament lamps in its luminaires. The Breakers, (Fig. 48) an American Beaux Arts mansion, is in Newport, Rhode Island and is open to the public.

Architects of this period had no conflict between employing historical detail with modern convenience. They employed complex electrical systems, elevators, mechanical communication devices, and sophisticated bathroom and kitchen equipment in their

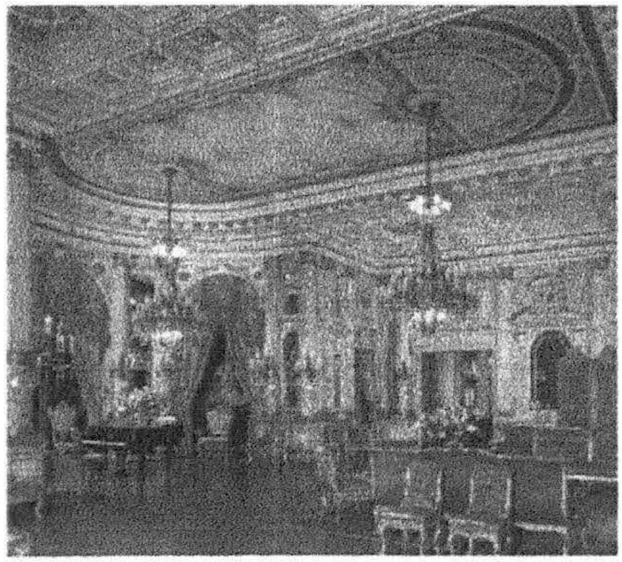
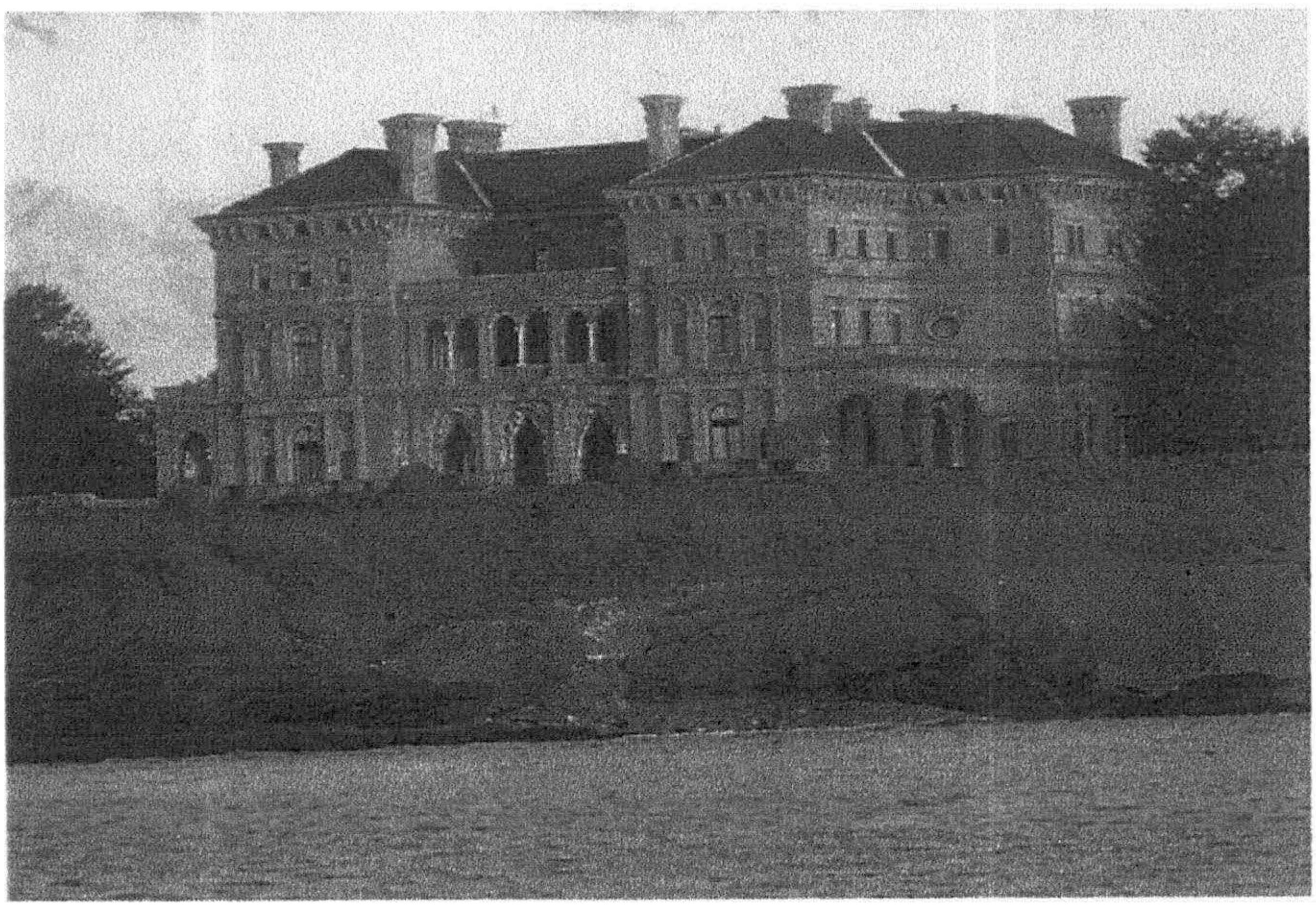


Fig. 46 (above) Music Room, The Breakers
Fig. 47 (left) Winter Garden, Biltmore Estate

Fig. 48 (below) The Breakers,
Richard Morris Hunt, 1893



houses. The interior equipment was also embellished, using such motifs as acanthus leaves curled around the corners of brass switch plates, and cast iron dolphins applied to the feet of stoves and bathtubs. These elaborate details were often found in a unifying theme for the interior and exterior of the mansions.[21]

The lighting in these homes were modeled after period luminaires, but were fully electric (Fig. 49). There were many revival styles of lighting and interiors to choose from for the wealthy industrialists of the Guilded Age. The houses of this period did not replicate historic houses, but the architects used the historic details to embellish the houses they designed that incorporated new domestic technology, ample service space and modern floor plans. They were designed for contemporary living, but borrowed from history for inspiration.

Gas burning luminaires were the most common type of lighting until about 1900, when electric luminaires using carbon filament lamps came into fashion. Chandeliers and sconces were especially popular, and period luminaires were rewired for electricity. Contemporary "French" style chandeliers incorporated gilded metal with tiers of crystal prisms. Some had twisted branches with candle sockets in the Rococo style, while others had a bronze oil burning font with gilded mounts in the Empire style. Spanish Revival chandeliers, sconces and lamps were typically made of wrought iron. Some chandeliers where designed like a wheel with thin iron rods radiating the diameter, and were joined in the middle with a finial. Houses built in the Colonial Revival motif usually contained branched glass chandeliers that were either authentic or reproduction. Queen Anne chandeliers featured a brass globe and ornate branches with strapwork. Huge bronze or gilded metal chandeliers in the Italian Renaissance style were also in fashion.[22]

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[21] Calloway, Stephen and Elizabeth Cromley, *The Elements of Style*, 384-387.
[22] Ibid., 387.

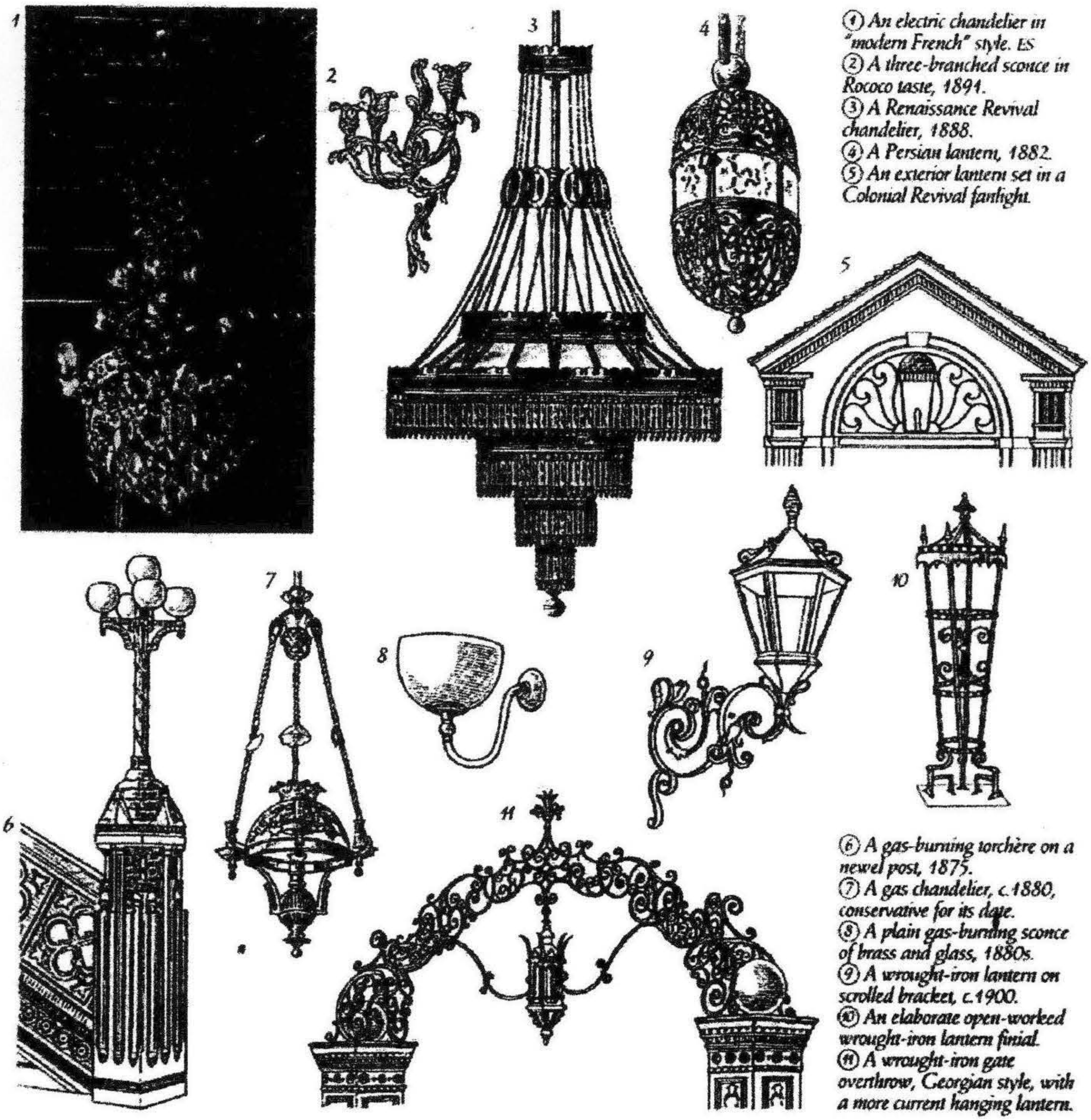


Fig. 49 Examples of the variety in Beaux Arts lighting

Art Nouveau 1888-1905

The design era of Art Nouveau was to become the most creative in the development of lighting in both the 19th and 20th centuries. There were two ingredients that spawned this. First, the philosophy of the Arts and Crafts Movement and, second, the artists themselves, who were weary and exasperated by the revivalism of the 19th century. They were sick and tired of the artistic bankruptcy that seemed to plague the world of design. The name of the movement became the international battlecry of common dissent and for these modernists, this new broom, so to speak, swept the plate clean.

So many people craved for new ideas that many architects, artists, artisans, and interior decorators all tried their hand at lighting design. It seemed that everybody at some stage of their career designed a table lamp, chandelier, candlestick or wall bracket. Lighting seemed to be the lowest common denominator for the pursuit of congruity within an interior, and it was the indispensable feature of a room (Figs. 50-51). Examining the stairwell at Tassel House (Fig. 50) the free flowing plant-like forms on the walls, banister and the luminaire, everything is integrated in a large sweeping fashion with rounded lines. The luminaire in the dining room (Fig. 51) is designed like a vine with four flowers at the end, represented by the lamps. These would have been the low candlepower carbon filament lamps available until 1911 when they were superseded by the drawn tungsten filament lamps. An architectural example of this fresh approach to design is captured in Louis Majorelle's villa in Nancy, France (Fig. 52). The openings in the fenestration illustrate a free form plant-like approach to architecture.

Electricity was also in its infancy at this time, and the designs of the luminaires were able to break free of the design restraints of combustion luminaires (Fig. 53). Because of the relative low output of the carbon filament lamp of the time, Art Nouveau luminaires generated more heat than light, but were stunning to look at and appreciate. Bronze was a favorite material to fashion the luminaires from because it gave sculptors a

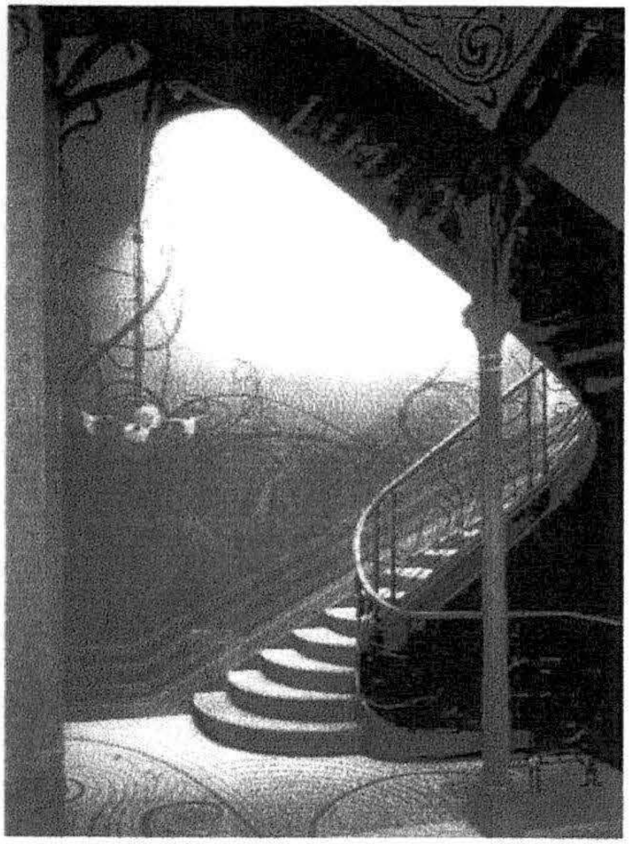
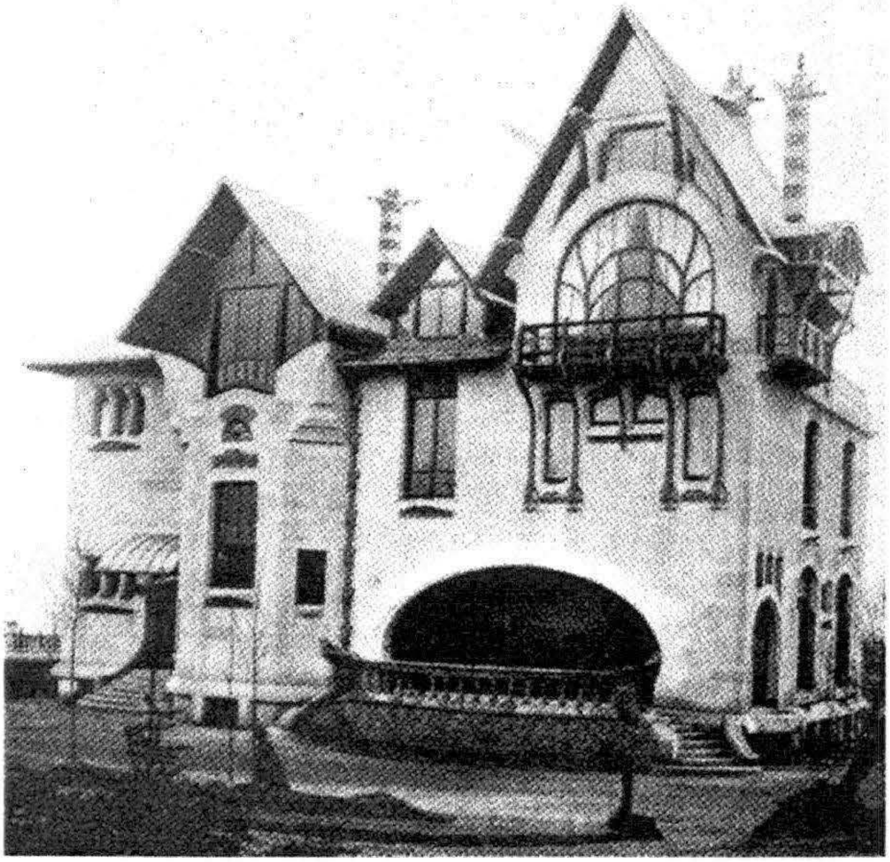


Fig. 50 (above) Tassel House, Brussels, Belgium, 1892

Fig. 51 (above right) Art Nouveau Dining Room

Fig. 52 (right) Louis Majorelle's villa at Nancy, Henri Sauvage, (no construction date given)



chance to be completely creative as the material was easy to work with and could be manipulated into incredible shapes and designs. There were some clichés of the period such as the use of entrelac and scrollwork designs that were transformed into metalwork wall supports; insect motifs such as the praying mantis, the cicada, and the stagbeetle swarmed and crawled across cameo lampshades; even the peacock was transformed into table lamps.[23] The three most common motifs to be used were the flower, a woman and the combination of the two 'femme-fleur.' The most frequently used motif, however, was the flower (Fig. 54). Orchids were a favorite because of the graceful petal shapes that could be emulated in glass. The floral aesthetic of 1900 and the incandescent filament bulb formed the most natural artistic liaison. Flower stems were transformed into the metal conduits for wiring; corollas became the glass shades that shielded the viewer from the glare of the lamp and leaves and petals acted as the reflectors for a centrally positioned light bulb. The angle of the flower could also be positioned downward, since the flame was no longer a consideration in design. The favorite flower types to be used were the convolvus family, the orchid, poppy, cyclamen, and sprays of honesty.[24] Some regional differences came from the Nancy School that frequently used the cow parsley, a native plant of the Lorraine.

The women depicted in the designs of these lamps threw caution, clothes and corsets to the winds. They became the instantly recognizable and notorious theme for the movement. The design interpretations of women depicted them as nymphs, naiads, or undines who were nubile, fleshy, melancholic, ethereal, Rubensesque, or somnambulistic.[25] They personified electricity. Unfortunately the public and the critics tired of this repeated motif, complaining that the proportions were disconcerting and the strange idea of adapting a light bulb for a woman's stomach was too much to bear. But overall, electricity could not have had better window dressing.

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[23] Duncan, Alastair, _Art Nouveau and Art Deco Lighting_, 27.
[24] Ibid., 27.
[25] Ibid., 27.

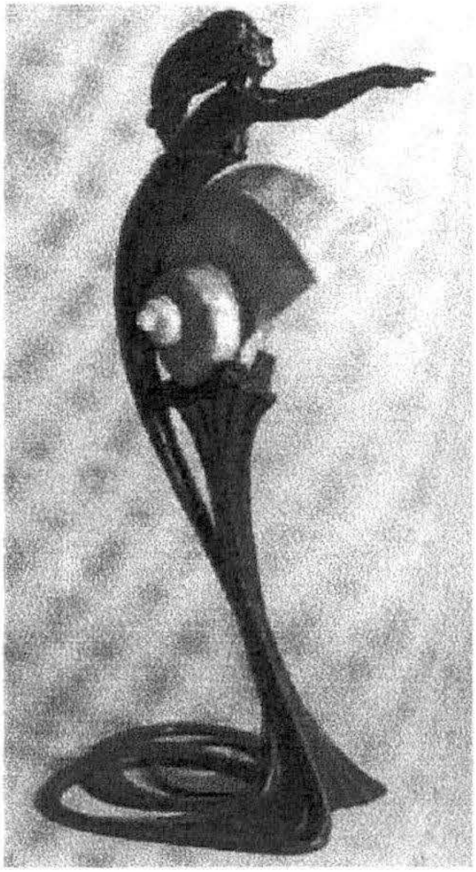
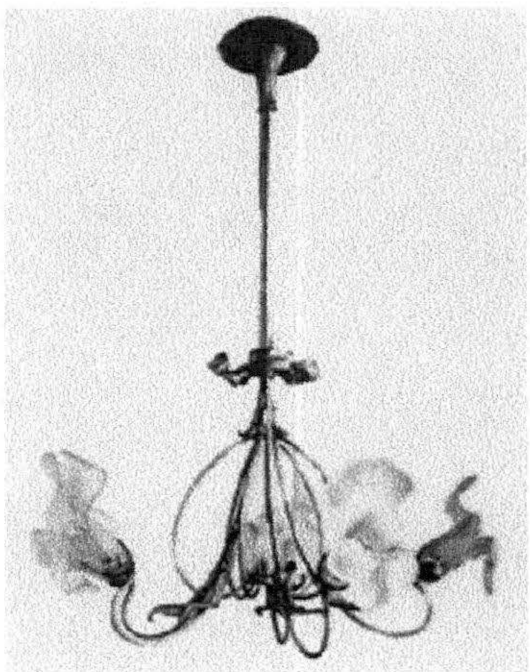


Fig. 53 (left) Gurschner, A bronze and Turbo Marmoratus shell table lamp

Fig. 54 (right) Dampt, An electric lustre with orchid flower lights



Duffner and Kimberly

The American designers who created Art Nouveau lighting designs of their own were overshadowed by the work of Tiffany Studios. Duffner and Kimberly produced fine works of art that would have in no way embarrassed Tiffany. The lamp technology they used was the same as Tiffany in that their stained glass designs were used with carbon filament lamps. The partnership lasted for six years, according to the business directories of the time, and they created leaded glass table and floor lamps, chandeliers (Fig. 55) and wall brackets. Comparing their work to Tiffany, their designs were more formal. There is not much in existence today of their work, as their output was relatively small.[26]

[26] Duncan, Alastair, _Art Nouveau and Art Deco Lighting_, 44.

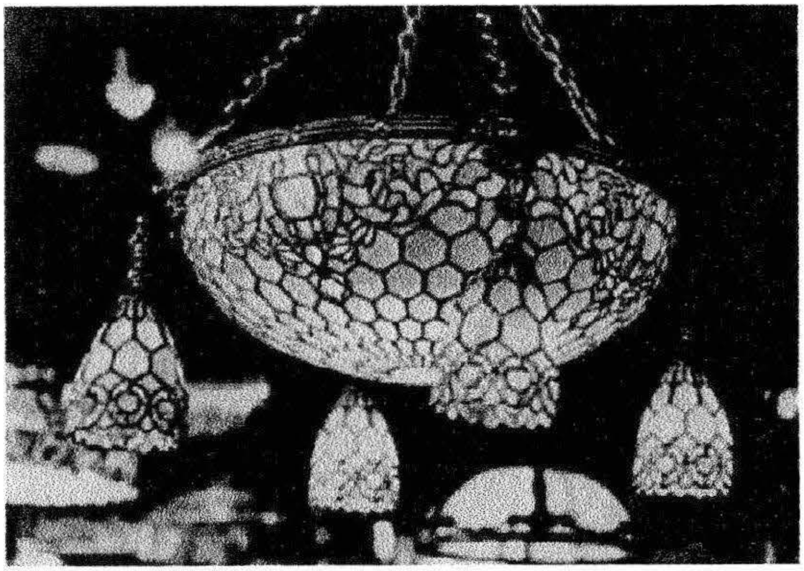


Fig. 55 Duffner and Kimberly,
Hanging lamp 'Dome number 1003'

Philip Handel

Philip Handel primarily focused his company on the production of lampshades (Fig. 56), and he employed an ever expanding studio of artists and craftsmen. He took on commissions of luminaires of any size. Nothing was too big or small to be produced. His firm produced large ceiling luminaires, floor lamps, and painted opal night lights. Nobody with the exception of Gallé incorporated a more diverse range of techniques into the manufacture of the glass lamps at the turn of the century than the Handel Company. None of the glass used in the luminaires was produced at the firm. He bought sheets of machine rolled glass and brought them to the shop for finishing. The glass was cut to the proper shapes, and was decorated with reverse painted designs or other techniques such as enameling, etching, filigreed metal overlays, and the addition of a chipped frosted finish to the outside surface of the shade.[27]

[27] Ibid., 45.

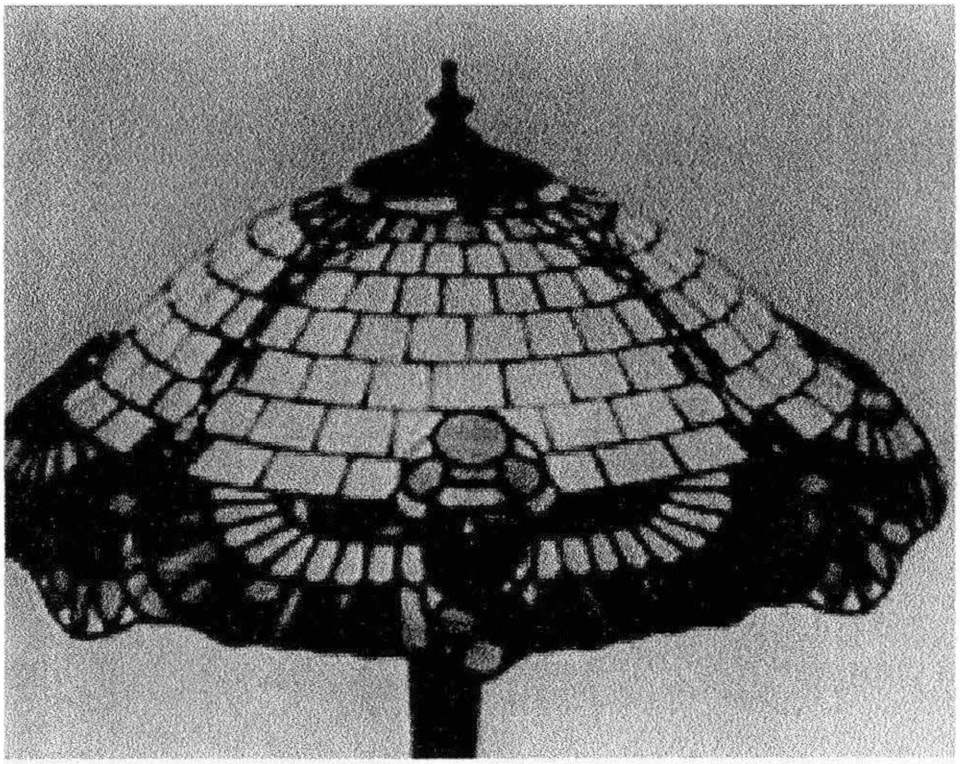


Fig. 56 Handel, leaded glass
lampshade with winged scarab

Quezal

The brilliant plumage of the Quetzal bird of central America was the inspiration for the name of the firm started by two ex-employees of Tiffany Studios. They concentrated their business on lampshades, and plagiarized the designs of Tiffany. They made some incredibly beautiful Art Nouveau glass at their factory, but they never introduced anything new or innovative in design or technique, and they seemed content to copy the carbon filament electric lamp usage, colors and decorating techniques they learned at Tiffany Studios.[28]

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[28] Duncan, Alastair, *Art Nouveau and Art Deco Lighting*, 46.

Edwardian 1901-1914

The Edwardian period of design was short lived, as the First World War ended this design style and created a watershed for the design world. The name of the period is derived from Edward II of England who ascended the throne after the death of Queen Victoria in 1901. Queen Victoria's reign saw the development of the railways, and Edward's reign, the advent of the automobile.

Until the late 19th century, Londoners and other English city dwellers preferred to live in houses, unlike the Parisians who enjoyed apartment living. The Edwardian period saw the introduction of the "mansion block" apartment building.[29] These structures featured electric lighting (Fig. 57), elevators, sanitary sewer systems with indoor plumbing, and central heating and hot water twenty-four hours a day. These apartments were seen as a convenient and economical way to live. The wealthy set found that it was much easier to close up an apartment in the city to go to the country houses, than to close up a house in the city.

The architectural influences on the style (Fig. 58) included a debased Baroque with Dutch and Queen Anne influences. Louis XIV, XV, and XVI styles (Fig. 59) also enjoyed some attention during this time period. Art Nouveau, Japanese styles and the Arts and Crafts style were also found in watered down commercial forms. The floor plans reflected the social structure of the time. If the household was wealthy enough for servants, their quarters were tucked away in the back of the house, behind the kitchen and up in the attic.

Interior design influences from the era can still be found today in some museum homes, and in the lighting designs of the period. Electric lighting was gaining popularity in this period. In poorer households and rural areas, candles and oil lamps were still the main source of light. Coal gas lighting was provided in towns, but was unhealthy due to the toxic fumes. Large country houses usually had their own private generators that ran

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[29] Calloway, Stephen and Elizabeth Cromley, *The Elements of Style*, 354.

(1) By 1911 the General Electric Company catalogue ran into three large volumes, one of which was almost entirely devoted to light fixtures. This G.E.C. ceiling light or "electrolier" – the "Cowbridge" – is in gilt-coloured polished brass. It would be suitable for a large drawing room or a ballroom. The bowls may be cut glass or satin finish. GEC
(2) The invention of the inverted gas burner made possible the downlighting gas pendant. This one is typical (Young and Marten, 1910). YM

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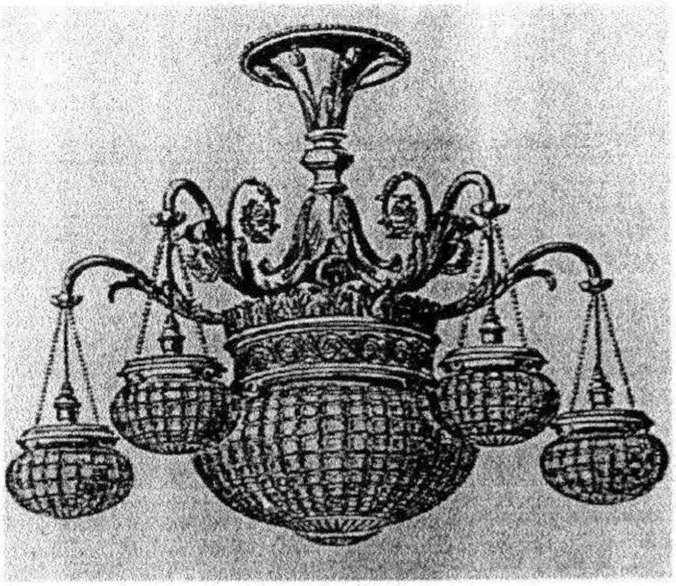

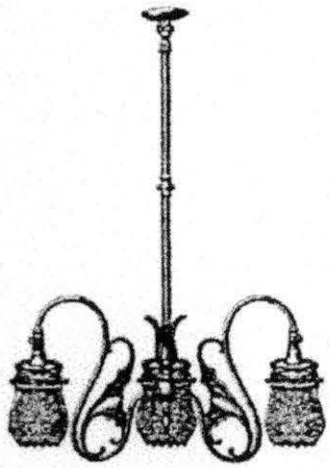

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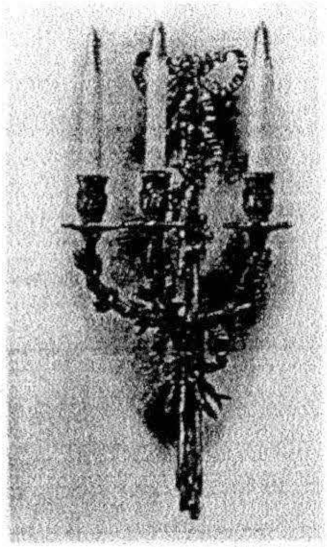

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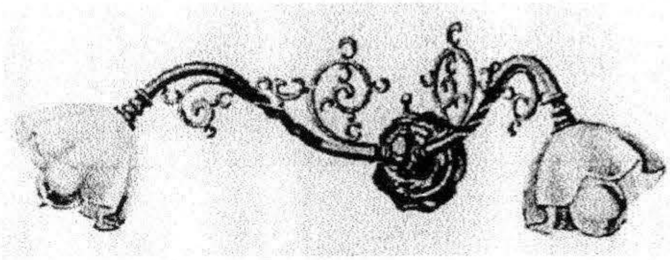

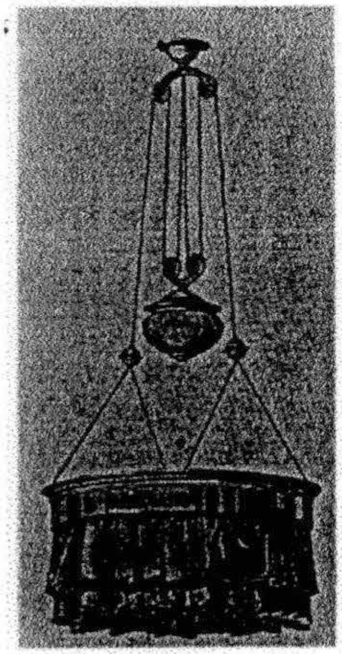

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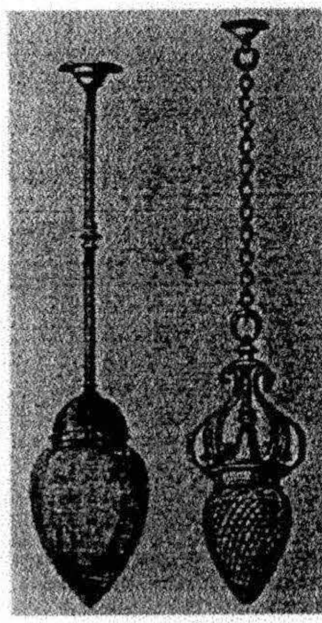

(3) A polished brass wall bracket with opal glass shades. Wall brackets were very popular. In smaller rooms all the fixed lights might be wall-mounted, with supplementary standard lamps for reading or sewing. GEC
(4) A French-style ormolu (gilt bronze) wall fixture with twisting ribbonwork. N. Burst and Co. (Wardour Street, London). Such brackets were also available in Neo-classical styles, with urn finials. NB
(5) Silk-skirted lamps, with counterbalanced weights so that they could be raised and lowered, were popular over dining room tables. This is the G.E.C. Penistone model. GEC
(6) Modestly styled pendant electric lights such as these would have been used primarily on landings and in corridors. GEC
(7) Two characteristic wall switches. Covers could be fluted brass or plain china. Such switches have become popular again today. GEC

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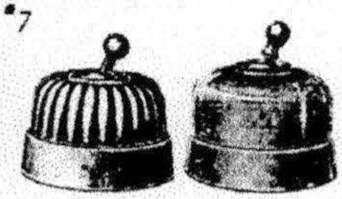


Fig. 57 Edwardian fixtures, General Electric Company, Young and Marten, and N. Burst and Co.

Fig. 58 Edwardian House
Halsey Ricardo, blue and
green glazed tile facade,
1905-07

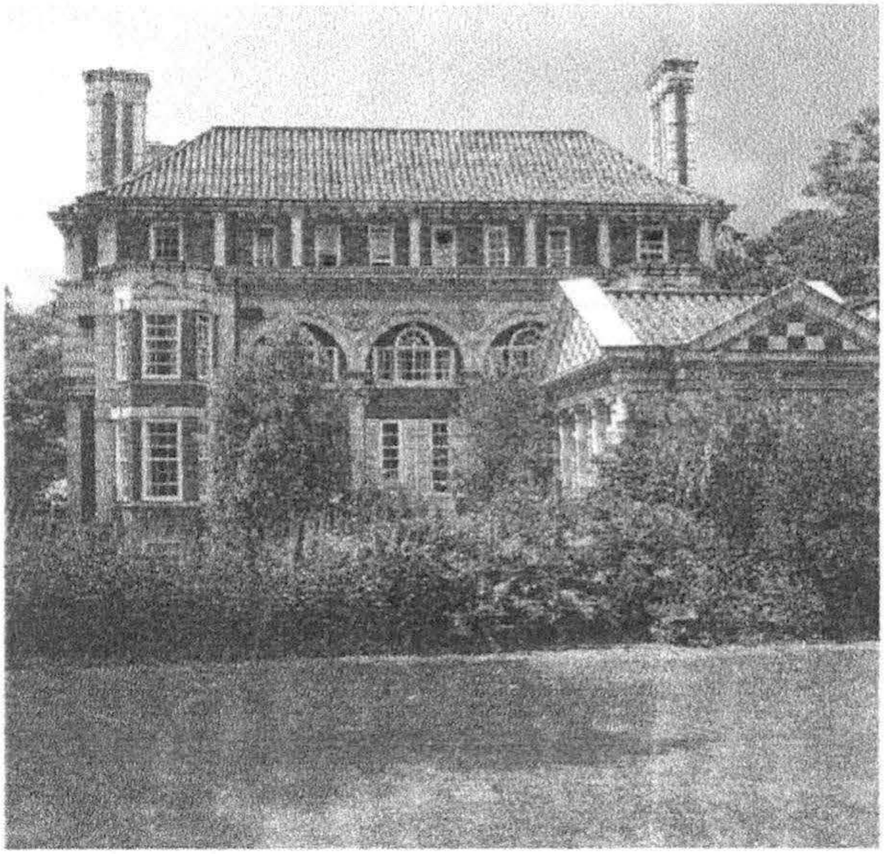
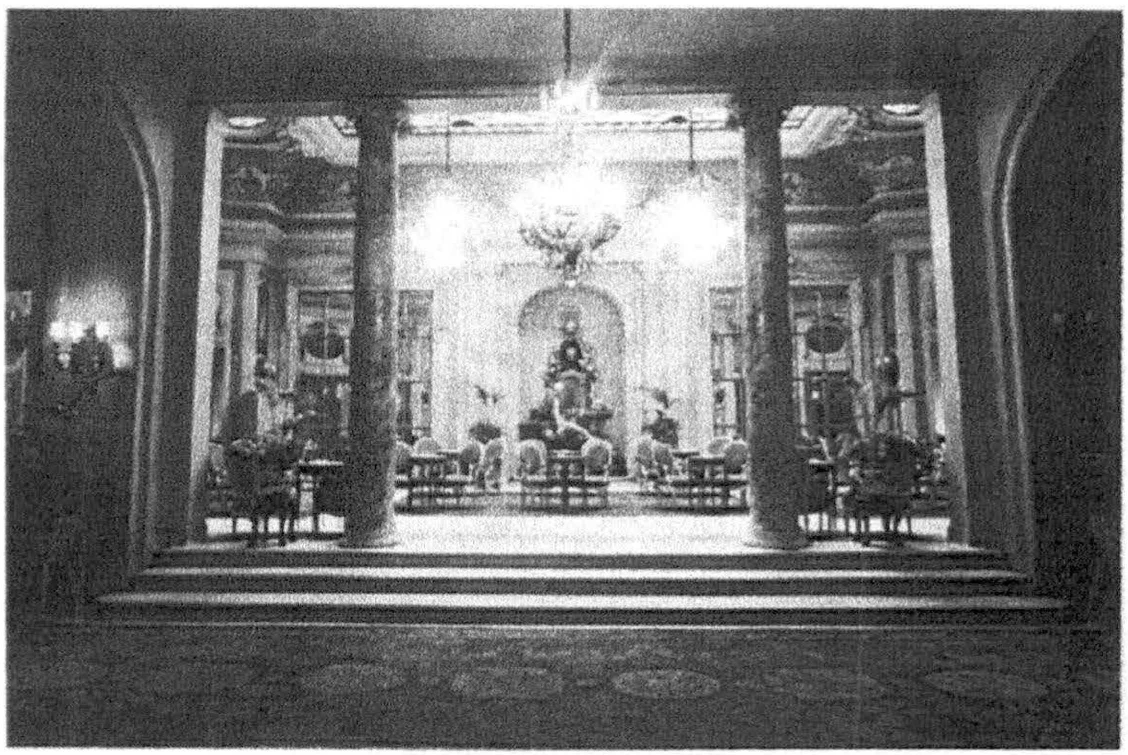


Fig. 59 (below)
The Tea Foyer,
The Ritz Hotel, London,
1904 Arthur J. Davis
and Charles Mewes



on gasoline or oil. Acetylene gas lighting was promoted by the Imperial Light Company in America.[30]

The advent of electric lighting created a new freedom in the design of lighting, much the same way that Art Nouveau was freed by electricity's advantages. W.A.S. Benson created Edwardian luminaires with an Arts and Crafts influence, but most people preferred lighting luminaires that mimicked the chandeliers of the candlelit era. In bedrooms and corridors pendant lights with cut glass shades were popular. Chandeliers, elaborate sconces and standard luminaires were used in drawing rooms, smoking rooms and libraries. The General Electric Company was largely responsible for bringing this lighting style to America.[31]

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[30] Calloway, Stephen and Elizabeth Cromley, ***The Elements of Style***, 380.
[31] Ibid., 380.

Art Deco 1920-1930

The name of this period of design was taken from the Paris Exhibition of 1925, and this has become the quintessential style of the 1920s and 1930s. During the mid-1920s, many designers were adapting historical styles to modern needs. The Exhibition was open to international competition. A designer from the United States, Paul Frankl commented that there was nothing worth sending except for architecture.[32] His reference was to the skyscrapers such as the Chrysler Building in New York. Domestic architecture was much more conservative, so the expression of the style was primarily in commercial structures.

On the domestic front, popular revival styles were the English and Spanish Colonial styles, along with adaptations of European styles. However, by the second half of the 1920s, architects such as Eliel Saarinen and Raymond Hood were feeling more daring. Furniture and interior designers such as Paul Nelson, Kem Webber, Ascherman, Joseph Urban and Paul Frankl, began to work in more simple geometric forms to emulate the architecture being produced.[33] This simplicity was inspired by European Modernism and was most prevalent on the West Coast and in Florida. Modern materials such as chrome and plastics with new types of glass were used in conjunction with concealed lighting to create rooms of extraordinary inventiveness.

The central pendant ceiling light was the most common form of fixed lighting within a room. Sometimes sconces were in place to create additional lighting. Tubular lamps were used in concealed lighting near the end of the 1920s to create a diffused glow and to highlight architectural detailing. The invention of the tipless bulb in 1922, the development of the modern incandescent lamp in 1925, and the development of mass production in 1927 of the lamp, lighting became much cheaper to purchase.

Many catalogues of lighting products in the early 1930s (Fig. 60) had pendant

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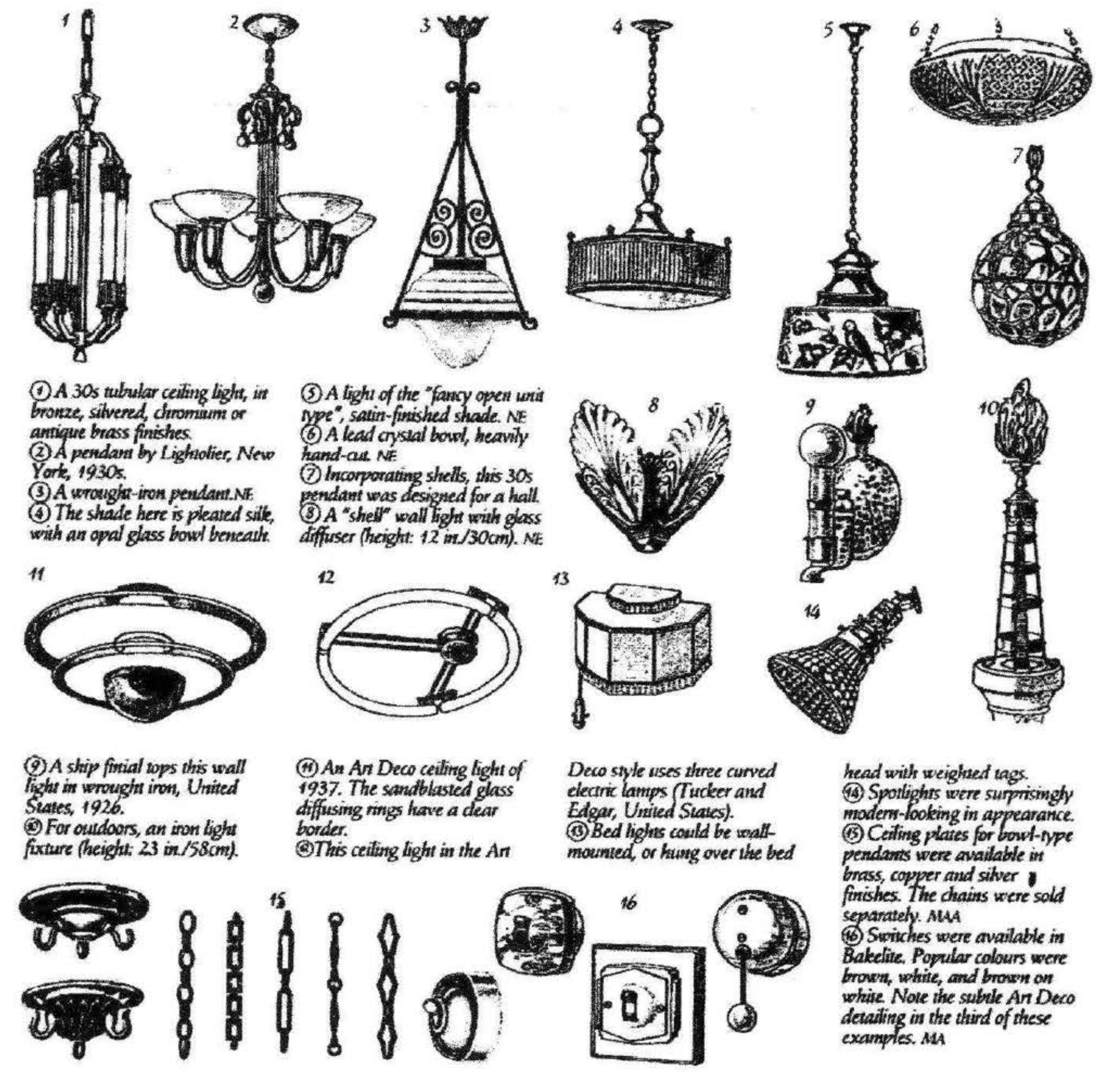
[32] Calloway, Stephen and Elizabeth Cromley, *The Elements of Style*, 416.

[33] Ibid., 416.



① A 30s tubular ceiling light, in bronze, silvered, chromium or antique brass finishes.
② A pendant by Lightolier, New York, 1930s.
③ A wrought-iron pendant. NE
④ The shade here is pleated silk, with an opal glass bowl beneath.
⑤ A light of the "fancy open unit type", satin-finished shade. NE
⑥ A lead crystal bowl, heavily hand-cut. NE
⑦ Incorporating shells, this 30s pendant was designed for a hall.
⑧ A "shell" wall light with glass diffuser (height: 12 in./30cm). NE
⑨ A ship finial tops this wall light in wrought iron, United States, 1926.
⑩ For outdoors, an iron light fixture (height: 23 in./58cm).
⑪ An Art Deco ceiling light of 1937. The sandblasted glass diffusing rings have a clear border.
⑫ This ceiling light in the Art Deco style uses three curved electric lamps (Tucker and Edgar, United States).
⑬ Bed lights could be wall-mounted, or hung over the bed head with weighted tags.
⑭ Spotlights were surprisingly modern-looking in appearance.
⑮ Ceiling plates for bowl-type pendants were available in brass, copper and silver finishes. The chains were sold separately. MAA
⑯ Switches were available in Bakelite. Popular colours were brown, white, and brown on white. Note the subtle Art Deco detailing in the third of these examples. MA

Fig. 60 A variety of fixtures available during the Art Deco era lights with tinted or marbled glass, usually in the shape of an inverted bowl with chains to attach them to the ceiling. Wall sconces were often in fan or shell shapes. Cheaper luminaires were made from synthetic parchments and vellums, as some were intended for reading lights on bed heads or dressing tables.

By 1920, the tungsten filament had greatly changed the quality of life. Designers were now able to make recommendations to architects to consider this element in residential design so that the home's inhabitants could lead more productive lives. Lighting was no longer considered a novelty, but a necessity. Interior lighting had taken on three forms; direct, totally indirect and semi-indirect illumination. Direct lighting implied a shade pointing the light down on a specific task, such as the dining room center luminaire. Light that was directed by an opaque shade back to the ceiling and then filtered down by reflection was indirect lighting. The semi-indirect shade allowed some light to come through the shade, so it reflected some light on the ceiling, as well as letting filtered light shine directly down. Studies of colors that were used on the ceiling for the purpose of indirect lighting noted that light or bright colors on the ceiling and lighter colored walls reflected more light, making a more cheerful and bright room. Frank Lloyd Wright incorporated these ideas in the Barnsdall residence in the Hollywood Hills, also known as Hollyhock House (Fig. 61).

Domestic studies for women's roles in the household suggested that a well lit kitchen added to the overall success of food preparation, and a well lit pantry avoided many dishes getting broken. Task lighting in the kitchen became important, as the center ceiling luminaires were often too low and cast long shadows on a person trying to work in the kitchen. A high ceiling mounted luminaire was recommended, and wall mounted bracket lighting over the sink and stove were recommended. Sewing in the evening also became an easier task with good task lighting. The laundry area in the basement was often a poorly lit area, and a well lit laundry area resulted in fewer burned shirts from a hot iron in dim lighting. In 1922, a good 100 to 150 watt bulb was recommended for the

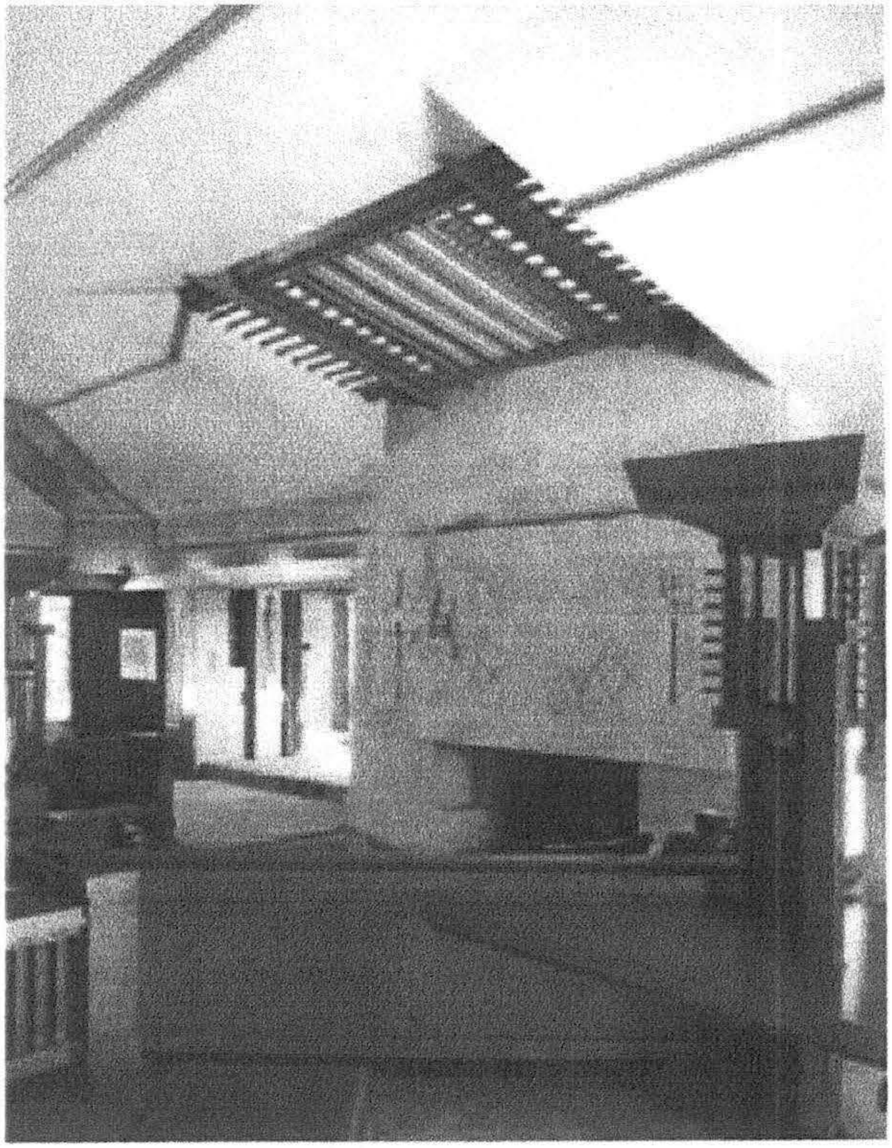


Fig. 61 Hollyhock House
(Barnsdall residence)
Frank Lloyd Wright, 1922

job, as well as a drop cord from the ceiling to plug the iron into for greater latitude in ironing the wash.

The living room of this era utilized portable task lighting with diffusing shades. The desire to avoid shadows and the look of being old or tired was the goal of lighting this room. Ceiling luminaires were no longer recommended for this space of the house unless an indirect shade could be utilized on the luminaire. The dining room had the center luminaire over the table, and this was to be the central area of attention, so it was generally the lighting focus of the room. For the hall or reception room, the lighting of the 1920s varied with the room function. If it was a small space used as a pass through to the rest of the house, a small luminaire with low level lighting was sufficient. For a hall that was used as a Reception Room, a larger, grander luminaire would be employed. Three-way switches had also been developed and were most conveniently placed at either end of the hall.

The recommended wattage for bedroom luminaires was 40 to 75 watts. Key sockets were still commonplace, but the new trend was to use a wall switch for the central luminaire. The designers of the day also recommended placing a convenience outlet near the bed to plug in a portable lamp or a heating pad and another by the dresser for a curling iron, heater or fan. In the bathroom, two light sources were placed on either side of the mirror to illuminate it well for shaving. Convenience outlets were also present for the electric heater, curling iron, or the hot water mug.[34]

When the Depression of the 1930s came, individual designers were pushed into producing designs for major manufacturers, using cheaper materials out of economic necessity. Architecture became more streamlined and the efficiency of the house became important as a cost saving measure (Fig. 62). Plastics, metals and variations on glass were the prominent elements of lighting and furniture from this era. A few designers were successful in selling their designs for mass production. They included Donald

[34] _IES Lighting Handbook_, 10-33, 10-45.

Fig. 62 General Electric House
of the Future, George Kraetsch, 1936
"American Moderne"

Deskey, Gilbert Rohde, and Kem Weber.

Modern Movement 1920-1965

The Modern Movement was the architect's and theorist's chance to break with the past, and start clean, using the machine age as its inspiration. Most of the residential structures built during the early era were the residences of the architects, as many developers were skittish about speculative development in such a radical style.

One of the fist proponents of the style was an Austrian, Adolf Loos (1870-1933), who came to America and spent three years from 1893-1896 evaluating the architecture. He wrote a critical essay called "Ornament and Crime" (1908) that lambasted the Victorian aesthetic.[35] Frank Lloyd Wright was the catalyst for the Modern Movement in America, whose architecture emphasized simplified horizontal designs.

Following World War I, social turmoil in Europe encouraged avant-garde movements in the arts. Cubic architecture was developed in Holland by the De Stijl group, and Le Corbusier (1887-1965) showcased his work in France. The aesthetics of the movement were to bring about a new way of life, increasing sunshine in the interiors, fresh air circulation and contact with nature, which both British and American cultures took for granted. The imagery of health and cleanliness was one of Modernism's main selling points, and the supposed reduction in dirt and housework was an argument to justify the removal of moldings and ornamentation. Most residential structures were experiments in concrete, and subsequently had many maintenance problems and were altered over time. People who bought these homes and lived in them were suspected of Communism or nudism.[36] The few residential commissions of Miës van der Rohe were eyed with the same skepticism, but were functional (Figs. 63-64). The living room of the McCormick House (Fig. 63) was simple, clean and streamlined with hidden cornice lighting to keep the room uncluttered by lamps. The exterior of the house (Fig. 64) looked more like an office building, but it was low maintenance and made full use of

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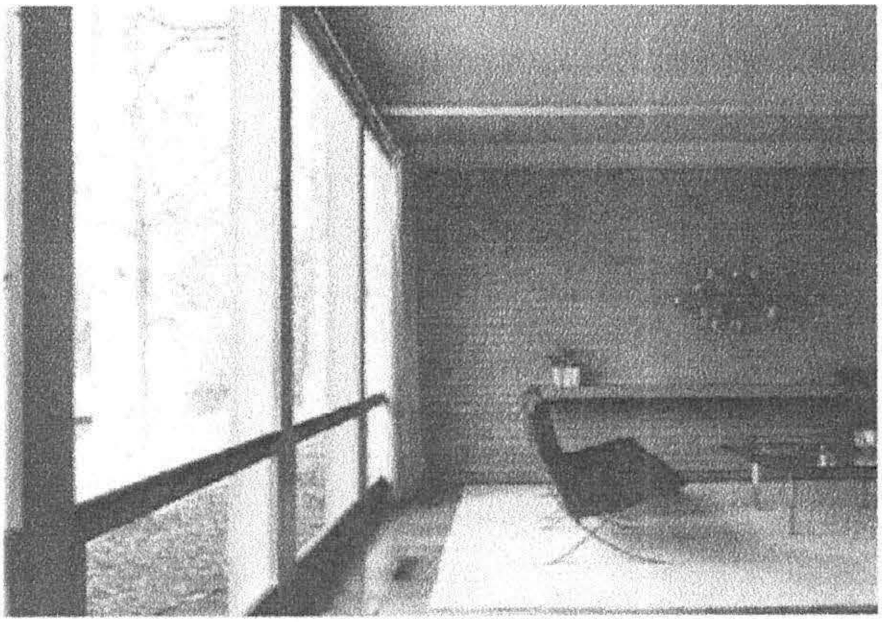
[35] Calloway, Stephen and Elizabeth Cromley, *The Elements of Style*, 448.
[36] Ibid., 449.

Fig. 63 (right) Living Room
McCormick House, 1952
Mies van der Rohe



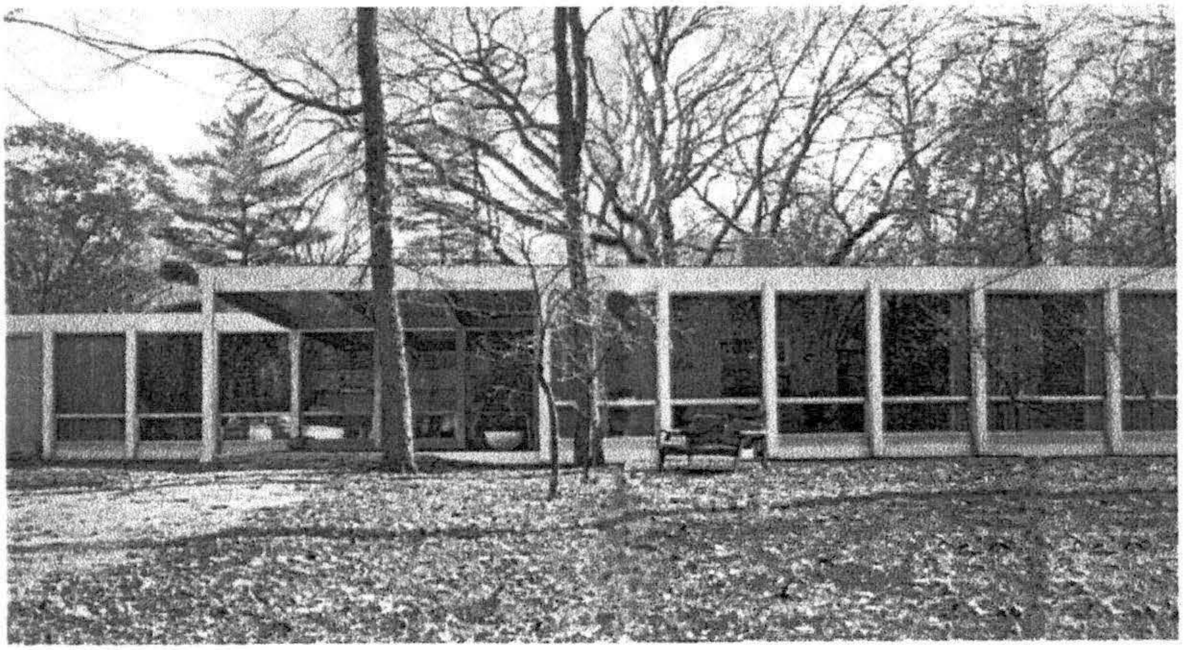


Fig. 64 The McCormick House, Elmhurst, Il, 1952 Mies van der Rohe

daylight for the interior.

Early lighting of the period was concentrated on built-in luminaires. Ceiling luminaires were frowned upon as they seemed to interrupt the "purity" of the room. If they were present, they were hemispherical globes mounted against the ceiling, and pendant lights were only found over the dining room tables. Wall mounted lights were a popular alternative, and they featured the shapes of upturned bowls or globes on stems. Architects often included ceiling tracks for work areas and concealed lighting, which became more fashionable in the post war era. Fluorescent lighting was used primarily in kitchens and bathrooms in the 1940s as it gave off much less heat than incandescent lighting did. Spotlight tracks became available in the 1960s, which diversified lighting techniques (Fig. 65).[37]

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[37] Calloway, Stephen and Elizabeth Cromley, *The Elements of Style*, 465.

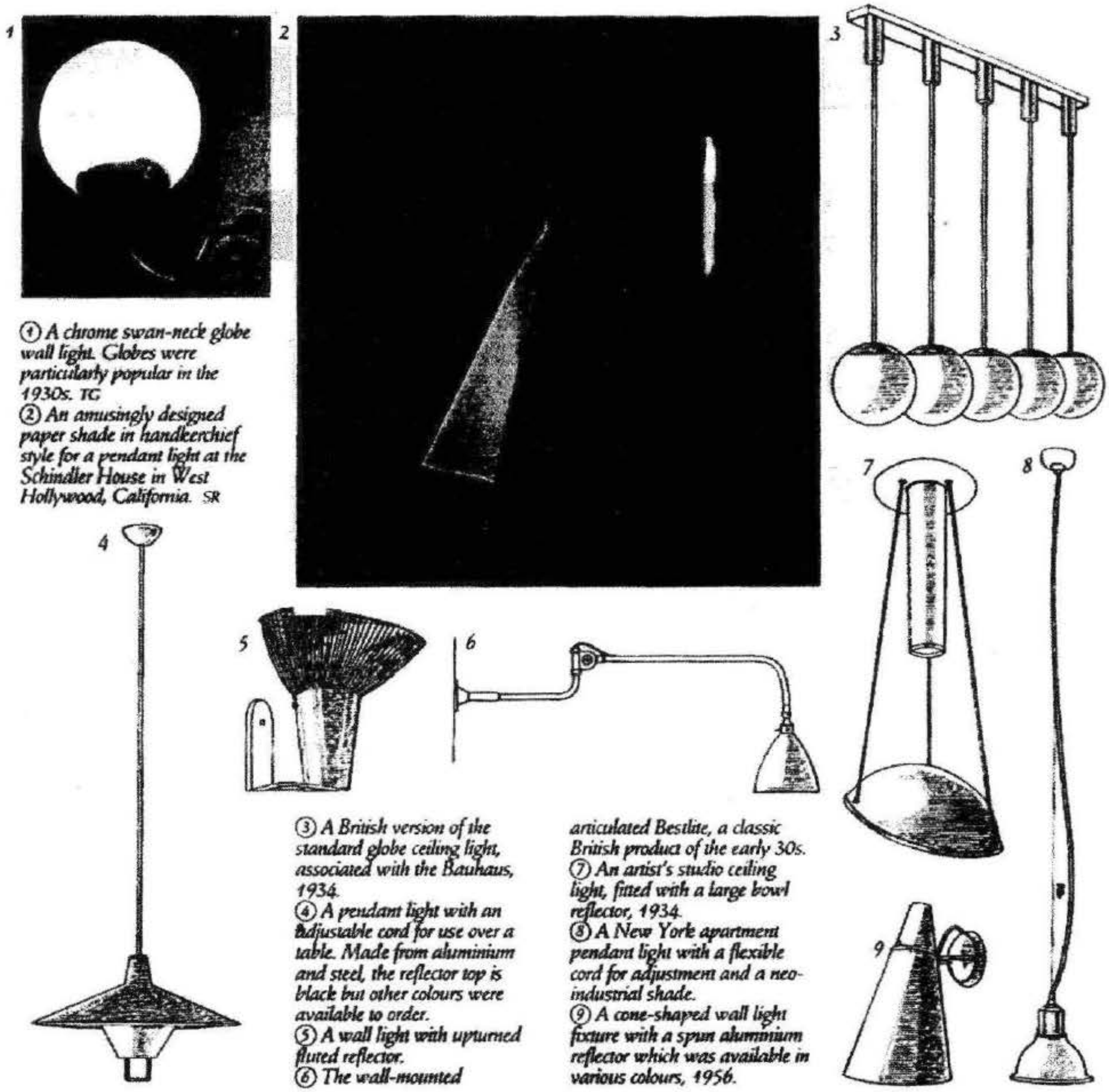

Fig. 65 Various fixtures available during the Modern Movement

V. Vernacular Lighting

Introduction

The term vernacular means to use the native materials or culture of a specific region. To translate that to lighting, if a farm house in a rural area is used as an example, in the early part of the century when cities were able to enjoy the benefits of electricity, farms in the country either had no electricity, or DC powered generators for lighting purposes. This stylistic aspect of historic lighting is a difficult one to define and separate. The defining characteristics of the stylistic periods outlined in Chapter Four go flying out the window when looking at vernacular lighting. Not only that, some homes may have used a combination of designer luminaires and vernacular luminaires. Case studies would have to be conducted to prove or disprove this theory. Instead of clearly defined periods, there were stylistic periods that combined, crossed over and meandered between the styles in the luminaires produced. The classical-transitional period points to the end of the American Victorian period as gas and electric luminaires were being combined. The artistic period points toward the Craftsman-Bungalow styles that were popular into the mid-1920s. The Colonial style coincided with the Colonial Revival period and in some small way used elements of the Beaux Arts movement. The modern period included Art Deco and the Modern Movement that were combined to create Streamline Moderne.

Luminaire designs changed with architectural aesthetics and the technology of the lamp. In 1925, a young chemist at the General Electric Company by the name of Marvin Pipkin (Fig. 66) discovered how to frost a lamp by doing a double acid treatment to the

Fig. 66 Marvin Pipkin
demonstrating a frosted lamp

glass.[1] Because of this breakthrough, vernacular luminaires did not need to conceal the lamp from view. It was commonplace in poorer homes to have one bare lamp hanging from a cord in the middle of a room.

Classical-Transitional Period

Vernacular luminaires of this era employed many common elements. For ceiling-mounted luminaires there were several choices for the mounting base including a plate or pan, a cast knob, canopy, or a husk or socket cover. For flush-mount luminaires a bowl holder was common. For shower luminaires (Fig. 67) (a luminaire with several lamps showering light down on a surface, hence the name) there were link chains. On single pendant luminaires (Figs. 68-70) a cotton covered cord, a round stem, a square stem, or a spindle and link chain could be found. The best room (fanciest room in the house) luminaires featured decorative elements such as prisms, pendalogues (Fig. 71) or chains with pendalogues in series. There was a plethora of shades to choose from (Fig. 72). The 1918 Sears catalog featured twenty different styles.[2]

The type of lighting present in a vernacular interior depended upon the source of power available at the time. In rural areas with no gas or electric service, a coal oil pendant luminaire without a shade may have been found (Fig. 73). It was a simple luminaire that consisted of a hanger, a clear glass chimney and an oil font. In a fancier interior, such as the library or parlor, the coal oil pendant might have an ornamented base and a glass ball shade over the chimney and a smoke shade on the top of the hanger (Fig. 74).

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[1] Keating, Paul W., _Lamps for a Brighter America_, 126-127.

[2] Jennings, Jan and H. Gottfried, _American Vernacular Interior Architecture 1870-1940_, 227.

Showers

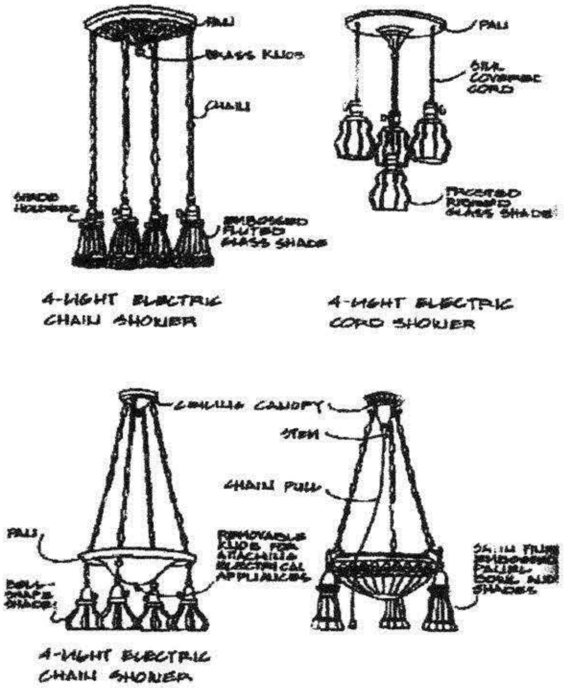

Fig. 68 Shower Fixtures

Pendants

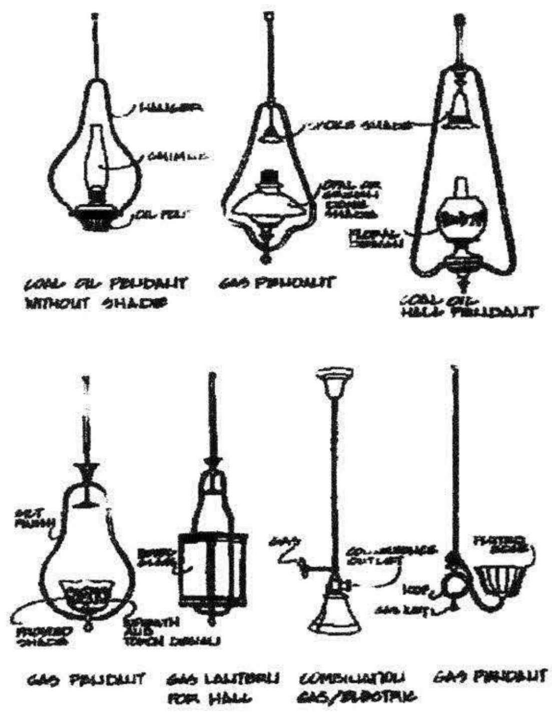

Fig. 69 Pendant Lamps

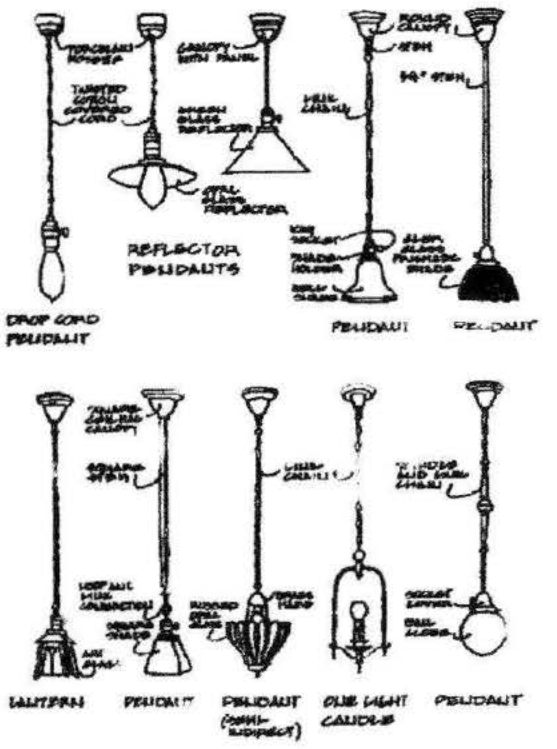

Fig. 70 Pendant Lamps

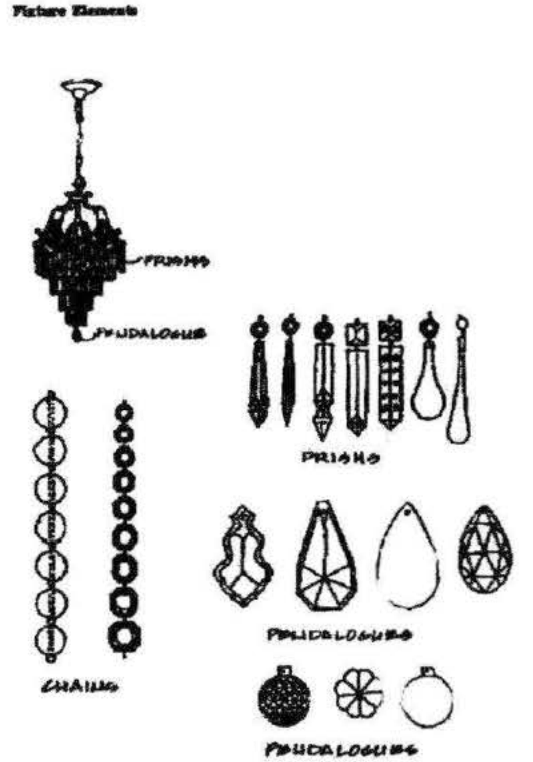

Fig. 71 Elements, Pendalogues

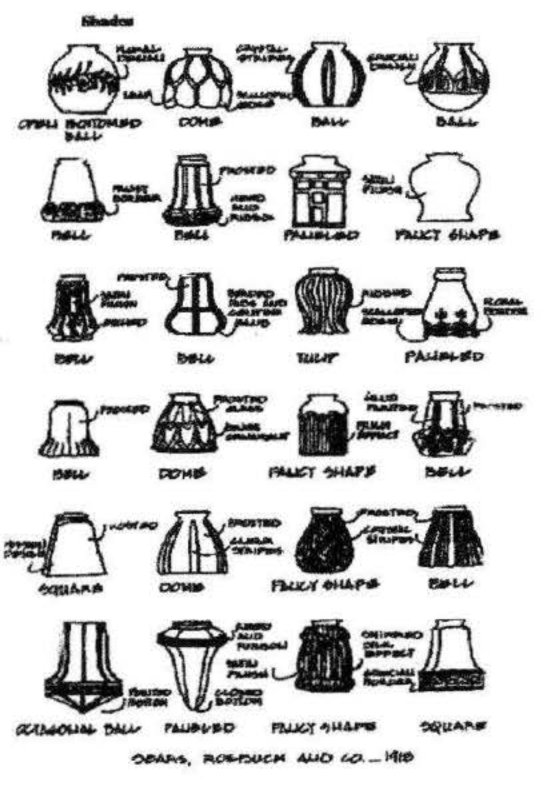

Fig. 72 Glass Shades

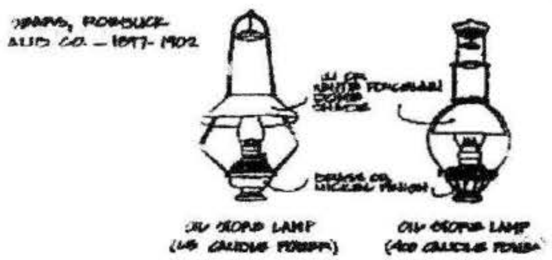

Fig. 73 Oil Lamp

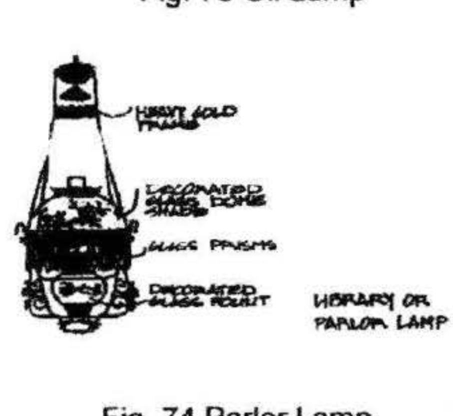

Fig. 74 Parlor Lamp

Residences served by gas lighting used the same design principle applied with decorative changes in the design. The gas lantern mantles would always be put in the up position because of the open flame. Once electric lighting came into use, the shades were usually pointed downwards on combination luminaires, and the gas portion of the pendant luminaire would have a metal loop coming on the branch to the lamp with a shade in the upright position (Figs. 68,75).

In the 1880s an inverted gas burner (Fig. 76) was developed so that gas lighting could point downwards and eliminate the shadows associated with gas lighting. Branched luminaires were very popular, as they were better suited for larger rooms that needed more light and for combination gas and electric applications. The styles varied greatly in the shades and branch shapes. They encompassed bell shades, ball shades, tulip shades, round balls with floral designs, cut glass shades, and etched glass shades (Figs. 74,77-78). Wall bracket lamps employed these same design characteristics.

Transitional luminaires were a crossbreed of styles. These luminaires used a ceiling canopy from the Victorian era, and used the modern individual lamps to form a shower of light. These ceiling mounted luminaires usually had three to five lamps on chains hanging down at uniform or staggered lengths (Fig. 67). Some included a pan with an indirect or semi-indirect lamp in the center. Later luminaires utilized the semi indirect bowl and eliminated the showers of individual lamps (Fig. 79). Another popular form of transitional lighting included ceiling mounted luminaires (Fig. 80). These could have one to seven lamps on the luminaire depending on the room size and application. Fancier luminaires would employ design motifs such as acanthus leaves on the multi-light luminaires.

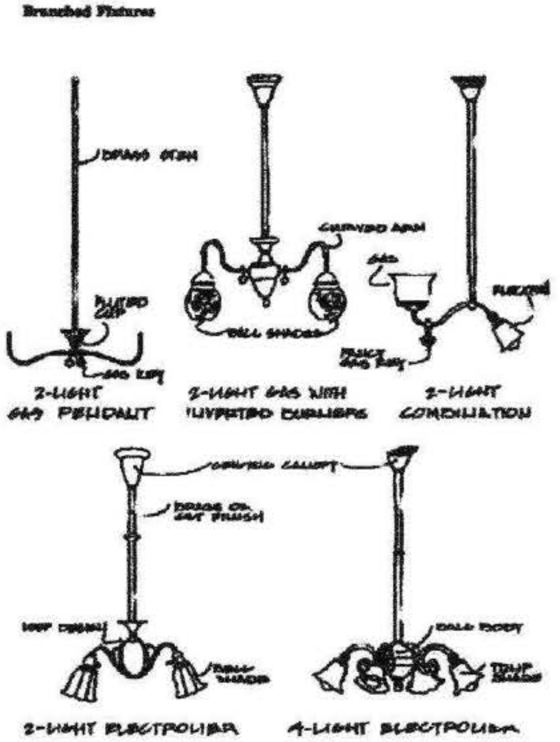

Fig. 75 Branch Fixtures

Fig. 76 Inverted Gas Fixture

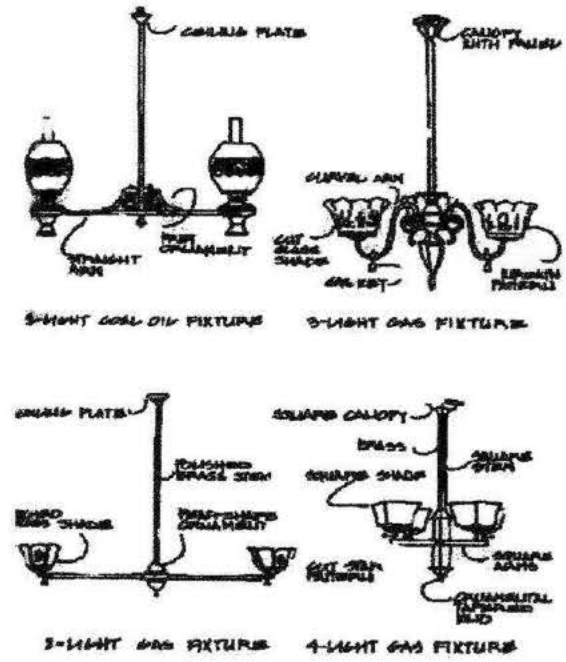

Fig. 77 Branch Fixtures

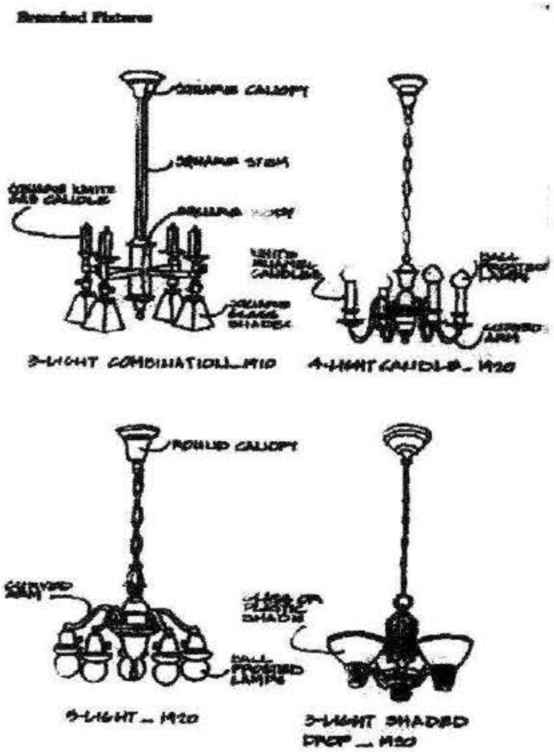

Fig. 78 Branch Fixtures

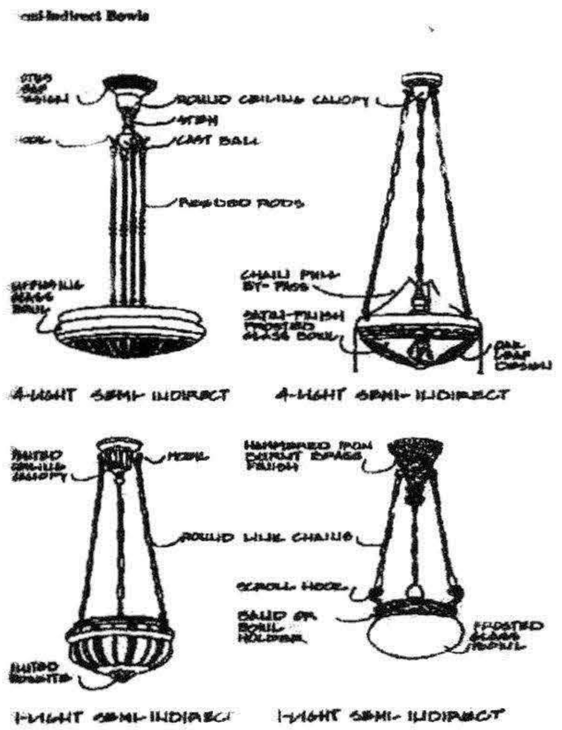

Fig. 79 Semi-Indirect Fixtures

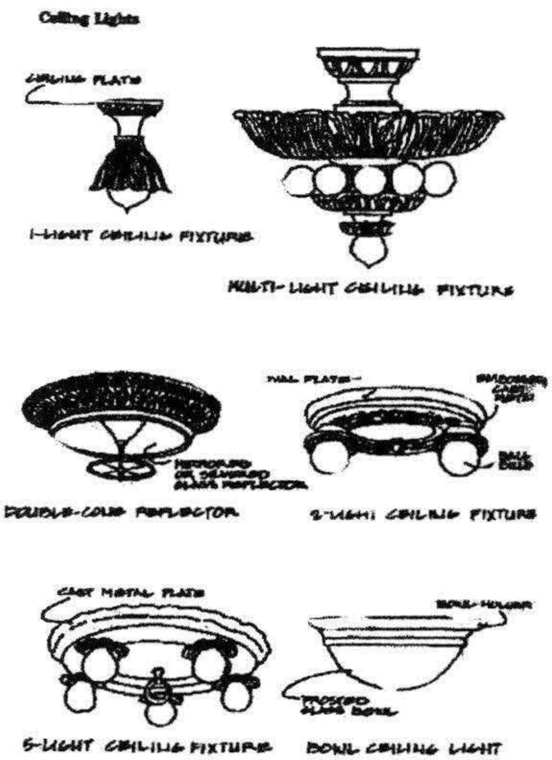

Fig. 80 Ceiling Fixtures

Craftsman-Bungalow Artistic Period

The Craftsman house often employed simpler, more rectilinear or cylindrical luminaires (Fig. 81). Branched luminaires would often have four branches with four square shades on four square arms on a square stem with an ornamental tapered end (Fig. 77). On a combination gas and electric branched luminaire, the gas lamps would face up and the electric lamps would be directly underneath them in the same shape to give a double light effect. Wall brackets would consist of three lamps in a series (Fig. 82) or single luminaires.

Other common styles that were found in this type of house would be a two-branch luminaire in the living room and dining room. Single pendants would be in the kitchen and bedrooms. The bathroom would often have wall bracket lighting at the sink and halls would have a ceiling luminaire. Porches usually had a wall bracket luminaire as well (Fig. 81).

In upper middle class homes a fancier luminaire might be found in the dining room. These were usually pendant luminaires that had art glass, or fabric shades with fringe that had one, two, three, or six lamps depending on the size of the space (Fig. 83). The height placement (Fig. 84) of the dining room luminaire was determined by the size of the opening through which light was emitted, and the distance of the lamp filament above the opening.

By the 1920s, standards for wiring, outlet switches, and luminaire locations had been established. One circuit was required for every 500 square feet of floor space and all rooms were to be served by at least two circuits to avoid interruption in service

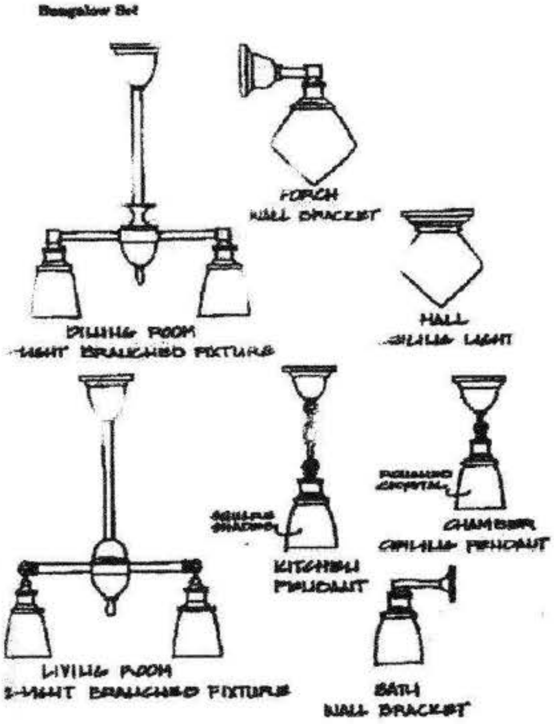

Fig. 81 Bungalow Set of Fixtures

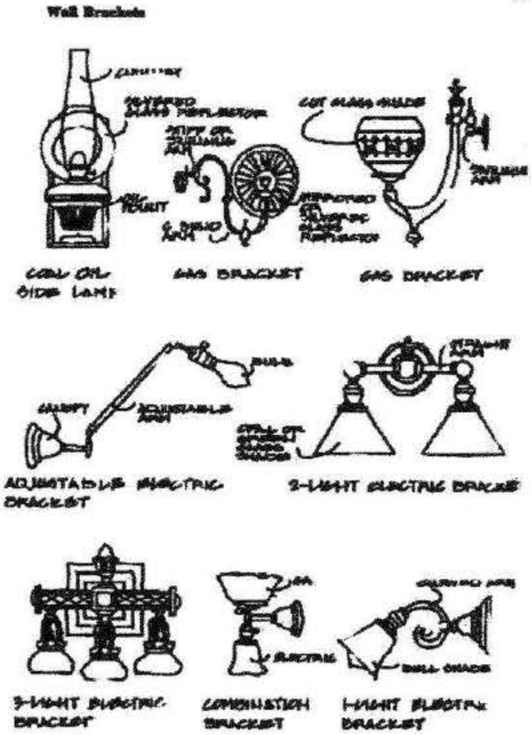

Fig. 82 Bracket Fixtures

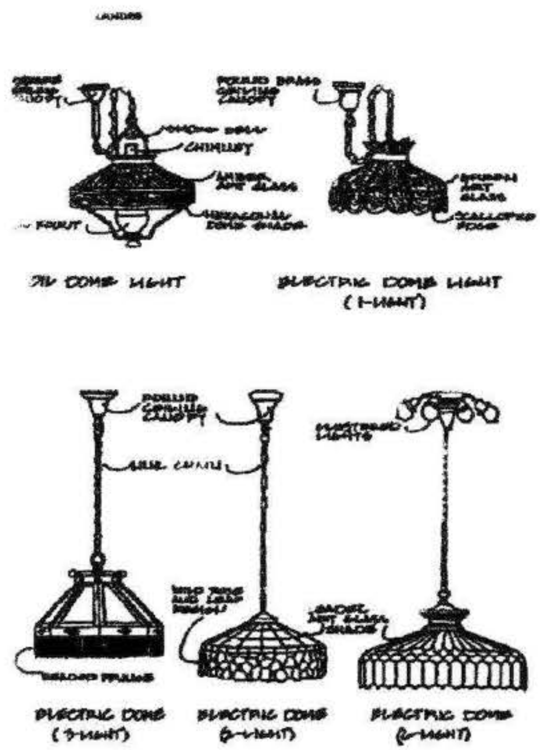

Fig. 83 Dome Fixtures

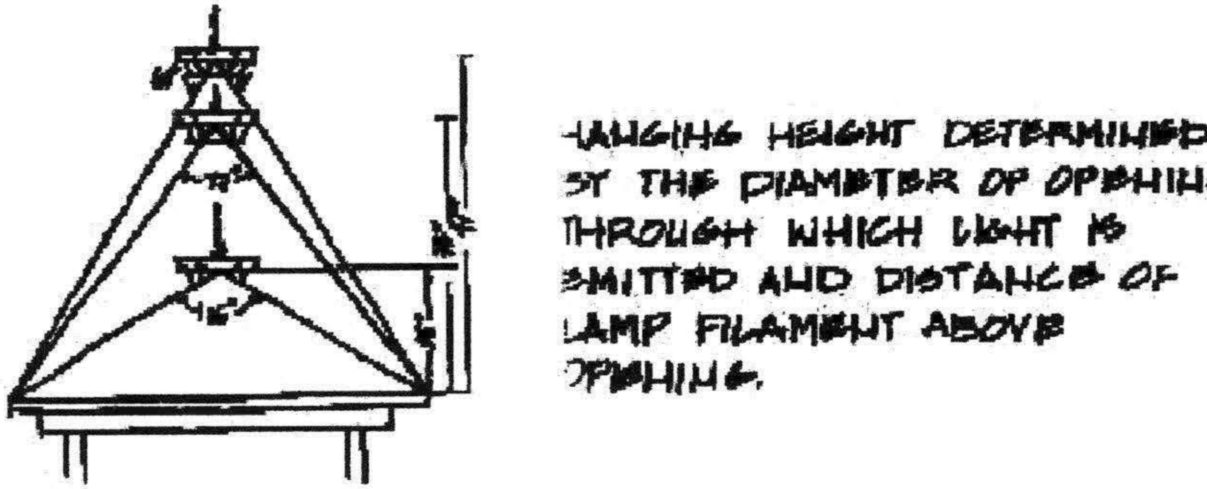

Fig. 84 Lamp to Table Height Ratio

(Fig. 85).[3] Electrical outlets were the key to expanding electrical service in vernacular buildings. In 1931, General Electric estimated that from 1920 to 1927 the average number of outlets in a six-room house increased from 21 to 53.[4] Not only did the number of outlets increase, but the styles they were available in varied (Fig. 86).

Colonial Period

The Colonial Revival period saw many electric luminaires imitating the look of candlelight. Tapered bulbs in the shape of a flame were being produced to accomplish this effect. The screw bases were white or cream, like the wax of a candle. Pendant luminaires with a link chain were often found in the halls, and multiple candle luminaires were usually placed in the dining rooms and living rooms if a central luminaire was appropriate for the space. Wall brackets had one or two lamp candles (Fig. 87). The design aesthetic called for simplicity, featuring an early American pioneer spirit influence in the designs. In more well-to-do households chandeliers with prisms might be in the best rooms of the house to add an air of elegance to the interiors. These luminaires might also include small lampshades for the individual candle lamps to reduce the glare from the lamps.

Modern Period

This period combined the Modern Movement, Art Deco, and Streamline Moderne into one package. Wall brackets had the chevron designs (Fig. 88), or in utilitarian areas of the house, opal glass shades on white porcelain. Lumiline (trade name) wall brackets for fluorescent tubes were often found in the bathrooms. Ceiling luminaires became

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[3] Ibid., 215.
[4] Jennings, Jan and H. Gottfried, *American Vernacular Interior Architecture 1870-1940*, 215.

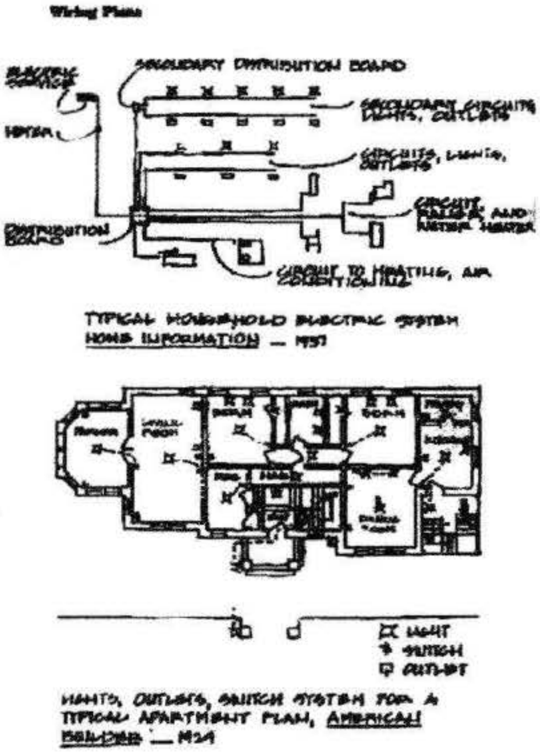

Fig. 85 Electrical Plan
Service Panel 1937
Layout 1924

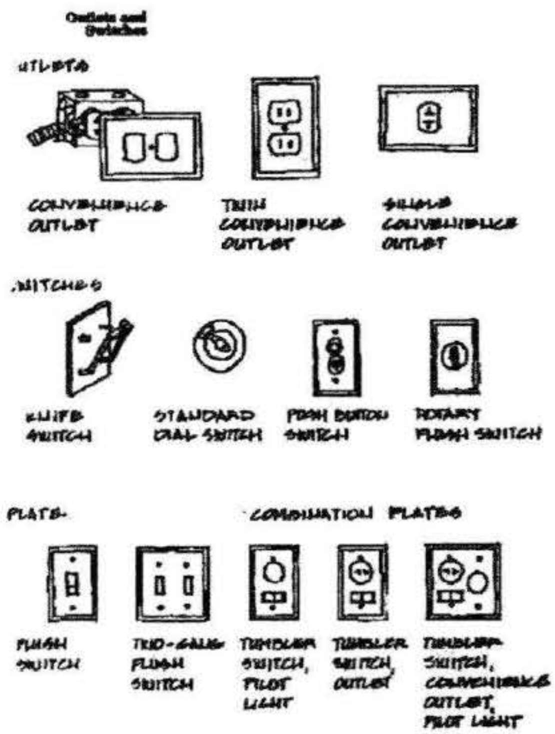

Fig. 86 Outlets and Switches

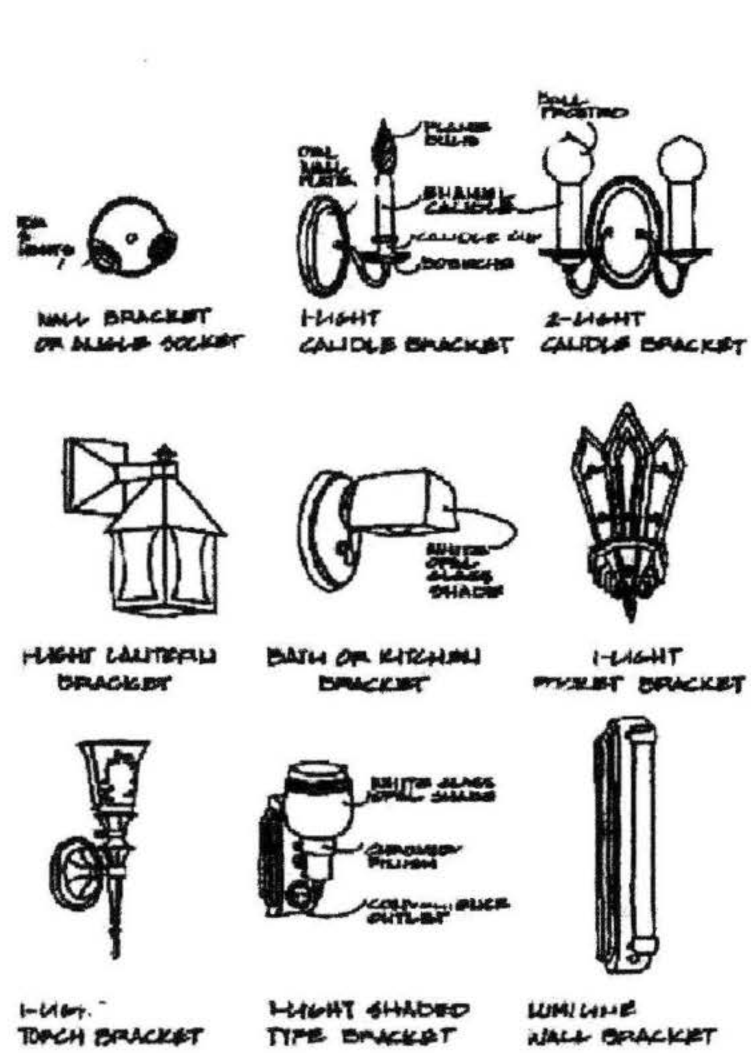

Fig. 87 Bracket Fixtures

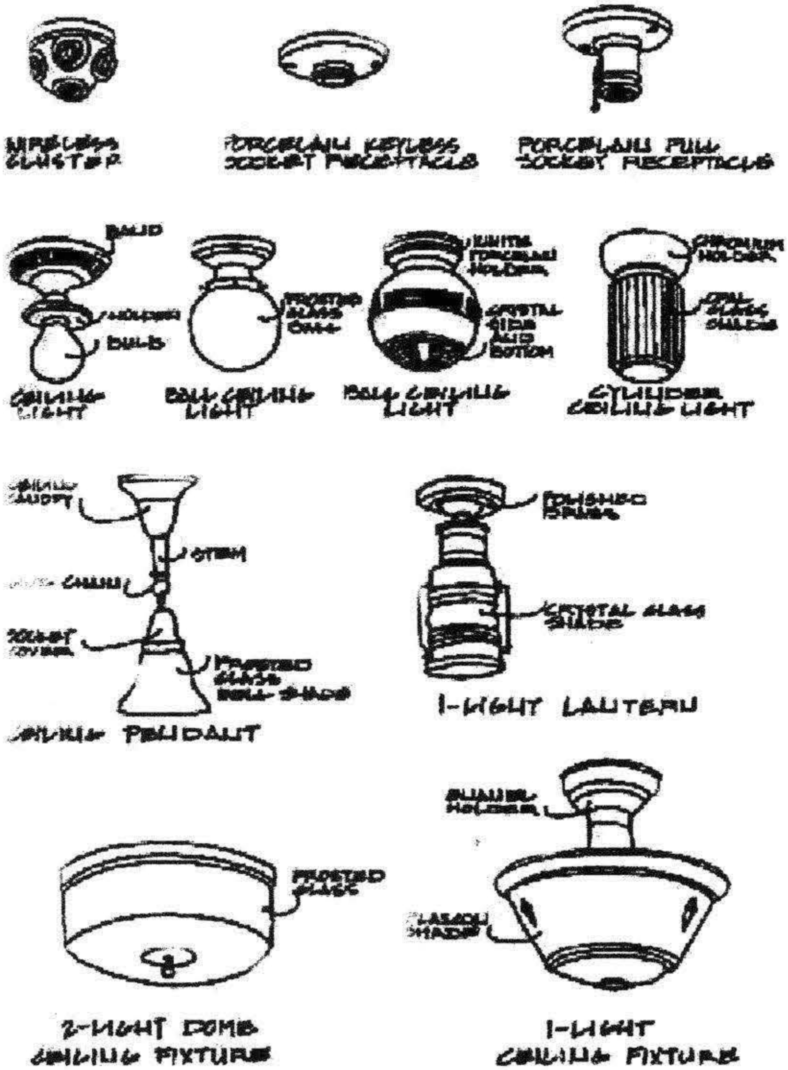

Fig. 88 Ceiling Fixtures

simplistic, using a single ball or cylinder of glass to shield the lamp (Fig. 87). By the 1930s there were specialty outlets for different uses such as floor outlets, radio, telephone, pilot light and switch control, heavy-duty polarity outlets, all in flush or weatherproof designs (Fig. 85).

Kitchens and Baths

For the rest of the house, changes in lighting design came about through stylistic changes, and technology changes that made lamps brighter and more efficient. The kitchen was treated differently. This workspace in the house was seen as a place where higher levels of light would alleviate eyestrain and contribute to a lighter, brighter ambiance.[5] Artificial light sources that were used through time in the kitchen were: oil lamps set on wall brackets over the sink and stove, gas luminaires in wall brackets and pendants hung from the center of the room, and electric luminaires using a single bulb, or multiple bulbs utilizing direct or indirect lighting techniques for the room.[6]

Between 1900 and 1920 the campaign against household germs and disease began, and the kitchen was the primary target for reducing these dangers. Plain, smooth surfaces were easier to keep clean, and the grouping of functions into workshop spaces were also concentrated on. The kitchen came to be thought of in terms of a laboratory; a gleaming white room where the result of time-and-motion and nutrition studies could be implemented.[7]

The kitchen in 1906 had separate workspaces but no cohesive work center like what we are used to by modern standards. The sink, stove and worktable were their own

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[5] Jennings, Jan and Herbert Gottfried, *American VernacularInterior Architecture 1870-1940*, 201.
[6] Ibid., 201.

entities. Fancier kitchens would have a hot water heater and wainscoted walls in some cases. Neither illustration of the 1906 kitchen (Fig. 88) has a wall bracket lamp, so for these two rooms, the assumption of the presence of a single pendant luminaire in the middle of the room has to be made.

Moving up to the kitchen of 1929 (Fig. 89), we see the white stove and white work surfaces. A wall bracket lamp is present over the sink, and an indirect lighting luminaire is centrally located in the room. Indirect lighting became popular in the teens and twenties. Smooth ceiling surfaces were used and a cream or white color was painted on the surface to reflect more light (Fig. 90). Indirect lighting luminaires were subjected to some good-natured humor by cartoonists such as Fontaine Fox (Fig. 91).

During this time period many new appliance inventions were being marketed to make the housewife's life easier and make her work in the kitchen less time consuming and tiresome (Fig. 92). But the sheer size of some of the appliances cut into the workspace, which defeated the purpose to some extent. Other advertisements were geared more toward the lady of the house who was well-to-do enough to have a maid, but one who would forget to switch off a lamp (Fig. 93).

In 1938 the fluorescent lamp manufactured by General Electric came onto the market (Fig. 94). Fluorescent lighting in the kitchen made a huge difference in the amount of light there was to work with. There was finally enough light to see what you were doing on the counter as illustrated by an ad from 1953 (Fig. 95). On the left panel there is an incandescent central ceiling luminaire that illustrated the shadows cast by the upper cupboards. On the right panel there is a new long luminaire on the ceiling, fluorescent tubes under the upper cabinets lighting the counter, and one each over the

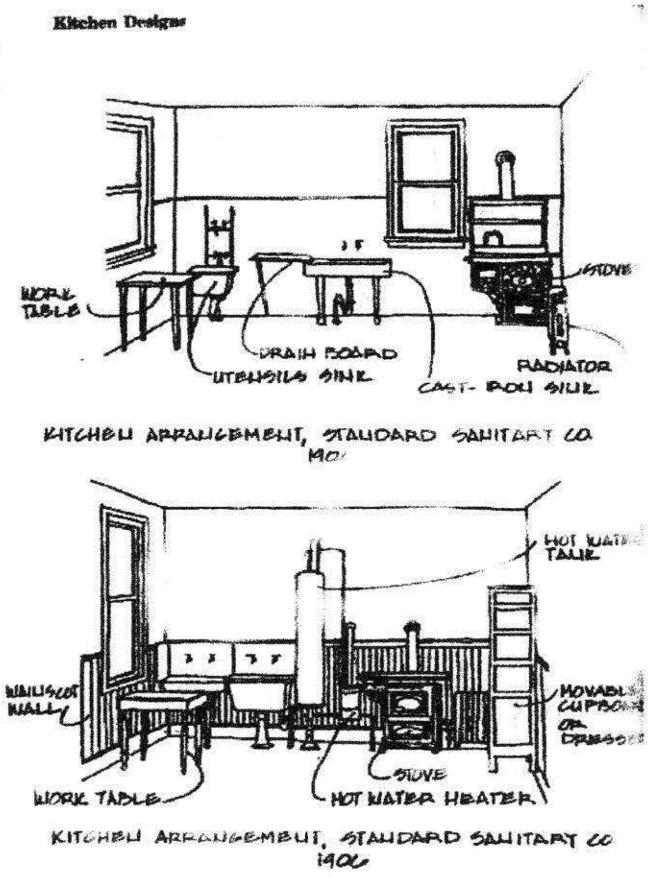

Fig. 89 1906 Kitchens

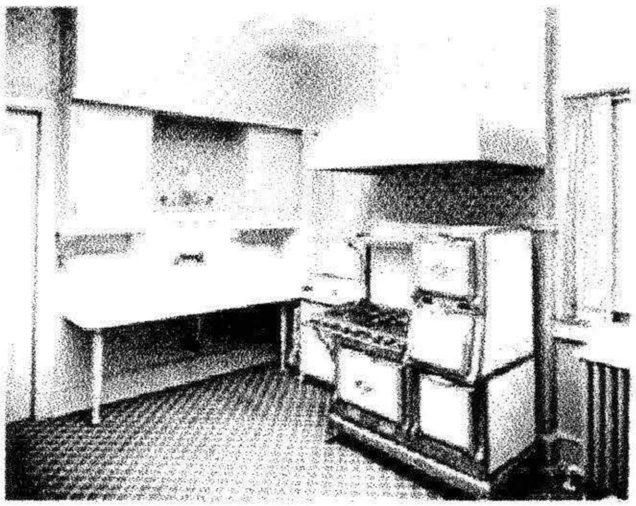

Fig. 90 1929 Kitchen

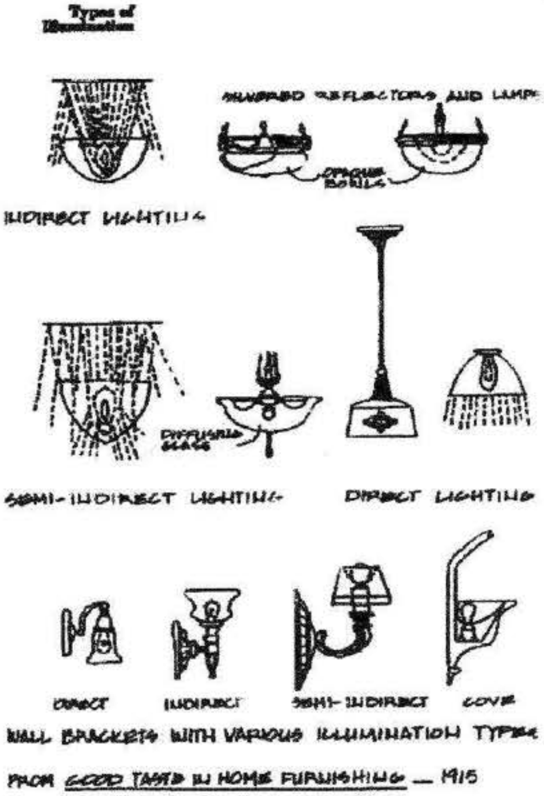

Fig. 91 Lighting Effects

Fig. 92 Fontaine Fox Cartoon Jesting at New Uses for Inverted Lighting

Fig. 93 Ad for new appliances to reduce amount of time spent in kitchen

Although the stated intent of the burgeoning electrical appliance industry was to bring Mother out of the kitchen, there were now so many new conveniences crowding her workplace that she may not have been able to make her way out. This was from an ad campaign promoting electric ranges in the [illegible] Synchronizer, October 1927. (PGE collection)

Electric coffee maker advertised in the Bulletin of the Portland General Electric Company, January 1906. (PGE collection)

COFFEE MAKING BY ELECTRICITY

ELECTRIC APPLIANCES began to appear immediately after the light bulb

- [illegible] Iron
- [illegible] Sewing machine
- [illegible] First refrigerator patented
- [illegible] Range
- [illegible] Fan
- [illegible] Heater
- [illegible] Vacuum cleaner
- [illegible] Toaster
- [illegible] Clothes washer
- [illegible] Dishwasher
- [illegible] Pop-up toaster

This illustration shows "economy in the dining room" through the use of an "economical turn-down lamp." This can effect savings because "servants leave the light burning with the result that bills often seem exorbitant." The turn-down lamp "can go from bright to dim." It is also versatile because "in homes where there are no servants the saving is the same." Bulletin of Portland Railway Light and Power Company, January 1908. (PGE collection)

Fig. 94 Advertisement for Dimming Lamp *note dates of kitchen appliances

Fig. 95 1938 Advertisement for
Fluorescent Lighting

Fig. 96 Advertisement of
Fluorescent Lighting
for Kitchen 1953

sink and stove. Also note the smooth clean lines of the cabinets and counters in gleaming white, giving that sanitary, clean look.

The bathroom of 1906 was much the same as the kitchen of 1906 in its lighting levels. There were wall brackets over the sink and a central pendant hanging from the ceiling (Fig. 96). The amenities of the vernacular bathroom were few and the room was plain and simple. Moving on through time to a bathroom of 1922, a few more amenities have been added, but the wall brackets not only flank the sink, they are also opposite the tub and toilet (Fig. 96).

As the modern movement and the Streamline Moderne aesthetic took over, the bathroom style changed dramatically. The Vitrolite bathroom of 1938 featured corners that were rounded, surfaces were smooth, glass wall panels were in place, and the lighting was changed to fluorescent for both the mirror and ceiling luminaires (Fig. 97).

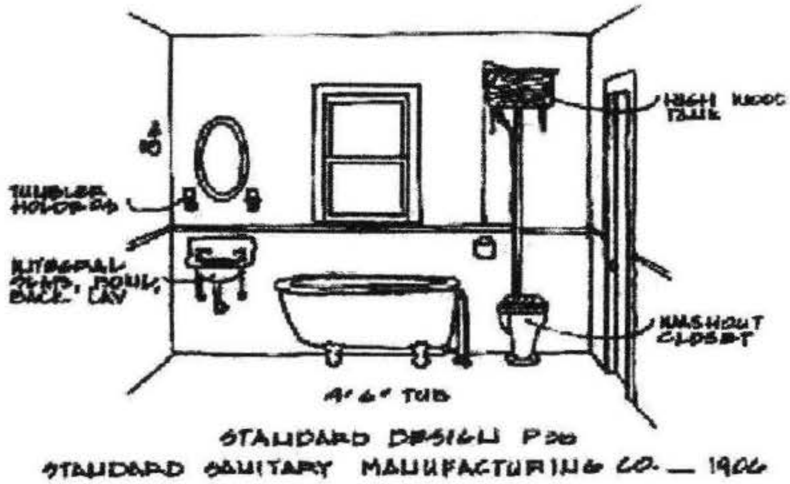

Fig. 97 1906 Bathroom

Fig. 98 1922 Bathroom
1938 Bathroom

Conclusions

The issues addressed in historic lighting systems are interrelated and each aspect influences each of the other aspects. The developments of the incandescent electric lamp influenced the electrical demands of the wiring and the heat generated through the ever-increasing consumption of electrical power. The insulations developed needed to be able to handle this increase and most historic systems have come to the critical point of needing replacement. This is an important issue to address because of the power consumption needs of today's lamps and appliances. The retrofitting of historic wiring systems have kept many electricians busy examining and replacing faulty wires and mechanical components. The stylistic changes over time were the result of the combination of the changes in aesthetic taste, and the compensation for the creation of newer and more powerful electric lamps. Better designs in wiring systems brought new potential for creative lighting designs in interiors in the 1920s and 1930s. With the invention of BX Cable knob and tube wiring became obsolete. Wiring could now be manipulated into awkward spaces more easily to connect to the newer streamlined luminaires without fear of damage to the insulation. Each mechanical component of the system could be looked at individually, and then looked at as a whole to determine what the best course of action should be when dealing with an historic lighting system developed between 1900 and 1950. After inspecting for wear and damage these components can be taken out of service if deemed unsafe. For the purposes of historical record many items can be left in place and in some cases, used as conversation pieces such as the knife switches often found in the second floor hall. Directions for further study would include examining power source development, exterior residential lighting, and commercial lighting applications.

The complexity of the issues surrounding historic wiring systems and how each aspect interrelates with the other aspects is illustrated through the use of the timeline graphics. If any given point in time during this fifty-year period is selected, one can look at the cross section of data from each of the main categories to see what was in use at the time. That can be very beneficial when determining if a retrofit of a wiring system is needed. For example, a house built in 1920 could be one of three main styles that were popular at the time. The choices in luminaire styles to select to emulate the architecture could reflect the Arts and Crafts Movement, the Art Deco Movement, or the Modern Movement. Looking a little further down the chart, the NEC codes for wiring systems could be examined to determine what standards were in place at the time. The Carter System was declared illegal the year the house in question was built, and interior surface mount wiring was still in use. Outlet boxes were not yet required, nor were the wires color coded, nor were lamp sockets electrified in their centers and mechanical equipment was not required to be grounded. Looking further down the chart all five wiring systems either concealed or visible were in use and four different kinds of insulation were in use. The incandescent lamps were not tipless yet, nor did they have the satin finish on the glass.

So what does all this information mean? First of all, the architectural style of the residence can be determined using the architectural style guides so that appropriate luminaire styles could be selected. Once these luminaires are purchased if not existing in the home, their code violations can be addressed using the timeline to determine what technology was in place at the time of their manufacture. Then the wiring system can be addressed using the information to determine what code violations are likely to be present, and what types of wiring insulation the electrician is likely to encounter and what its deterioration characteristics are like. For example, if felted asbestos wiring is in place, special considerations have to be put in place for its removal because of its health hazards. Besides that, the type of concealed or exposed mechanical system can be anticipated that will have to be taken out of service. Once all of those issues are completed and the finishing touches of the room are being selected such as the color palette and furnishings, then the lamp type can be considered. This should be kept in mind when selecting the luminaires, as the incandescent electric lamps of the time were the drawn tungsten wire variety, without a satin finish on the glass. The proper shades would need to be selected for the luminaires that would shield the eyes from the direct glare of these lamps. For occasional lighting, the shade types should be selected to filter the light, and direct it downward towards the task at hand.

The development of the incandescent lamp and the other factors surrounding it are a complex and fascinating subject to study. Through the changes in technology and the development of new, brighter and more efficient lamps, luminaire designs had to change to accommodate these developments. Not only were new luminaires developed to accommodate a new technology but there were also aesthetic reasons for change. The early examples had many lamp outlets, and used frosted glass shades to diffuse the light, but not diminish the directions in which the light could illuminate a room. Once brighter tungsten filament lamps were produced, designers change the style and shape of the luminaires and shades to light indirectly to shield the eyes from the irritating glare of the incandescent lamp.

Occasional portable luminaires became commonplace in a room to aid in task completion, but presented a challenge to the existing wiring systems of the residence. As more portable luminaires were purchased for any given residence, the need for more electrical outlets was apparent. To economize on wiring costs, extra lines to existing circuits were often added, making the power load more intense on a given circuit, thus jeopardizing the integrity of the wiring insulation from heat buildup. Task lighting was a necessity as the general illumination of the room was inadequate for reading or other detail work such as crafts. Designers of occasional lighting had to compensate for the glare of the lamp by elongating the shades to redirect the light downward out of the eyes, but design the shade in a manner that a pool of light wide enough could be shed to the task at hand.

Residential wiring systems had to be developed to put Edison's invention into the home of all Americans. Safe and efficient means of doing this had to be developed, and many systems insulating methods failed before better and safer methods could be developed. Insurance companies alarmed at the costs in fire damage to buildings as a result of this "new fangled contraption" lobbied for regulation of this new power source. The National Electric Code was established in 1897, almost twenty years after Edison produced the first commercially viable incandescent lamp. Several different concealed wiring methods were developed along with the insulations of the conductors. Once safer operating methods were established and service was extended to the public, rural electrification became an issue. Thanks to the Rural Electrification Act passed in 1935, many men went back to work, and farms across America could now tune in to the radio to find out what was going on in the world. Contrary to popular belief, the intention of adding electrical connections to rural areas had little to do with electric lighting and the associated conveniences, but more to do with having the radio become a form of national communication. Europe and the Far East in 1935 were going through a tumultuous time, and the American government began to worry what Hitler, Mussolini and Emperor Hirohito were up to. If the radio was in place in homes across America, the nation could be quickly mobilized for the armed forces to defend ourselves and our allies around the world. The additional benefits of the Rural Electrification Administration of electric lighting and convenience outlets for time saving appliances were apparent to the rural consumers of the 1930s, who had been waiting for the same conveniences as city dwellers for quite some time. However, if the wiring systems were installed in a cheap and shoddy manner, problems would become apparent at a later date.

Early wiring systems can be a dangerous problem to tackle if not addressed in the proper manner. Although the National Electric Code was established in 1897, there were electrical contractors out there that did not adhere to the standards set. For instance, the installation of the Carter System, using the lazy neutral wire was common even after it was made illegal in 1920. An electrician who is knowledgeable about historic wiring systems, and who is sensitive to the integrity of historic interiors should be engaged for any retrofitting work that needs to be done. Through the modern blend of technology and historic aesthetics in design, reproduction switching systems are now available to keep the historic appearance in an interior, but meet modern safety codes. An electrician well versed in the issues of historic retrofits will cost more because of the special considerations in dealing with potentially dangerous historic wiring systems. The acid test would be to test the electrician's knowledge of historic luminaires for the appropriate style selection of luminaires to match the architectural style of the residence.

The costs associated with retrofitting a wiring system are usually higher than the installation of wiring in new residences because of the inconvenience of fishing wires through walls and the safety and health hazards. There are many health hazards associated with crawling around in attics or crawl spaces while servicing an historic wiring system that can be encountered. These things can range from asbestos insulation, to rodent droppings, to bats flying around the workers. That can be startling causing the electrician to physically react and possibly bump into a live wire, or tripping and putting a foot through a ceiling. Besides those hazards, being bitten by poisonous insects such as the Brown Recluse and Black Widow spiders can happen. For these reasons, it is wise to allow for a large budget when retrofitting an historic wiring system.

Knowledge of stylistic history is important, especially to a person who is rehabilitating an historic structure that has lost its original luminaires. Unless historic photographs are available to have a custom reproduction made, an appropriate luminaire to the period and task should be selected. The wiring and mechanical components should be inspected by an electrician to find out if rewiring the luminaire is warranted. In most cases, the answer will be yes. The lamp socket should be replaced, as they wear with age, and if the luminaire was produced before 1925, the outer edge of the socket could be electrified. Turnkeys often wear out, and wiring that has been subject to motion in the luminaire over the years may have insulation that has been compromised. The relative age of the luminaires selected can serve as a reference point as to what type of lamp to install in the luminaire to create an historic lighting effect. Taking a 1906 house as an example, examine the number of lamp sockets, shade type, and whether the lamp is concealed or not. These factors will help determine whether a carbon filament or a tungsten filament would be more appropriate for the luminaire.

For most Americans completing rehabilitations to historic structures, the vernacular periods in historic lighting will have to be considered. Unless the house was architect designed for a prominent citizen, the presence of vernacular lighting designs are almost always included in the interior. The possibility of vernacular designs in architect designed interiors are another consideration to speculate about.

Kitchens and bathrooms are almost always the two spaces in the house that were remodeled over time, and it is very rare that an intact space will be discovered. Today, many manufacturers are producing reproduction luminaires that match the styles of the original fittings, but function to modern standards. Some research should be conducted to determine what luminaires went into the original kitchen and bath, and then appropriate period or reproduction lighting luminaires can be implemented. If the historic lighting appearance is desired in the kitchen, but needs to function in a modern manner, 40 watt clear glass ceiling fan lamps work well to approximate the early tungsten filament lamps lighting levels, but at a much lower cost.

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