The History of the Light Bulb – An Electric Dawn

Who invented the light bulb then? An easy
enough question to answer you might think. After all, every American schoolboy (and girl) surely knows that the great American scientific genius and inventor, Thomas Alva Edison invented the light bulb in 1879. He of the near incredible 1300 inventions and patents. There's a difference there; invention and patent. He did hold the patent and he did invent his own light bulb, and did indeed make it into a commercially viable and successful working invention by extensive research and development on original ideas, but he did not invent the light bulb. Instead, he bought the patents from those who did.

Early beginnings

Man-made electrical lighting itself began in circa 1810 when a chemist in England called Humphrey Davy (who also invented the miner's safety lamp, known as the Davy lamp) invented the arc light. This worked by connecting a battery (itself invented in 1800 by Italian physicist Count Alessandro Volta, with the word volts being a derivative of his name) to two wires, and attaching the other ends of the wires to a strip of charcoal. The charcoal (which is a form of carbon remember) became electrically charged and began to glow, with arcs of electricity in the air surrounding it.

Then in 1820 Warren De La Rue placed a coil made of platinum into an empty tube and allowed an electric current to pass through to form the first known proto-light bulb. This lit up well enough but the problem was that the chosen material for the coil, platinum was and still is extremely expensive to obtain, making the design a non-starter for commercialization.

Finding the filament

The ideas for filaments (in this case, very fine wires) producing light, was then worked on for years by numerous scientists around the globe. This modern word comes from the Latin 'filare' which means 'to spin'. The theory behind this change of tack in research was developed by James Prescott Joule, an English physicist who stated that if an electric current was passed through a resistant conductor, (the filament), this would itself glow hot with a good amount of the thermal energy produced turning to luminous, or light-giving, energy.

The prize would be great, but so were the problems. The electric lamp had to be first safe, cost-effective, and then practical; as small as possible in size allowing for easy transportation and installation, and it had to light up the surrounding area well, and not burn out after only a short time. This last problem was the main obstacle to significant progress. Many different materials that had a high melting point were used in trials and all in a variety of inert, vacuum, or partial vacuum chambers. This last point was because the oxygen in the air, while vital for life to exist, causes fires to burn at lower temperatures and at faster rates.

A Swan crosses the line first

The year of 1840 saw the English physicist and chemist Joseph Wilson Swan join the race to produce a workable electric light and twenty years later in 1860 he patented an incandescent lamp with a filament made from carbonized paper in a partial vacuum. This was the world's first electric light bulb.

But only being an experimental version there were limits to its' illumination (it was quite dim) and it also could only be used very close to the source of power. The vacuum maintenance was also causing some trouble, so Swan, successful but frustrated, turned to other science projects and only returned to improving his invention in 1875 when he switched the filament to one of compressed and carbonized fibrous cotton thread.

In 1878 he demonstrated his new version. This was a year earlier than Thomas Edison, who had independently chosen the same textile for the filament in his light bulb, after he and his assistants had exhaustively tested 6000 alternative plant fibers from every corner of the Earth, before settling on cotton as the best.

Edison takes charge, (with some help)

Swan's improved lamp lit well for thirteen and-a-half hours. Edison did beat this, his lasting for a little under fifteen hours.

Thomas Edison however was no ordinary inventor and due to his numerous past successes and fame, had a number of wealthy industrialists providing him with money to back his projects. So he bought Swan's patent from the company that then owned it (not from Joseph Wilson Swan himself) and the latter passed into the history books (or the better ones, anyway).

Edison now began to rapidly improve the working life span of the light bulb. His further experiments leading to better and better versions until by 1880, his bamboo fiber filament lamp was a 16 watt bulb that lasted for anywhere between 1200-1500 hours.

Though this again was not entirely down to him. A large reason for the long burning filaments was the complete lack of oxygen inside the glass bulb. An inventor called

Herman Sprengel had produced a device called a mercury vacuum pump, which was better than anything Swan or Edison himself had yet come up with at evacuating the air from the lamp's chamber. This at last could allow for the first 'long life' light bulbs.

And the design for the bulb itself employed by Edison was not his alone, his had evolved out of a glass concept invented by two Canadians: Henry Woodward and Matthew Evans; but they had been unsuccessful in finding willing backers for their bulb, and having no financial muscle themselves, ended up like Swan, having their rights to patent bought by Thomas Edison, and also like Swan, are hardly known today whilst Edison is regularly hailed as the father of the light bulb.

One should not belittle Edison, mind. He behaved perfectly legally at all times and improved the originals immensely, allowing them to become widespread in use. And although he did not get there first, his original had also been slightly better than the competition.

Moving on

In the next century 1903 saw Willis Whitnew invent a metal-coating for the carbon filament which avoided the inside of the bulb turning dark with sooty residue. In addition to this, 1906 saw tungsten (still in common use today) making its appearance as the General Electric Company patented a way of producing filaments from this excellent candidate metal. Indeed Edison himself had known tungsten would eventually prove to be the best choice for filaments in incandescent light bulbs, but in his day, the machinery needed to produce the wire in such a fine form was not available. Engineering had come on in leaps and bounds in the intervening years but tungsten filament production was still a costly pastime for business until 1910 when William David Coolidge of General Electric improved the process of manufacture to make the longest lasting tungsten filaments available to all.

So the wonder of light bulbs were soon seen in all parts of the world where electricity itself stood proud, and even in some places where it didn't yet (which must have been unbelievably maddening). Little electric friends that make life so much easier for everyone, and they continued to evolve and adapt to a number of choices of types for different purposes, looks and occasions.

Here are just some of the changes that occurred.

- In the twenties the first 'frosted' light bulbs emerged.
- Also in the twenties; adjustable power beam bulbs for car headlamps, and neon lighting.
- The thirties saw the invention of little one-time flashbulbs for photography, and the fluorescent lamp.
- The forties saw the first 'soft light' incandescent bulbs.
- The fifties had Quartz glass and later, the halogen light bulb.

- The sixties and the seventies brought better ellipsoid reflectors and mirrors for even brighter bulbs.
- The eighties had new low wattage metal halides.
- The nineties produced the amazing 60,000+ hour magnetic induction light bulb invented by the Dutch electrical company Philips. Also, the popularization of new environmentally friendly bulbs like the full spectrum light bulb.

So what next? Who knows, maybe LED (Light Emitting Diodes) will replace them eventually but electric light bulbs probably still have a few tricks up their sleeves yet. They've already come a long way and will continue to brighten our lives in all their glorious shapes, sizes and colors for a long time to come.

About The Author

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http://www.naturalhandyman.com/iip/infelectrical/lightbulbhistory.html

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Glossary of Light Bulb Terms and Definitions - Enlightening Your Choice

Light bulbs themselves may be quite simple in operation, but there is such a range of options out there that it can get quite bewildering at times. How many times have you found yourself staring up at the shelves in a store holding your shopping list (you probably wrote down 'more light bulbs' or similar) and not knowing which ones to pick. Choice is a good thing, but when a sales assistant asks (a bit too loudly for your liking) if they can help, and you mumble, "I just want a light bulb," it can also be embarrassing.

So here is a helpful glossary of many of the common terms that you've seen in the lighting department but been a bit unsure about:

- **A-Lamps (Also known as General Service Bulbs)**
  The standard incandescent bulb for most common uses.
- **Accent Lighting**
  A type of lighting used to accentuate a given locality or object in the home or office, for example; a doorway or a painting.
- **ADA Brackets**
  Fixtures for mounting on a wall that extend no more than 4 inches from the wall to comply with the Americans with Disabilities Act.
- **Adjustables**
  Fixtures that can be adjusted or aimed for accent and directional lighting requirements.
- **Alternating-Current (AC)**
  An electric current reversing its direction regularly at certain intervals.
- **Ambient Lighting**
  Also can be referred to as general lighting. This is the all around, uniform illumination that lights up every home.
- **Amps/Amperes**
  The unit used to measure electric current. The amount of current sent through one ohm by one volt. It comes from the name of M.Ampere who was a French scientist.
- **ANSI**
  The American National Standards Institute. This is a consumer organization that develops many voluntary guidelines and standards for the electrical and other industry.
- **Aperture**
  An opening or gap to allow the free passage of light.
- **Architectural Lighting**
  A broad generic term for built-in light fixtures, such as valance lighting, or recessed lighting in ceilings, or in bookshelves or ledges high or low on walls.
- **Argon**
  An inert gas from the Earth's atmosphere that is used inside most light bulbs.
- **Average Rated Life**
  The time expressed in hours that half of a given number of test lamps burnt out in. The lifespan of individual bulbs purchased will almost always be slightly above or below this time. (Also expressed as Lamp Life).
- **Baffle**
  A part of a fixture used to prevent glare by absorbing or blocking any excess light.
- **Ballast**
  A electrical apparatus used to provide current for the start up of HID and fluorescent lamps, and then control the current to regulate their operation.
- **Base**
  That part of the light bulb which is placed inside the socket. (Usually these are screw in and made of either aluminum or brass). For HID bulbs they might be ceramic. For compact fluorescent they mostly have either two or four pins. The two pin versions are designed for preheat and have an internal starter. The four pin types (which are dimmable) do not and need a ballast to be used. Slimline

fluorescents have only one pin at either end of the lamp. (See also Fluorescent and HID).

- **Beam Spread**
  A measure of the angle of the light beam from a lamp with a reflector. This might be narrow spot, narrow flood, or wide flood.
- **Brass**
  A metallic alloy made of zinc and copper. Fixtures can be made of this.
- **Bulb**
  The commonly used term for an incandescent lamp.
- **Candela or Candlepower**
  The unit of measurement of luminous intensity in any given direction from a source of light.
- **Candlepower Distribution**
  A representation of how light is spread from a source, whether evenly throughout a curve, or not.
- **Canopy**
  A part of a light fixture that conceals an outlet box.
- **Cans**
  A term sometimes used to refer to recessed down lights.
- **Cathodes**
  An electron emitting electrode. Used in fluorescent lighting systems. (See Fluorescent).
- **Channel**
  A selection of fixtures that are jointly operated when using dimmers. Typically they would be of similar function or type. This can also be known as a zone.
- **Chromatics**
  The branch of optical science that deals with color and the perception of color.
- **Circuit**
  The chosen wiring route for an electric current to traverse.
- **Circuit Breaker**
  A safety device that can be fitted to prevent too much current from flowing.
- **Clip**
  An attachment that secures a shade to a light bulb.
- **Color Rendering Index (CRI)**
  This is very important as it tells you how your light will render, or portray, the accurate color of everything it illuminates. The CRI runs from 1 (for Low Pressure Sodium lamps) to 100 (for the Sun). A CRI somewhere in the 80's will give you good and true color portrayal.
- **Compact Fluorescent Lamp (CFL)**
  These are small long living fluorescent lights that can be used as an alternative to incandescent bulbs. They can also be known as BIAX lamps. (See Fluorescent).
- **CCT (Correlated Color Temperature)**
  This specifies the color that a given bulb itself appears when it is in use. (Whether it looks 'hot' 'warm' or 'cold'). It is compared in degrees Kelvin (K), to a source of reference at a given temperature. (Not the color of the glass).

- **Crystal Glass**
  Very fine quality glass like that used in chandeliers.
- **Current**
  The flow of electricity, measured in amps.
- **Cut-off Angle**
  The angle (measured from the vertical) whereat anything used to shield the light from direct view cuts-off that light source from the viewer.
- **Damp Location**
  A UL listing (see UL) for fixtures that are used in locations where there is moisture present.
- **Decorative Bulbs (D)**
  Attractive looking light bulbs that come in many assorted and unusual shapes.
- **Dichroic Coating**
  A film that is used on reflector lamps to prevent as much heat being reflected as light. The thermal energy is instead transmitted through to behind allowing the light beam not to be so hot.
- **Diffuse Lighting**
  Light which has been scattered or dispersed so as not to appear to be emanating wholly from its' source.
- **Diffuser**
  Anything used for diffusing light. This might be a paper or fabric shade or etched or Opal (milky looking) glass on the light bulb.
- **Dimmer**
  A control switch that reduces the illumination of a lamp by lessening the electricity available to it. These may be incremental, or full range with rotary or slide controls.
- **Direct Current (DC)**
  An electric current that flows continuously in only one direction without any alterations.
- **Direct Lighting**
  A form of lighting where a minimum of 90% of the light produced is cast in a downwards direction.
- **Directional Lighting**
  See Adjustables.
- **Disability Glare**
  A glare from a too bright light that results in a high discomfort that affects visibility levels considerably.
- **Discomfort Glare**
  This glare is a lesser form of the above. Discomfort is produced but visibility is still kept to an acceptable level.
- **Downlights**
  Small recessed lights in a ceiling.
- **Efficacy**
  A guide to the efficiency of a light bulb expressed in lumens per watt (LPW). The higher the number, the more light given out for energy used.

- **Energy**
  A gauge of how an electrical device works over time, usually shown as kwh (kilowatt hours). Which is 1000 watts used for 1 hour.
- **Etched Glass**
  Glass (on a light bulb) treated with acid for the purpose of diffusion. (See diffusion).
- **Extended Life Lamp**
  Light bulb with an average rated life of 2500+ hours. (See Average Rated Life).
- **Eyeball**
  An adjustable light that is fitted into the ceiling.
- **Filament**
  A wire coil made of tungsten that produces light when heated by an electric current.
- **Fill Gas**
  The gas inside the light bulb. For incandescent lamps this is usually argon or krypton with sometimes added nitrogen. Halogen is used in addition to this in halogen bulbs.
- **Flood**
  The very wide light dispersal from a reflector bulb. FL can be used as an abbreviation.
- **Fluorescent**
  A lighting system which works by creating electric arcs inside a gas rich tube to produce ultraviolet light, then converting this to visible light by its passage through a layer of phosphor on the inside of the glass.
- **Foot-Candle**
  This is the common measurement of luminance (level of light) used in the United States. One foot-candle is one lumen on one square-foot of a surface. (See also Lumen and Lux).
- **Frosted Glass**
  Glass used for light bulbs that has been roughened or treated with a spray on coating (See IF), for the purpose of diffusing light. (See Diffusion).
- **Full Spectrum**
  Light bulbs with this designation accurately imitate natural light and are thought by some to be beneficial to health by reducing stress, depression and headaches, amongst other things.
- **G-Lamp**
  Globular shaped light bulbs.
- **General Lighting**
  See Ambient Lighting.
- **Gimbal Lighting**
  The adjustable ring holding a PAR or MR bulb in place. (See also MR and PAR).
- **Glare**
  An excessively bright light that causes discomfort and vision impairment. May be direct or indirect (from a reflection).
- **Gloss**
  A glossy finish is a shiny, reflective finish.

- **Halogen Lamp**
  A type of bulb which contains halogen gases, usually iodine, or chlorine, bromine, or fluorine, to extend the life of the tungsten filament through a recycling system know as the halogen cycle. They are also made of quartz glass, or 'hard glass' because they have to be hotter to work properly. Halogen bulbs are brighter and produce more lumens per watt (LPW). (See Efficacy and Quartz Lamp).
- **Hard-Back**
  A lamp shade with a plastic lining.
- **Heat Ratings**
  A safety guide for surface mounted fixtures, which limits the wattage of the bulb to be used.
- **HID (High Intensity Discharge) Lamps**
  A group of type of lamps that include mercury vapor, high pressure sodium, low pressure sodium and metal halide. They are long lasting and energy efficient.
- **IC Fixture**
  Insulated Ceiling Fixture. A fixture that can be directly placed in thermal insulation.
- **IF**
  This stands for Inside Frosted. (See Frosted Glass).
- **In-Ground Up Lights**
  These are outdoor lights recessed in the ground (for the garden path, or patio, etc.) They can be low-voltage or solar powered.
- **Incandescent Lamp**
  A light bulb which uses incandescence to produce light. (See below).
- **Incandescence**
  Light produced by the electrical heating of a material.
- **Indirect Lighting**
  A form of lighting where a minimum of 90% of emitted light is cast upwards.
- **Infrared (IR)**
  An invisible radiation with very long wavelengths which is produced by light bulbs as well as visible radiation (light).
- **Instant Start**
  A fluorescent light which can power up immediately without the need to pre-heat the cathodes or use starters. (See Cathodes, Fluorescent and Starters).
- **Integrated Dimming System**
  An advanced dimmer that remembers pre-set lighting 'themes', and can re-create them by the use of a button on a wall box or remote control.
- **IR Lamp**
  Infrared Reflecting Halogen Lamp. A special type of halogen lamp which directs excess IR energy on the filament, so as to heat it further without extra use of power. (See also Infrared and filament).
- **Jack**
  Plug in attachment found in low voltage light fixtures. (See Low Voltage Fixtures).
- **Kelvin**
  An advanced unit of temperature used by scientists. (See CCT).

- **Krypton**
  A gas sometimes used in premium bulbs instead of argon.
- **Lacquer**
  A clear or colored coat that prevents metal from tarnish and rust.
- **Lamp (Electric)**
  A source of man-made or artificial light. The whole of the light bulb.
- **Lamp Holder**
  A socket to secure the lamp and connect it to an electric current.
- **Lamp Life**
  See Average Rated Life.
- **LCL (Light Center Length)**
  The length, usually in inches, from a given point on the base of a lamp to its light center.
- **Light Distribution**
  The pattern of light in a room.
- **Light Fixture**
  A complete lighting unit containing a lamp, reflector, housing and a connection, a socket and baffles. Also known as a Luminaire.
- **LLF (Light Loss Factor)**
  A factor used to calculate the illumination after a certain time according to whatever conditions are present. (Like varying temperature, fluctuating voltage, atmospherics, dust buildup, and maintenance procedure, if any). This used to be referred to as the Maintenance Factor.
- **Line Voltage**
  In the U.S.A, this should be 120 volts. (See Volts).
- **Louvers**
  A screen of numerous baffles. (See Baffles).
- **Low Voltage**
  Lamps that use 6, 12, or 24 volts instead of 120, and require a transformer connected between them and the standard 120 volt power source.
- **Lumens (LM)**
  The actual quantity of light produced by a lamp or other source. From the Latin word ’lumen’ which means ’light’. Correctly known as luminous flux. (See Luminous Flux).
- **Luminaire**
  A complete light fixture. (See Light Fixture).
- **Luminaire Efficiency**
  This is a ratio of light produced by the luminaire as a whole, including whatever shades, baffles and or reflectors that may be fitted, compared to the light produced by the fitted lamp or bulb alone.
- **Luminance**
  Reflected light sent in a given direction. The observation of brightness expressed in the measuring unit of light intensity, candelas. (See Candela, Candlepower).
- **Luminance Contrast**
  How a given object stands out (or not) from its background due to available light.

- **Luminance Ratio**
  A comparison between two or more areas within the viewer's field of vision.
- **Luminous Flux**
  The amount of light flowing over a given area in a period of time. (See Lumens).
- **Lux**
  The international standard unit for measuring light levels (as oppose to Foot-Candle in the U.S.A). It is one lumen per square meter. (See Lumens and Foot-Candle).
- **Matte**
  A low reflecting dull finish to reduce brightness and glare.
- **Mogul Base**
  A lamp base used for high-wattage bulbs. (See Watts).
- **MOL (Maximum Overall Length)**
  The entire length of a lamp usually in inches (for the U.S.A). Can be in centimeters.
- **MR Lamp**
  A Multi-facet Reflector lamp.
- **National Electric Code (NEC)**
  A standard for safe and proper wiring and electrical appliances to be used as a guide for local jurisdictions in disputes.
- **NEMA (National Electrical Manufacturers Association)**
  An organization for promoting harmony and agreement within the industry, and deciding on the designation of new products.
- **Neodymium**
  A metal used in the production of full spectrum bulbs. (See Full Spectrum).
- **Neon Lamp**
  Culturally famous high voltage, low pressure bulbs used in outdoor signage.
- **Nominal Watts**
  The power rating of light bulbs and other lamps. (See Watts).
- **Opal Glass**
  A milky looking glass used to diffuse light. (See Diffuse Lighting).
- **Opaque**
  Any material through which light does not penetrate.
- **Over Voltage**
  It will shorten the operating life of a bulb to use it above its proper voltage. (See Volts).
- **PAR Lamps**
  This stands for Parabolic Aluminized Reflector. These are extremely bright bulbs that can be used for the accurate controlling of light levels. Since the parabola shaped reflector is excellent at reflecting and focusing all the light produced in a beam in a chosen direction.
- **Pendant Lights**
  These are suspended from the ceiling and regularly seen in many homes.
- **Power Factor**
  This is a measure of efficiency of electrical devices.

- **Prism**
  This refracts light, or bends it. A light beam enters through one of the prisms' multiple, see-through straight sides, and leaves via another. (Light is sent off in different directions). It is not a reflector because the light changes direction inside the prism, rather than bouncing off the outside surface. (See Reflector).
- **Quality Of Lighting**
  Simply; a term used for matching the type of lamps chosen for the task required.
- **Quartz Lamp**
  A halogen bulb with glass made of quartz. This should never be touched with bare skin as an oily mark will appear that will cause the structure to weaken. If touched, clean the glass with an alcohol such as methylated spirits or a turpentine.
- **R Lamp or Reflector Lamps**
  Reflector lamp are made of 'soft' glass as oppose to the 'hard' glass of a PAR lamp. This distinction concerns the glass structure and ability to deal with higher temperatures. They also differ in usually having their reflector source as a aluminum or silvery coating on the bulb itself.
- **Rated Lamp Life**
  See Average Rated Life.
- **Recessed Fixture**
  A light fixture mounted into the ceiling.
- **Recessed Lighting**
  Here the fixture is installed above the ceiling, with only an opening for the light visible from below.
- **Reflectance**
  The amount of light in percentage reflected by a given surface. (The rest of the light is either absorbed by the material, or transmitted through it).
- **Reflector**
  A device for reflecting light in a chosen direction from its surface. Depending on the brightness desired, these may be either diffuse, glossy, matte, or specular. (See Diffused Lighting, Gloss, Matte and Specular).
- **Relamping**
  A maintenance project either at work or home to clean all light fixtures and replace bulbs with new ones.
- **Rough Service Lamp**
  Incandescent light bulbs with extra support to the filament for better withstanding shaking and vibrations.
- **Satin Finish**
  A lightly textured 'brushed' finish to metal or glass.
- **Scalloped**
  The fan or shell shaped pattern on some fixtures.
- **Scene**
  Pre-set settings for dimmers. (See Dimmer).
- **Sconce**
  A wall mounted fixture in the shape of a candelabra. Popular for use with decorative bulbs as they are exposed (to allow them to be admired).

- **Shade**
  An opaque or translucent covering to lessen the light from a bulb when viewed from certain angles, and redirect it to others. (See Opaque and Translucent).
- **Shade Measurement**
  Always should be in this order:
  - Across at the top
  - Across at the bottom
  - The slanting of the sides
  - The height
- **Shielding**
  A group term for diffusers, baffles, louvers and shades.
- **Soft Shade (Also known as a Lined Shade)**
  A lamp shade that has a liner of a fabric.
- **Solid Brass**
  These are fixtures that are made of brass only, not a simulation or brass-plate. Some confusion exists here as the fixtures are probably hollow and not solid at all! The word ‘solid’ applies only to the brass itself. This comes from an old expression which referred to something as being ‘solid’, when it was honest and trustworthy. So in this case, meaning; it is what it says it is - brass!
- **SPD (Spectral Power Distribution)**
  An illustration of how the power output of a given bulb changes in each different wavelength across the spectrum.
- **Specular**
  A finish to a surface that is highly polished and mirror-like.
- **Spider**
  The name of the cross frame by the top of a lamp shade.
- **Spot Lamp**
  A reflectorized bulb with a narrow beam of light emitted.
- **Starters**
  An electrical mechanism used together with a ballast for starting a fluorescent or HID lamp. (See Ballast, Fluorescent and HID).
- **Step Lights**
  These are lights recessed into a wall along a pathway or into stairs on a stairwell.
- **Surface Mounted**
  This is another term for ceiling mounted light fixtures.
- **Swing Arm**
  A horizontal arm for the multiple positioning of a wall mounted or table light.
- **Switch Leg**
  This is how the wiring between a light fixture and its control or dimmer switch is known.
- **T-Lamps**
  A lamp that is tubular in shape.
- **Task Lighting**
  Lighting that is designed for a specific task. Examples of this are security lighting, which has to be extra bright and reliable, and sometimes comes with an infrared sensor or motion detector attached. Or another example being a reading light,

which should be bright enough to prevent eyestrain but not too glary, to avoid the user from having to squint.

- **Three-Way Lamp**
  An incandescent light bulb with two filaments inside it for three levels of light from a sequential switch. The smaller filament is used for the low light level, the larger for the medium setting, and both are used simultaneously when the switch is set to high.
- **Three-Way Switch**
  Sometimes also known as a 'three-pole switch' this is a system that operates a light fixture from two separate locations. This could be the top and bottom of a stairway for example, or next to the bed and the door in the bedroom.
- **Tilt**
  The angle of inclination in an upwards direction of a source of light from the horizontal level starting position.
- **Timer**
  A gadget that will turn lights on or off at pre-set times. Either through its own clock or a countdown.
- **Tinted Glass**
  Glass that had a color (any color) pigment added during manufacture rather than being applied after the glass had cooled from its molten state.
- **Toggle**
  A common control switch for electric lamps.
- **Torchiere**
  A lamp for the floor that sends almost all its emitted light upwards. (See Indirect Lighting).
- **Translucent**
  A translucent material allows some light that hits it to pass through and emerge from the other side.
- **Transmission**
  The passage of light through an object.
- **Transparent**
  A transparent material allows all light that strikes it to pass through it and emerge from the other side.
- **Types (Of Bulb)**
  The designation used for bulbs is that of a letter or letters to indicate the shape, and then a number to show the size. In the United States, light bulbs are measured in eighths of an inch around their maximum diameter.
- **UL (Underwriters Laboratory)**
  A wholly independent organization that apply strict tests to electrical manufacturer's products. When and if they pass these tests, the makers can designate them as 'UL Listed'.
- **U-Lamp**
  A fluorescent lamp with two ends that is shaped like the letter 'u'.
- **Utility Lighting**
  Often partly made from plastic these are basic and durable unadorned fixtures for everyday usage.

- **Urn**
  A wall bracket fixture shaped liked an urn for sending light upwards.
- **Valance Lighting**
  This is where the fixture or fixtures are installed behind a horizontal shielding running along a wall or above a window. It is a form of Architectural Lighting.
- **Vanity Lighting**
  A light fixture installed above or alongside a mirror.
- **Vapor-Tight Luminaire**
  A light fixture that is resistant to entry by vapors or gases to its chamber. Often this applies to water vapor that as steam might cause problems in a kitchen or bathroom.
- **Volts**
  The unit of electrical force or pressure that creates current. Named after Alessandro Volta, an Italian scientist who invented the electric battery in 1800.
- **Voltage Drop**
  This is the difference in current along a circuit caused by the resistance of the lights and the wire. When using low voltage wiring it can cause lights at the far end from the transformer to be noticeably dimmer than the ones nearer.
- **Wall Brackets**
  Light fixtures designed for vertical surfaces such as walls. They are also referred to as Wall Mount Fixtures.
- **Wall Grazing**
  A method of lighting where light is aimed down a wall to produce dramatic shadowing.
- **Wall Lighting**
  A lighting method where light is 'bounced' off walls to give the appearance of more spacious rooms.
- **Wall Washing**
  A technique used to bathe a wall in light to give it added emphasis.
- **Watts**
  A unit of electrical power. Named after James Watt, a British inventor. 746 watts = 1 horsepower.
- **Wattage**
  The amount of electricity used by a light bulb to produce light.
- **Xenon**
  A rare gas used in specialized lamps.
- **Yard Lighting**
  A general term used for outdoor and garden light fixtures.
- **Zone**
  See Channel.

About The Author: **Matt Jacks** is a successful homebased freelance writer, one of experience and diversity. He provides tips and advice for consumers purchasing or comparing flurorescent light bulb, radio control cars and help desk institute. His numerous articles offer moneysaving tips and valuable insight on typically confusing topics.

The "Glossary of Light Bulb Terms & Definitions" reprinted with permission.

Repairing and Troubleshooting Fluorescent Fixtures and Tubes

On the home repair scale of 1 to 10 (10 being hardest), repairing a fluorescent fixture is a 3 or 4... fairly simple but some basic electrical skills are necessary, such as being able to identify wires by color, stripping insulation from the ends of cut wires, installing wire nuts and reading instructions. I added the first and last with tongue in cheek... I know most of you are not **c**o**l**o**r**-blind and most of you can read... or you wouldn't be here!

Here are some common fluorescent freak-outs and some suggested solutions! Note that I will be primarily referring to fixtures using straight fluorescent tubes in this discussion. Curved tubes work in a similar fashion but have different mounting methods.

I use the term "bulb" and "tube" somewhat haphazardly and inconsistently. My apologies. Both are correct, though "tube" is the more correct term and probably a little less confusing.

Fluorescent bulbs designed to replace incandescent bulbs in standard fixtures, such as in recessed lights or table lamps, have all the same features of a fluorescent fixture. Alas, they cannot be repaired... they must be replaced if they become defective.

Finally, let the buyer beware!! Parts for some small fluorescent fixtures may cost more than a new fixture!

Troubleshooting dead or flickering fluorescents... could be a bulb, the starter or the ballast!!

A dead fluorescent can be caused by lack of electrical power (tripped breaker or blown fuse), a dead or dying ballast, a dead starter or a dead bulb(s). Check for power first... then the starter (if applicable) and then the bulbs. When all else fails, the ballast should be replaced. Since it is the most expensive item, be sure it really is dead!! Ahd check the price before you buy... some ballasts are more expensive than new fixtures!!

When flickering is the issue, you still must do the same sort of troubleshooting since all the same problems that can cause a lamp to not work can also cause flickering... defective starters, defective bulbs or a defective ballast.

IMPORTANT: Flickering fluorescent tubes can cause the ballast to overheat and fail prematurely! They can even cause a starter to burn out! Don't wait too long to fix the problem or you may end up with a bigger repair!

Testing fluorescent tubes...

First and foremost... look at the bulbs! If either bulb appears to be very dark near either end the bulb is defective or close to failure. Note the upper bulb in the left graphic... it is definitely approaching its golden years! Though this bulb is still producing light its days are numbered.

There is an electrode located inside each end of a fluorescent tube. Each has two visible pins which fit into the mounting sockets on either end of the fixture. By testing across these pins you can determine whether or not the electrodes are intact. Electrically speaking, if there is continuity across the pins, the electrode should be working. However, **even if the electrodes are intact the bulb may not light.** This can occur if some or all of the gas has leaked from the bulb... a condition for which there is no sniff test! Also, there may be a slight short in the electrodes that gives you a positive reading but the electrode is in fact ***kablooey***!

Thus, the most reliable way to test a fluorescent bulb is to install it into a known working fixture. If you are troubleshooting a 4-tube fluorescent fixture, this is easy! Just remove one of the still-working pair of fluorescent tubes and replace it with each of the questionable tubes, one at a time. 99% of the time it will be one of the tubes that is the culprit.

What about pairs of fluorescent tubes?

A flickering fluorescent bulb means that it or one of a dependent pair of bulbs in the fixture has *bought the farm*. In many fluorescent fixtures, power is sent through a pair of bulbs. If either bulb is bad, they may both flicker or one may flicker and the other show no life.

My philosophy of sensible repair is to always replace both bulbs. Fluorescent tubes have such a long life and are so inexpensive (with the exception of some of the "natural light" bulbs) that it makes no sense to skimp.

Not that it's the most economical solution... it is just a practical viewpoint from someone (me) who has been paid to do this type of work for others (you). To receive a second call in a month because the other of the two bulbs has gone bad is neither desirable from the customer's point of view ($$) or mine (pride in a job done right).

However, if both tubes are functional, the problem is with the **ballast** or, if applicable, the **starter**. The starter is replaced first, and if that does not solve the problem, the ballast should be replaced. Read on...

Does your fixture have a starter? Maybe... though probably not!

A fluorescent starter is a little gray metallic cylinder that plugs into a socket attached to the fixture's frame. Its function is to send a delayed shot of high-voltage electricity to the gas within the fluorescent bulb. The delay allows the gas to become ionized so that it can conduct electricity. Because this process is not instantaneous, the bulbs will flicker for a few seconds before lighting. Hence, a defective starter can cause either flickering or total darkness!

Most modern fluorescent fixtures do not use starters, so you might not find one if your fixture is less than 15 to 20 years old. When determining whether your fixture uses a starter, be sure to look underneath the bulbs... sometimes the bulbs have to be removed first to gain access to the starter. If you do not see a starter... they are never hidden under any covers or "trap doors"... your fixture is a modern "self-starting" type.

Starters are rated by wattage to the bulbs they will control. If you have a fixture but have misplaced the starter, write down the wattage of any of the fluorescent tubes and take that information to the hardware store, lest you be scolded by the mean clerk and sent home without supper... or a starter.

Sadly, there is no way for the home handyman to troubleshoot a starter except by replacing it. Before replacing the existing starter, though, be sure it is securely seated in the base by removing and then reinstalling it. A starter is installed by pressing it into the socket and then turning clockwise till it locks in place. To remove a starter, press in and turn counterclockwise... then withdraw the starter. You may need

If you own fluorescent fixtures that use starters, always keep a few handy for troubleshooting purposes! And don't forget to throw away used ones... most of the time it is impossible to tell the difference between a good and bad starter!

Replacing the ballast (or not) may have unexpected side effects on your wallet!

I'm sure many of you wonder where the name "ballast" came from. After all, there is the nautical

term "ballast" which refers to the contents of tanks on a submarine which control its buoyancy. Fill the ballast tanks with water and the submarine sinks... with air and it surfaces.

A defective ballast in your fluorescent fixture may make you want to sink it in the nearest pond! Indeed, the cost of replacing the ballast in a fixture may rival the cost of a new fixture... especially if you want to use a modern electronic ballast that lights the bulbs faster, runs cooler and is virtually hum-free. (Yes, Virginia, that hum when you flip on the fluorescent lamp is from the ballast, not the bulbs!)

When my customers ask my advice in this matter, I always lean to the aesthetic first. Do they like the appearance of the fixture? If not, add one point to the "replace it" side. Then I confront the ceiling repair issue. If the new fixture is smaller or has a different "footprint" than the original fixture, the ceiling may need to be repainted to cover the unpainted area under the old fixture. Sometimes, ceiling texture also has to be touched up after a fixture is taken down!

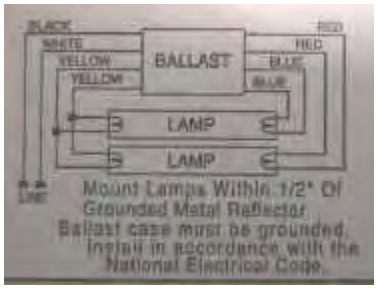
Smaller fluorescent fixtures, such as those in kitchens to illuminate countertops or built into furniture, follow the same basic criteria. Since you may have a problem finding an exact replacement fixture (especially if the fixture is very precisely sized), replacing the ballast may be the best choice.

Thus, unless the fixture is absolutely hideous, replacing the ballast is usually the least expensive repair overall when all other factors are considered!

Replacing a ballast... just follow the colors!

To the left is a graphic of a two ballast, four-bulb fluorescent lamp system, with the ballast cover off to expose the wiring. One look at the spaghetti-like wiring could make anyone lose their appetite! But get the Rolaids... all is not lost! Within that snarly mess is order... just follow the colors!

Fortunately, most modern ballasts have a wiring diagram right on the body of the ballast, with the wire colors clearly marked. If not, the diagram will be packed in the box or printed on it. As if that wasn't enough help, common ballasts often use the same color scheme, making the job about as easy as it can get!



(Diagram copied from a MagneTek F40T12ES ballast. Lots of technical info is available at their new website http://www.universalballast.com)

Choosing the correct ballast...

Needless to say, when you go shopping bring your old ballast with you to assure you get the correct size. Size is not everything, though. Since you must purchase a ballast that is wired identically to the existing one, your only choice is the type of ballast, **magnetic or electronic**.

Magnetic ballasts are the old-time workhorses in the fluorescent world. They are inexpensive and will give 10 to 20 years of service. There were some fluorescent fixtures in my father's gas station that were over 40 years old and still working!!

Electronic ballasts are the new guys on the block. They have some specific advantages over magnetic ballasts. First, they start more quickly than magnetic ballasts. Second, they do not hum. Magnetic ballasts hum right out of the box. The sound comes from the internal vibrations caused by the magnetic core which supplies power to the bulbs. As they age, magnetic ballasts tend to get louder and louder... till they finally fail. Electronic ballasts are silent out of the box and remain so... till death do you part.

Whether the additional cost of an electronic ballast is worth up to double the cost is up to you. I personally prefer the electronic ballasts because the hum makes me nuts. It's up to you!

Can you use a dimmer with fluorescent light fixtures?

Yes and no. Yes, there is a specially-designed dimmer switch that will work with *some* fluorescent fixtures. However, this type of dimmer is "ballast-dependent", meaning that each brand of fluorescent dimmer will only work with certain ballasts from certain manufacturers. In other words, trying to find a dimmer to match your fixture may be a mind-numbing chore. The ideal situation is to choose the dimmer and the light fixture together to assure compatibility. Also, these dimmers will not work for incandescent fixtures. You cannot mix fluorescent fixtures and incandescent fixtures on the same switch.

The "No" part of this question is that the "conventional" dimmer switches you can purchase at the hardware store are designed for incandescent lighting only, not fluorescent lighting. If you attempt to use them, the fluorescent fixture may work but only in the full-on position, if at all.

Leaving Fluorescent Lights On... An Energy Saver??

Not necessarily! As with most things in life, moderation is the key to longevity! Read our article on the facts and myths around the great fluorescent shutoff! Click **HERE** for the full article!

Other resources...

If you want some good technical information of testing ballasts, the most complete source I have found on-line is The Lighting Center, at http://www.thelightingcenter.com/lcenter/technica.htm.

If you would like an in depth look at how fluorescent fixtures work, visit "How Stuff Works" for a detailed, high brow explanation, at http://www.howstuffworks.com/fluorescent-lamp.htm

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Should I Turn Off Fluorescent Lights When Leaving A Room?

This article courtesy of the **Lighting Design Lab**, promoting quality design and energy efficient technologies through training and education

Short Answer: Turn them off if you will be gone for more than about 15-20 minutes (for details keep reading).

There are a few misconceptions about fluorescent lighting that keep too many people from turning lights off to save energy. The first misconception is that it takes more energy to start a fluorescent light than it takes to run it. The second misconception is that turning a fluorescent light off and on will wear it out right away. Like many of our myths about energy, there is a small amount of truth in the belief. *(Special thanks to Steve Selkowitz of Lawrence Berkeley National Labs for doing the research that this article is based on.)*

Misconception #1: It takes more energy to start a fluorescent that it does to run it, so leave the lights on all the time to save money on your electric bill.

Reality: When you turn on a fluorescent light bulb (correctly called a "lamp"), there is a very brief jump in current when the ballast charges the cathodes and causes the lamp to start. This inrush of current can be many times greater than the normal operating current of the lamp. However, the spike of current draw normally lasts no longer than 1/10th of a second, and draws the equivalent of about 5 seconds of normal operation. So, if you turn your fluorescent lamp off and on more frequently than every 5 seconds, you will use more power than normal. So, normal switching of fluorescent lamps has very, *very*, **very** little effect on a power bill.

Misconception #2: Turning fluorescent lamps off and on wears them out right away.

Reality: Electric lights have a published rating for expected life. This rating is in the hundreds of hours for many incandescent lights, and in the thousands of hours for most fluorescents. Fluorescent lights have a life rating based on how many hours they are left on every time they are turned on. This is usually referred to as "burn time", and for fluorescent lights the burn time is three hours.

Every time a fluorescent light is turned on, a tiny amount of the coating on the electrodes is burned off. Eventually, enough coating is burned off, and the lamp fails to start. Most full-size fluorescent lamps are rated to last 20,000 hours when left on for 3 hours every time they are turned on. This means that the lamp has roughly 6,667 starts available to use up. (20,000/3 = 6,667)

Longer burns extend lamp life. If you "burn" your fluorescent lamps shorter than 3 hours per start, you use up your potential starts faster. If you "burn" them longer than 3 hours per start, you use up your starts more slowly. However, you are paying energy costs for the operating time of the lamps, and the most efficient lamp is the one that is not on when it is not needed. See **Table 2** (at end of article) for the effects of longer burn time on lamp life.

But longer burns use more energy. Operating a light when it is not needed is simply spending money for no purpose. Today's rapidly rising electric rates mandate that every building becomes leaner with energy use to control costs. See **Table 3** (at end of article) for a comparison of operating costs for a typical fixture.

Find the trade off point.
There is a point where the amount of money you save from turning off the light exceeds the cost of reducing lamp life by more frequent starts. If you use the formula in **Table 1** (at end of article) at $0.05 KWh, you come up with a time of about 15 to 20 minutes for that point. As energy rates go higher, that time becomes shorter. If you pay less than a nickel per kilowatt hour, your turning-off point would be longer.

The kind of ballast you use may make a difference if you turn your fluorescent lights off frequently. There are three different kinds of electronic ballasts: instant start; rapid start; and programmed start. Which one you use can influence your choice of how frequently to switch off your fluorescent lights. Check with your ballast supplier, or contact a lighting specialist at the Lighting Design Lab for more information on different types of ballasts.

Table 1:
The "Official Formula" to calculate how often to switch lamps off and on

In "Economics of Switching Fluorescent Lamps" IEEE Transactions on Industry Applications Vol 24, No 3, May/June 1988, Carriere & Rea provide a function f(u), that describes the lamp life in burning hours relative the rated lamp life under that standard burning cycle of 3 hours lamp operation per start.

Actual Lamp Life =
Rated Lamp Life x f(u) where, f(u) =
1.71 (1-exp[-(u/3.89)^0.505]) u =
burning cycle, hours of operation per start

Table 2: Burn hours and Fluorescent Lamp Life for a Typical 4-foot Rapid Start Lamp (32W)

3 hr	**6 hr**	**12 hr**	**24 hr**
20,000	24,000	28,000	34,000

Table 3: Comparative annual operating costs for a 3-lamp T-8 fixture with electronic ballast (94W) (@$0.05/kWh)

Burn Time per day	Annual Hours	Annual Cost
3 hrs	1095	$5.15
6 hrs	2190	$10.29
12 hrs	4380	$20.59
24 hrs	8760	$41.17

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A Fundamental Filament

This filament is central in importance to the light bulb as well as central in position. It is made out of tungsten, which is a metal with an extremely high melting point, and it certainly needs one. After the light bulb is switched on, the tungsten filament is heated to between an incredible 2,200 and 2,500 degrees Centigrade! As well as its' own properties, to further stop it burning up; the glass bulb does not contain any oxygen, but instead holds an inert gas called argon or a mixture of argon and nitrogen for all regular bulbs or krypton/xenon instead of the argon for more expensive premium models. (What about halogen bulbs? We'll get to them later).