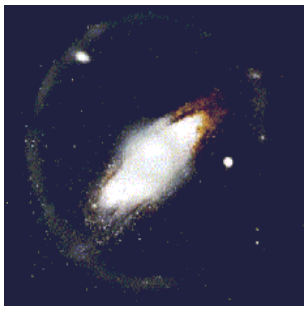
A History of Light and Lighting

Edition: 2.3 - (2005)

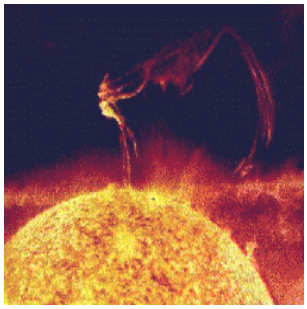


IN THE BEGINNING - (c 4.5 Billion BC)

Let There Be Light!

In the beginning it was dark and cold. There was no sun, no light, no earth, no solar system. There was nothing, just the empty void of space. Then slowly, about 4.5 billion years ago, a swirling nebula, - a huge cloud of gas and dust was formed. Eventually this cloud contracted and grew into a central molten mass that became our sun. At first the sun was a molten glow. As the core pressure increased, and the temperature rose to millions of degrees - a star was born. Through the process of thermonuclear hydrogen fusion, the sun began to shine.

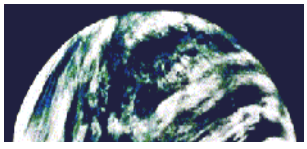
This was the nebular hypothesis, first proposed in 1755 by the great German philosopher, Immanuel Kant.



THE SUN - (c 4 Billion BC)

Our sun is an atomic furnace that turns mass into energy. Every second it converts over 657 million tons of hydrogen into 653 tons of helium. The missing 4 million tons of mass are discharged into space as energy. The earth receives only about one two-billionths of this. Scientists calculate that the sun should keep burning for another 10 to 30 billion years. It has been estimated that in 15 minutes our sun radiates as much energy as mankind consumes in all forms, during an entire year.

The sun is approximately 93,000,000 miles from the earth, 864,000 miles in diameter, and is only an 'average' star in size, brilliance and age. There are more than 100 billion other stars in our sun's own galaxy, the Milky Way. Energy, with a color temperature of approximately 6500 degrees Kelvin, is received on earth, from the sun. It takes light from the sun approximately 8 minutes to reach the earth. The illumination on the earth's surface by the sun may exceed 100,000 lux, (10,000 fc) in mid summer.



THE EARTH - (c 4 Billion BC)

About 4 billion years ago, soon after the Sun was formed, the Earth and our other planets were formed from violent explosions and spinoffs from the process that created the Sun. The nine planets created are now known as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto, (arranged in order, from the sun). As rocks and other particles collided forming the Earth, it became molten. The rocks liquefied and the heavier elements sank to the core of the planet. The surface of the Earth cooled and hardened. Gradually oceans appeared and sunlight and water gave birth to life, eventually, intelligent life.

The earth has a diameter of 7,900 miles (compared to the sun's diameter of 864,000 miles).

EARLY LIFE - (c 3 Billion BC)

Without light, there would be no life. Life was dependent on three things being present: a.) the basic long molecule building block, carbon, b.) water, and c.) light. The Earth had all three. Eventually the oceans formed a rich organic soup that ultimately bore life. The oldest verified evidence of life comes from Rhodesia, where rocks formed approximately 3 billion years ago, bear 'stromatolites', the fossilized remains of algae.

Originally our atmosphere contained; hydrogen, helium, nitrogen, methane, ammonia and water vapor. For millions of years, the waste product of oxygen, from the ocean's algae, bubbled up out of the sea and into the atmosphere. Gaseous oxygen reacted strongly with the methane and ammonia in the atmosphere, turning it into carbon dioxide and water vapor. Over time, methane, ammonia and carbon dioxide were almost eliminated from the atmosphere. As oxygen began to build up in the atmosphere, the usual oxygen module (0-2) began to absorb ultraviolet wavelengths from the sun to form three atom molecules (0-3). In time a layer of poisonous ozone had built up high in the atmosphere, about 30 miles above the surface of the Earth. This ozone layer effectively blocked much of the damaging ultraviolet rays from reaching the Earth. Paleontological records show that life moved from the sea to land, only after the ozone layer had formed, providing a 'sunscreen' to protect the land from harmful ultraviolet radiation.

Today, the air we breath today is approximately 78 percent nitrogen, 20 percent oxygen and 2 percent noble gases, carbon dioxide and water vapor.

PHOTOSYNTHESIS - (c 2 Billion BC)

Somehow, as the primitive ocean organisms developed, one managed to develop a molecule that could use the energy of sunlight to produce food for itself. Sunlight, water, carbon dioxide and simple inorganic elements were all that was needed to sustain itself. No longer did ocean creatures have to eat other ocean creatures to survive. This was the birth of the first 'autotroph', a creature that could manufacture its own food. The plant was born and the process of photosynthesis had begun.

FIRST MAN - HOMO ERECTUS EMERGES - (c 1 Million BC)

EARLY MAN - (c 500,000 BC)

For people that lived before the dawn of history, there was no such thing as a solar system. The world as they understood it, was a small patch of land bounded perhaps by hills and by the blue line of the sea. Overhead was the sky, and across it rode the sun, a god, giving light and warmth. The moon was a lesser god, shining with a lesser light, and with it at night, rode the brilliant innumerable stars. Outside of this little universe, lay unimagined mystery.

FIRE, FLAME and TORCH - (c 400,000 BC)

Homo erectus probably discovered fire by accident. Fire was most likely given to man as a 'gift from the heavens' when a bolt of lightning struck a tree or a bush, suddenly starting it on fire.

The flaming touch and the campfire probably constituted early man's first use of 'artificial' lighting. For the first time man gained some small degree of freedom from the blindness of night, and some small degree of safety from the fear of unseen prowling beasts. As early as 400,000 BC, fire was kindled in the caves of Peking man.

The torch was the first portable lamp. One of the earliest developments was the discovery that a bundle of sticks tied together made a blazing torch, producing a brighter and longer lasting light. Man had finally learned to control fire and the human race was on the road to civilization.

The discovery of fire has had such a profound effect on humankind that all early societies constructed a myth to commemorate it. Years later, to the ancient Greeks, the fire bringer was Prometheus.

ANCIENT ART - (c 28,000 BC)

In the Ice Age snow and cold of 30,000 years ago, Cro-Magnon artists used natural pigments to create primitive paintings. Excellent examples of early art have been found in the cave at Lascaux, in France. Clearly man must have been using fire to provide the necessary light to create his art, as many painting have been found deep within caves, far beyond the reach of daylight.

PRIMITIVE LAMPS - (c 13,000 BC)

Prehistoric man, used primitive lamps to illuminate his cave. These lamps, made from naturally

occurring materials, such as rocks, shells, horns and stones, were filled with grease and had a fiber wick. Lamps typically used animal or vegetable fats as fuel. Hundreds of these lamps (hollow worked stones) have been found in the famous Lascaux caves (France), dating to about 15,000 years ago.

The Sumerians of 2600 BC left behind them alabaster lamps so close to shell form that it is indisputable that shells themselves must have been used long before. Early man also realized that a crude reflector would help direct and intensify the light. Niches have been found carved into cave walls that are thought to have served this purpose.

In the Mediterranean area, hand fabricated lamps appear in Palestine, before 2000 BC.

Additional Reading: Greek and Roman Pottery Lamps, Donald Bailey, British Museum, 1972.

WORLD POPULATION - (8000 BC) - 100,000 people.

AGRICULTURE - (c 8000 BC)

About ten thousand years ago, man made an incredible discovery. For hundreds of thousands of years before, man has been a hunter/gatherer. Once man realized that he could actually plant crops and harvest them at specific times he now had a stable food supply. Man had discovered agriculture and now was able to settle down and farm a small patch of land. The knowledgeable use of light and other important factors brought man new freedom.

Successful agriculture meant for the most part predicting the seasons. Whoever could predict the coming of spring, the flooding of fertile river planes and the proper time to harvest - was certainly a god or a magician. It is possible that many ancient monuments were built to predict the coming of the seasons. The [STONEHENGE] is an example.

ANIMAL LAMPS - (c 5000 BC)

Animals were also used as lamps. Oily birds and fish needed only be threaded with a wick to produce a working lamp.

There are also records of the early use of fireflies to provide man with a source of convenient light. In the West Indian Islands (and also in Japan) fireflies were imprisoned in primitive cages to provide illumination through the process of bioluminescence. See also: [BIOLUMINESCENCE].

(REF: Lighting 1, Early Oil Lamps, British Science Museum, 1966).

EARLY LAMP FUELS - (c 5000 BC)

The fuel used in ancient lamps, depended largely on availability. Olive oil was probably the principal fuel employed in the Mediterranean countries, and was exported to areas where the olive did not grow. Other oils which were probable used in lamps include sesame oil (mainly in the East), nut oil, fish oil, castor oil and other plant oils.

Lamp fuels were editable, so lamps were more likely to be used by the wealthy than the poor. In times of hunger, fats would be consumed by the poor, and they would have less fuel available for their lamps.

(REF: Greek & Roman Pottery Lamps, Donald Bailey, British Museum,1972).

WORLD POPULATION - (3000 BC) - 100 million people.

EARLY LIGHTING - (3000 BC)

In the ancient civilizations of Babylonian and Egypt, light was a luxury. The Arabian Nights were far from the brilliance of today. The palaces of the wealthy were lighted only by flickering flames of simple oil lamps. These were usually in the form of small open bowls with a lip or spout to hold the wick. Animal fats, fish oils or vegetable oils (palm and olive) furnished the fuels.

ORIGIN OF THEATRE - (c 3000 BC)

Ancient theatre is as old as man's need to tell stories. The origins of theatre go far back into the past, to the religious rites of the earliest civilizations. Throughout the history of mankind there can be found traces of songs and dances in honor of a god, performed by priests and worshipers. The earliest civilization in which primitive rituals developed into truly elaborate performances was the Egyptian. It has been argued however, that the earliest existent Egyptian texts for funerals and coronations, some dating as far back as 3000 BC are really plays. See also: [EARLY THEATRE, GREEK], [EARLY THEATRE, ROMAN].

EARLY GLASS - (c 2500 BC)

The most reliable research places the invention of glass in the third millennium before the birth of Christ, in Mesopotamia, (or present-day Iraq and Syria). The earliest known glass makers worked in Mesopotamia, as far back as 2500 BC, crafting beads and other small objects. Hollow vessels do not appear before about 1500 BC.

Mix sand, soda and lime, cook and cool, the results: glass. Natural glass can sometimes be

created with little more than a strike of lightning on a sand beach. It appears in the form of thin tubes called fulgurites. There are also tektites: small, rounded bodies of glass formed as a result of meteorites crashing to earth. Among natural glass, the most prevalent is obsidian. Shiny and dark, it is born in the fires of volcanoes and was first used by humans to make tools, more than a million years ago. The Romans introduced glass blowing, about 50 BC. See also: [MEDIEVAL STAINED GLASS].

RE (THE SUN GOD) - (c 2300 BC)

(Also: RA) - The Egyptians believed that at night the sun god, Re, would travel through dark regions beneath the world where his ship faced destruction by a dragon named Apophis. A papyrus in the British Museum records a ceremony based on this theme, dating from about 2300 BC. Although Egyptian art survives in some quantity, direct illustrations of early rituals do not. Dancing and music, however, the secular entertainment of the pharaoh's courts are well illustrated by paintings and other artifacts.

STONEHENGE - (c 2000 - c 1500 BC)

Early man considered himself to be a child of the sun. Worship of the sun became part of early civilization.

Stonehenge was built on the Salisbury Plain (England) between about 2000-1500 BC. From the stones and other existing landmarks, archeologists have long puzzled over its meaning. Dr. Gerald S. Hawkins, (astronomer) showed in 1963 (with the aid of computers) that the stones were aligned to indicate the solstices and the beginning of seasons, and to predict eclipses of the sun and moon.

SUNDIAL - (c 1500 BC)

The sundial is an instrument for measuring time, by means of location of a sun shadow, cast by a marker. A sundial consists of two parts; a gnomon and a dial plane. The gnomon is the shadow producing device. The principal of the sundial was discovered about 1500 BC and allowed early man to divide the day into hours. The first hemispherical sundial was described about the 3rd Century BC by Chaldean astronomer Berossus. Sundials were used for determining the time until the 18th. Century, when clocks and watches became available.

TEMPLES - (1000 BC)

Although early Roman temples date as far back as 2000 BC, Greek temples were built after the Dorian immigration (before 1000 BC). One of the best examples is the Parthenon, from the 5th Century BC.

Most Greek temples were usually oriented to the east to illuminate the statues within through the doorways at sunrise.

OIL POTTERY LAMPS - GREEK - (600 BC)

After the natural oil lamp, then the crude worked lamp, pottery lamps followed. Early Greek pottery and were hand-modeled. Handles first appeared on Minoan lamps, and on the first Athenian lamps of the 7th Century BC. In addition to hand-modeling, later lamps were also manufactured by pottery wheel and molding techniques. Both of these techniques became far more popular than the hand-modeling method.

Pottery lamps were a cheap and practical means of illumination, easy to produce, easy to use, but rather messy to handle. The oil would often ooze from the wick hole and run down the outside of the lamp.

During the 6th, 5th and 4th centuries BC, Athens was a major manufacturer and exporter of high quality poetry lamps. Lamps similar in basic design may still be used today, in some parts of the world.

Additional Reading: Greek and Roman Pottery Lamps, by Donald M. Bailey, The British Museum, 1972.

PYTHAGORAS - (c 582 - c 500 BC)

Pythagoras was a Greek philosopher and mathematician who was born in Samos. He founded the Pythagorean School that emphasized the study of musical harmony and geometry. He also put forth the 'Particle' theory of light. This assumed that every visible object emits a steady stream of particles, that bombard the eye. Pythagoras suggested that "light consists of rays that acting like feelers, travel in straight lines from the eye to the object, and the sensation of sight is obtained when these rays touch the object", much like the sense of touch.

HERACLITUS - (c 535 - 475 BC)

Heraclitus - Greek philosopher - "The world, an entity out of everything, was created neither by gods nor by men, but was, is and will be eternally living fire, regularly becoming ignited and regularly becoming extinguished" (The Cosmic Fragments #20, c 480 BC).

OIL RESERVOIR LAMP - (500 BC)

Gradually the body of the oil lamp closed, forming a completely enclosed reservoir, by about

500 BC. The oil reservoir lamp consisted of pottery or metal bowls with one or more wicks projecting through openings in the spouts and a cover to keep the reservoir from being spilling or being ignited. The cover also helped keep rats and mice from drinking the oil and prevented insects that were attracted to the light, from falling into the oil.

Artisans of that day found in the oil lamp, an intriguing medium for their artistic expression. Early Greek, Roman and Egyptian lamps are highly artistic in design.

Additional Reading: Greek and Roman Pottery Lamps, by Donald M. Bailey, The British Museum, 1972.

EARLY THEATRE, GREEK - (500 BC)

The first great theatrical age in the history of Western civilization is that of Greece in the 5th Century BC. It was there that tragedies and comedies were first performed by actors, not by priests, in special buildings. The Greeks built open air theatres, and used natural daylight and sunlight for their lighting. In the Greek theatre, lanterns were used to show that the scene was set at night. Early theatres were constructed from wood. Later, theatres (300 B.C.) were constructed from stone.

Additional reading: Theatre Design & Technology, December 1991. Additional reading: A Concise History of the Theatre, P.Hartnoll 1974.

EURIPIDES - (484 - 406 BC)

Euripides (Greek) a contemporary of Sophocles was the last great writer of Greek tragedy. Eighteen plays survive (out of a possible ninety-two.)

PLATO - (c 427 - c 347 BC)

Plato was a Greek philosopher and one of the most creative and influential thinkers in Western philosophy. Born to an aristocratic family in Athens, he eventually became a disciple of Socrates. The Platonic School complicated the theory of light, by supposing that vision was produced by rays of light that originate in the eye and then strike the object being viewed.

ROMAN - LIFE & LIGHT - (400 BC - 80 AD)

From the earliest days, light became a part of religious ceremony. In the pagan temples of the Romans, The Vestal Virgins tended the everlasting light. Apparently, any of the virgins who broke their vow of virginity, would be buried alive.

In 264 BC, the first year of the war, gladiatorial combats were made part of the 'games', prisoners being allowed to hack each other to death for the amusement of the people, instead of being executed. By the first Century AD there were sixty days of games at various times of the year. Three centuries later, the figure had risen to one hundred and seventy-five days a year. By then, the games had moved from temporary to permanent buildings and started to offer more extravagant horrors. Crocodiles, bison, zebra, lions and tigers were imported to fight each other or the gladiators. In 80 AD, Titus dedicated the 'Colosseum" in Rome with games lasting a hundred days, in which some nine thousand animals were killed in 'hunting scenes'

ARISTOTLE - (384 - 322 BC)

Aristotle was a Greek philosopher and scientist. He was also a pupil of [PLATO]. He had a different theory of light from the Pythagorean School. Aristotle concluded that light travels in something like waves.

Regarding the relationship between color and sound (music), he wrote: "colors may mutually relate like musical concords for their pleasantest arrangement like those concords mutually proportionate".

'The whole terrestrial region, (wrote Aristotle in his Meteorologica) was composed of four 'bodies': fire, air, water and earth'.

According to Aristotle, a play is 'an imitation of an action, not the action itself".

Additional reading: "Aristotle's Works" were translated into English and edited by Sir David Ross and S.J. Smith, 12 vols (New York & London, 1910-1952).

COLOR AND MUSIC (SOUND) - (c 350 BC)

Many people over the years have tried to find a relationship between the color of light and music (or sounds).

See: [ARISTOTLE, NEWTON, CASTEL, HOFFMAN, WILFRED, and COLOR ORGAN].

EUCLID - (320 - 275 BC)

Euclid, (probably Greek) a mathematician studied light and followed the teachings of [PLATO]. He was to greatly influence the development of the field of optics. He described the behavior of light and in his book on optics, (in his twelve postulates), he anticipates the important ray theory. The first postulated stated: The rays emitted by the eye, travel in a straight line.

Euclid also gathered all the geometry of his time into a single logical system, in his book 'Elements'. It is still the basis of geometry taught today.

The speed of light must be very high, Euclid believed, because you can close your eyes (thus making the things you are looking at disappear!) and then, when you open them again, even the distant stars appear instantly.

EARLY OPTICS & LENSES - (c 300 BC)

The earliest known lenses to the Greeks and Romans consisted of glass spheres filled with water. These early lenses were used as 'burning lenses'. True glass lenses were unknown at this time. It wasn't until the end of the 13th Century that glass lenses were manufactured in Europe.

Today, most lenses are made from special types of high quality glass known as optical glass. This glass is generally free of internal bubbles, and imperfections. First a glass 'blank' is cut from a block of optical glass. Next the blank is ground into rough shape by grinding on a cast iron plate, covered with a mixture of abrasive material and water. Convex or concave surfaces are formed using special curved grinding tools. The final process of manufacture is polishing, a process accomplished on a pitch covered iron tool coated with jeweler's rouge and water.

ARCHIMEDES - (287 - ??? BC)

Archimedes a Greek, discovered the principal of buoyancy in his bathtub. He invented a device for lifting water (Archimedes Screw) and he built many devices for the study of astronomy.

In 212 BC as the Roman republic invaded Syracuse in Sicily, Archimedes is said to have built large focusing mirrors that reflected and directed intense sunlight onto the Roman ships in the harbor, setting them alight. (This is doubted by most historians).

PHAROS OF ALEXANDRIA (LIGHTHOUSE) - (c 280 BC)

The Pharos of Alexandria was a lighthouse more than 134 m. (440 ft.) tall, that stood on an island at the entrance to the harbor at Alexandria, Egypt. A fire burned at the top as a signal to ships on the Mediterranean. The Pharos has been called "archetype of every modern lighthouse." It lasted to about the 14th Century AD.

HERO OF ALEXANDRIA - (c 150 BC)

Hero of Alexandria, was a Greek scientist and mathematician, probably born in Egypt. He wrote at least 13 works on subjects concerning applied mathematics, mechanics and physics. Although [EUCLID] could explain plane surface reflection, Hero of Alexandria is often credited with discovering the properties of reflection of light, and putting forward the law. {1ST REFLECTION}

The early Greeks, assumed that light traveled in straight lines. Although the Pythagorean school assumed that every visible object emits a steady stream of particles, [ARISTOTLE] on the other hand, concluded that light travels in waves.

EARLY THEATRE, ROMAN - (55 BC - 200 AD)

The Romans, developed their theatres after the Greeks, however there were a number of differences. Rome theatres were built on flat ground, not on a hillside, and had a vast wall of surrounding masonry, often elaborately decorated. The first stone theatre in Rome was built by Pompey in 55 BC. Soon after, other theatres were built, each steadily becoming more vast and ponderous. The 'Theatre at Sabratha' (North Africa), was built about 200 AD and had a typical Roman semicircular orchestra (seating), raised stage and elaborate three story stage facade (frons scaenae).The Roman theatre had no real great dramatists. Plays were read and quoted from, but not acted.

The Romans continued to use natural light as the main source of lighting for their plays. The Romans also used torches and fire in their presentations to indicate the time of day.

ROMAN - LIGHT AND ARCHITECTURE - (c 15 BC)

The use of natural light in buildings was the domain of the architect. The Roman Architect Vitruvius devoted a whole chapter to natural lighting in his text book 'De Architectura' written about 15 BC.

WORLD POPULATION - (0 BC) - 250 million people.

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0 BC - BIRTH OF CHRIST

LIGHT AND THE BIBLE

There are more than 200 references to the word 'light' in the Bible. About 75 of these occur in the new testament. The book of Job contains the most references (over 25) and the book of Psalms has about 25 references to light. In the new testament, the Gospel of John has the most references (about 16),

Light was the first of God's creations, according to the book of Genesis. "And God said, let there be light, and there was light". (Old Testament, Genesis, i,3.)

God saw that the light was good, and he separated the light from the darkness. (Old Testament, Genesis, i,4.)

"Speak to Aaron and say to him 'When you set up the seven lamps, they are to light the area in front of the lampstand'". (Old Testament, Numbers 8.2.

The Bible, Numbers 4.9: "They are to take a blue cloth and cover the lampstand that is for light together with its lamps, its wick trimmers and trays, and all its jars for the oil used to supply it."

"to the land of deepest night, of deep shadow and disorder, where even the light is like darkness". Job 10.22.

"What is the way to the abode of light? And where does darkness reside?" Job 38.19.

"His snorting throws out flashes of light, his eyes are light the rays of dawn". Job 41.18

Light was identified throughout the New Testament with the nature of God, himself. "The word is light that the darkness cannot extinguish, and this light illuminates every man.....We are the children of light, who have put aside the world of darkness."

"The first creature of God in the works of the days, was the light of the senses, the last was the light of reason". - (Francis Bacon, Essays of Truth.

HORN LANTERN - (c 100 AD)

The horn lantern provided a portable light source. It was not only suitable for moving about outdoors, it was also no doubt used for moving around safely indoors. The lamps were made from the working of horns from cattle into transparent plates and are described in detail by Plinty the Elder (1st Century A.D.) and the lamps were clearly referred to even earlier by Plautus (254?-184 BC).

PTOLEMY, CLAUDIUS - (c 100 - c 170 AD)

Claudius Ptolemaeus, also, Ptolemy (tol-e-mi) of Alexandria was a Greek who lived in Egypt in the 2nd Century of the Christian era - and may have merely recorded the ideas of others. Ptolemy developed a theory of the planets about AD 150. Ptolemy was also able to measure the bending of a beam of light as it passed from air into water or glass. It is known that whatever observations Ptolemy may have made, he was not led to the correct reflection laws, as later discovered by [SNELL] in 1621. {1ST REFRACTION}

THEATRE IN THE MIDDLE AGES - (400)

There is little known of the Romanesque and Byzantine theatre. In the 5th Century A.D. all

performers of mime were excommunicated; in the 6th Century Justinian closed the theatres and the end of theatrical entertainment was finally sealed with the arrival of the Barbarians in 568 A.D. For almost 1000 years, very little theatre or performance took place.

CANDLE - (c 400)

The invention of the candle dates back to about 400 A.D., perhaps somewhat earlier. Relatively few candles were used in the home until about the 14th Century, however they were an important symbol of the Christian religion. The best candles were made of beeswax and were used chiefly in church rituals because the bee was regarded as a symbol of purity. But because beeswax was expensive, crude tallow candles had to be used by the common people. Tallow was smelly and smoky. The candles dripped badly and generally gave a feeble light.

MEDIEVAL STAINED GLASS - (905)

According to legend, glass is a Phoenician discovery and, therefore, more than 2000 years old. As recorded in literary sources, it was often used for windows in late antiquity and early Christian times. The German monk Theophilus Presbyter in his "Schedula diversarum artium", of the tenth or eleventh Century, says that the stained-glass window, was a craft long practiced in France, and the chronicle of the St. Remi in Reims, dating from 905, says the window in the church depicted various scenes.

The art of stained glass reached its height in the Middle Ages, between 1150 and 1250. Outstanding examples of 12th Century stained glass can be found in the windows of such churches as Saint-Denis, in Paris, and Canterbury, in England. Excellent examples of 13th Century works include the windows at Chartres and the Saint-Chapelle in Paris.

See also: [EARLY GLASS].

ALHAZEN (IBN AL HAITAM) - (965 - 1039)

Abu Ali Mohamed ibn al-Hasan Ign al-Haytham (also: ibn al-Haitam) was an Arabian scientist and scholar, also known as 'Alhazan'. He was one of the earliest, to write and describe optical theory. He studied light, the nature of vision, the eye, and solar and lunar eclipses. His early experiments led to a forerunner of the [CAMERA OBSCURA] which he used to prove that light travels in straight lines. He also studied reflection and refraction, and published a book on optics in 1038. Alhazan's work became an historical reference work in the evolution of optics.

His treatise on optics was translated into Latin by Witelo (1270) and afterwards published by F. Rismer in 1572 with the title "Opticae Thesauris Alhazeni Libri VII cum ejusdem libro de crepusculis et nubium ascensionibus" Other manuscripts are preserved in the Bodleian Library at Oxford and in the Library of Leiden.

CAMERA OBSCURA - (c 1000)

The development of the modern day camera is based on the early discovery of the camera obscura. Although it is difficult to prove the original inventor, certainly one of the first to describe and use the principles of the camera obscura, was [ALHAZEN], in 1038. Others including Roger [BACON], and Giovanni [PORTA], also are credited with the invention or development of the camera obscura. The principals of the camera obscura were frequently used by early painters and artists, in their studies of architecture, much like a photograph is used today.

The camera obscura at first was simply a small room, completely darkened and light-tight. A small pinhole was made in an outside wall and the brightly illuminated exterior scene would be projected on the opposite wall. No lens was required. The image was inverted, or projected up-side-down. The principal of the camera obscura evolved into a small box, with drawing paper being used to trace the image and by about the year 500, artists began using the device as a drawing aid. Some versions were made with an internal mirror to reverse the image and turn it right side up again. Over the years, the camera obscura became smaller in size and eventually evolved into the modern day camera.

MEDIEVAL RELIGIOUS DRAMA - (11th Century)

After the disappearance of classical drama, it is within the Church itself, that theatre is revived in the Middle Ages in the form of the liturgical or church drama of western Europe. The first liturgical plays were written for performances by priests and choir boys in a church. The alter with its crucifix was always central to the playing area. On stage right was Heaven, on stage left was Hell. Several other scenes, were arranged in between.

MEDIEVAL THEATRE - (12th & 13th Century)

It was during the late 12th and 13th centuries that plays began to move out of the Church. Productions continued to become more elaborate and complicated. They continued to demand a great number of properties and working machinery. The raised wooden platform would conceal traps, there were cranes by which God and his angles could descend from Heaven, and in the Mons play of 1501 the mechanism of Hell-Mouth which opened to belch out clouds of smoke and closed to swallow up the damned, was so complicated that it took seventeen men to work it. The stage carpenters thought nothing of producing floods, fires and earthquakes. Realistic executions were called for, with bloody wounds, severed heads and limbs. Costumes were elaborate and sometimes splendidly embroidered.

1200

MAGNIFYING GLASS - (1200's)

- See: [BACON, ROGER]

SPECTACLES (EYEGLASSES) - (1200's)

Credit to developing spectacles generally goes to Roger [BACON]. One of the earliest paintings to show spectacles is by the artist Jan van Eyck and dates to 1436.

BACON, ROGER - (c 1214 - c 1294)

Bacon (place of birth unknown) was an English monk, scientist and scholar and was also known as Doctor Mirabilis. Details of his life are obscure however he did make a great impression on the learned minds of his time.

Bacon is usually given credit for developing the magnifying glass. He is also variously credited with the discovery of eyeglasses. Others also give him credit for developing the [TELESCOPE], the [CAMERA OBSCURA] and gunpowder. He followed the work of [ALHAZAN] and spoke of concave and convex lenses. He also expressed interest in the natural sciences, mathematics, perspective and astronomy.

He wrote in his 'Opus Majus': "...pictures could be projected into space, into air where it could become visible for the multitudes."

1300

1400

LEONARDO DA VINCI - (1452 - 1519)

A scientist and artist, Leonardo did much to study the natural forces and actions of nature. Leonardo's world reached from philosophy to mathematics to physics, optics, botany, zoology, mechanics, hydraulics, astronomy, and other scientific areas. He investigated the nature of light and studied reflection, refraction and mirrors. He studied the structure and anatomy of the human eye and compared it to the [CAMERA OBSCURA]. Leonardo also attempted to fly, but failed. He was an excellent painter. In fact, he was a true genius.

Born in 1452, Vinci, Leonardo lived at first just outside of the Italian village of Vinci. In 1469, Leonardo's father took him to Florence to continue his schooling. He outshone his fellow pupils

at every skill and in 1472, when he was 20, was accepted into the guild of painters, allowing him to seek independent commissions for his work.

Leonardo was a master of light. As a painter, he studied; light, reflection, shadow and color in detail. The presents and importance of light is clearly evident in Leonardo's work. Leonardo produced a great many sketches and paintings. He left behind, however, very few completed works, most of which can be found today in the Louvre museum. da Vinci is probably best know for his painting of the 'Mona Lisa', painted between 1503-1505. He kept this painting at his side, until the day he died, as he claimed it was unfinished. This painting is now perhaps the most famous painting in the world.

There is evidence from his note books that Leonardo may have combined a negative and positive lens to observe the Moon. Unfortunately he kept his notes secret during his lifetime and they were edited much too late to have any influence on [GALILEO] who did extensive work with the telescope in the early 1600's.

Leonardo was also left handed and wrote his notes in mirror writing (reversed).

Additional Reading: National Geographic, Vol. #152, Sept. 1977, Leonardo da Vinci: A Man for All Ages, James L. Amos.

COPERNICUS, NICOLAUS - (1473 - 1543)

Copernicus, (Poland) in 1512, correctly placed the sun at the center of the solar system. Finally, the world was free from the misconception that all other heavenly bodies revolved around a stationary earth. He still believed however that the planets orbited in perfect circles. It wasn't until 1609 that Johannes [KEPLER] correctly identified the orbits as being elliptical in nature, instead.

SERLIO, SEBASTIANO - (1475 - 1554)

Serlio (Italian), a painter then architect was the first published theorist of the Renaissance theatre. His six chapters on how to build stages and scenery appeared first in Paris in 1545 under the title 'Le second livre de la perspective'. He also developed a system of 'color filters', using candles placed behind translucent containers of color liquid. He went on to give recipes and recommendations for the use of specific colors. By using a brightly polished barber's basin behind a torch or candle, he developed an elementary spotlight, with a round bottle serving as the lens. {1st EARLY SPOTLIGHT}

MAUROLYCUS, FRANCISCUS - (1494 - 1575)

Maurolycus wrote on the subject of light in 1554 in his "Light on the Subject of Light".

AGRICOLA, GEORGIUS - (1494 - 1555)

Agricola was a German scientist and the founder of petrology and the science of mining (mineralogy). He studied medicine in Italy and became town physician in the mining town of Joachimsthal. He wrote on the subject of the color of flames when common salts were dropped into them. He concluded that "it must be possible to obtain from the color of a flame enlightenment concerning the materials burning therein." We know today that is the sodium in the salt that causes yellow flames, potassium salts, when burned produce a violet color, strontium salts red, and barium salts, green. See also [MELVILL].

1500

VESALIUS, ANDREAS - (1514 - 1564)

Andreas Vesalius (vi-sa-le-as) was a Flemish physician born in Brussels, Flanders. His dissections of the human body and descriptions of his findings helped to correct misconceptions held since ancient times and are the basis of the foundation of the modern science of anatomy. In 1543 he published his 'Fabric of the Human Body" and clarified many obscure details, including those of the human eye. Much of his work is noted for its remarkable drawings of the body.

DI SOMI, LEONE - (1527 - 1592)

Leone di Somi was a stage artist and a noted physician. In 1565 in Mantua, he wrote his 'Dialogues on Stage Affairs' giving valuable insights into period theatre design practices of the time. Di Somi is also credited with being the first person to discuss the advantages of the darkened auditorium during a stage performance.

PORTA, GIOVANNI - (1533 - 1615)

Giovanni Basttista Porta - Although the invention of the [CAMERA OBSCURA] has been attributed to a number of people, [ALHAZAN, BACON, LEONARD0], before him), Porta often also is given credit. In 1558, Porta published a book "Magis Naturalis" and describes the use of convex lenses in order to improve the formation of images. In 1593 Porta wrote another book "De Refractione", which tried to explain the theory of lenses.

GRECO, EL - (1540 - 1614)

El Greco (a pupil of Titian), became one of the most remarkable exponents of individualism,

that can be found in the history of art. El Greco went his own way, free from any fashion or trends in painting. He introduced into his work expressionistic ideas, in regards to both form and color.

It is often thought that his elongated figures were attributed to astigmatism. Others dispute this and claim that X-ray evidence shows that the elongated paintings were applied to non distorted drawings.

BRAHE, TYCHO - (1546 - 1601)

Tycho Brahe (Danish astronomer) was an early observer of the heavens. Night after night, for more than twenty years he studied and recorded the position of the planets and the stars. Near the end of his life, he hired an assistant, Johannes KEPLER, an excellent mathematician. Using Brahe's data, Kepler formulated three laws of planetary motion. The data accumulated by Brahe was superior to all other available astronomical measurements, made until the invention of the telescope in the early 17th Century (about 1600).

INGEGNIERI, ANGELO - (c 1550 - c 1613)

In 1598, Angelo Ingegnieri, a stage designer, published his views in a work entitled "Dramatic Poetry and How to Produce Plays". He calls lighting 'one matter of supreme theatrical importance'. The lighting of the actors' faces was especially important. Ingegnieri was also an advocate of the darkened auditorium, during a performance.

GALILEO, GALILEI - (1564 - 1642)

Galileo was an Italian astronomer, mathematician and physicist from Pisa who developed the scientific method of studying natural events. He studied light and observed the heavens with a telescope and in 1609, discovered that Jupiter had satellites and that Venus displayed phases like the moon. Although Galileo did not invent the telescope he did invent modern astronomy.

He also studied motion and acceleration and defined the laws of motion He was an outspoken advocate of Copernicus's theory that the sun forms the center of the universe, which led to his persecution and imprisonment by the Inquisition in 1633.

See also: [TELESCOPE].

SHAKESPEARE, WILLIAM - (1564 - 1616)

The English dramatist and poet, William Shakespeare was the author of the most widely admired and influential body of literature by any individual in the history of western civilization.

His work comprises 36 plays, 154 sonnets, and 2 narrative poems.

Very little is know about the life of William Shakespeare. Born perhaps in Stratford-upon-Avon, he married at eighteen and soon went to London where he became first an actor then a playwright and a shareholder in the Globe Theatre, where many of his plays were performed. It was indeed fortunate that his plays were printed, as none of his manuscripts survived.

During a play in Shakespeare's day, attendants were assigned the task of caring for the candles. Candle wicks needed to be trimmed constantly, to keep the flame from smoking. To keep these candles burning brightly, these attendants were constantly crossing the stage, even at the most tense moments of the drama, to trim the wicks.

Shakespeare wrote: "Mary, sir, she's the kitchen wench, and all grease; and I know not what use to put her to, but to make a lamp of her and run her by her own light. I warrant her rags, and the tallow in them will burn a Poland winter". (Comedy of Errors iii.ii).

"Light, seeking light doth light of light beguile".
(Love's Labours Lost, i,i.)

RENAISSANCE THEATRE - (1565 - 1675)

During the Renaissance, theatre in Europe flourished. Natural light, the torch, the oil lamp and the candle, were still the principal sources of illumination. Gradually, theatre began to move indoors, from the palace gardens, into the great halls of the ruling nobles. Chandeliers with candles above the stage and the auditorium were used for general lighting. Lighting along the front edge of the stage was (later) provided with candles or oil 'float' lamps. Candles behind the proscenium, were used to light the scenery.

The first permanent classic theatre was the Teatro Olimpico, which still survives today in Vicenza, Italy. Built between 1580-1584, by the famous Italian architect, Andrea Palladio, the auditorium was originally open to the sky. The first theatre with a proscenium arch and a front curtain, (as we know it today) was the Teatro Farnese, build at Parma about 1618. During this period other major design elements of the 18th and 19th Century theatre were developed, including auditorium design, stage sets, wings with flats, the orchestra pit and auditorium balconies. Renaissance Italy was the birthplace of lighting specifically devised for stage productions.

KEPLER, JOHANNES - (1571 - 1630)

Kepler was a German astronomer and mathematician. A contemporary of [GALILEO] he is often credited as being the true founder of modern astronomy, and the first to explain the laws of natural planetary motion. In 1604 Kepler compared the eye to a camera, (a darkened chamber). In 1609 Kepler showed that the earth's orbit was elliptical.

SABBATTINI, NICOLA - (c 1574 - 1654)

Nicola Sabbattini was an architect, theatre designer and painter at the court of Urbino, Italy. He published his famous 'Practica' or 'how-to' on theatrical devices in two volumes (1637 and 1638). His Practica is the first handbook on the art of scenography for the practicing theatre technician. He describes a number of techniques relating to lighting, illumination, scenery and special effects. He describes in detail the need and placement of footlights and the arrangement of other lighting around the stage and auditorium. He even shows (drawing of 1638) a mechanical method of lowering cylindrical metal hoods around burning candles, to cause them to dim. The publication of this text represented a significant step in the evolution, awareness and use of light in the theatre as an art form.

JONES, INIGO - (1576 - 1656)

Jones was England's first major architect. He was born in London on July 15, 1573. Between 1600 and 1603 he visited Italy where he was influenced by the architecture of the Romans and especially as adapted by the Italian architect Andrea Palladio.

Returning to England, he began in 1605 a long association with the English court as a theatre designer and architect. He also introduced the classical manner of Palladian architecture, which he had studied.

Between 1605-1613 he produced a number of elaborate stage and costume designs for the theatre. As a theatre designer, he brought the spirit and vitality of the Italian theatre to lavish masques at the British court. He also became a master at lighting and created many spectacular effects for his productions.

He was also an architect of theatres, one of which still exists today, the Banqueting House. This is considered to be Britain's oldest theatre, built in 1622 with a massive cellar underneath, to support the large stage and the one hundred stage hands required to work it.

Additional reading: Ian Mackintosh, Tabs, September 1973.
Additional reading: Microsoft Bookshelf 97 Encyclopedia.

ELIZABETHAN THEATRE - (1576 - 1640)

The first permanent theatre in London was built appropriately enough, by a carpenter, James Burbage, who was also a part time actor, obviously a man born for the theatre. One of his two sons, the younger, Richard, was the first leading English actor, the creator of Hamlet, Lear, Othello and Richard III, while the elder, Curthbert, acted as his brother's manager. The building which the elder Burbage erected in 1576 was known simply as 'The Theatre'. It was an enclosed structure of wood, which because of opposition from the Lord Mayor of London, was built outside the city boundary.

The most famous Elizabethan theatre, is the 'Globe' built by Burbage's sons on London's South Bank in 1599, with timber from 'The Theatre'. It was here that most of Shakespeare's

plays were produced and it was after a performance of Henry VIII in 1612, that the theatre was destroyed by fire. It was rebuilt the following year, and remained in use until it was demolished in 1644. In 1640, the Puritans effectively put an end to theatre until the end of the war in 1648.

As in Greece, there were no women on the Elizabethan stage. Boys, specially selected for their slight, graceful build and light voices, were apprenticed to older actor's and trained to play such parts as Juliet, Rosalind, Viola and Portia. As in Italy, all the actors had to be dancers and singers.

MICROSCOPE - (1590)

The microscope was invented about 1590 by Zacharias Jenssen of Holland. This was the first compound microscope, using two lenses. The microscope wasn't really put to serious use until in 1665, when the English scientist, Robert [HOOK], published his 'Micrographia', the first documentation of the microscopic world.

FURTTENBAC, JOSEPH - (1591 - 1667)

Also: (JOSEF FURTENBACH) a German architect, in 1628 described a stage sloping toward the audience. In front was an orchestra pit with a wall masking the musicians from the audience. He also developed a mechanical method of blacking out candles by remote control and a type of reflector for the candle, using mica. He gives very detailed descriptions of lighting instruments.

SNELL, WILLEBROD, VON ROIJEN - (1591 - 1626)

Willebrod Snell (commonly known as Snellius) was a Dutch mathematician and physicist. He is known for his discovery of the simple relationship between the angle of incidence and the angle of refraction for a ray of light crossing from one medium to another. Although he never published his discovery, (Snell's Law), he merely lectured on it. His discovery (1621) of the law of refraction was of significance for the study of the nature of light. Now crude optical instruments, already in use (i.e. [TELESCOPE]), could now be further explained.

DE LA TOUR, GEORGES - (1593 - 1652)

Georges de la Tour (French) was a painter of Louis XIV's time. Many of his (later) works show a masterful, almost obsessive use of artificial light. He was born in Vic-Sur Sille in 1593 and died in Lun,ville in 1652.

DESCARTES, RENE - (1596-1650)

Rene Descartes (da-kart) was a French philosopher, scientist and mathematician. In 1637 he published his "Les Meteores" in which there is an admirable explanation of the [RAINBOW], showing how both primary and secondary colors are formed. Descartes study of optics led him to the independent discovery of the fundamental law of reflection, that the angle of incidence is equal to the angle of reflection. His essay on optics was the first published statement of this law.

VELAZQUEZ, DIEGO RODRIGUEZ DE SILVA Y - (1599 - 1160)

Velazquez was a Spanish painter with an extraordinary technique and mastery of light. He painted still lifes, portraits, and historical scenes, such as 'The Surrender of Breda' (1635).

1600

AVERAGE LIFE EXPECTANCY - 33 YEARS in 1600

TELESCOPE - (c 1600)

Hans Lippershey was a Dutch lens grinder and maker of spectacles. He is usually credited with the invention of the first telescope about 1600 and he applied for a patent in 1608. About a year later, various lens grinders of northern Europe, were making telescopes. Records show that the telescope was further developed by [GALILEO] and by others. [BACON] (in the 1200's) is also sometimes given credit for discovering the first telescope.

KIRCHER, ATHANASIUS - (1601 - 1680)

Kircher was a professor of mathematics in Rome, about 1650. Kircher is often given credit for the invention of the [LATERNA MAGICA], the earliest form of projection device (about 1645). [HUYGENS] and [WALGENSTEIN] are also given credit). Kircher published a number of books, and also described the [CAMERA OBSCURA], lenses and optics. Kircher was also one of the first to experiment with moving images. He was also one of the first to try and correlate and relate light to sound.

REMBRANDT VAN RIJN - (1606 - 1699)

The art of oil painting originated in Holland. Rembrandt Harmenszoon van Rijn was born in Leyden, in the province of Holland, on July 15, 1606. Rembrandt was to become the supreme dramatist of light. He saw man isolated in nature and he revealed man in nuances of light and dark. Rembrandt remains unrivaled in his understanding of the complex world of feelings and emotions. Although the source of light is seldom seen in his paintings, his figures often 'radiate' light as if they were the source of light itself.

Many of his works show very dramatic lighting. A perfect example is 'The Woman Taken in Adultery' which shows great contrast and dramatic side lighting.

GRIMALDI, FRANCESCO - (1618 - 1663)

Grimaldi, in Italy, discovered optical diffraction and observed its periodic nature. {1ST DEFRACTION}

BOYLE, ROBERT - (1627 - 1691)

Robert Boyle, physicist and chemist, is often referred to as the father of modern chemistry. He invented the vacuum pump and used it in the discovery of what is known as Boyle's law. Boyle was also a pioneer in the laboratory study of the field of [BIOLUMINESCENCE]. In 1667, he showed that the light of luminous bacteria and fungi goes out if the organisms are deprived of oxygen.

HUYGENS, CHRISTIAN - (1629 - 1695)

Huygens (hoi'gens) was a Dutch scientist, who thought that light consisted of waves, not particles, as did [NEWTON]. Both theories had strong arguments in their favor.

His wave theory suggested that light results from the molecular vibration in the luminous material. Further, that vibrations were transmitted through an 'ether' as wavelike movements (like ripples in water). Huygens concluded that the result of these transmissions acted on the retina, stimulating the optic nerves to production vision.

His numerous, original discoveries won him wide recognition and honors among the scientists of the 17th Century. He discovered a new method of grinding lenses, and using the sharper definitions obtained, he discovered a satellite of Saturn and was able to provide the first accurate description of the rings of Saturn.

In 1678 Huygens discovered the polarization of light by double refraction in calcite. Huygens is often also given credit for the development of the projector [LATERNA MAGICA].

HOOKE, ROBERT - (1635 - 1703)

Hooke was an English physicist who discovered the law of elasticity, known as Hook's Law. He also did research in a remarkable variety of fields. Hooke was educated at the University of Oxford and later went on to assist the English physicist Robert Boyle in the construction of the air pump. In 1662 he was appointed the curator of experiments of the Royal Society and served in this position until his death. After the great fire of London in 1666 he was appointed surveyor of London and was responsible for designing many new buildings. Hooke was also a pioneer in microscopic research and published his observations, which included the discovery of plant cells.

RAINBOW - (1637) See: [DESCARTES, RENE] and [NEWTON].

PURITANS - (1640)

In 1640, the Puritans effectively put an end to theatre in Britain, until the end of the war in 1648.

NEWTON, SIR ISAAC - (1642 - 1727)

Sir Isaac Newton was an English scientist and mathematician who greatly contributed to many fields of science including; motion, gravity and optics. He was first to formulate the corpuscular theory of light. Newton said that luminous bodies radiate energy in particles or corpuscles, and that these particles are ejected in straight lines. The particles then act on the retina of the eye in a manner to stimulate the optic nerve and produce the sensation of vision in the brain. Newton was born the same year that [GALILEO] died.

In 1666 Newton at the age of 23, performed his famous prism experiment. He noticed and recorded that sunlight is white light that contains all the colors of the spectrum. In 1704 he published the first edition of his famous book 'Opticks'. Newton correctly identified the principals of refraction associated with his experiment in that light is bent as it travels from one medium to another at a slight angle, dependent on its wavelength. He didn't know that he was repeating what [LEONARDO DA VINCI] had noted down, in mirror writing, approximately 200 years earlier.

Newton, like others before him also tried to discover a link between light and color and between light and sound. Newton divided the visual spectrum into seven colors. He considered that these divisions corresponded to the diatonic scale. He wrote: " Considering the lastingness of emotions in the bottom of the eye by light, are they not of a vibratory nature? Do not the most refrangible rays excite the shortest vibrations - the least refrangible the largest? May not the harmony and discord of colors arise from the proportions of the vibrations propagated through the fibers of the optic nerve into the brain, as the harmony and discord of sounds arise from the proportions of the vibrations of the air?" The answer to Newton's question today, would be no! His color scale was as follows:

- Red - C
- Orange - D
-
- Green - F
- Blue - G
- Indigo - A
- Violet - B

"Nature and Nature's laws lay hid in Night:
God said, Let Newton be, and all was Light"
(Alexander Pope, 18th Century)

ROEMER, OLAF - (1644 - 1710)

(Also: Olaus and Ole) - The speed of light was roughly calculated in 1675 by the Danish astronomer Olaf Roemer. He used the moons of Jupiter, discovered several years earlier by Galileo to assist in his calculations. His calculations led to an estimate of 132,000 miles per second. Roemer's submitted his work to the French Academy of Science in 1675. He was ridiculed and his work was largely forgotten. Fifteen years after his death the British astronomer James Bradely started out from the same observations that R”emer had made and his thinking ultimately led to a conclusive figure for the speed of light (186,000 miles per second). See also: [SPEED OF LIGHT].

LATERNA MAGICA - (c 1645)

The Laterna Magica (magic lantern) was the first early projection device and a forerunner of the modern slide and motion picture projectors.

[KIRCHER], (in about 1645) is usually given credit for the invention of the Laterna Magica. Although it is very difficult to prove the original inventor, [HUYGENS] and [WALGENSTEIN] are also given credit for invention of the Laterna Magica.

In his book, German historian, Helmuth Wolff wrote: "It is possible to prove the use of the Laterna Magica at the beginning of the 18th Century, that is for the years 1726-27, at the Opera in Hamburg. The designer and architect Thomas Lediard describes these projections very precisely, eliminating any doubts".

WALGENSTEIN, THOMAS - (1650)

Walgenstein (Danish), demonstrated an early projection device [LATERNA MAGICA] throughout Europe and worked with an early projector in Rome in 1650.

RESTORATION THEATRE - (a 1660)

During the interval of Puritan rule in Britain, all of the formerly supported stage productions were suspended (1640). The main source of light in Restoration theatre was usually chandeliers concentrated toward the front of the house, especially over the forestage. The chandeliers were somewhat of a nuisance however, as they had to do for indoor and outdoor scenes alike. Furthermore, they dripped hot grease on both audience and actors.

The candle snuffer was a characteristic figure of these times. Candlewicks needed frequent trimming, regardless of what was taking place on the stage.

GREAT PLAGUE SWEPT ENGLAND - (1664 - 1665).

COLORS OF THE SPECTRUM - (1666)

Color is an electromagnetic wave phenomenon. It is a sensation produced when light stimulates the retina of the eye, and the brain interprets this sensation as 'color'.

Early scientists always considered the primary colors to be relatively large areas of the spectrum: red, orange, yellow, green, blue and violet. However in 1666, [NEWTON], named a 7th color located between blue and violet, as indigo. Aubert in 1865 estimated that the solar spectrum contained approximately 1,000 distinguishable hues. Root in 1881 found 2 million tints and shades can be distinguished.

See also: [COLORS, PRIMARY].

DISCOVERY OF PHOSPHORUS - (1669)

Phosphorus - from phos-phoros, or 'light bearer'. Hennig Brand (German) discovered the strange new element phosphorus in 1669. A painting by the Englishman Joseph Wright in 1771 shows Hennig on his knees praying, while his dark laboratory is illuminated by the eerie glow of phosphorus, contained in a glass vessel. He obtained the material from human urine.

FIRST - USE OF WING LIGHTS - (1670)

There is reference to candles having been fixed behind the shutters (sliding flat wings), as early as 1670, at the Hall Theatre.

FIRST - USE OF FOOTLIGHTS - (1673)

One of the first recorded use of footlight can be seen in the French painting 'Les delices du genre humain', 1670. The painting of the Comedie Francais in Paris shows a row of small protruding flames along the downstage edge of the stage. Four chandeliers with candles are also shown, hanging above the stage.

Another of the first recorded uses of footlights in the English theatre (also with chandeliers above the stage) can be seen from the drawing (front piece) to Francis Kirkman's 'The Wits', published in 1673. ('The Wits' or 'Sport upon Sport', was a collection of short comedies acted in private halls during the Puritan ban of the theatres between 1642 and 1660.) The footlights are candles (or possibly, oil lamps). Oil lamps usually had two or more wicks in individual containers, and their use certainly predates this print.

POLARIZATION/POLARIZED LIGHT - (1678)

In 1678 [HUYGENS] discovered the polarization of light by double refraction in calcite. Polarized light is a special type of light. It occurs in nature and can also be manmade. Ordinary light consists of a mixture of waves vibrating in all directions perpendicular to its line of propagation (or travel). Polarized light consists of the electric or magnetic waves all confined to one plane. Polarized light can be obtained by reflection (depend on the angle of incidence) and it can also be obtained by double refraction in certain crystals, such as calcite. See also: [POLAROID FILTER] and [ETIENNE, LOUIS MALUS]

CASTEL, PADRE - (1688 - 1757)

Over the centuries, many efforts have been made to compare color to sound and to link the two media into a single systematic language. The French Jesuit, Louis Bertrand Castel claimed that he was inspired by Kircher, and was the first to create an actual [COLOR ORGAN]. Castel called his device 'Clavessin Oculaire'. The device consisted of a remodeled harpsichord with a keyboard. Padre gave his first recital in Paris on December 21, 1734.

Additional Reading: The Art of Light & Color, Tom Jones, 1972.

1700

FRANKLIN, BENJAMIN - (1706 - 1790)

Franklin was an American painter, author, diplomat, philosopher, and scientist. He was born in Boston on January 17, 1706, and at the age of 13 was apprenticed to his brother James, who had recently returned from England with a new printing press. In 1723 he left Boston and moved to Philadelphia, to continue work as a printer. In 1724 he traveled to London (at age 18) and obtained employment from two of the leading printing houses in London. In 1726, Franklin returned to London to resume his trade as a printer.

Always interested in scientific studies, he invented the Franklin stove, and then later in 1747, he began to experiment with electricity. He supported the hypothesis that [LIGHTNING] was an electrical phenomenon, and proposed an effective method of demonstrating this fact. His plan was published in London and carried out in England and France before he himself performed his celebrated experiment with the kite in 1752. He invented the lightning rod and offered an explanation of positive and negative electricity.

In 1784, Franklin also invented bifocals. He was also a critic of the corpuscular theory of light. His research into the nature of electricity helped pave the way for its practical use and resulted in the development of the lightning rod.

GARRICK, DAVID - (1717 - 1779)

David Garrick was the leading figure of the English stage from 1741 to 1776. He was responsible for many innovations in the theatre.

Perhaps the most significant lighting of the eighteen Century was practiced at the Drury Lane Theatre under the management of David Garrick. On his return from the Continent in 1765, Garrick began to institute his so-called reforms at the theatre. While in Paris he was particularly impressed with the lighting and staging techniques at the Paris Opera that he decided to import many of the French stage techniques and lighting equipment, to Britain.

Further Garrick removed the traditional chandeliers, and lighting shifted to sources located behind the proscenium and across the apron. We know in Britain that the sidelight unit had been in use for some years and that the footlight unit had been in use since 1673. Garrick put footlights into the Drury Lane Theatre in 1765 and masked them from the audience with metal screens which also served a reflectors. The notion that Garrick brought the footlight from France is clearly false.

PHOTOGRAPHY, EARLY - (1727)

It had been know for centuries that salts containing silver, when exposed to light would darken. This was discovered by Johann Heinrich Schultz in 1727 and probably by others, earlier. Using Schultz's research, in 1802, Thomas Wedgewood and chemist Humphry Davy studied a method of reproducing drawings on materials that had been treated with silver chloride or silver nitrate. They created the first photogram. The images were 'burned' directly onto a sensitized plate by intense light. The images were not very permanent however. See also: [DAVY].

In 1819, Sir John Herschel discovered that the images could be permanently 'fixed' if they were treated with certain chemicals containing sulfur (hyposulfides). In 1839 Sir John Herschel coined the word 'photography'.

See also: [PHOTOGRAPHY, MODERN]

WATT, JAMES - (1736 -1818)

The term horsepower was first used by James Watt, a Scottish inventor and engineer, known for his improvements to the steam engine.

Roughly expressed, a horsepower is defined as 550 foot-pounds of work per second, or 33,000 foot-pounds of work per minute. The metric unit of power is the watt, and even though the term nowadays describes electrical power only it could just as well be used in the automotive field. One horsepower equals 745.7 watts. If an engine lifts a 550 pound object to height of two feet in one second, it delivers two horsepower.

DE LOUTHERBOURGH, PHILIPPE - (1740 - 1812)

De Loutherbourgh, artist and designer received his early training in Paris. In 1771 he was engaged by [GARRICK], the English actor and producer, to design at the Drury Lane Theatre. He often would combine two and three dimensional scenic elements and he also conceived many of his designs in terms of light.

De Loutherbourgh eventually left the theatre to devote his time to an idea known at the time as the 'Eidophusicon'. The Eidophusicon consisted of a miniature theatre constructed to conduct a performance of nothing but scenic effects using light, space, color, movement and sound.

HOFFMANN, JOHANN LEONARD - (1740 - 1814)

Hoffmann, a painter as well as a writer, produced an essay in 1786 where he sought to establish relationships between 'painterly harmony' and 'color harmony'. He also tried to relate color to sound. Hoffman's system was highly theoretical and was based on the concept of polarities or opposites. Hoffman's system was highly subjective and was based on arbitrary personal choices.

GOETHE, JOHANN WOLFGANG VON - (1749 - 1832)

Goethe was a German dramatist, philosopher, poet and pioneer of colorimetry and physiological optics. He was also one of the principal stage directors of the 19th Century. He published a book on color, in 1810. This remarkable book, was exacting in its structure, methods of analysis and the manner of presenting conclusions. In his book "Theory of Color" he recommended the use of complementary colors in to order to help separate costumes from the scenery.

It is in a production of Goethe's Faust, where the use of projection in the theatre - for expressive purposes, is documented for the first time.

"More Light" .... Goethe, on his deathbed.

"Lamps make spots, and candles need snuffing, it is only the light of heaven that shines pure and leaves no stain". - (Goethe, Spruche in Prosa).

Additional reading: Towards a Theatre of Light, E.M. Feher, c 1975. Additional reading: Microsoft Encarta 97 Encyclopedia

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MELVILL, THOMAS - (1752)

Melvill (Scottish), was on of the first to make a scientific study of the color of flames, burning various salts. Melvill, like [AGRICOLA] before him, was unable to provide answers to many questions. See also: [SPECTROSCOPE].

MURDOCK, WILLIAM - (1754 - 1839)

William Murdock, a Scotsman is generally regarded as the father of gas lighting. In 1792 he heated coal to produce gas and used it to light his home and office in Cornwall, England.

ARGAND LAMP / AMI ARGAND - (1755 - 1803)

In 1783/4, Ami Argand a Swiss chemist developed the principal of using an oil lamp with a hollow circular wick surrounded by a glass chimney. The wick and chimney improved the combustion of the oil and resulted in a brighter light with less smoke. This was the first real advancement in lamp technology, in thousands of years. The Argand lamp required much more fuel than did conventional oil lamps, limiting their use to the rich, and to public places. The Argand lamp was perfected by Quinquet in 1785.

LIGHTING OF CANDLES - (1761)

In 1761, at the coronation of George III, groups of 3000 candles were connected together with threads of gun cotton, and lit in half a minute. Those clustered below were showered with hot wax and burning thread. See also: [CANDLES].

ADDITIVE COLOR MIXING - (1769)

In 1769, Guyot (French) discovered the additive method of color mixing, by experimenting with transparent colored papers.

YOUNG, THOMAS - (1773 - 1829)

Thomas Young (born in England) was a London physician, linguist, and expert in many fields of science. He read fluently at the age of two (2) At an age of fourteen (14) he was familiar with Latin, Greek, Hebrew, Arabic, Persian, French, and Italian. Young strongly supported the [HUYGENS] wave theory of light, mainly by virtue of his now famous double slit experiment (1801) demonstrating the interference of light waves. He was also the first to describe and measure astigmatism (1801).

While in medical school, he made original studies of the eye and later developed what is now known as the three-color theory of vision. He also did research in physiology. Young also turned to optics and showed that many of [NEWTON's] experiments with light could be explained in terms of a simple wave theory of light. This conclusion was strongly attacked by some scientists in England who defended Newton.

COLORS, PRIMARY, (OF LIGHT) - (1775)

Even before [NEWTON's] famous prism experiment in 1666, man has long pondered the nature of color. After Newton, it was discovered that sunlight actually contains a continuous spectrum of colors, not just the seven distinct colors that Newton identified. Modern scientists however have recognized only three primary colors as follows:

Mayer (1775): - red, yellow and blue.

Thomas Young (1801): - red, green and violet

Clerk Maxwell (1860): - red, green and blue

Today we consider red, green and blue to be the three primary colors in light. These are the three colors from which all other colors may be 'mixed'. White light is a mixture of equal parts of all three primary colors. Secondary colors in light are formed when any two primary colors are mixed together. The secondary colors are as follows:

- red and blue = magenta
- red and green = yellow
- blue and green = cyan

Complementary colors are any two colors when mixed together provide 'white light" Examples of complementary colors are as follows:

- magenta and green = white
- yellow and blue = white
- cyan and red = white

The color sensation of 'black' is produced by the absence of light.

TURNER, JOSEPH MALLORD WILLIAM - (London, 1775 - 1851)

Turner was an English landscape painter, renowned for his vibrant and dramatic treatment of natural light and atmospheric effects. He viewed the world through the medium of light and sought to explain light and its action upon the physical nature of things by his own theoretical ideas. Turner became one of the first to give art a new intellectual basis whose only goal was objective expression of the subjective experience.

ETIENNE, LOUIS MALUS - (1775 - 1812)

Louis Etienne was a French physicist who discovered that light when reflected becomes partially plane polarized, i.e. its rays vibrate in the same plane. He published a paper in 1809 on his discovery, and a memoir in 1810 on the theory of double refraction of light in crystals. See also: [POLARIZATION] and [POLAROID].

DAVY, SIR HUMPHRY - (1778-1829)

Davy was a renowned British chemist, best known for his experiments in electrochemistry and for his invention of a minor's safety lamp. Davy was born on December 17, 1778, in Cornwall, England. He experimented with the properties of gases during which he discovered the anesthetic effects of nitrous oxide. (laughing gas). Davy was appointed assistant lecturer in chemistry at the newly founded Royal Institution in London in 1801 and the following year became professor of chemistry there.

Davy is also given credit for inventing the electric arc. The electric arc revolutionized lighting at the time, as now there was a powerful 'clean' source of light available as an alternative to oil or gas. The high (relative) light output made the electric arc lamp particularly suited to both theatre and street lighting applications. See also: [ELECTRIC ARC].

FRESNEL, AUGUSTIN JEAN - (1788 - 1827)

Fresnel (pronounced (Fr'nel) was an engineer of bridges and roads for the French government. In his spare time (as a physicist) he carried out extensive experimental and theoretical work in optics. Fresnel developed a comprehensive wave model of light that successfully accounted for; reflection, refraction, interference, and polarization. He also designed a lens system for lighthouses that is still in use today. The fresnel lens is also used in the modern 'fresnel spotlight', a common fixture with an adjustable beam spread, used for stage and television lighting applications.

See also: [FRESNEL SPOTLIGHT].

DAGUERRE, LOUIS JACQUES MANDE - (1789 - 1851)

Daguerre was a French scene painter known for his illusionistic stage sets. He was also the inventor (with C.M. Bouton), of the diorama. The diorama was a three dimensional setting usually melded with two dimensional painted backgrounds and realistic lighting effects. Today dioramas are commonly used by museums for display or exhibit applications.

Daguerre, working, with J. Nicephore Niepce, developed the daguerreotype, a photograph formed on a copper plate coated with silver and treated with iodine vapor. This was the first practical photograph.

BETTY LAMP (& BETSY LAMP) - (1790)

The simple oil lamp, consisting of an open (then later enclosed) saucer or pan filled with animal or vegetable fat and some form of porous wick, remained virtually unchanged for several millennia.

Early American lamps, (originating from Europe) included tin and iron versions of this simple oil lamp. An improved oil lamp, using an integral wick support caused the drip to run back into the reservoir and made it a 'better lamp'. This improved lamp became known to the American colonists as the 'betty lamp' and the 'betsy lamp'. It was simply a metal variation, of the early Greek and Roman oil reservoir lamp, once made from pottery.

As defined by Charles L. Woodside in "Early American Lamps", they usually were of an 'open' type, although some of the later betty lamps were covered but not spill proof. The lamps of this period burned any grease or oil available and were apt to be smelly, messy, and demanding of constant attention". Examples of the betsy lamp date from about 1790.

Additional Reading: Lighting in America, Lawrence Cook, 1977.

FIRST - GAS LIGHTING - (1792)

- See: [MURDOCK, WILLIAM]

1800

19TH CENTURY STAGE LIGHTING - (1800's)

At the beginning of the 19th Century stages were illuminated by [ARGAND] oil burners. They were provided as footlights, stage side lights and by overhead chandeliers. For stage use, the glass chimney was often made from colored glass. During the Century, [GAS LIGHTING]

developed and flourished. Other sources such as the [ELECTRIC ARC] lamp and the [LIME LIGHT] were also developed and put to use on stage.

However, up until this point in time, all lighting devices had one major drawback - they all were flame sources. They had to burn right side up, be supplied with air, protected from objects that might catch fire, and be protected from drafts. Also, they were difficult to start, and they were a source of pollution.

Additional Reading: Legge, Tabs September 1968.

INFRARED - (c 1800)

About 1800, an astronomer, William Herschel discovered that the spectrum of the sun contains more than invisible colors. Using a prism to split the sun into a spectrum, he experimented with a thermometer, and measured the temperature of each color. He found that the highest temperature reading came from the region beyond the red, where no color could be seen. Herschel had discovered that infrared energy is a form of invisible light.

Energy, with a greater wavelength than 0.0008 millimeters fall in the range of the infrared range. We experience these rays as heat. The longer such heat rays are, the more insensitive to them, our eyes become.

ULTRAVIOLET LIGHT (UV) - (1801)

The 'dark portion' of the solar spectrum (adjacent to violet light) was discovered in 1801 by the German physicist Johann Wilhelm Ritter and was named 'ultraviolet' radiation.

Today we classify UV radiation as follows:

UV-A (320-400 nanometers) - which is adjacent to visible light, is often referred to as near-UV or black light. This band is the least energetic UV radiation.

UV-B (290-320 nanometers) - lies in the middle spectrum. It is commonly known as erythemal UV and is the band that converts ergosterol in the skin to vitamin D.

UV-C (160-290 nanometers) - is the shortest UV wavelengths, and because of its effectiveness of killing one cell organisms, is called germicidal UV. The shorter wavelengths produce ozone in air (oxygen).

See also: [SUNLIGHT AND CANCER] - (a 1990)

WINDSOR, FREDERICK ALBERT - (1804)

In 1804 Frederick Albert Windsor, a German entrepreneur, demonstrated and lectured on gas light at the Lyceum Theatre in London. His main interest in gas was for street lighting. Windsor acquired a house in Pall Mall, London and on June 4th, 1807, the King's birthday, he exhibited lights and a gas-lit transparency along the walls. In 1809-10, Windsor established the first public gas company, The Gas Light and Coke Company, which remained in existence until the company was nationalized in 1948.

ELECTRIC ARC LIGHT/ CARBON ARC LIGHT - (1809)

In 1809, SIR HUMPHREY DAVY first demonstrated the electric carbon arc at the Royal Institution in London. The electric arc was also used for lighting at the Paris Opera. At that time and until about 1860, the only source of electrical power came from batteries. After the electric generator developed sufficiently, there was a surge of activity from 1878 onwards. (B.S.M.)

Electric arc lamps were introduced outside the Paris Opera in 1877. These were [JABLOCHKOFF] candles in which two parallel sticks of carbon where separated by an insulator which was melted slowly away by the arch thus self-feeding the two carbons.

By 1884 there were 90,000 electric arc lamps burning by night in the USA, where development was on a greater scale than elsewhere.

The principal of the electric arc is still used today by many older followspots and film projectors, used in entertainment facilities around the world. Modern followspots and projectors now tend to rely on a High Intensity Discharge, (Xenon, CSI, HTI, etc.) lamps, instead. See also: [FIRST - FOLLOWSPOT]

BUNSEN, ROBERT WILHELM - (1811 - 1899)

In 1855, Bunsen (German chemist) was given credit for inventing the Bunsen Burner. The burner is a short, vertical tube of metal connected to a gas source and perforated at the bottom to admit air. The flow of air is controlled by an adjustable collar on the tube. He also was a co-inventor of the [SPECTROSCOPE] along with the German physicist Gustav Robert Kirchhoff.

Contrary to popular belief, he had little to do with the invention of the Bunsen burner, a burner used in scientific laboratories. Although Bunsen popularized the device, credit for its design should go to the British chemist and physics Michael [FARADAY]. Among Bunsen's inventions are the ice calorimeter, a filter pump, and the zinc-carbon electric cell. He used the cell to produce an [ELECTRIC ARC] light and invented the photometer to measure its luminosity.

ANGSTROM, ANDRES JONS - (1814 - 1874)

(Also: ANGSTROM) - Angstrom was a Swiss (Swedish?) physicist known for his study of light. He studied spectrum analysis and mapped the sun's spectrum. He discovered hydrogen in the solar atmosphere and was the first to examine the spectrum of the [AURORA BOREALIS]. The

unit of wavelength, the angstrom, was named after him.

GAS LIGHTING - ENGLAND - (1814)

The first general use of gas street lighting took place in London in 1814. By 1823 nearly 40,000 lamps had been installed in 215 miles of London streets.

It was the introduction of gas lighting to the theatre that began the first real advance in theatre lighting. Gas was manageable and controllable. Centralized remote control systems were developed, usually in wings, backstage. The 'gas plate' contained control valves between the main gas supply and each gas lighting 'circuit', and allowed the footlights, wing lights, etc. to be dimmed, brightened or extinguished at will.

By 1817, Covent Garden, Drury Lane and the Lyceum were all lit by gas. The last London theatre to adapt to gas was the Haymarket, where candles and oil lamps were used until April 1843.

GAS LIGHTING - AMERICA - (1816)

Gas lighting was introduced to the American theatre in 1816 at the Chestnut Street Theater in Philadelphia. In 1926 the Bowery Theater was the first in New York, to be lighted by gas. The theatre burned nine times before it was demolished in 1930. There was no gas lighting in Chicago theatres, prior to 1850, when the first municipal gas works were constructed.

As municipal gas companies did not exist throughout the country, each theatre had to manufacture their own supply of gas. Although gas had many advantages over oil lamps and candles, it is said that several hundred theatres burned down in Europe and America from the use of gas lighting.

By 1817, the development of gas production, storage and metering was virtually complete. By 1860, gas jets were lighted with electric sparks and most fixtures had glass chimneys.

Additional Reading: Theatre Design & Technology, May 1969. (& photos)

HELMHOLTZ, HERMAN - (1821 - 1894)

Helmholtz, (helm'holts) Germany, was a pioneer of physiological optics and acoustics and he made fundamental contributions to the physiology of the senses of sight and hearing. He also studied electricity, magnetism and higher mathematics.

Additional Reading: Microsoft Encarta 1997 Encyclopedia

CON EDISON - (1823)

Con Edison, which traces the corporate lineage of its electric company back to Edison, has been part of New York City since 1823, when its founding corporate ancestor, the New York Gas Light Company, was chartered. Con Edison, as we know it today, is the result of the acquisitions, dissolutions, and mergers of more than 170 individual companies. By far, the most historically significant of those companies was the Edison Electric Illuminating Company of New York, formed by Thomas [EDISON] in 1880.

PHOTOGRAPHY, MODERN - (1826)

After the early work of Schultz, Wedgewood, Davy and Herschel, it was Joseph Niepce who made the next major advancement in the field of photography.

In 1826, Joseph Nicephore Niepce, a French lithographer used a small camera obscura to capture an eight hour exposure on a sensitized sheet of pewter. Although the results would have been quite crude, Niepce had brought together the concept of the camera obscura with the ability to form an image through a chemical reaction triggered by light.

In 1829 Niepce began to work with Louis Daguerre, a Parisian painter and scenic designer for the Paris stage. Niepce died in 1833. Daguerre eventually succeeded in developing the first practical photograph - the daguerreotype in 1839. A lens was added to the camera obscura about this time resulting in sharper images using less light. The Daguerreotype Camera soon followed. See also: [DAGUERRE].

In 1840 William Henry Fox Talbot developed a paper 'film', treated with silver chloride crystals. When exposed and chemically treated, the paper would produce a negative image. This negative image could be pressed against a similarly treated paper and exposed to sunlight to make a positive print. Any number of prints could be made from a single negative. Until this time, the image was formed completely in the camera.

In 1847, Claude Niepce (a cousin of Joseph Niepce) invented the photographic glass plate. The light sensitive emulsion was applied directly to the glass plate, yielding a negative far superior in image quality, to that of previous methods.

In 1881 the halftone printing process was developed making possible the reproduction of photographs in magazines and books.

In 1884 Eastman produced a celluloid film that both produced high quality images and could be rolled into a compact spool. After development, the negative image could be printed directly on to sensitized paper. See also: [EASTMAN].

Eastman coined the word 'Kodak' and in 1888 started to market a compact hand held box camera, using his new film.

In 1861 James Clerk Maxwell demonstrated the first color photographs. He exposed the same plate three times through filters of red, green and blue. See also: [MAXWELL].

See also: [PHOTOGRAPHY, EARLY]

DRUMMOND, THOMAS - LIMELIGHT - (1826)

The limelight was invented an Englishman, Thomas Drummond, about 1826. He discovered that a piece of lime glowed brilliantly when heated by an oxygen and hydrogen flame. When placed at the focus of a parabolic reflector, it allowed him to signal from Antrim to Ben Lomond Scotland, a distance of 95 miles. Details were first published in his ' Philosphical Transactions' in 1826, in which he described how he ad achieved a light 83 times brighter than the brightest flame from an Argand burner.

It wasn't until about 1856 that the first theatrical use seems to be made at the Princesses Theatre, London, where a lens was placed in front of a limelight to give a spotlight. By 1860 limelight was in common use, and was useful for the provision of sunlight moonlight, or for use as a followspot. In its popular form, for magic lanterns and for stage lighting, coal gas was substituted for hydrogen. The limelight had an exceptionally long run in the theatre and was still in regular use in London theatres until about 1910.

FRICTION MATCH - (1827)

The friction match was invented in England in 1827, by a druggist, John Walker, and were known as 'lucifers'. Until that time, all lamps and candles had to be lighted from either another flame or from fire struck with flint and steel. Now man had the additional freedom to produce fire, anywhere, on demand.

MAXWELL, JAMES CLERK - (1831 - 1879)

Maxwell was a Scottish physicist born in Edinburgh. Like Newton before him, Maxwell made contributions of fundamental importance to many branches of physics. In 1873 he found that magnetism and electricity were related and he formed a single unified theory of electromagnetism Maxwell realized that light was electromagnetic radiation and as such must consist of a wave with two components, an electric field and a magnetic field that vibrate at right angles to each other. Maxwell also developed a quantitative theory of color vision - and even produced one of the first (if not the first) color photographs.

FARADAY MICHAEL - (1832)

In 1832, Michael Faraday (England) announced that he had converted magnetism into electricity. He had sent a current through a coil of wires, creating a magnetic field which induced a momentary current in a second coil. In America Joseph Henry affirmed that he had done much the same thing at about one year earlier. The discovery of electromagnetic induction led to the development of electric motors, generators and dynamos.

LANGLEY, SAMUEL PIERPONT - (1834 - 1906)

An instrument with which heat rays can be measured with the utmost precision in the bolometer, so named because in Greek 'bole' is equivalent to 'ray'. Bolometers have been known for a comparatively long time. The first instrument of the kind was a 'resistance' bridge invented by the American Samuel Pierpont Langley (1834-1906), consisted of four fine, blackened iron wires. They formed the branches of a very sensitive measuring instrument that operates on the zero principle. When no current is flowing through the instrument, the needle of a galvanometer connected to it shows no deflection. In Langley's bridge, two of the wires were connected to a small battery, and the other two to the terminals of a sensitive galvanometer. When a beam of light was directed at one of the wires through a narrow slit, the wire was heated. This altered the electrical resistance and the electrical equilibrium on the bridge was thereby upset, so that a current was set up in one arm of the bridge and deflected the needle of the galvanometer.

Also see: [INFRARED].

MONET, CLAUDE - (1840 - 1926)

Monet was a French landscape painter and one of the founders of impressionism. Monet is also considered to be one of the leading landscape artists of all time. Later in his career he devoted himself to painting the changes of light and atmosphere caused by different seasons and different times of day. He broke light down into its component colors much as does a prism. He repeatedly painted such subjects as haystacks, Rouen Cathedral, and the great lyrical series of water lilies (1899 & 1904-1925) in his garden at Giverny.

EDISON, THOMAS ALVA - (1847 - 1931)

Thomas Alva Edison was born at Milan, Ohio, and spent most of his boyhood at Port Huron, Michigan. His first love was chemistry. In 1877 Thomas Edison became interested and experimented with electric lighting but abandoned his work later that year due to a lack of funds and other pending developments. In 1878, his friend Grosvenor P. Lowrey, a patent attorney helped raise $300,000 from investors to back Edison's experiments. On October 15, 1878, the Edison Electric Light Company was incorporated. The objectives of the company were: "to own, manufacturer, operate and license the use of various apparatus used in producing light, heat or power by electricity."

Edison patented more than 1000 inventions. Besides the incandescent lamp, Edison is given credit for inventing a system of electric generation, the phonograph, and the kinetoscope (motion picture camera) and the motion picture projector (the Vitascope patented in 1896).

"Genius is ninety-nine percent perspiration and one percent inspiration" - (Thomas Edison).

See also: [EDISON LAMP].

WAGNER, RICHARD - (1849)

Wagner showed great interest in the operation of the theatre and created a demand, for extensive technical elements. He was concerned with staging, scenic and lighting effects, and to a limited degree, theatre architecture. In 1849 he published his conceptions of a new art, under the title of 'The Work of Art of The Future'.

SPEED OF LIGHT - (1849)

A ray of light directed along the 25,000 miles of the earth's equator would return to its starting point in 0.13 seconds. In one second it would have covered the distance seven or eight times. By comparison, sound, which travels at only 1,086 feet per second, would require 33.3 hours, while an express train with a speed of sixty miles per hour would need 17 days, assuming its journey were unbroken.

Speed of Light: All forms or radiant energy are transmitted at the same speed, in a vacuum. After early calculations by Roemer and British astronomer James Bradely, the French physicist Armand Fizeau (30), in 1849 established the speed of light at approximately 186,300 miles (300,000 kilometers) per second.

In 1968, in accordance with recommendations from the International Astronomical Union (Hamburg) the speed of light was established at 299,792.5 kilometers per second or 186,282.3976 statute miles per second. Solar parallax, 8".794; constant of nutation, 9".210 and constant of aberration, 20".496.

Light travels at different speeds in different media. In the vacuum of space, light travels at approximately 186,000 miles per second. It is slower in air and still slower in glass.

And Finally:

Nothing is faster than the speed of light... To prove this to yourself, try opening the refrigerator door before the light comes on. (Anon.)

See also: [ROEMER] and [EINSTEIN].

SPECTROSCOPE - (c 1850)

The credit for investigating the light of flames (after Agricola and [MELVILL]) belongs to two Heidelberg professors; the physicist Gustav Robert Kirchoff (1824-1887) and the chemist Robert Wilhelm [BUNSEN] (1811-1899). At first they made use of a prism only. When the light of flames so colored was passed through a prism, sharply defined single lines in unmistakable colors appeared. To be able to observe these better, the two scientists constructed a simple but highly effective and sensitive instrument. The whole apparatus was rigged up from an empty cigar box, a prism, and parts of an old, discarded telescope. It was the first

spectroscope, a little thing on three legs like a microscope, and provided with an eye-slit. Inside it the light rays made their way through lenses and the prism. With this instrument, it was possible to study the spectra of red-hot bodies and gases, much more accurately than with a prism alone.

PROFESSOR PEPPER - (c 1850)

During the mid-1800's an illusion was described and illustrated, that later became know as 'Pepper's Ghost'. The illusion consisted of the merging of live actors with reflected (ghost) images of hidden backgrounds or other actors. The technique had several variations however all used an angled sheet of glass, separating the audience from the illusion.

Dr. John Henry Pepper was Director and Professor of Chemistry at the Royal Polytechnic Institution, London, (founded in 1838). Pepper presented the illusion in the form of 'The Knight Watching his Armour'. Others with patents for the illusion include Munro in 1863 and Maurice in 1865.

The illusion is still used today in many a 'Haunted Castle' and themed exhibits and dark rides throughout the world.

KEROSENE LAMP - (1853)

The kerosene lamp was introduced in Germany in 1853. Kerosene was distilled from petroleum obtained from oil shale, found in mines. By 1856 Kerosene was used to light homes in New York (gas came to that city in 1864.)

EASTMAN, GEORGE - (1854 - 1932)

Eastman (USA) invented roll film and the name 'Kodak'.

In 1885 American inventor George Eastman marketed his first box camera. It sold for $25.00, a considerable sum in those days. The Kodak camera, the first camera designed to use roll film, came with the film already installed. After the purchaser took 100 pictures, the camera had to be returned to the factory, where the film was removed and processed and new film was installed.

FIRST - FOLLOWSPOT SPOTLIGHT - (c 1856)

The followspot is simply a high power spotlight mounted on a stand. An operator (or stagehand) controls the lamp and is able to pan and tilt the spotlight, following an actor anywhere on stage. Although it is not certain when the concept of the followspot was

developed and first used for theatrical applications there is documented evidence that a limelight with a lens was used in a London theatre, about 1856.

Today, the followspot fixture is still commonly used, for theatre, dance, opera and other entertainment events. Over the decades, the followspot has evolved from the [LIME LIGHT] to the [ELECTRIC ARC] to the modern Xenon units of today. Leading manufacturers of followspot products include: [STRONG] [ALTMAN], Lycian and Phoebus.

See also: [LIME LIGHT], [ELECTRIC ARC].

THOMPSON, SIR JOSEPH - (1856 -1940)

Joseph J. Thompson, (British) investigated the properties of cathode rays under the influence of magnetism and electrically charged plates. He constructed a specially designed 'cathode ray tube' and identified the radiation and the particle we now call the 'electron'. At the age of twenty-four he was made a Fellow of the Royal Society, and a year later was elected to professorship at Cambridge. In 1906 he received the Nobel Prize for physics, and he was knighted in 1908.

HERTZ, HEINRICH RUDOLF - (1857 - 1894)

Hertz was a German physicist who produced and studied electromagnetic waves (radio waves), which he showed are long transverse waves that travel at the speed of light. Further he showed that these waves can be reflected and refracted, like light. The unit of frequency, the hertz, is named after him.

PLANCK, MAX - (1858 - 1947)

Max Planck (German), derived quantum theory from study of black body radiation. This was a modern form of the corpuscular theory [NEWTON], based on the following premises: That energy is emitted and absorbed in discrete quanta (photons) and that the magnitude of each quantum may be calculated in accordance with Planck's constant.

MUNSELL, ALBERT H. - (1858 - 1918)

Albert H. Munsell, (American) published his first edition of "A Color Notation" in 1905. This was followed by the production of his first color chart. During the next ten years. he prepared a series of color charts which he later assembled into the "Munsell Color Atlas".

Today, the Munsell System, is the most widely accepted method of accurately describing object color. (assumes a normal observer, daylight illumination and observation of the color

samples against a gray to white background). In the Munsell System, colors are specified in terms of three (3) attributes: hue, value and chroma.

CANDLEPOWER - (1860)

In 1860, one of the basic lighting measurements, the candlepower, was established using a Spermaceti candle, of a specific weight and burning at a particular rate, as the basis.

See also: CANDELA.

APPIA, ADOLPHE - (1862 - 1928)

Appia was a Swiss theorist of stage lighting and decor. His use of light and shade when staging [WAGNER'S] operas revolutionized modern scene design and stage lighting. He was also one of the first to realize the great potential of light in the theatre, once electricity had been introduced. Appia rebelled against naturalism and defined the stage in terms of time and space and suggested the use of light to create mood and composition.

He called the familiar light of his time (from borderlights and footlights) general illumination (Helligkeit). According to Appia, this type of light was useful, perhaps, but inadequate, there must be a new kind of light, a 'form revealing light' (gestaltendes Licht) to give objects on stage their natural three-dimensional quality - there must be 'living light' for living people.

Additional Reading: Norman Marshall, Tabs, September 1969.

KLIEGL, JOHN H. - (1869 - 1959)

John Kliegl - was one of the founders of the American lighting manufacturer [KLIEGL BROTHERS].

KLIEGL, ANTON - (1872 - 1927)

Anton Kliegl - was one of the founders of the American lighting manufacturer [KLIEGL BROTHERS].

CRAIG, EDWARD GORDON - (1872 - 1966)

Edward Craig (British) began his career as an actor but unable to work freely in England moved to the Continent. He spent most of his life battling against what he considered the

egotism and stupidity of the actor, the inadequacy of the producer, the crudity of the usual scene designer. He revolted against the conventions of the theatre and demanded the use of light as scenery and compositional elements with the play.

PHOTOGRAPHY, MOTION PICTURES - EARLY - (1872)

For centuries, adults and children alike have been amused by toys that utilized the persistence of vision to present the appearance of a moving picture. One early device was the Zoetrope, a revolving drum with pictures inside. Spin the drum and when viewed from the right angle, the pictures would blend together into a moving picture.

Eadweard Maybridge in 1872 snapped 12 consecutive photos of a horse galloping. His technique for talking sequential photos with the phenomenon of the persistence of vision provided the basis for motion pictures. Eastman's celluloid film which could be rolled into a cylinder, made it practical.

REINHARDT, MAX - (1873 - 1943)

Max Reinhardt was the first director to make an international reputation. He dominated the theatre of Central Europe for more than twenty-five years, refusing to be confined to the proscenium arch, and setting his plays in a ballroom, a circus, a cathedral square, or an exhibition hall, anywhere in fact, where he could find space for his grandiose projects. The most memorable of them was "The Miracle", a vast spectacle whose crowds he manipulated with ease. His extensive travels brought him into prominence everywhere. He finally settled in the United States in 1933.

Reinhardt also applied the principals of [APPIA] and [CRAIG] and used light as a dramatic medium.

ELECTRIC LIGHTING

FIRST - ELECTRIC FILAMENT (INCANDESCENT) LAMP - (1874)

Although Edison did not invent the electric filament lamp, he did however turn theory into practicable form and was one of the first to successfully market incandescent lighting. We must not over look the work done before him by [SWAN] (Britain), Cruto, Gobel, Farmer, Maxim, Lane-Fox, Sawyer, and Mann, to name only a few. The first Canadian patent covering an incandescent lamp was submitted by Henry Woodward and Matthew Evans, dated July 24, 1874 - approximately five years before the development of the Edison lamp. It was probably however, the German chemist Herman Sprengel who pioneered the vacuum light bulb in 1865.

Reference: for further information consult the MIT studies of invention publication, authorized

by Arthur A. Bright, entitled "The Electric Lamp Industry".

See also: [EDISON LAMP] & [SWAN LAMP].

TELEVISION, THE CONCEPT - (1875)

The first electric TV system was proposed by George Carey of Boston in 1875, and was based on selenium cells.

See also: [FIRST - PHOTOCELL], (1880)

JABLOCHKOFF, PAUL - (1878)

By 1878, Paul Jablochkoff had developed an arc in the form of an electric candle. It was made of two carbon rods, side by side, with an insulating material placed between them, that burned away at the same rate as the carbons. In 1879 a theatre in France was equipped with some of them, but the development of the incandescent lamp prevented them from appearing in general use.

EDISON LAMP - (1879)

Edison's first successful lamp used carbonized cotton thread as a filament, installed in a glass bulb, with all air evacuated. On the afternoon of October 21, 1879, Edison's prototype had lasted 45 hours. The next day Edison began to experiment using cardboard as a filament. The cardboard filament was even more successful, and in a couple of months, production of his lamps had increased. On New Year's Eve, December 31, 1879, Edison gave his first public demonstration of his new invention, at Menlo Park, New Jersey. Special trains were run on the Pennsylvania Railroad to accommodate the masses of visitors. About 100 cardboard filament lamps were used in this demonstration, lighting the streets, the laboratory, and the station at Menlo Park. Each lamp was rated at 16 candlepower and consumed about 100 watts. (Average life was about 100 Hrs.)

In 1880 Edison experimented with other materials for filaments, including wood, grasses, hair and bamboo. Of the over 6000 specimens tested by his laboratory, bamboo, became commonly used for filaments.

In 1880, on January 17, Patent number 223,898 was issued to Edison for the T.A. Edison Electric Lamp.

In 1881, two years after the first incandescent lamp left Edison's workshop, the steamship 'Columbia' was fitted with a thousand of them. Within another two years, there were over 300 electric power stations in existence, feeding over 70,000 incandescent lamps, each with an average life of 100 hours.

See also: [FIRST - ELECTRIC FILAMENT LAMP] - (1874)

SWAN LAMP - (1879)

Along with [EDISON], (and others) Joseph Swan, is also credited with inventing the incandescent lamp. Swan demonstrated a carbon filament lamp to about 700 people in Newcastle-upon-Tyne on February 5, 1879.

Swan's development of the incandescent lamp was reported in the Oct. 29th, 1880 issue of "Engineering", which quotes him as follows: (SWAN) "Electric lighting by incandescence is just as simple as arc lighting is difficult, all that is required is a material which is not a very good conductor of electricity, highly infusible and which can be formed into a wire or lamina, and is neither combustible in air, or if combustible, does not undergo changes in a vacuum".

The first premises to be lighted by the new Swan lamp were those of Sir William Armstrong at Cragside near Newcastle in December 1880.

See also: [FIRST - ELECTRIC FILAMENT LAMP] - (1874)

PHOTOELECTRIC CELL - See: [FIRST - PHOTOCELL] - (1880)

FIRST - PHOTOCELL - (1880)

The first means for converting sunlight directly into electrical energy date back to 1880. In that year the first selenium cells were constructed by Charles Summer Tainter (American) The photoelectric cell, as it called, has been improved in recent years, however the typical output of a single cell is still not be enough to light a small flashlight bulb (lamp). Photo cells are also used in light meters and in other optical measurement equipment.

PHOTOPHONE - (1880)

In 1880, The Photophone was developed by Alexander Graham Bell. This device used a mirror to transmit a speakers voice over a beam of reflected sunlight. The transmitter mirror was modulated by the speakers voice. The receiver used a rod of selenium, a metal whose resistance changes with the intensity of light falling on it. Electricity turned out to be more reliable than sunlight and Bell turned his efforts to the telephone. Bell apparently wanted to name his second daughter after the Photophone as she was born a few days after his first successful demonstration of the device in February 1880. Apparently Mrs. Bell did not share his enthusiasm.

Modern day versions of the Photophone even exist today. From time to time many of the

popular electronics magazines provide construction projects for 'light beam communicators'.

LIGHT PIPE - (1880)

In 1880, William Wheeler of Concord, Massachusetts, applied for and received a patent, on light pipes. His idea was to use pipes with reflective inner surfaces to direct light from a source at one end, along the length of the pipe. Concord's prototype was not very efficient and most of the light was absorbed by the mirrors.

The light pipe uses the principal of 'total internal reflectance'. This principal was noted about ten years earlier by John Tyndal, when he shone a light at a spout of water as it gushed out of a tank. The water fell in an arc and the light went with it. The outer edge of the water spout was acting as a mirror, reflecting the light that reached it back toward the interior of the spout. Total internal reflection only works when light strikes the air/water boundary at a small glancing angle. At larger angles the light passes through, the water like transparent glass.

The principal of total internal reflection is used by the modern light pipe and by fiber optics.

See also: [TIR SYSTEMS].
See also: [FIBER OPTICS].

CARTE, RICHARD D'OYLEY - (1881)

Richard D'Oyley (often: D'oyly) Carte, was the enterprising manager of the new Savoy Theatre in London. In 1881 he opened the theatre and advertised that the Savoy was the first public building lighted 'entirely' by electricity. In fact, there were a total of 1158 of the new Swan lamps, used to light the auditorium, the dressing rooms, the corridors and the stage. The electrical and dimmer system was by Siemens Brothers and Company, one of the early pioneers in stage lighting control systems. There were six (6) dimmers in all.

An article published in 'Engineering, March 3, 1882' reported: "In an artistic and scenic point of view nothing could be more completely successful than the present lighting of the Savoy Theatre the illumination is brilliant without being dazzling, and while being slightly whiter than gas, the accusation of "ghastliness," so often urged against the light of the electric arc, can in no way be applied. In addition to this the light is absolutely steady, and thanks to the enterprise of Mr. D'Oyley Carte, it is now possible for the first time in history of the modern theatre to sit for a whole evening and enjoy a dramatic performance in a cool and pure atmosphere".

At the same time, the Grand Opera in Paris installed the Swan lamp.

LANGMUIR, IRVING - (1881 - 1957)

Irving Langmuir (General Electric Research Lab.) pioneered the development of the first gas-filled electric lamp, at atmospheric pressure. He demonstrated that it was not the vacuum in

the bulb that allowed the filament to burn for a long time. Instead he showed that by simply adding nitrogen gas, evaporation of the filament was slowed, prolonging the life of the lamp. Later, Langmuir later substituted argon for nitrogen. See also: [GAS FILLED LAMP] - (1913)

TELEVISION, EARLY - (1884)

Some of the earliest work on television began in 1884, when the German engineer Paul Nipkow designed the first true television mechanism. In front of a brightly lit picture, he placed a scanning disk (called a Nipkow disk) with a spiral pattern of holes punched in it. As the disk revolved, the first hole would cross the picture at the top. The second hole would passed across the picture a little lower down, the third hole still, and so on. With each complete revolution of the disk, all parts of the picture would be briefly exposed in turn. The disk revolved quickly, accomplishing the scanning within one fifteenth of a second. Similar disks rotated in the camera and receiver. Light passing through these disks created crude television images.

Nipkow's mechanical scanner was used from 1923 to 1925 in experimental television systems developed in the United States by the inventor Charles F. Jenkins, and in England by the inventor John L. Bard. The pictures were crude but recognizable. The receiver also used a Nipkow disk placed in front of a lamp whose brightness was controlled from the light-sensitive tube behind the disk in the transmitter. In 1926 Baird demonstrated a system that used a 30-hole Nipkow disk.

GAS MANTLE / WELSBACH - (1885)

Some improvement in gas lighting was made over the years by the development of new types of burners. It was not, however until Welsbach introduced the gas mantle in 1885 that gas lighting was greatly improved. A gas mantle is made from a small knitted bag, dipped into chemical and then dried. When a new mantle is tied to a gas jet and the gas is lighted, the knitted material will burn away leaving a fragile shell of chemicals which glow brightly in the heat of the gas flame. Many 'gasoline' type and camper lanterns today still use mantles.

Credit for the first metal filament lamp also goes to Welsbach. He developed a rather efficient lamp with a filament of the rare metal Osmium in 1905. However, this metal was even more rare and expensive than platinum and the lamps were not highly successful.

WESTINGHOUSE - (1886)

Westinghouse was founded in 1886 by George Westinghouse. Westinghouse received more than 400 patents for his many inventions, including the air brake (1882) and a method of transmitting electrical power. He also refined the transformer, providing a practical method of distributing A.C. power over a large network. Edison at the time rejected alternating current in favor of direct current.

Westinghouse has grown to be a world wide supplier of electrical components, appliances and lamps. In 1995 Westinghouse purchased CBS for $5 Billion (US), just one day after the Walt Disney Co. announced its purchase of Capital Cities/ABC Inc.

DUBOIS, RAPHAEL - (1887)

Dubois, in 1887 demonstrated the existence of a specific compound he called luciferin, which interacts with an enzyme, luciferase and oxygen to produce light. See also: [BIOLUMINESCENCE].

FINSEN, N.R. - (1889)

It was in 1889 than Niels Ryberg Finsen, a Dane, discovered that the ultraviolet component of natural sunlight, in fact, was responsible for sunburn. Finsen received the Nobel Prize in 1903 (04?) for his pioneering work - which led to widespread study of UV and its effects. Finsen investigated the photo biological effects of sunlight and even had an engineer commissioned to build a large [ELECTRIC ARC] lamp so that he could further experiment with the effects of artificial sunlight for therapeutic purposes. The arc lamp operated at a current of twenty-five amperes and was rich in ultraviolet rays. {1ST SUNLAMP}

See also: [ULTRAVIOLET].

Additional reading: UV Lamps, LDA, June 1980. Additional reading: The Magic of Rays, Johannes Dogigli, 1961

LEONARD, HARRY WARD - (1889)

Inventor, Ward Leonard worked with Thomas [EDISON] to introduce the central station electrical system concept to cities in America. Leonard in 1892 received a patent for an electric elevator.

WILFRED, THOMAS - (1889 - 1968)

Thomas Wilfred, was born in Nestvad, Denmark. Between 1905 and 1911 he studied music and art in Copenhagen, Paris and London - and became a singer of old songs. He began to experiment with color mixing and projection and developed a device called the 'Clavilux' (1919). It consisted of spot and flood lights, rheostats, screens, filters and prisms, all controlled by an elaborate control console.

In 1916 he came to the United States and continued his career as a singer in order to gather funds for his experiments in the use of light as an art medium. Wilfred debuted his Clavilux at

the Neighborhood Playhouse in New York in 1922. Between 1922-1929 he made tours and gave concerts in the USA and Canada. In 1925 he appeared in Paris, London and Copenhagen. Later he founded the Art Institute of Light in West Nyack, New York. He continued lecturing, creating and writing, until his death in 1968.

See also: [COLOR ORGAN].

Additional Reading: The Art of Light & Color, Tom Jones (1972).

GENERAL ELECTRIC COMPANY - (1892)

Created in 1892 through a merger of Edison's General Electric with Thomson-Houston Electric Co. The Edison name was eliminated because it had lost prestige since an electric chair fiasco two years earlier. Edison still insisted that DC not AC current should be used.

Today, General Electric has grown to be one of the largest suppliers of electrical components, appliances, equipment and machinery, in the world. The company is a major manufacturer of lamps (light bulbs) for all applications. In 1985 General Electric purchased RCA and its National Broadcasting Co. for $6.3 billion US dollars.

http://www.ge.com

INTERNATIONAL ASSOCIATION OF THEATRICAL STAGE EMPLOYEES - (1893)

I.A.T.S.E. (IATSE) - is a professional union with more than 75,000 members in over 500 locals, throughout the United States and Canada. The 'I.A.' serves the technical needs of most professional stage productions, arena shows and films, throughout North America.

ARGON - (1894)

Argon, (Ar), from argon, or inactive, was discovered in 1894 by Scottish chemist William Ramsay, who removes from air, various known gases including nitrogen, oxygen, and carbon dioxide and find an inert gas remains. The most abundant of noble gases, argon is used in welding applications, as it provides an inert atmosphere, in which welded metals will not burn. It is also the gas that fills most incandescent lamps.

ROENTGEN, WILHELM - (c 1895)

About 1895, Roentgen (German) discovered X-Rays. These rays could penetrate most forms of solid matter, as ordinary light passes through glass. Today his discovery is used for a

number of medical diagnostic and therapeutic uses. Roentgen died in 1894 at the early age of 37.

KLIEGL BROTHERS - (1896)

Kliegl Brothers of New York, was founded in 1896 and was one of the oldest if not 'the oldest' stage lighting manufacturer, established in North America. The company made high quality lighting fixtures and control systems for the stage and studio industries. Unfortunately after a turbulent decade of changes, the company ceased operation in the 1990's.

The company was founded by American lighting experts John H. Kliegl (1869-1959) and Anton Kliegl (1872-1927). Kliegl was the manufacturer of the 'Klieglight, a powerful carbon-arc lamp, producing an intense light, used initially for film lighting. It was first introduced in 1911 and then later, the 'Klieglight' was redesigned for the incandescent lamp.

NEON - (1898)

Neon, (Ne), from neos, or new, was discovered in 1898 and is the best known of the inert gases. When an electric current is passed through a minute amount of neon, enclosed in a glass vacuum tube, it glows bright orange red.

Red neon tubes (for display) were first made by Claud in France in 1910. On January 19, 1915, the first patent was issued for a neon sign. In 1925, blue tubes containing argon and mercury first appeared in central London, and sometime later, a green light was produced (simply by enclosing a blue tube in yellow glass). It wasn't until 1933 that fluorescent power coating of neon and mercury discharge tubes produced a whole new range of colors. Neon lamps have almost an indefinite life.

XENON - (1898)

Xenon, (Xe), (pronounced: Zee-non) - from xenos, or stranger, was discovered in 1898. The properties of an electric discharge arc in an atmosphere of xenon gas under high pressure was investigated by Aldington in 1947, and a few limited but important commercial applications followed. Today, the Xenon lamp is used in the commercial [STROBE] (or stroboscopic or high speed flash), as well as a source for projection equipment and followspots.

RADIUM - (1898)

Radium (Ra), from radius, or ray, was discovered in 1898 by Pierre and Marie Curie. It is the sixth rarest of the elements. Radium bromide is often mixed with zinc sulphide to produce a mixture used for luminous watch dials. The radium gives off dangerous radiation which causes the zinc sulphide to glow.

ELECTRICITY - (1899)

Although many early men experimented with electricity, none knew that electricity was atomic in nature. It was the English physicist Joseph John (later Sir Joseph) Thompson, who finally lifted the veil shrouding the phenomenon of electricity. In 1899, he demonstrated that electrons are the carriers of electricity, and, further that each of them carries an elementary quantum of a negative electric charge.

1900

THE 20TH CENTURY - (1900's)

Although the principals of lighting design had been well established during the oil and gas light eras, it wasn't until the development of the incandescent lamp (c1879), that stage lighting could really flourish as an art form. Now for the first time in history it was possible to provide odorless and controlled lighting. The development of lighting fixtures flourished. The gas; striplight, box flood and footlights were redeveloped using the incandescent lamps.

BOX FLOOD / SCOOP / FLOODLIGHT - (1900's)

The 'Box Flood' is an early type of basic stage lighting fixture. Before the widespread use of electricity and the incandescent lamp, candles, oil lamps and gas were all used for stage lighting. Long ago, some brilliant designer enclosed a typical flame source with a cube type housing, having only one open side. Voila, a significant development in lighting fixture design. First, the enclosure would have shielded the source from the audience, increasing visibility and visual comfort. Second, the enclosure would have acted as a crude reflector, helping to direct additional reflected light out of the front opening (or aperture).

Soon after the development of the incandescent lamp, the gas floodlight fixture would have been redesigned to incorporate this new technology. The electric box flood was the most basic of all stage lighting fixtures, as all that was required was a metal box, a socket, a power cord and a lamp. No lens or mechanical controls were required.

The illustration above shows a modern day floodlight fixture, using an electric filament lamp. This fixture, known as the 'Scoop', evolved from the simple box flood and provides a soft wide wash of light. Today modern fixtures often incorporate special asymmetrical reflectors, to help provide an even distribution of light on a vertical surface (backdrop or cyclorama). Some floodlights are also available in multi-cell designs, incorporating 2, 3 or 4 partitioned lamps, each with a different color filter. Modern floodlights typically come in wattages of 300 - 1000 watts.

LINNEBACH PROJECTOR - (c 1900)

Adolf Linnebach was the technical director of the Munich Opera in the early 1900's. He developed a simple projector for background and scenic projection. The projector did not use a lens. Instead, it simply cast a shadow of a silhouette cutout, placed in front of the shielded, light source. The results was a simple, effective image projection, with a soft focus. (Bentham).

The modern Linnebach projector uses a slide size of 24x24 or 36x48 (inches). KLIEGL BROTHERS lighting, claims to have introduced the Linneback projector to the American market in 1922.

FOOTCANDLE (and LUX) - (a 1900)

It was in the early days of electric lighting that users began to ask how much light they needed. The measurement unit of the footcandle was developed as a measure of 'illumination'.

DEFINITION - footcandle, fc: The unit of illuminance when the foot is taken as the unit of length. It is the illumination on a surface, one square foot in area on which there is a uniformity distributed flux of one lumen, or the illumination produced on a surface all points of which are at a distance of one foot from a directionally uniform point source of one [CANDELA]. (REF: IES Lighting Handbook, Ref. Vol. 1981).

The International (metric) unit of illumination is the 'lux'. It is the illumination produced on a surface one square meter in area at a distance of one meter from a uniform point source.

Lux / Footcandle conversions:

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FC  = LUX x .0929  -   Example 1:  500 LUX x .0929 =  46.5 FC
LUX =  FC x 10.76  -   Example 2:   50 FC  x 10.76 =  538 LUX
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Generally you may multiple FC by 10 to obtain LUX - or, divide LUX by 10 to obtain FC.

The recommended illuminance levels for various activities and tasks are published by the Illuminating Engineering Society. Today we know that it is not just the 'amount' of light that affects visibility. Other factors such as contrast and glare are equally important.

The illumination from the sun on the earth's surface can exceed 100,000 LUX, (or 10,000 FC) during a summer day. At night the reflected light from the moon might be as high as 0.2 LUX, (or .002 FC).

SALTWATER DIMMER - (a 1900)

Soon after the development of the electric filament lamp, applications were immediately found in the theatre for this exciting new invention. New lighting fixtures and methods of control were quickly developed and put into use. One early means of lamp 'dimming' was through the use of the salt water dimmer. The dimmer consisted of a tank (or barrel) of salt water brine with a

permanent electrode submerged. As a second electrode was slowly raised (or lowered) into the brine, the conductivity between the two electrodes would increase (or decrease) respectively. Lamps connected in series to the dimmer, would be dimmed accordingly. It was not uncommon for a theatre to have a large number of these dimmers and it is said that the heat from the boiling brine would often help to heat the backstage areas. Undoubtedly messy and difficult to operate and maintain, the electric salt water dimmer was soon to be replaced by the somewhat more efficient (and dryer) electrical resistance dimmer.

See also: RESISTANCE DIMMER, AUTOTRANSFORMER DIMMER, SCR DIMMER.

MCCANDLESS, STANLEY - (c 1900 - 1967)

Stanley McCandless (American) is often regarded as the 'father' of modern stage lighting design. He worked as a teacher, educator and lighting designer, throughout his career. After graduating from the University of Wisconsin, "Mac" got his degree in architecture at Harvard. He then worked as an architect for some time and in the late 1920's he opened an office in New York City as an independent lighting consultant. He was the architectural lighting consultant for Radio City Music Hall and many other important projects. With the opening of the Yale School or Drama in the 1920's he was asked to teach stage lighting. He taught at Yale between 1925 and his retirement in 1964.

McCandless wrote two very important books on stage lighting "A method of lighting the Stage" (1st published, 1928), and "A Syllabus of Stage Lighting". McCandless provided a 'method' of lighting that is still the foundation of modern lighting methods today. He taught visibility of the actor first, and illumination of the surrounding scenery, second. He proposed a system of dividing a typical (proscenium) stage in to 'acting areas'. Each area was lighted with two fixtures - placed at 90 degrees to each other, and in a 45 degree frontal position to the actor. For additional interest, McCandless recommended a 'warm' color from one side and a 'cool' color from the other.

McCandless was also the holder of numerous patents in the architectural lighting field. He consulted on some of the largest and most important projects at the time in the American nation. He taught many lighting professionals in the field and lectured and wrote extensively in architectural and illumination publications.

RAMBUSH, HAROLD W. - (c 1900 - 1981)

Harold Rambush was the interior designer of many American and Canadian cathedrals and church interiors, (over 500) as well as the decorator of numerous American theatres, including the Roxy and Radio City Music Hall. He also served as the director of the Rambusch Company, a leading American manufacturer of church lighting fixtures, founded by his father in 1898.

MIELZINER, JO - (1901 - 1976)

Jo Mielziner designed sets and lighting for more than 300 productions. He designed his first Broadway play in 1924 and was active in the theatre until his death in 1976. Among his most famous Broadway productions were "Carousel", "Annie Get Your Gun", "A Streetcar Named Desire", "Death of a Salesman", "The King and I", "South Pacific", "Look Homeward Angel" and "Gypsy". (BW)

Additional Reading: Theatre Design & Technology, May 1969

HIGH INTENSITY DISCHARGE (HID) LAMP - (1901)

High Intensity Discharge (HID) lamps and lighting have been in use since the early days of the 20th Century, as an alternative to the electric filament lamp. The first HID lamp introduced was the mercury lamp in 1901. Later, low pressure sodium, high pressure sodium and metal halide lamps, were developed. All of these sources consist of electric arcs, operating in a gaseous environment, sealed within a glass tube or bulb. HID light sources are all more efficient than the electric filament lamp, however they also have limited color rendering abilities, due to their 'line' spectrum (not continuous spectrum). Many HID lamps are now also provided with a phosphor coating on the inside of the bulb. This coating causes additional secondary emissions of visual radiation, providing a wider 'spectrum' of light and color. Typical applications include industrial, commercial and architectural lighting.

See also: [METAL HALIDE LAMP], [MERCURY-VAPOR LAMP], [SODIUM LAMP]

MERCURY-VAPOR LAMP - (1901)

The first practical mercury-vapor lamp was the Cooper-Hewitt lamp developed by Peter Cooper Hewitt in 1901. This was a tubular source about 4 feet long which produced light that was distinctly bluish green in color. The first high pressure mercury lamps similar to the ones used today, were introduced in 1934 in the 400 watt size. Today, mercury lamps now available, range in size from 40 watts to 1000 watts. Mercury lamps produce approximately 55-60 lumens per watt.

Operation: the arc tube of the mercury lamp has argon gas and a little pearl of mercury as filling ingredients. It's electrodes are made of tungsten and carry an emitter paste, e.g. a barium-yttrium compound, that reduces the ignition voltage required to start the lamp. Within three to five minutes after ignition, the mercury is completely vaporized and the characteristic blue-green spectrum of the mercury discharge is emitted. It contains strong ultraviolet radiation at wavelengths of 254 nm and 365 nm. Radiation in the red area of the spectrum is virtually negligible. A mercury lamp's color temperature ranges between 4000K and 4500K, while its color rendering index (CRI) is only approximately 20, for a clear bulb. Applying phosphor coatings to the outer bulb increases the light output by 10 to 15 percent and improves the CRI to approximately 50.

ALBERT EINSTEIN - 1905

THE SPEED OF LIGHT - In 1905 Einstein postulated that nothing in the universe travels faster than the speed of light and he put forward his Special Theory of Relatively. Although many scientists have tried to test his theory, none have proven him wrong. In the vacuum of space, light travels at approximately 186,000 miles per second. This gave rise to a special T-shirt design worn at such places as MIT and Caltec:

186,000 MILES PER SECOND
IT'S NOT JUST A GOOD IDEA
IT'S THE LAW!

LIGHTYEAR

The lightyear is an astronomical measurement used to measure distance, not time. There are approximately 31.5 million seconds in a year. This means that light can travel a distance of 5.60 trillion miles in one year. The metric light year is approximately 9.5 trillion kilometers. The Milky Way is approximately 100,000 lightyears in diameter.

ILLUMINATING ENGINEERING SOCIETY - (1906)

I.E.S. (IESNA/IES) - The Illuminating Engineering Society of North America. The I.E.S. was formed in 1906 and has approximately 10,000 members world wide. Its membership includes; lighting consultants, engineers, architects, users, educators, equipment sellers and others, dedicated to the areas of lighting and illumination. Through its activities in research in all phases of lighting application, it has achieved recognition as the authority for recommended illumination practices in North America. The I.E.S. also makes available a great many lighting related publications. The society is located at 345 East 47 Street, New York, NW, 10017 (212) 705-7926.

Honorary IES membership was presented to Thomas Alva Edison on February 10, 1916 at the Hotel Biltmore in New York City.

INVENTION OF THE VACUUM TUBE - (1906)

In 1906, the American engineer, Lee De Forest, patented the triode vacuum tube. By 1920 the tube had been improve to the point where it could be used to amplify electric currents for television.

TUNGSTEN FILAMENT LAMP - (1907)

Prior to 1880 all filaments were either carbonized paper or cotton thread. From 1880 to 1894 bamboo was the usual filament material. In the 1888-1890 period, the squirted cellulose filament appeared. The tantalum lamp was introduced in 1908 and the first tungsten filament lamps were used about 1907-1910.

The first electric lamps using tungsten filaments first appeared in America in 1907, and were made in wattages up to 500 watts. The filaments were extremely fragile however.

The ductile tungsten filament was developed about 1911 by William D. Coolidge, (General Electric, Research Laboratory). This resulted in a much more durable and rugged lamp design. Tungsten has a melting point of 3370 degrees C. (Visible light is produced when a filament reaches 572 degrees Fahrenheit - 'DuroTest').

Additional Reading: LDA, July, 1980, file

ROSCO LABORATORIES - (1910)

Rosco manufacturers and supplies a wide range of products for the entertainment industry and has offices in New York, Hollywood, Toronto, London, Madrid and Sydney. Products include 'Roscolux' brand lighting filters, stainless steel projection templates (gobos), scenic paints, fabrics, plastics, projections screens, flooring, software and many other unique items.

"In 1915, the Rosco swatchbook had three blues: Medium Blue, Dark Blue and Green Blue. By the 1930's the range had expanded to six blues, including Daylight Blue, Pale Blue and No Color Blue". Rosco began producing color in 1910. (REF: quote, Rosco advertisements, Theatre Crafts, Feb/1989, pg 4).

See also: [ROSCOLUX].

Rosco Laboratories 30 Bush Avenue
Port Chester, NY, 10573, USA
Fax: 914-937-5984 (New York)
800-ROSCONY (New York)
800-ROSCOLA (Hollywood)
WWW/: http://www.rosco.com.

RESISTANCE DIMMER - (a 1910)

One of the earliest electrical dimmers put to use in the theatre (after the [SALTWATER DIMMER]) was the 'resistance dimmer'. The resistance dimmer was simply a long length of wire, usually wound in the form of a coil. A 'wiper' contact would move along the coil, usually controlled by a manual leaver (or motor control). As the contact moved along the coil, the coil resistance would decreasing or increase accordingly. This coil resistance was placed in series with one or more electrical filament lamps to provide a relatively efficient means of dimming.

Stage lighting switchboards were large and heavy. Many used an elaborate system of sub-switches and interlocking control levers. Master leavers were often provided to allow a single operator to raise or lower the control handles of a number of dimmers, all at the same time. It usually required considerable skill to achieve a smooth fade.

KELLY, RICHARD - (1910 - 1977)

Richard Kelly was an American, architectural lightning designer and consultant, with a vast number of projects credits. He also did extensive work with day lighting. He was familiar with the destructive characteristics of light (UV) and provided the lighting for a number of leading art galleries and museums.

BAY, HOWARD - (1912 - 1986)

Howard Bay has designed the sets and lighting for over 170 Broadway shows. He had designed fifty-seven Broadway productions by the time he was thirty-six. Among his credits are "Man of La Mancha", "Music Man", and "Show Boat". His Broadway career began in 1933 with 'There's a Moon Tonight'. His first designs for a musical were for 'Count Me In'.) His book, "Stage Design" is one of the most popular textbooks of its type.

Additional reading: Theatre Design and Technology, December 1969.

ROSENTHAL, JEAN - (1912 - 1968)

Jean Rosenthal born, N.Y.C. Studied at Yale with Stanley McCandless (c. 1932), and later went on to become one of the leading lighting designers on Broadway and in modern theatre. She was a pioneer in the art and craft of lighting design. Over her 30 year career, she is said to have designed over 400 productions, including plays, musicals, opera and ballet. Among her best known Broadway shows were "West Side Story", "Plaza Suite", "Becket", "Hello Dolly", "Hamlet" (with Richard Burton", "The Odd Couple", "Cabaret", "The Sound of Music" and "Fiddler on the Roof". Her well known book; "The Magic of Light", is published by Little, Brown and Company in association with Theater Arts Books.

COOLIDGE, WILLIAM DAVID - (1913)

Coolidge was a General Electric research worker who in 1913 received a patent for "tungsten and method for making same for use as filaments of incandescent electric lamps". Tungsten will now replace carbon filaments in the manufacture of Edison and Swan lamps

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GAS FILLED LAMP - (1913)

Up to this time, all lamp filaments operated in a high vacuum. After the introduction of the tungsten filament, by [COOLIDGE] the next highly significant step in the development of the incandescent lamp, came in 1913 when [LANGMUIR] (G.E. Research Lab.) made the first gas-filled lamp, at atmospheric pressure. He found that the higher pressure did reduced evaporation of the tungsten, but so much heat was conducted away by the gas that the lamp

efficiency was reduced. He discovered that coiling the filament reduced the effective area exposed to the gas and thus minimized the loss of heat. Coiled filament gas-filled lamps in 500, 750 and 1000 watt sizes were introduced in 1913. They gave a much better light at higher efficiency with the same life as former lamps. Nitrogen gas was used in the first lamps but argon was substituted in 1914. Argon has lower heat conductivity than nitrogen. These lamps could be made smaller than carbon lamps and produced three times the light per watt.

Now the development of advanced lighting fixtures and projectors, using lenses, was possible. See also: [IRVING LANGMUIR] (1881 - 1957).

HUB ELECTRIC COMPANY INC - (c 1915)

Hub was a large American manufacturer of theatre lighting products, located in Illinois. The company was active in educational theatre and provided a wide range of dimming products and design services.

MAJOR CONTROLS - (1916)

'Major' was formed in 1916 and is one of the oldest manufacturers of theatre lighting systems.

Major Controls,
740 Industrial Drive,
Cary, Illinois, 60013, USA
Tel: (312) 639-8200.

STRAND ELECTRIC COMPANY - (1917)

STRAND LIGHTING

The Strand Electric Company was established in 1917 in London, to serve the needs of the London theatre district. Strand Lighting Canada began operations in 1958. In 1969 the Rank Organization acquired both Strand Lighting and the American company of Century Lighting and consolidated them as Strand Century. Rank combined all of its Strand Century Companies into one international group under the Strand Lighting name in August 1985. In 1986 Rank acquired Electro Controls (Controls Lighting) of Salt Lake City, Utah and Calgary and Quartzcolor Ianiro SPA of Rome. In the fall of 1996 Schroder Ventures purchased the Strand Lighting International Group of companies from Rank. Today 'Strand', with offices around the world, manufacturers one of the most comprehensive ranges of lighting fixtures, dimming and control equipment for theatre and television, in the industry.

See also: [CENTURY LIGHTING]

Strand Lighting

18111 South Santa Fe Avenue
Rancho Dominguea, CA, 90221, USA
310-637-7500
800-733-0564
WWW: http://www.strandlight.com

See also: [CENTURY LIGHTING].

ADB LIGHTING - (1920)

ADB is a large European lighting company currently based in Belgian. The company was founded by Adrien De Backer in 1920 and started as manufacturers of electrical equipment including rheostats.As eqrly as 1925 ADB had developed rheostats to control the lighting for stages, music halls and movie theatres. Today the company manufactures a wide range of luminaires, accessories, dimming and controls, for the theatre and television markets. ADB has been a 'Siemens' company since 1987.

STRIPLIGHT / COMPARTMENT BATTEN - (1920's)

The striplight (compartment batten, in Britain) is a stage lighting fixture, designed to provide a linear 'wash' of light. In addition to being used for the lighting of scenery, striplights are also useful for the lighting of cycloramas and backdrops. Early striplights would have used candles, oil or gas and would have been most unpractical to handle and difficult to control.

In England, the compartment batten was made popular by Adrian Samoiloff who used many for his color lighting stunts, which hit the headlines in the early 1920's. Prior to the compartment batten, color was obtained by dipping the individual lamps in lacquer.

Today, the modern striplight is 6 to 10 feet in length and, wired in 3 or 4 circuits. Usually lamps of 100 - 500 watts are used behind plastic or glass filters. Sometimes the primary colors of light, red, green and blue are used. When the colors are 'mixed' together with dimmers, a wide range of dramatic colors may be attained. Often striplights will be used to illuminate large sky cloths. They are usually placed end to end, above the cloth, running from one side of the stage to the other. Additional striplights are often also placed on the floor, parallel to the cloth. The floor strips can provide an assortment of horizon lighting including sunrise and sunset effects.

FIRST - FRESNEL LENS SPOTLIGHT - (c 1920)

The modern fresnel spotlight is one of the most basic tools used by lighting designers for spot-lighting applications. The fresnel spotlight, in its simplest form consists of a housing, a light source and a 'fresnel' lens. When the source is moved slightly towards (or away) from the lens, the size of the light beam changes, from spot focus to flood focus. Early fresnel type lighting fixtures would have included, gas, oil, electric arc and other sources, and were commonly used as lighthouse type fixtures, able to project a narrow concentrated beam, a great distance.

The modern fresnel lighting fixture uses either a tungsten halogen or a discharge type of lamp. Fresnel fixtures are available in lens diameters of 3 inches to 36 inches or more. The typical stage and studio fresnel has a lens diameter of 6, 8 or 10 inches.

Today, the fresnel with its adjustable beam size is invaluable for area lighting and color wash applications. The fresnel fixture produces a 'round' beam with an intense 'hot' center and a 'soft', yet defined edge. Fresnel fixtures come in wattages of 150 to 10,000 watts and have adjustable beam spreads of from 10 to 60 degrees.

The fresnel lens and the early fresnel fixture was developed by and named for, [AUGUSTIN JEAN FRESNEL], (1788 - 1827).

[KLIEGL BROTHERS] (in a 1969 catalog) claims the incorporation of a fresnel lens into a theatrical lighting fixture, in 1929.

LEVE, CHARLES - (1922 - 1985)

Charles Leve was a graduate of Yale University Drama School and later went on to be the director of development of lighting, for Strand Century, a position he held for 34 years, since 1951. Leve was also the designer of the Light Palette, a computerized lighting control system that did much to revolutionize theatre lighting of Broadway shows. Prior to his death Leve also had worked with Colortran Inc. and Four Star Stage Lighting.

SCHWABE - (1923)

Schwabe (Germany) was a leader in the development of early stage lighting fixtures (not dimmers and control). The firm of 'Reiche and Vogel' is a descendent of the Schwabe Company. Schwabe made a number of theatre lighting installations in London, as early as 1923. (St. Martin's Theatre).

REICHE AND VOGEL - (1923)

- see: SCHWABE

NIETHAMMER, EMIL - (c 1924)

Emil Niethammer, founded about 1924, is a large manufacturer of high quality stage and studio lighting fixtures. The company is located in Stuttgart, West Germany and was purchased by [AVAB] in the late 1980's. All fixtures are designed and manufactured to a very high standard, and optical performance is among the best in the world.

STROBOSCOPE (ELECTRONIC STROBE) - (c 1926)

EARLY STROBOSCOPE

The stroboscope is a device for viewing a rotating object by making the object appear to be at rest. In its simplest form, it consists of a rotating disk with one or more viewing slits, through which the object can be viewed. The observer looks through the viewing slit and sees the object in exactly the same position each time the slit passes the observers eye. The disk must be rotated in precise synchronization with the object. If the disk is rotated slightly slower than the object, the object will appear to be moving slowly in the direction of its actual motion. If the disk is turning faster that the moving object, then the object will appear to move slowly in the direction opposite to its actual motion.

The stroboscope is of great use in engineering studies of moving parts, as they can actually 'freeze' and view the image in real time.

ELECTRIC STROBOSCOPE

Modern stroboscopes no longer use the rotating wheel with slits. Instead electric lamps are utilized that produce short flashes of light at the same rate that the object is revolving. The high speed gas discharge lamp, stroboscope was developed by Harold Eugene Edgerton and his associates at the Massachusetts Institute of Technology around 1926 to 1931. Today, [NEON] lamps are also commonly used for low power stroboscopic applications, producing a flash rate synchronized with a 50/60 cycle frequency, of the standard A.C. (alternating current) power line.

ENTERTAINMENT APPLICATIONS

On a darkened stage in a theatre, a single flashing light source can provide a very striking and dynamic - stop action effect, of all moving objects on stage.

During the mid-1900's, a device known as the 'lobsterscope' was developed for theatre and stage applications. The device consisted of a spinning disk with apertures to mechanically 'chop' the beam of light produced from an incandescent spotlight. This produced a rapid flickering light, able to 'freeze' the action on stage.

During the 1960's the [XENON] 'Strobe' was frequently used for discotheque lighting applications. Designers tried to build the 'ultimate' strobe and units continued to became larger, brighter and more sophisticated. Often several powerful strobe units would be used in a single stage production, with control systems developed to synchronize their firing from a number of inputs (audio beat, keyboard, programmer, etc.)

Today strobe technology in the entertainment industry is stronger than ever. Large productions might incorporate 50-100 or more units, usually mounted in banks of several fixtures each.

FIRST - PUBLIC TELEVISION - (1926)

On January 27, 1926, the first public demonstration of television was given. The first

commercial color TV broadcast was presented by CBS on June 25, 1951.

CENTURY LIGHTING - (1926)

Century Lighting opened for business in New York in 1926. The company later was purchased by [STRAND ELECTRIC] to become 'Century Strand', then 'Strand Century' then finally [STRAND LIGHTING], in the 1990's. 'Century Lighting' (USA) made many fine lighting products, including fixtures, dimmers and accessories for stage and television lighting. Century also produced the well known 'leko', (ellipsoidal reflector spotlight), in a number of different sizes and wattages.

The company was founded by Ed Kook and Joseph [LEVE].

MOLE-RICHARDSON CO. - (c 1927)

Established about 1927, Mole Richardson is one of the leading manufacturers in the world of motion picture, television and professional photographic lighting. They manufacturer an extensive range of lighting fixtures and related accessories and are located in Hollywood California, USA.

Mole-Richardson
937 North Sycamore Avenue
Hollywood CA, 90038-2384, USA
Tel: (213) 851-0111
Fax: (213) 851-5593

SKELTON, THOMAS R. - (1928 - 1994)

Tom Skelton, was an well known American stage lighting designer. He died, August 10, 1991. at the age of 66. "The late Tom Skelton was an artist truly revered in the entertainment industry. He began his lighting career as an apprentice to Jean Rosenthal. He went on to inspire other great designers including Jennifer Tipton and Paul Gallo. Skelton was a brilliant lighting designer and innovated color techniques for both theatre and dance. He designed for the Jeffrey, New York City, Paul Taylor, Jose Limon and the Ohio Ballet, which he co-founded. His Broadway credits include "A Few Good Men", "Peter Pan", "Oklahoma", "Brigadoon", "The King and I", "Carousel", and the revivals of "The Iceman Cometh", and "Death of a Salesman". He received 3 Tony nominations, the Carbonelle Award. and the Los Angeles Drama Critics' Award during his career." (REF: quote from, Rosco, Pattern Catalog, 1996).

CLEMANCON - (1928)

The French firm of Clemoncon, was founded in Paris in 1928, and has a long record in the

manufacturing of stage lighting equipment.

UNION CONNECTOR CO., INC. - (1929)

In 1929, the Union Connector Company was founded by William J. Wolpert, as a manufacturer of stage lighting connectors. Today, the company makes a large variety of high quality electrical connectors for the stage, motion picture and television industries.

Union Connector Co., Inc.
300 Babylon Turnpike
Roosevelt, New York, 11575, USA
Tel: (616) 623-7461
Fax: (616) 623-7475

PANI, LUDWIG - (1930)

The Viennese firm of Ludwig Pani, is one of the world's leading manufacturers of projection and lighting equipment. The firm was formed in 1930 as a division of the optics firm: 'Optischen Werke C. Reichert, Wien'. Herr Pani who headed the projection division of the parent company, gave his name to the new firm. Pani manufacturer a number of different high powered, optical projectors, accessories and lenses. Pani has several models including a 2000 and 5000 watt incandescent model and a super bright 4000 watt HMI model. These projectors are suitable for large scale scenic projection, for opera and other large scale projections including outdoor architectural and building projection, at night. Pani projectors are very expensive, but very impressive. In the USA, the firm is represented by Production Arts, (New York City, USA).

FLASHBULB - (1930)

The photographic flashbulb was patented by a German inventor, Johannes Ostermeir. A small filament in the 'flash lamp' heated to ignite foil inside the bulb, providing a bright, smokeless, flash of light. This provided a much safer and more practical means of photographic illumination than did previous methods using flash powder.

TIMES SQUARE CORP. - (a 1930)

TIMES SQUARE THEATRICAL AND STUDIO SUPPLY CORP. was established around 1930 in New York City. Since its inception, the company has grown to be a leading supplier lighting equipment and accessories to the stage, studio and entertainment industries, around the world.

Times Square Lighting,

Industrial Park, Route 9W.
Stony Point, N.Y., 10980, USA,
Tel: (914) 947-3034,
Fax: (914) 947-3037

COMMISSION INTERNATIONAL DE L'ECLAIRAGE, (CIE) - (1931)

C.I.E. (CIE) - The International Commission on Illumination, in 1931, adapted a set of tables to define the color matching characteristics or a standard observer and establish a framework for the specification of colors. This was the trichromatic system of color measurement. The recommendations were for pure spectrum colors and were based on a number of research programs which dated from at least as early as MAXWELL'S work in 1854, and continued by other researchers until 1931.

Additional reading: Measurement of Color, W.D. Write, 1964, Hilger & Watts Ltd., London.

LAND, EDWIN HERBERT

- See: [POLAROID FILTER], [POLAROID CAMERA]

POLAROID FILTER - (1932)

The principals of polarized light have been known for many years, having been discovered by [HUYGENS] in 1678. It was the American inventor Edwin Herbert Land however who in 1932 invented a material to conveniently produce polarized light from ordinary light. The light gray glass or plastic filters are relatively inexpensive, and only pass light waves vibrating in one direction. The filter material is now known by the trademark 'Polaroid'.

Today, there are several modern uses of polarized light. Glare from the sun (or other source) reflecting off of a shiny surface will often reflect polarized light. If the glare is viewed through a polarization filter, the glare will disappear and reappear, as the filter is slowly rotated around a central axis. This is the exact principal used in polarized sunglasses. The orientation of the filter tends to block any reflected polarized glare, that is not on axis with the filter. 'Polaroid' sunglasses were introduced by Land-Wheelwright Laboratories in 1936. The following year the company changed its name to the Polaroid Corp.

Polarized light also has several spectacular visual properties associated with it. For example many crystals and plastics produce impressive and dramatic colors when illuminated with and viewed under polarized light. This principal is used in the study of stress in engineering structures. A scale model (of a bridge for example) will be constructed from clear plastic. The model will be illuminated with polarized light and viewed through a polarized filter. Any loads or stresses placed on the scale model will immediately produce dynamic color effects, showing stress lines throughout the structure. The crumpled plastic from a cigarette package and two small polarized filters can demonstrate this colorful experience.

In the 1960's and early 1970's many 'light shows' made and projected slides, made from crumpled and scrunched pieces of clear plastic sandwiched with a polarized filter. When projected from a source with a polarized filter on the lens, the image would become alive with color. When the filter at the lens was rotated the images would swirl, flicker and dance in a psychedelic display of color.

See also : [POLARIZATION/POLARIZED LIGHT]

SODIUM LAMP - (LOW PRESSURE) - (1932)

L.P.S. (LPS) - Research into low pressure sodium gas discharge lamps started in the 1920's. The first commercial application was a road lighting installation that was put into service between Beek and Geleen in the south of the Netherlands on July 1, 1932. The installation employed low pressure sodium lamps with a lumen efficacy 40 lumens per watt. In the same year, the Purley Way in London was also lit by low pressure sodium lamps. Today, the modern low pressure sodium lamp, is considered to be the most efficient lamp available, providing more than 220 lumens per watt. Low pressure sodium lamps can be recognized from their deep amber color.

Additional Reading: LDA, June 1983, Low pressure sodium lighting, the past, present and future - (file)

See also: SODIUM LAMP - (HIGH PRESSURE)

ELLIPSOIDAL REFLECTOR SPOTLIGHT - (1933)

Although not completely certain, the invention of the modern ellipsoidal reflector spotlight often goes to [KLIEGL BROTHERS] (USA). In 1933, the first KLIEGLIGHT, was used in the spectacular outdoor pageant "Romance of the People", at the Polo Grounds in New York. Its first indoor use was in the Earl Carrol Vanities of the same year. Century Lighting (USA) produced a similar fixture in the same year known as the [LEKOLITE].

Today, the ellipsoidal reflector spotlight is still one of the basic tools of the stage lighting designer for spot-lighting applications. The 'ER' as it is often known, is also used to a lesser extent in modern television and film lighting applications. In Britain the 'ER' is referred to as a 'profile spotlight' or a 'mirror spot'.

In its simplest form, the ER fixture consists of a housing, a light source, an ellipsoidal reflector and a plano convex lens. The light beam produced by an ER fixture is round (or 'conical') with a sharp defined cut-off edge. The fixture is actually a simple projection device and will optically project the image of anything placed at its focal point. The typical ER fixture has 4 integral framing shutters or an iris - to provided limited beam shaping. In addition, and of particular importance the ER fixture will also accept and project the design of a metal pattern, commonly known as a template or gobo. There are hundreds of different stock patterns and designs available from various manufacturers.

The typical ER spotlight uses a tungsten halogen type of lamp. Fixtures are available in lens diameters from about 4" to 10" and with wattages from 500 to 2000 watts. The typical stage and studio ER fixture has a lens diameter of 6 inches and a 1000 Watt lamp.

The ER spotlight is selected by beam spread. Fixed beam spreads are available as follows: 5, 10, 15, 20, 25, 30, 35, 40, 50 degrees. Formerly in North America (1950's-1980's) beam spread was designated by specifying first the diameter and then the focal length of the lens. Example: a 6x9 (pronounced 6 by 9) was a fixture with a 6" diameter lens and a 9" focal length. In order to determine the spread in degrees of any particular fixture, the designer still needed to consult the manufacturers data sheet as the designation did not accurately identify the beam spread of the fixture. Today spotlights are specified in 'degrees' only. The following table shows approximate beam spread of several common ER spotlight fixtures:

- 6x9 - 40 degrees
- 6x12 - 30 degrees
- 6x16 - 25 degrees
- 6x22 - 15 degrees
- 8x9 - 20 degrees
- 8x13 - 13 degrees
- 10x20 - 15 degrees

'LEKO' (also LEKOLITE) - (1933)

About the same time that [KLIEGL BROTHERS] developed the first ellipsoidal reflector spotlight, [CENTURY LIGHTING] also developed a similar type of lighting fixture known as the [LEKO] or [LEKOLIGHT].

Joseph [LEVE] and Edward F. Kook were founders of Century Lighting and in 1933 they filed a patent for a new type of reflector spotlight. Each gave one half of their names LE and KO to their joint development. The 'leko' used an ellipsoidal reflector with beam shaping controls (shutters & templates). The leko is still manufactured today by [STRAND LIGHTING], however it has gone through many improvements over the years. Although the term 'Lekolite' is often used to generically refer to any type of ellipsoidal reflector, lighting fixture, the name is now owned by Strand and Strand alone, has the right to use the name.

See also: [ELLIPSOIDAL REFLECTOR SPOTLIGHT]

GOBO/TEMPLATE - (a 1933)

The development of the modern [ELLIPSOIDAL REFLECTOR SPOTLIGHT] (1933), provided an effective acting area type of fixture. It also provided, however, a 'crude' but effective method of image projection.

Typically a pattern is cut or etched into a thin metal plate. When the plate is inserted into a slot, at the focal point of the fixture, an image of the pattern is projected. As the pattern or template was 'to go between' the lamp and the lens - it is was nicknamed: 'gobo'.

The use of template projection is a very valuable tool for the modern lighting designer. Many designers use gobos to provide 'texture' to acting area lighting. Other designers use gobos to provide interesting floor patterns, or to texture the scenery. The image may often be slightly softened, by placing the lens out of focus. Alternately a sharp image may be produced, by 'hard' focusing the lens. Focus may sometimes be made even sharper by the addition of a 'donut' in the color frame. Typically a donut for a 6" ellipsoidal reflector spotlight consists of a 7.5" x 7.5" foil mask, with a 2-3 inch hole, punched in the center. Although the image will be sharpened, by the use of the donut, some intensity, will also be lost.

Several companies produce 'stock' pattern designs precision etched in stainless steel. Both the [GREAT AMERICAN MARKET] and [ROSCO] produce hundreds of unique designs in several different sizes. It is also possible to custom etch your own projection templates using brass shim stock and an etchent of potassium ferra-chloride.

AUTOTRANSFORMER (DIMMER) - (c 1933)

The first autotransformer was developed and patented about 1933 by General Radio Company (USA). This device was a continuously variable transformer with the trade name of "Variac". The Variac provided a much more efficient means of dimming electric lighting fixtures in theatres, than did the existing resistance and saltwater dimmers of the time.

In the 1960's, the American Superior Electric Company, produced a number of autotransformer dimming systems for theatre and television applications. These products had the trade name 'Luxtrol' or 'Powerstat' and were used extensively across Canada and the United States. Portable systems of 6 or 12 dimmers in a single (heavy) metal enclosure were common. Each dimmer had a handle to provide direct and individual control. When the operator 'rotated' a dimmer handle, it would interlock to a 'master' handle to facilitate the fade-up or fade-down of all selected dimmers at once. Some theatre installations remained in operation in North America well into the 1970's. Now all modern theatre dimming systems employ the [SILICON CONTROLLED RECTIFIER] dimmer.

Autotransformers can also be motorized for remote operation. The autotransformer dimmer is still used today in some applications (recording studios & hospitals) as they do not generate radio frequency interference (RFI) as does a modern SCR type dimmer.

See also: [SALTWATER DIMMER], [RESISTANCE DIMMER], [SCR DIMMER].

FLUORESCENT LAMP - (1937)

The fluorescent lamp was first introduced to the public at the New York World's Fair in the late thirties (1937). The lamps were introduced commercially in about 1938. The fluorescent lamp is a low pressure gas discharge source, in which the light is produced predominantly by fluorescent powders activated by ultraviolet energy generated by a mercury arc. Typically, a fluorescent lamp must efficiently generate 253.7 millimicron ultraviolet radiation to excite the phosphors coating the inside of the tubular glass bulb.

The lamp is usually in the form of a long tubular bulb with an electrode sealed at each end. The modern fluorescent lamp has an efficacy of approximately 65-80 lumens per watt. Today fluorescent lamps are also available in circular and 'folded' shapes. Lamps with various different color temperatures and color rendering properties are commonly available. The most common fluorescent lamp is the CW or cool white version, although new 'warmer' versions are now gaining popularity, worldwide. All fluorescent lamps require a ballast, for operation.

Developed in the late 1980's the compact fluorescent lamp revolutionized the lighting industry. This lamp (also referred to as the PL lamp), is simply a folded fluorescent tube, sometimes no larger than a standard 'light bulb'. The ballast is usually mounted in the base pf the lamp. This new lamp allows most household incandescent lamps to be replaced with these new energy saving fluorescent lamps. In addition to retrofit applications, new 'pot light' fixtures have been developed specifically for the PL lamps, for residential, commercial and industrial lighting applications. PL lamps are available in various wattages from approximately 9 - 50 watts, and are available from all major lamp manufacturers.

PAR LAMP (SEALED BEAM LAMP) - (a 1940)

The PARABOLIC ALUMINIZED REFLECTOR (or PAR lamp) is a sealed beam type of lamp, similar to an automotive headlamp. The filament, reflector and lens are all optically aligned at the factory, and sealed into a single lamp - resulting in a highly efficient source. As the PAR lamp is a complete lighting unit, fixtures for them are very simple indeed. Today, PAR lamps are available in various diameters (4.5" to 8"), and various wattages (75-1000 w.) The highly efficient PAR64 lamp (8' lens) is extensively used by the theatre and entertainment industry and the fixtures are often referred to as 'PAR cans'.

The PAR lamp is also sometimes known in Europe as the 'pressed glass reflector lamp'.

There are some historical pictures showing one of the inventors, Dick Thayer, with prototype lamps made from "Pyrex" custard cups purchased from the local hardware store. That was in 1937. The first sealed beam automotive headlamps appeared on the 1940 model cars.

The author's research has also uncovered an early patent drawing of a sealed beam lamp dated Feb. 21, 1939. The drawing is numbered 2,148,314 and is signed Daniel K. Wright, Inventor. The lamp looks very similar to a modern PAR lamp. The lamp was thought to have been placed into production, shortly thereafter.

HEMSLEY, GILBERT V. JR. - (a 1945)

Gilbert Hemsley (USA) was a Professor at the University of Wisconsin at Madison and a well liked and respected stage lighting designer. Unfortunately, he passed on, before his time.

PHOTOGRAPHY - POLAROID CAMERA - (1947)

In 1947, American Edwin Land invented the Polaroid instant camera. Land's big contribution was to develop a film that developed a positive image within seconds. Both the negative film and the positive paper were sandwiched together in the film pack. After being exposed, when the film is pulled from the camera it passes through rollers that break a chemical pod releasing chemicals that develop the film and transfer the image to the positive paper. The Polaroid camera is still very much in use today by both professional and amateur photographers alike. Film packs are available for both black & white and color prints. In 1963 one-step color film became available.

See also: [POLAROID FILTER].

FROST, ROBERT - (1947)

It Bids Pretty Fair (from Steeple Bush - 1947)

The play seems out for an infinite run.
Don't mind a little thing like the actors fighting
The only thing I worry about is the sun.
We'll be all right if nothing goes wrong with the lighting.

STRONG ELECTRIC COMPANY - (a 1947)

STRONG INTERNATIONAL, (established about 1947) is the oldest American manufacturer of motion picture projection light sources and followspots in the entertainment industry. 'Strong' followspots are of high quality and performance and are known around the world. Their products include: the Super Trouper (carbon arc spot), the Gladiator and the Trouperette. Most current models now use a [XENON] lamp.

Strong International
4350 McKinley Street
Omaha, NE, 68112, USA
402-453-4444.
WWW: http://www.strongint.com

CANDELA - (1948)

The modern unit adapted in 1948 for the measurement of light intensity is the candela (cd). One candela is equal to one square centimeter of a blackbody radiator at the temperature at which platinum solidifies (2046 degrees Kelvin). The former unit of intensity was the candlepower. This term is sometimes still used interchangeably with candela, today.

See also: [CANDLEPOWER].

SYLVANIA/OSRAM - (a 1950)

Sylvania is a large North American based lamp manufacturer. They are one of the largest in the world. About 1994, they combined forces with 'Osram' a large European lamp manufacturer. They are now known world wide as 'Osram/Sylvania'.

UNITED SCENIC ARTISTS - (a 1950)

The United Scenic Artists is an American based association of professional stage designers. Membership in the USA is generally considered necessary in order to be able to design on Broadway in New York City. Members include set designers, lighting designers, costume designers, and others. Requirements for membership are quite stringent and require both a written and practical examination, in most cases.

SON ET LUMINAIRE - (a 1950)

The French phenomenon of the Son et Luminaire (or light and sound show) has been produced at various antiquities around the world. These shows use large scale automated lighting and sound systems to produce scripted presentations, usually for the tourist. Large Son et Luminaire shows are regularly provided in Rome, Athens and Cairo.

PATTERN 23 - (1952)

The famous Pattern 23, - 500 watt Baby Mirror Spot, was introduced by STRAND ELECTRIC in 1952. This highly efficient and compact spotlight, became known as the PATT-23 and used for many years in theatres around the world. Different lens configurations were available, 4 framing shutters were standard, and the PATT-23 had optional accessories, including iris and template holder. The PATT-23 was finally retired about 1980, with fixtures of an even more efficient design. Note: many modern theatre spotlights (of similar size, weight and wattage) do not perform as well as this early fixture.

FIBER OPTICS - (1955)

The invention of fiber optics changed the world of communications and technology. The principal of 'total internal reflectance' had been known for some time and was demonstrated about 1870 by TYNDAL, when he shone a light at a spout of water as it gushed out of a tank. The water fell in an arc and the light went with it. See also: LIGHT PIPE, 1880.

The invention of modern fiber optics is credited to Kapany (British) in 1955 and at about the same time to Brian O'Brien Sr. at the American Optical Company in America. During the 1960's early fiber optics were developed as a means of transmitting messages as an

alternative to electrical wires. By 1970 the Corning company produced the first practical fiber optic cable. It could transmit light about a third of a mile before most of the light was absorbed. By 1990 fiber optics were transmitting light more than 20 miles without a repeater. Fiber optics consist of small hair like optical fibers, bundled together within a plastic jacket. They come in various diameters and are quite flexible. Using high speed light pulses (traveling at the speed of light) fiber optics are able to transmit data, audio, video and telecommunications from location to location. Fiber optics can transmit far more information than electrical wire transmission systems, making them invaluable for computer and telephone applications.

Unlike conventional copper wires, fiber optic signals are not subject to electromagnet interference from nearby motors, ballasts, relays or electronic dimmers.

Fiber optics also transmit light in automotive, aircraft and medical equipment. Often car headlights are simply 'monitored' by running a fiber optic from the headlight to an indicator on the dashboard. The driver always knows 'for sure' if a headlight is operating or not, as the fiber optic is literally 'watching' the light from the headlight. In addition, there is no 'bulb' to burn out (and replace) in the dashboard. The system is truly maintenance free.

Fiber optics may also be manufactured as 'coherent' bundles, that is with all of the hundreds of individual similarly aligned at each end. An optic of this type is able to transmit and actual picture or image from one end to the other. This principle is used in the endoscope, an instrument used to look inside the body. Endoscopes are used to explore and biopsy such areas as the colon and the bronchi of the lungs as well as to perform surgery through small incisions.

See also: [LIGHT PIPE].

DICHROIC LAMPS - (a 1955)

These special reflector floods incorporate a dichroic reflector. In a lamp with a conventional reflector, much of the infrared energy (heat) from the source is reflected into the beam. In a lamp using a dichroic reflector, some infrared energy is dissipated out through the reflector, and not into the beam, resulting in a cooler beam. These 'cool beam' lamps are particularly useful for museum or gallery lighting applications where excess heat [INFRARED] could damage precious artwork or artifacts. Dichroic lamps are manufactured in MR11, MR16 and in various PAR sizes to PAR38.

ALTMAN STAGE LIGHTING - (c 1955)

The Altman Stage Lighting Company (U.S.A.) was established in the 1950's and has become one of the leading manufacturers of stage lighting fixtures, in the world. The Altman 360Q series of ellipsoidal reflector spotlights have become an international standard for performance and efficiency vs size and weight. Altman manufacturers a full range of all equipment types in various sizes and wattages. The company is located in Yonkers New York.

The company is very much a family business, started by Charlie Altman. In the start-up days,

Charlie liked to compete with his brothers; Edward owned Capital Stage Lighting, Arthur owned Eastern Stage Lighting. Charlie Altman, Alice his wife, and other family members worked hard over the years. By the 1980's, Altman was the dominate lighting fixture manufacturer in North America and perhaps in the entire world. Alice Altman died in 1990. Charlie Altman died on May 5, 1995. He lived to be over 90 years old. The company is now run by Robert Altman, by children of Ronald Altman, and by other family members.

Altman Stage Lighting
57 Alexander Street
Yonkers, NY, 10701, USA
914-476-7987
800-4ALTMAN
WWW: http//www.altmanltg.com

COLORTRAN - (a 1955)

Colortran is a leading American manufacturer of theatre and television lighting fixtures, dimmers, control systems and accessories. In 1964 Colortran won an Academy Award for its development of the tungsten halogen fixture. During the 1970's and 1980's the company built a full and comprehensive range of products. The company changed ownership several times becoming first 'Berkey Colortran' and then later 'Lee Colortran'. In the late 1990's, the product line was taken over again by 'NSI Corporation', an already existing manufacturer of stage fixtures, dimming and control.

Colortran
A division of NSI Corporation
9126 SW Ridder Road
Wilsonville, OR, 97070, USA
503-576-6060
WWW:http//www.colortran.com

SCR DIMMER - SILICON CONTROLLED RECTIFIER - (1958)

S.C.R. (SCR) - In 1958, General Electric announced the introduction of the silicon controlled rectifier. This semiconductor device was about to revolutionize dimming applications for theatre and television lighting around the world. Previous to this time, dimming systems were large, generally inefficient and mechanically very complex.

The SCR allowed the design of compact, remote controlled dimming systems - with no moving parts in the dimmer. By 1960 [KLIEGL] was installing SCR systems, and [CENTURY] Lighting was installing their C-Core line. The SCR is still the basis of modern electronic dimming systems today.

The typical modern SCR dimmer employs two PNPN semiconductor devices commonly know as silicon control rectifiers, or thyristors, connected in inverse parallel and in series with the lamp load. A signal applied to the control gates of these devices is utilized to control their

conduction period. The dimmer thereby controls the effective power dissipated in the lamp load and, thus the intensity of the lamps. The dimmer is completely inert and requires no maintenance.

MANITOBA THEATRE CENTRE (MTC) - (1958)

M.T.C. - In Canada, the 1950's to mid-1960's constituted the "regional theatre era". Each province was endowed with a government supported, permanent professional theatre. The Manitoba Theatre Centre founded in 1958 was the country's first. It was built following the landmark report issued by the government sponsored Massey-Levesque Commission which 1.) affirmed such a thing as Canadian culture did exist; 2.) devised the current system of government arts funding; and 3.) recommended the establishment of a federal arts funding body (The Canada Council) to be supplemented by provincial and municipal agencies.

The Manitoba Theatre Centre is still active today, producing or co-producing approximately 10 - 12 productions a year, between its two stages (Mainstage and Warehouse Theatres).

LASER - (1960)

The 'laser' - or - (light amplification by stimulated emission of radiation) was perfected in 1960, by research scientist Theodore Maiman at the Hughes Laboratory in Malibu California. The actual term 'laser' originated about 1957 by Gordon Gould (40) at the University of Columbia, where his notarized notebooks show the basic laser concept. Gould tried to interest American defense officials in the development of a potential 'death-ray', but as he was involved in some left-wing political activities in the early 1940's, the Defense Department classified his patent application secret, denied him security clearance, and confiscated his notebooks.

Physicists Charles H. Townes and his brother-in-law Arthur Schawlow were the first to actually apply for a patent on the laser and they were the first to publish their findings in scientific journals.

The He-Ne laser (red beam) was in commercial use, by 1968. Today many different types of lasers exist, for a wide range of applications. Lasers are used for surgery, for cutting metal, for determining distance, for projecting 3-dimensional holographic images, for computer printing and for entertainment lighting applications.

Laser light differs from ordinary light in four ways. Briefly it is much more intense, directional, monochromatic and coherent. Most lasers consist of a column of active material with a partly reflecting mirror at one end and a fully reflecting mirror at the other. In a typical solid laser material, a ruby crystal, the active ingredients are chromium atoms interspersed in the crystal lattice of aluminum oxide. The laser is primed by pumping these atoms, by means of a flash of intense light, to an excited state. This causes the system to produce a cascade of photons, all of the same wavelength and all in step with each other.

See also: [HOLOGRAM/HOLOGRAPHY]

HOLOGRAM/HOLOGRAPHY - (a 1960)

The term 'holography' was coined by Hungarian physicist Dennis Gabor in 1947, to describe a new form of three-dimensional images. His work related to the area of electron beam microscopes, however it became evident that a coherent light source was required to make a hologram and it was not until the laser was fully developed that his concepts were realized.

In the early, 1960's Emmet N. Leith and Juris Upatnieks of the University of Michigan working with a laser, created the first hologram or holographic image.

A hologram is created by splitting the beam of light from a laser into two, using a beam splitter and mirrors. One beam illuminates a photographic plate (the hologram). The other beam illuminates the object and reflects its image to the plate. The two beams set up an interference pattern that is recorded on film. The object can be captured in three-dimensions. To reconstruct the image, simply shine a laser of identical wavelength on the developed holographic plate. The image forms in mid-air. If you move around the image you will be able to view it from different angles in three-dimensions. Tear off a small piece of the hologram and you will still see the complete three-dimensional image. All of the information is contained in any part of the hologram.

LUMINAIRE - (a 1960)

A lighting fixture is properly referred to as a 'Fixture' or as an 'Instrument', in North America.....as a 'Light Fitting' or a 'Lantern' in Britain...and as a Luminaire (the 'e' is silent), in other parts of the world and by the engineering community. All of these terms are taken to mean: 'a complete lighting unit', usually consisting of; a metal housing, socket, lamp, reflector, electrical cord, connector and (lens). The term 'luminaire' is also commonly used by electrical engineers and architectural lighting designers. Although the word luminaire (from the French) has been in use for sometime, it is only in the 1960's that the term started to be used in North American theatre by the architectural and theatre lighting industries.

CCT THEATRE LIGHTING - (a 1960)

CCT was a large British based manufacturer of high quality stage and studio lighting fixtures. Installations include; the Bolshoi (Moscow), La Scala (Spain), the Lido (Paris), the Orpheum (Vancouver), the Sydney Opera House and the National Theatre (Britain). W.J. Furse & Co. Limited (Nottingham, England) acquired CCT about 1988.

FOUR STAR STAGE LIGHTING - (a 1960)

Four Star is a large New York based lighting company with a long reputation for lighting sales, rentals and service.

Four Star Lighting
30 Warren Place
Mount Vernon, N.Y., USA
914-667-9200.

IMERO FIORENTINO ASSOCIATES - (1960)

Founded in 1960, Imero Fiorentino Associates was originally a firm of leading television lighting directors and consultants. The firm has now expanded to provide lighting and staging consulting to concert, corporate and industrial projects. IRA has offices in New York, Las Vegas and Hollywood.

TEATRO - (a 1960)

Teatro is an Italian manufacturer of high quality stage and studio lighting fixtures. They make a wide range of fixtures from fixed and zoom ellipsoidal reflector spotlights, to floodlights and fresnel type fixtures.

Teatro
slr Via Inghilterra
2-4602 Castel Goffredo (Mn) Italy
Tel +39 (0)376-780702
Fax:+39 (0)376-780888

UNITED STATES INSTITUTE FOR THEATRE TECHNOLOGY (USITT) - (1960)

U.S.I.T.T. (USITT) - Non-profit membership association comprised of individuals, organizations, manufacturers and suppliers specializing in all aspects of technical production and design in the performing arts industry. USITT produces an Annual Conference and Stage Expo, publishes TD&T and Sightlines, sponsors projects, programs, research symposia and exhibits, and assists in developing industry standards for safe, efficient and ethical practices. Founded in 1960, the mission of the institute is to actively promote the advancement of the knowledge and skills of its members.

USITT
6443 Ridings Road
Syracuse, NY, 13206, USA
315-463-6463 TEL
315-463-6525 FAX
800-93USITT
WWW:http://www.ffa.ucalgary.ca/usitt/

QUARTZ HALOGEN LAMP - (1960)

(Also the TUNGSTEN HALOGEN) lamp was introduced in 1960 for use by the stage and studio market. General Electric often claims to have invented the halogen lamp in 1957.

The bulb of a typical tungsten filament lamp, blackens with age as the filament boils off and the tungsten is deposited on the bulb wall. Halogen lamps are 'self-cleaning'. Halogen vapor present in the lamp combines with particles of tungsten that have been evaporated from the filament and redeposits them on the filament. For this process to take place, bulb wall temperatures should not be below. 482ø F., (250 øC.) Hot spots on the bulb wall may go as high as 1250ø F., (700ø C.) Lamp base temperatures should not exceed 622ø F., (350ø C.), as above that point, lead wires may deteriorate and the basing cement may loosen, causing premature lamp failure.

METAL HALIDE LAMP - (a 1960)

The first metal halide lamp was developed about 1960. Metal Halide lamps are essentially mercury high pressure discharge lamps that have additional metal halides in their arc tubes. Metal Halide lamps provide improved efficiency and improved color rendering qualities over mercury lamps. The modern metal halide lamp has a luminous efficiency of 85-115 lumens per watt.

THORN LIGHTING - (a 1960)

Thorn was a leading European manufacturer of high quality lighting fixtures, lamps and accessories. Their lamp division was taken over by the General Electric Company in the early 1990's. Several years later the company ceased all operations.

'CINEMOID' COLOR FILTERS - (a 1960)

In the early days of the electric filament lamp, gelatin color filters were used to color stage lighting fixtures. Gelatin filters dissolved when wet, and could not withstand the high heat from the tungsten halogen lamp (developed in the early 1960's). As a result, a new type of filter, 'Cinemoid', was developed by [STRAND ELECTRIC] (London). Cinemoid used a colored acetate sheeting, with inherent self-extinguishing properties. Less than 60 colors were shown by a 1966 product catalog sheet. 'Cinemoid' is no longer produced and has been replaced by polyester based materials, such as 'Roscolux' and 'Lee' filters.

See also: [ROSCOLUX], [LEE]

LIGHTING TEMPLATE - (a 1960)

Lighting designers working in theatre and television often must produce a drawing known as the 'light plot'. This drawing will use a number of specialized symbols to represent the specific type of lighting fixtures, required. The fixtures will usually be shown to scale, and will be drawn in their exact position.

About 1960, the plastic drafting template was developed, specifically for the lighting designer. This greatly assisted in the drawing of lighting symbols. Although plastic drawing templates are now widely available through any stage lighting supply company, Lighting Associates has long produced a number of different lighting templates specifically for the lighting, sound and scenic designer.

Lighting Associates
P.O. Box 229
Chester, CT, 06412, USA
Tel: (203) 526-9315

LIGHT BULB JOKES - (c 1960)

Somewhere around 1960, the 'light bulb' jokes started to appear throughout North America. Some of the best of the worst, are as follows:

Q: How many Californians does it take to change a light bulb?
A: Six. One to turn the bulb, one for support, and four to share the experience.

Q: How many Oregonians does it take to screw in a light bulb?
A: Five. One to change the bulb and four more to chase off the Californians who have come up to share the experience.

Q: How many New Yorkers does it take to screw in a light bulb?
A: None of your damn business!

Q: How many Union Electricians does it take to screw in a light bulb?
A: 50 - its in the contract.

Q: How many straight San Franciscans does it take to screw in a light bulb?
A: Both of them.

Q: How many WASPs does it take to change a light bulb?
A: Two. One to call the electrician and one to mix the martinis.

Q: How many Psychiatrists does it take to change a light bulb?
A: Only one, but the bulb has got to really WANT to change.

Q: How many `Real Women' does it take to change a light bulb?
A: None: A 'Real Woman' would have plenty of real men around to do it.

Q: How many `Real Men' does it take to change a light bulb?
A: None: `Real Men' aren't afraid of the dark.

Q: How many Jewish mothers does it take to screw in a light bulb?
A: None. ("That's all right...I'll just sit here in the dark...")

Q: How many mice does it take to screw in a light bulb?
A: Two. (Hint:They are small enough to fit inside).

Q: How many valley girls does it take to change a light bulb?
A: Oooh, like, manual labor? Gag me with a spoon! For sure.

Q: How many managers does it take to change a light bulb?
A: Three. One to get the bulb and two to get the phone number to dial one of their subordinates to actually change it.

Q: How many lawyers does it take to change a light bulb?
A: How many can you afford?

Q: How many Jewish-American Princesses does it take to screw in a light bulb?
A: Two. One to get a Tab and one to call Daddy.

Q: How many accountants does it take to screw in a light bulb?
A: What kind of answer did you have in mind?

Q: How many mystery writers does it take to screw in a light bulb?
A: Two, one to screw it almost all the way in and the other to give it a surprising twist at the end.

Q: How many consultants does it take to change a light bulb?
A: I'll have an estimate for you a week from Monday.

Q: How many people from New Jersey does it take to change a lightbulb?
A: Three. One to change the light bulb, one to be a witness, and the third to shoot the witness.

ASSOCIATION OF BRITISH THEATRE TECHNICIANS - (1961)

A.B.T.T. (ABTT) - was founded in 1961 to provide a forum for discussion among theatre technicians, to collect and disseminate information of a technical nature and to advise and assist all those involved in the planning and construction or reconstruction of new and existing theatres. The organization is based in London.

SKIRPAN ELECTRONICS - (1965)

Skirpan Electronics was founded in 1965 by Stephen J. Skirpan. The company (located in Long Island City, N.Y.) rapidly grew to be a leading manufacturer of computer assisted lighting control systems. Their control system known as the "Autocue", used a light pencil and video monitor, for operator input. Their "Astral" dimmer was one of the first compact dimmers produced by the industry. It was a small 'strip' (1.75" high), dimmer, packaged for installation in

a standard 19" rack. Unfortunately Skirpan Electronics closed their doors about 1980.

ASSOCIATED DESIGNERS OF CANADA - (1965)

A.D.C. (ADC) - Founded in 1965, (Canada) the A.D.C. represents professional designers working in the theatre and film industries. Members include; set, costume, lighting and sound designers located across Canada. The organization is dedicated to promoting professional and public recognition of the designer's role, as well as increasing communications among Canadian designers. Although not a union, the A.D.C. provides a similar function, as does the United Scenic Artists, in America. Currently, the A.D.C. has approximately 150 members, located across Canada.

LIGHT EMITTING DIODE - (a 1965)

The light emitting diode (LED) is p-n junction semiconductor lamp which emits radiation then biased in a forward direction. The emitted radiation may be either invisible (infrared) or in the visible spectrum. Visible solid state lamps are used for long life indicator service. Infrared diodes have outputs carefully matched to silicon photoreceivers. They are used in conjunction with the receivers, for counting, sensing, and positioning applications. LED's generally operate in the range of 1 to 3 volts at currents of 10 to 100, milliamperes continuous.

LED's are commonly used in indicator lighting applications. Due to their very long life and low operating current, they are ideal replacements for incandescent indicator lights. Early LED's came in red only. Next green and amber were introduced. By the mid 1990's blue and white LED's had been developed.

PABLO LIGHT SHOW - (a 1966)

Pablo, was a New York City company of light show artists, and technicians that performed throughout the late 1960's and 1970's. Experts in projection techniques, the artists at Pablo provided some of the most detailed and dynamic projection shows, using a wide range of photographic and hand painted slides.

One special projection technique used, was the 'amoeba'. The amoeba was performed using a horizontal (overhead type) projector and two large watch glasses of about 14" and 12" in diameter. The larger glass was placed on the projector and filled with various oils, alcohols and waters, colored with dye. Next the smaller dish was gently placed on top of the mixture and then 'squashed' in time with the music. When projected on a 20 ft. x 20 ft. rear screen behind a performer the effect was usually quite spectacular, as a giant, kinetic, dancing blob constantly changed in color, complexity and form. It was totally psychedelic.

Pablo's multi-media presentations included theatre and television productions, corporate presentations, fashion shows, discotheques and concerts. The Pablo Light Show provided visual support to virtually all of the major rock groups of the time. The founders of the company

included: Patrick Firpo, Jay Moss and Bob Quinn.

JOSHUA LIGHT SHOW - (a 1966)

Under the creative guidance of Joshua White, the Joshua Light Show Group consisted of several talented projection artists and technicians. For a period of time, the New York City based group was the resident light show at the Fillmore East. They also provided special effects for films (including Midnight Cowboy), stage productions and television.

The Joshua Light Show provided the colorful background to many musical performers and groups in the late 1960's and early 1970's. The show was projected on a large rear screen (20' x 40' typical) and used a wide range of projection equipment, including slide, overhead and film projectors. Equipment was typically modified to suit the specific needs of the 'light artists.' Usually working from a scaffolding behind the rear screen, the artists would create a kinetic and always changing blend of light and imagery, always synchronized with the music. The affect was mind blowing (or so it seemed at the time).

SODIUM LAMP - (HIGH PRESSURE) - (1966)

H.P.S. (HPS) - The high pressure sodium lamp has steadily developed and gained in popularity, since its introduction 1966. It provides a more economical source of illumination than mercury, fluorescent, or incandescent and has a more natural color than low pressure sodium. The H.P.S. sodium lamp has a luminous efficacy of approximately 80-140 lumens per watt.

See also: SODIUM LAMP - (LOW PRESSURE)

'LEE' COLOR FILTERS - (1967)

'Lee' (by Lee Electric Lighting, Britain), manufacturers a wide range of filter and light control products for stage, film and television lighting applications. The company was founded by David Holmes an accomplished lighting cameraman. The company is known around the world for their extensive product range of color filters for the stage and color correction filters for the film and television industries. All Lee's light control and color effect filters are made from a tough polyester film base, which is impervious to water, is totally transparent and has a high melting point. 1500 meter rolls of the film are coated with specially prepared lacquers. Each formula is recorded on a computer, to ensure the exact reproduction of color, from batch to batch. The lacquer coating is applied to both sides of the film, is also tough and flexible and has a high resistance to water and heat.

Lee Filters
2301 W. Victory Blvd.
Burbank, CA, 91506, USA
818-238-1220

800-576-5055
Canada: 416-890-0935

COLOR ORGAN, (EARLY ELECTRONIC) - (c 1967)

For centuries, man tried to provide a scientific correlation between the color spectrum and the audio spectrum. It wasn't until mid 1960's that a practical color organ device was developed for entertainment lighting applications. This was the 'electronic' color organ. At first transistors and then later SCR's were used to drive a number of incandescent lamps. The typical color organ had three (3) channels. Different colored lamps would be attached to each channel. Each channel would be controlled by a separate audio input, tuned to a specific audio frequency. A typical three (3) channel unit might be wired as follows:

Channel	Lamp Color	Frequency
1	Red	Hi (10-20Kz)
2	Green	Mid (5-10Kz)
3	Blue	Low (0 5Kz)

When activated, the 3 channels of lights would automatically dance and respond to the beat of the music. More advanced color organs might contain as many as 15 individual channels. This color organ became popular for discotheque and psychedelic lighting applications. Today, many entertainment lighting control boards now also contain advanced color organ functions.

HMI LAMP - (1969)

The HMI lamp (mercury medium arc iodides), first appeared in Germany. These metal halide lamps were developed by OSRAM GmbH to meet a need established by the German Federal Television System in 1969, and their use quickly spread throughout Europe and to the rest of the world. Although originally designed for television lighting, they are now used for location film lighting and as a source for many common followspot spotlights. The modern HMI lamp is highly efficient (100-110 lumens per watt), and produces a daylight type spectrum with a color temperature of 5600 degrees K. Lamp wattages currently range from 200 to more than 12,000 watts.

The HTI lamp is a more recent version of the HMI. They area available with an integral reflector and are often used in followspots, fiber optic illuminators and in slide projectors.

Although not widely know in the name HMI, the H stands for mercury (Hg), M indicates presence of Metals and the I refers to the addition of halogen components (iodide, bromide). HMI is the registered trademark of Osram Lighting.

See also: [OSRAM] and [METAL HALIDE].

USHIO - (c 1969)

Ushio is a leading manufacturer of stage, studio and specialized lamp products.

Ushio America, Inc.
20101 S. Vermont Avenue
Torrance, CA 90502
Tel: (800) 326-1960
Tel: (213) 329-1960

GREAT AMERICAN MARKET - (a 1970)

G.A.M. (GAM) - The Great American Market Company supplies a great many products to the professional theatre and stage industries. Products include color filters, [GOBOS], projection equipment, lighting control systems, and other speciality products. They are also the North American distributor for the RDS projection system, marked under the name of the Great American Scene Machine.

Great American Market
826 N. Cole Avenue
Hollywood, CA 90038
Tel: (213) 461-0200
Tel: (213) 461-4308

EARLY AUTOMATED LIGHTING - (a 1970)

Automated luminaires first started to appear in the USA in the early 1970's. One of the first was the 'Moto-Light' manufactured by Dyna-Light, Springfield, MO. Another early automated lighting fixture was the 'Mac Spot' from Europe. The Mac Spot retrofitted a conventional Par64 fixture, allowing remote horizontal and vertical positioning (physical movement of the fixture). It did nothing else. Modern automated fixtures, in addition to pan and tilt movement, also provide variable color, focus and template adjustments.

See also: [VARI-LITE] and [AUTOMATED LIGHTING FIXTURES].

AVAB - (1972)

AVAB Electronik AB, one of the world's leading manufacturers of professional stage and studio dimming products, has its headquarters in Gothenberg, Sweden. Their control and dimming systems have always been considered to be state-of-the-art in design and engineering around the world. AVAB purchased EMIL [NIETHAMMER] (c 1982) a large German manufacturer of lighting fixtures. Avab founded around 1972 now also has an office in the USA.

AVAB Transtechnik AB
Salsm„staregatan 32
S-422 46 Hisings Backa Sweden

+46 31 585 200
Email: sales@avab.se

DHA LIGHTING INC - (1972)

(D.H.A.) - Founded by lighting director [DAVID HERSEY], the British firm specializes in lighting equipment design and manufacturing, with products ranging from slides to moving effects, fiber optics and software. The company also specializes in etching metal and glass [GOBOS] from custom artwork. In North America, the company is represented by [ROSCO].

DHA Lighting Ltd.
284-302 Waterloo Road
London SE1 8RQ
Tel: 44-171-771-2900
Tel: 44-171-771-2901

THEATRE MAGIC - (1974)

Founded in 1974, Columbus OH USA based Theatre Magic, sells special effect equipment and accessories for the stage and studio industries. They have an extensive range of etched metal projection patterns [GOBOS]. In 1992 they changed their name to SFX DESIGN.

SFX Design
6099 Godown Road
Colombus OH 43235 USA
Tel: 614-459-3222
Fax: 614-459-5087

AUTOMATED LIGHTING FIXTURES - (c 1975)

The development of the automated lighting fixture in the early 1980's caused a revelation and a breakthrough in entertainment lighting design. Although several different automated fixtures first appeared in the 1970's, most were crude and mechanically awkward. Early products included the 'MacSpot' and the 'Moto-lite'. They used conventional stage lighting fixtures (PARS's, lekos, etc,) fitted with a large mechanized yoke. The yoke allowed the fixtures to pan, tilt, and not much else.

In 1981 the American company [VARI-LITE] was the first to make a successful automated fixture that gained wide acceptance. The fixture was called the Vari*Lite and allowed remote control of pan, tilt, and color. The fixtures were and are still today, mechanically, electrically and optically complex. For this reason Vari*lite provides a technician, on-site to service equipment as needed.

Today, there are now several other manufacturers providing reliable and comprehensive

automated lighting fixtures. Both [HIGH END SYSTEMS INC] and [MARTIN], now provide a wide range of automated lighting products gaining acceptance throughout the world. Other manufactures include Clay Paky, Coemar Nat and [STRAND].

ELECTRONIC THEATRE CONTROLS INC. - (1975)

E.T.C. (ETC) is a leading American manufacturer of theatre; control, dimming, and lighting fixtures. Their dimmers and control systems are clearly among the best in the industry. In the mid 1990's E.T.C. developed a series of 575 watt spotlights, known as the 'Source-4' series. These fixtures are generally smaller, more compact, and more efficient than any similar fixtures, available to date - marking a new generation in fixture design and development.

E.T.C. also makes a fixture known as the 'Source-4-Par'. This fixture, provides a beam similar to a PAR64 lamp, except the beam is round and not oval. All fixtures use the same single ended tungsten halogen lamp, however the beam spread is controlled by using one of the four 'spread lenses' included with each fixture, allowing; spot, medium flood, wide flood and flood capabilities, all from the same fixture.

Electronic Theatre Controls
3030 Laura Lane
Middleton, WI, 53562, USA
608-831-4116

INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS - (a 1975)

I.A.L.D. (IALD) - is a professional organization for lighting designers whose education and training may be in architecture, interior design, theatre or electrical engineering. Dedicated to the professional advancement of lighting design, IALD members may not be involved in any way with the sale of lighting products.

I.A.L.D.
18 East 16th Street
Suite 208
New York, NY, 10003
212-206-1291.

DESISTI LIGHTING - (a 1975)

De Sisti Lighting, (also Desisti) is a leading manufacturer of high quality lighting fixtures and accessories for the stage, film and television industries. Desisti makes a wide range of spotlights and floodlights, for both incandescent and discharge type lamps. They have offices and representatives, located around the world.

De Sisti Lighting Srl

00040 Cecchina - Albano Laziale (Rome) - Italy
Tel: 06/9344414
Fax: 06/9343489

JULIAT, ROBERT - (a 1975)

Robert Juliet a French based firm, manufactures a broad line of HMI and tungsten profile spotlights, fresnels, and followspots. Many units are of extremely high quality in respect to design, engineering and construction.

Robert Juliat
62/64 rue Danielle, Casanova F
93207 Saint-Denis Cedex
tel: (33) 1.42.43.35.35
fax: 1.42.43.08.05.

THEATRE BOOKS - (1975)

Theatre Books (Book shop) was established in 1975 in Toronto Canada. It is a large specialized store (at 11 St. Thomas Street) handling a vast collection of arts, theatre and motion picture books. (416) 922-7175.

AMX192 - (c 1975)

AMX192 is an older control protocol standard for dimmers. The standard, adapted by the United States Institute for Theatre Technology, is non proprietary and may be used by all manufacturers. AMX192 uses a small twisted pair cable to communicate with a maximum of 192 dimmers. The data signal is 'de-multiplexed' (usually at the dimmers) resulting in individual 'analog' control signals (usually 0-10 volt, DC). A newer control protocol [DMX512] provides digital control to a maximum of 512 dimmers, on a single twisted pair cable.

'ROSCOLUX' COLOR FILTERS - (1978)

'Roscolux' color filters were introduced by the American company [ROSCO] in about 1978. Today Roscolux with more than 140 different colors has become one of the most recognized and widely used filters in the world. The filters are designed to withstand the high temperatures of stage and studio lighting fixtures, unlike earlier filters made from acetate or gelatin. Some filter manufacturers simply surface coat clear plastic to form their colors. These filters may scratch and the surface color may actually vaporize from the surface, through atmospheric contact. Roscolux filters are colored when the plastic is in the resin stage before the polymer is cast into film. This results in a tough, resistant and durable filter with the color actually part of the plastic, instead of just applied to it.

WESTSUN - (1978)

From its inception in 1978 as a local lighting rental house, Westsun has grown to a recognized international supplier to the event and entertainment industries. With companies and equipment stocks located throughout Canada and the United States, Westsun offers comprehensive lighting, sound, staging, and drapery - sales and rentals. Extensive fabrication shops allow for the design and construction of automated scenery, specialized staging and custom lighting products. In 1997, Westsun International Inc. moved into a new 70,000 square foot corporate headquarters in Winnipeg, Canada. Recently, Westsun Show Systems Inc. has provided lighting or sound to a number of 'mega-musicals', including; Disney's 'The Lion King', 'Show Boat', 'The Phantom of the Opera', 'Rag Time' and 'Sunset Boulevard'.

Westsun Winnipeg Inc.
Attn: Marc Raymond
1390 Pacific Avenue
Winnipeg, Canada, R3E 1G6
204-774-7800
800-WESTSUN
WWW: http://www.westsun.com

TIR SYSTEMS - (a 1980)

The commerical light pipe is a Canadian invention, developed by TIR Systems Ltd., (Burnaby, BC). Single point source luminaires direct light into hollow linear light guides to produce, through the principle of Total Internal Reflection, lines of brilliant white or colored light. Light pipes are made of extruded, impact resistant, clear acrylic, and use a 250 watt, metal halide lamp, with a life of approximately 10,000 hours. One luminaire is required for every 44-foot run of light guide.

Various architectural and decorative lighting applications are ideally suited to use of the light pipe. As the entire length of the 'pipe' emits light, the light pipe might be used to provide lighting above a swimming pool or to other generally inaccessible locations. The luminaire is usually located in an accessible location, along the side of the pool area.

See also: [LIGHT PIPE].

VARI-LITE - (1981)

VARI*LITE - Although a number of attempts had been made in recent years at developing a 'moving' or automated, lighting fixture, the Vari*Lite was the first to gain acceptance. In fact the Vari*Lite revolutionized the music and entertainment lighting industry. Automated fixtures, that pan, tilt, change color, project different patterns - are extremely complex devices. The Vari*Lite, Model 1, was introduced on the Genesis tour in 1981, by Showco, USA.

VL1 - introduced in 1981
VL2C - spot luminaire, introduced in 1993, (uses 600 watt HTI source)
VL5 - wash luminaire. incandescent model.
VL5A - wash luminaire, 575W MSR, twice as bright, as VL5.

Also see: [AUTOMATED LIGHTING FIXTURES]

Additional reading: Lighting Dimensions Nov. 1986 (great photos)

Vari-Lite Inc.
201 Regal Row
Dallas, TX, 75247, USA
214-630-1963
WWW: http://www.vari-lite.com

DMX512 - (1986)

DMX512 is a standard for digital data transmission between lighting controllers and dimmers. A committee of the United States Institute for Theatre Technology developed DMX512 as a non proprietary digital protocol to be used by all manufacturers. DMX512 uses a small twisted pair cable to communicate with a large number of dimmers. It does so by digitally encoding the dimmer level information and sending the data for multiple dimmers over the control cable, one dimmer at a time, one after another. The dimmer level is encoded as one byte (eight bits). The information is sent to the dimmers at a rapid rate, and has to always be present to keep the dimmer from going to black. Update rate of 20 - 40 times per second are common.

Up to 512 dimmers can be controlled on a single twisted pair. Often a second twisted pair is also run for 'talkback' or other applications. DMX applications typically use 5 pin XLR type connectors. The use of 3 pin XLR connectors is not recommended by the USITT standard.

Pin 1 - shield - ground
Pin 2 - black - data (-)-
Pin 3 - white - data (+)
Pin 4 - green - spare data (-)
Pin 5 - red - spare date (+)

See also: [AMX192].

Additional reading: Recommended Practice for DMX512 by Adam Bennette, 1994, published by PLASA & USITT.

ENTERTAINMENT SERVICES & TECHNOLOGY ASSOCIATION - (1987)

E.S.T.A. (ESTA) - Founded in 1987, ESTA is a non-profit trade association representing the North American entertainment technology industry. Many of the members are equipment

dealers or manufacturers. Other members provide services only. In addition to members in the United States and Canada, ESTA has members in a number of countries, throughout the world.

ESTA
875 Sixth Avenue
New York, NY, 10001, USA
212-244-1505
WWW: http://www.esta.org/

SUNLIGHT AND CANCER - (a 1990)

It was in the early 1990's when modern medicine brought us the bad new regarding sun and skin cancer. Now the evidence is clear and indisputable. There is no such thing as a 'nice natural tan' anymore . Although we still worship the sun, as did our ancestors, we now do so with a whole new respect.

There are three kinds of skin cancer, basal cell carcinomas, squamous cell carcinomas, and melanomas. In the US there were 500,000 cases of the first, 100,000 of the second, and 27,600 of the third in 1990. [Wayne] More than 90% of the skin carcinomas in the US are attributed to UV-B exposure: their frequency varies sharply with latitude, just as UV does. The mechanism by which UV-B induces carcinomas has been identified - the pyrimidine bases in the DNA molecule form dimers when stimulated by UV-B radiation. [Taylor] [Tevini] [Young et al.]. Fortunately, these cancers are relatively easy to treat if detected in time, and are rarely fatal. Skin carcinoma rates vary sharply with latitude, just as UV-B does. Fair-skinned people of North European ancestry are particularly susceptible; the highest rates in the world are found in Queensland, a northerly province of Australia, where a population of largely English and Irish extraction is exposed to very high natural UV radiation levels.

Malignant melanoma is much more dangerous, but its connection with UV exposure is not well understood. There seems to a correlation between melanomas and brief, intense exposures to UV (long before the cancer appears.) Melanoma incidence is definitely correlated with latitude, with twice as many deaths (relative to state population) in Florida or Texas as in Wisconsin or Montana, but this correlation need not imply a causal relationship. Some claim that UV-A, which is not absorbed by ozone, may be involved. [Skolnick] [Setlow et al.]

SULFUR LAMP - (1994)

One of the more exciting recent developments in light source technology is the sulfur lamp. This source was developed in 1994 by Fusion Lighting (USA), with support from the U.S, Department of Energy. About the size of a golf ball, the sulfur lamp consists of a quartz bulb containing non-toxic sulfur and inert argon gas at the end of a thin glass stick. A microwave energy source of 2.45 Ghz. (magnetron) bombards the lamp while a fan cooled motor spins the lamp at 3400 rpm. The microwave energy excites the gas, which heats the sulfur, forming a brightly glowing plasma that can illuminate a very large area.

The first early prototype lamps were 5.9 Kw. units with a system efficacy of 80 lumens per watt. Correlated color temperature was about 6000K with a color rendering index of 79 CRI. The sulfur lamp starts within seconds even at low ambient temperatures and can be dimmed. The surfer lamp emits no electric or magnetic fields and the light output remains constant over its life.

A new version, the LightDrive 1000, is a 1425 watt device that produces 135,000 lumens after about 20 seconds. The current technology produces approximately 120 lumens per watt (including losses).

The energy output is continuous throughout the visual spectrum (much like sunlight) however the source is low in both the ultraviolet and infrared energy. The design life of the lamp is currently approximately 60,000 hours, however the design life of the magnetron is currently only about 15,000-20,000 hours.

One of the first early fixtures to use the sulfur lamp was developed by Cooper Lighting (USA). The fixture was incorporated into a free standing kiosk, providing uplight to the ceiling and a fixture efficiency of 85-88 percent. Other lighting companies are currently working with Fusion lighting to develop new fixtures and equipment for the sulfur lamp.

Fusion Lighting, USA, 301-284-7236.

MODERN STAGE LIGHTING DESIGNERS

BENTHAM, FREDERICK

Frederick Bentham (Britain) is an acknowledged pioneer and authority on lighting for the stage. He was in charge of research and development at [STRAND ELECTRIC] from approximately 1935, until 1965. He was responsible for the technical development of many early Strand lighting fixtures and related products.

Bentham published a book on 'The Art of Stage Lighting' in 1968. This publication has been revised and is still today considered to be a major textbook on the subject.

Bentham was also the author of "Tabs" from its inception in 1938 until 1973.

BILLINGTON, KEN

Ken Billington is a well known, New York based stage lighting designer. He studied at The Studio and Forum of Stage Design in New York, and later went on to assist Tharon Musser, Tom Skelton, and others. He has designed the lighting for over 50 Broadway productions (including; Fiddler on the Roof & Sweeney Todd) and his concert credits include work with Shirley MacLaine, Ann-Margaret and Liza Minnelli. He won a Tony award for his lighting of 'Chicago'.

BRIDGE, ANDREW

"Stage lighting designer (British). Bridge won the Tony, Drama Desk and Outer Critics' Circle Awards for his designs for the "Phantom of the Opera". West End credits include the Musicals, "Time", "Oliver", "An Evening with Tommy Steele", "Troville and Dean", "Bing Crosby" and many others". (REF: quote from, Rosco, Pattern Catalog, 1996)

CLARK, PEGGY

Peggy Clark is a leading American stage lighting designer (American).

DAVIDSON, DAVID

"Davidson, has designed the lighting for some of the most acclaimed performers and acts in the world. A partial list of his most recent clients includes Bon Jovi, Van Halen, Jackson Brown, and Kiss. In addition, he has designed lighting for such acts as Ted Nugent, Stray Cats, The Kinks, Englebert Humperdinct, The Jacksons, Santana, The Blues Brothers and Hot Tuna." (REF: quote from, Rosco, Pattern Catalog, 1996)

FEDER, ABE

Abe Feder was one of the first independent lighting designers in both the theatrical and architectural worlds. His Broadway credits include "My Fair Lady" and "Camelot". His architectural lighting credits range the world and include the United Nations in New York, the Israel National Museum in Jerusalem, Philharmonic Hall in Lincoln Center and the Kennedy Center for the Performing Arts in Washington, D.C.

FEHER, ERWIN M.

Studied stage design at the Federal Institute of Technology, Graz, Austria and at Columbia University. He worked in the graduate school of Yale University-MFA program. He joined with JO MIELZINER in planning for the New York World's Fair in 1964, and for a time was a specialist for projection design at New York's Metropolitan Opera. Erwin Feher published a number of books, including the very comprehensive "Towards a Theater of Light".

FINGERHUT, ARDEN

Stage lighting designer (American)

FISHER, JULES

Jules Fisher is a well known American lighting designer, who works extensively in both theatre and architectural lighting design. His Broadway credits include the lighting for "No No Nanette", "Hair", "Lenny", "Pippin", "Butterflies are Free", "Half a Sixpence", "High Spirits", and many more. He has won 6 Tony Awards and in his spare time, he practices magic.

GALLO, PAUL

Paul Gallo (New York), has designed the lighting for many Broadway productions, including "Six Degrees of Separation", "The Little Foxes", "Grown Ups", "Heartbreak House", and many others. He has received Tony nominations for "Anything Goes" (1988), "The House of Blue Leaves" (1988) and "The City of Angels" (1990). He is also the recipient of two Obe Awards and the Maharam Award. (REF: quote from, Rosco, Pattern Catalog, 1996).

GLEASON, JOHN

Gleason (American) was the Associate Chair of the Department of Design at New York University and was the resident lighting designer for the Repertory Theater of Lincoln Center from 1967 to 1972. He designed the acclaimed revival of "A Streetcar Named Desire". On Broadway, he has designed more than 90 shows, including: "My Fair Lady", "Hello Dolly", "The Great White Hope", and "Over Here".

HERSEY, DAVID

David Hersey, (American) stage lighting designer, has lived in London for over twenty years and has designed over 200 production for major national theatre, operas and ballet companies. West End productions include: Cats, Starlight Express, Les Mis,rables, Chess and Miss Saigon. For ten years he was lighting consultant for the National Theatre in London. His work has also been seen in New York on Broadway. David Hersey also manages D.H.A., a leading British supplier of specialized lighting accessories and effects.

MUSSER, THARON

Tharon Musser is a well known American stage lighting designer. She has received three Tony Awards for her work on "Follies", "A Chorus Line", and "Dream Girls". Her many contributions include being the first lighting designer to use a computer lighting system on Broadway. She

has designed plays and many musicals and operas around the world. Her work on Broadway includes: "The Sunshine Boys", "A Little Night Music", "Applause", "A Long Day's Journey Into Night", "42nd Street", "The Wiz", "Chorus Line", "Follies" and "Ballroom".

Additional reading: Lighting Dimensions, March 1990.

PILBROW, RICHARD

Richard Pilbrow (Britain) is a leading designer and authority on the subject of stage lighting. His work since 1958 has been seen in more than 200 productions, principally in London but also in New York and Moscow. His excellent book on lighting; "Stage Lighting", first published in 1970, is often considered to be a leading text on the subject. His new book "Stage Lighting Design" was published in 1997.

Richard Pilbrow is also founder of Theatre Projects, a large London based theatre consulting firm, now also based in the USA. As theatre consultant, he has designed the stages and lighting for a number of theatres, including the National Theatre of Great Britain, the Calgary Centre for the Performing Arts (Canada), and the Barbican Theatre for the Royal Shakespeare company.

LESTER POLAKOV

Stage designer (U.S.A.) Polakov formed and ran the Lester Polakov Studio and Forum of Stage Design at 727 Washington Street in New York City for many years. Reid is a well known British lighting designer and consultant. He is also the author of a great many articles relating to theatre and stage lighting.

SVOBODA, JOSEF

One of the most renowned and inventive designers in the world today is the contemporary Czech designer, Josef Svoboda. With hundreds of productions to his credit, Svoboda is best known for his remarkable technical innovations in lighting, projection and kinetic scenery. Svoboda views science and technology as a means to an end, as instruments to be controlled by an artistic vision. More often than is generally thought, his scenography employs the simplest of technical devices or virtually eliminates them. What is almost never absent from his work however is a poetic, theatrically organized sensibility.

Additional reading: Theatre Design and Technology, Summer 1976 and February 1970)

TIPTON, JENNIFER

Jennifer Tipton (American), is a well known lighting designer for theatre dance and opera. She has designed the lighting for such leading choreographers as Jerome Robbins, Mikhall Baryshnikov and Twyla Tharp. She won a Tony award for her lighting of "The Cherry Orchard". Her many lighting awards include two Bessies, two Tonys, a Joseph Jefferson Award, a Kudo, and others. Ms. Tipton also teaches lighting at the Yale University School of Drama.

WECHSLER, GIL

Stage lighting designer (American)

WHITFIELD, MICHAEL

Michael Whitfield has designed over 50 productions for the Canadian Opera Company in Toronto and more than 80 productions for the Stratford Shakespearean Festival where he is the resident lighting designer. The operas cover the entire range from Albert Herring to Idomeneo and include among others Fidelio, Aida and Electra. In addition to productions at Stratford, he has designed such productions as Cabaret, Carousel and Our Town. His designs have also been seen at the San Francisco Opera, the Welsh National Opera, De Nederlandse Operastichting, the National Ballet of Canada, Canadian regional theatres and in London's West End. (REF: quote from, Rosco, ad. TCI. April 1993).

WILLIAMS, BILL

Bill Williams is a well known Canadian lighting designer, working in the fields of stage and architectural lighting design. Williams studied lighting design in New York, at The Studio and Forum of Stage Design, where his work was strongly influenced by one of his teachers, lighting designer Tom Skelton. In the 1960's Williams worked as a designer with the New York based, multimedia group 'Pablo', where he designed and developed special effects and projection equipment for one of the world's leading 'light shows'.

In the early 1970's, Williams returned to Canada and established an active design practice in Winnipeg. When not designing for the stage, he works as a theatre consultant, assisting architects with the design of theatres and cultural facilities. Subsequent work has included more than 500 projects in over a dozen countries, around the world. Bill Williams is a member of the Associated Designers of Canada and is also the author of this file.

LIGHT - NATURAL PHENOMENA

SUN & SUNLIGHT

For years, man thought that the earth was the center of the known universe, not the sun. It was only in the 16th Century that COPERNICUS finally proved the sun to be the center of our solar system.

The main part of the sun's radiation at sea level, lies between about 290 and 3,500 nanometers The shorter wavelengths are [ULTRAVIOLET], and the longer are [INFRARED]. Visible wavelengths lie in the relatively narrow wavelength band of 380 to 770 nanometers. Intensity and spectral composition of natural daylight vary with time of day, season, geographical location and weather.

MOON & MOONLIGHT

The moon shines solely by virtue of its ability to reflect sunlight. It is approximately 238,000 miles from the earth. It takes about 8 minutes for the light of the sun to reach the moon and another 1.3 seconds for the light reflected from the moon, to reach the earth.

Illumination on the earth's surface by the moon may be as high as 0.2 lux, (.002 fc).

LIGHTNING

Lightning is a meteorological phenomenon arising from accumulation, in the formation of clouds, of large electrical charges. The charges are (usually positive) are suddenly released in a spark type of discharge.

About 100 times every second, the earth is struck with lightning, which streams down in belts 1,000 to 9,000 feet long. A single bolt may develop 3750 kilowatts. About 75 percent of the energy in lightning is dissipated as heat that rises the temperature of surrounding air to about 27,000øF. This causes the air to expand quickly, like the gases in an explosion. The movement creates sound waves that can be heard as thunder for distances of up to 18 miles. ..(REF: Time, Energy, 1963) (PHOTO: Time, Energy, 1996)

Divide time delay (in seconds) between lightning and thunder by 5, to calculate approximate storm distance (in miles).

AURORA BOREALIS (NORTHERN LIGHTS)

"These hazy horizontal patches or bands of greenish light on which white, pink or red streamers sometimes are superimposed appear 60 to 120 miles above the earth. They are caused by electron streams spiraling into the atmosphere, primarily at polar latitudes". (REF: quote from: I.E.S. Lighting Handbook - Ref. Vol. 1881)

AURORA AUSTRALIS (SOUTHERN LIGHTS)

The same phenomenon of the Northern Lights, also exists in the southern hemisphere and is know as the Aurora Australis. See also: [AURORA BOREALIS].

BIOLUMINESCENCE

"Living Light - is a form of chemiluminescence in which special compounds manufactured by plants and animals are oxidized, producing light. Although is has been proven that oxygen is required to produce bio luminescence, there is no evidence that the light producing compound must be a 'living' material The light producing compound may be dried and stored for many years and upon exposure to oxygen, emit light". (REF: I.E.S. Lighting Handbook - Ref. Vol. 1981)

MAN MADE LIGHT SOURCES

"Historically, light sources have been divided into two types - incandescent and luminescent. Fundamentally the cause of light emission is the same , i.e., electronic transitions from higher to lower energy states. The mode of electron excitement is different, however, as well as the spectral distribution of radiation. Incandescent solid substances basically emit a continuous spectrum, while gaseous discharges radiate mainly in discrete spectral lines, however there is some overlapping. Incandescent rare earth elements can emit lines, whereas high pressure discharge produces a continuous spectrum".

LIGHT - QUOTATIONS

We owe a lot to Thomas Edison - if it wasn't for him, we'd be watching television by candlelight. (Milton Berne)

Many a man has fallen in love with a girl, in a light so dim, he would not have chosen a suit by it. (Anon)

And GOD said "Let there be light", and there was light, and GOD saw that is was good, and put the bloody electricity bill up by 4 pence a unit. (Anon)

The weight of moonlight on the oceans causes the water to spread out to the edges of the land. (G.E. Last, 19th Century)

The Speed of light is very fast. (Carl Sagan)

Nature and nature's laws lay hid in night, God said, "Let Newton be," and all was light. (Anon)

Genius is one per cent inspiration and ninety-nine per cent perspiration. (Thomas Alva Edison)

All art is quite useless. (Oscar Wilde)

No great artist ever sees things as they are. If he did he would cease to be an artist. (Oscar Wilde)

She is like most artists; she has style without sincerity. (Oscar Wilde)

Writing about art is like dancing about architecture. (Anon)

The sun was shining on the sea,
Shining with all his might:
He did his very best to make
The billows smooth and bright --
And this was very odd, because it was
The middle of the night.
(Lewis Carroll)

We will have solar energy as soon as the utility companies solve one technical problem -- how to run a sunbeam through a meter. (Anon)

CROSS REFERENCE

CENTER	- also try:	CENTRE (for British references)
CENTRE	- also try:	CENTER (for American references)
COLOR	- also try:	COLOUR (for British references)
COLOUR	- also try:	COLOR (for American references)
THEATER	- also try:	THEATRE (for British references)
THEATRE	- also try:	THEATER (for American references)
QUARTZ HALOGEN	- also try:	TUNGSTEN HALOGEN

BLACKLIGHT	- see:	ULTRAVIOLET and UV
BLACK BODY	- see:	BLACKBODY
BLACK LIGHT	- see:	ULTRAVIOLET
CAMERA	- see:	PHOTOGRAPHY, CAMERA OBSCURA
FIXTURE	- see:	LUMINAIRE/LEKO/FRESNEL/ELLIPSOIDAL
FLOOD LIGHT	- see:	FLOODLIGHT
FOLLOW SPOT	- see:	FOLLOWSPOT
FOOT CANDLE	- see:	FOOTCANDLE
FOOT LIGHT	- see:	FOOTLIGHT
GREECE	- see:	GREEK
LANTERN	- see:	LUMINAIRE/LEKO/FRESNEL/ELLIPSOIDAL
LIGHT HOUSE	- see:	LIGHTHOUSE
LIGHT YEAR	- see:	LIGHTYEAR
LIME LIGHT	- see:	LIMELIGHT
MAGIC LANTERN	- see:	LATERNA MAGICA
PHOTO CELL	- see:	PHOTOCELL
PROFILE SPOT	- see:	ELLIPSOIDAL REFLECTOR
ROME	- see:	ROMAN
SALT	- see:	PHOTOGRAPHY
SALT WATER	- see:	SALTWATER
SPOT LIGHT	- see:	SPOTLIGHT

STRIP LIGHT - see: STRIPLIGHT / COMPARTMENT BATTEN
SULPHUR - see: SULFUR

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HELP

To SEARCH or FIND any topic, reference or word - you may use the built in search capabilities of your own particular HTML browser. Common browsers include 'Netscape Navigator' and 'Internet Explorer'.

We recommend that you perform most searches, with the [Cap Locks]: ON. This will locate all CAPITALIZED, headings and major topics, (only). For example: if you search for 'LIGHT' you will find all major references and topic headings, perhaps 50 items. (CASE SENSITIVE search)

If you search for 'light', 'Light' or 'LIGHT' with a CASE INSENSITIVE search you will find

thousands of references, - both in the headings and in the text of the various articles. Use case insensitive searches for 'obscure' names, or if you wish to find ALL occurrences of a word, whether or not it is capitalized or contains capitalization.

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