Competencies

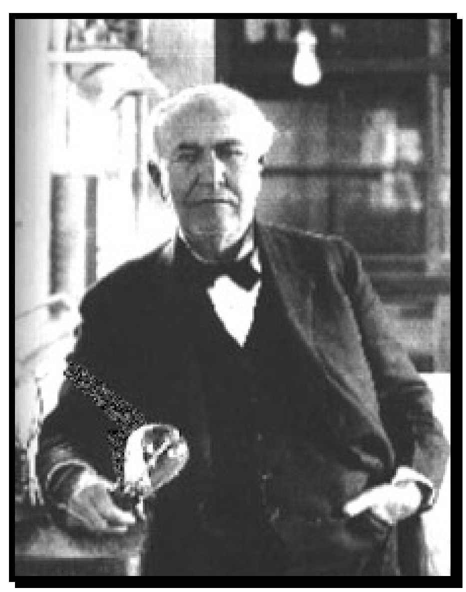
- History of lighting
- Lighting venues
- Basic electricity
- Electrical conductivity and insulation
- Units of electrical measurement and formulas
- Wire measurement and color coding
- Safety Procedures

History

Performances during the first five thousand years of performing arts were done with limited technology. Most performances occurred during the day with the sun providing the illumination. Later, illumination was provided with controlled fire from oil lamps and candles.

The first controllable light source was natural gas flames. Elaborate tubing and control valves provided a rather sophisticated control system. Different gasses and minerals were added to the natural gas to change the color of the flame. The open flame was the main problem with the natural gas system. Many of the theaters burned down, either because of carelessness or ignorance.

Thomas Edison developed the incandescent bulb in 1879 and ushered in a new era for lighting of performances. Electricity provided a controllable source of light energy. Developments over the past 25 years in lamp technology have allowed new designs in lighting instruments. Solid-state devices have also opened new possibilities in intensity control and storage and recall of lighting queues.



Lighting Venues

There are numerous venues or "places" where lighting is applied. Each general area requires its on unique lighting style. Most applications of lighting would be in:

- Television
- Motion Pictures
- Theater
- Concert/Club Setting

Basic Electricity

An understanding of electricity may seem just a bother to the artistic lighting designer; but such information is essential for you, the lighting practitioner. At the very least, we must understand electricity and basic electronics well enough to make intelligent choices concerning usage and safety. Unfortunately, too many people believe that electricity is solely an electrician's concern and, as a result, a curious mystique surrounds electrical practice and theory. The fact is electrical theory and basic electrical practice is simple and quite easy to understand.

Conductors

To allow electric current to move through circuits (established paths for electricity) of any kind it is necessary to provide a path for electricity to flow as easily as possible. Materials, which allow electricity to flow easily, are known as **conductors**. Actually all materials will offer some resistance to such movement; however, all metals are relatively good conductors.

Gold and silver are the best conductors. Because of cost, the use of gold and silver for extensive wiring is not very practical, and a less expensive material must be used. Copper is this material. It is relatively inexpensive, and it is easy to work with to form wires and other parts. Aluminum is coming into use in some applications. Brass is valuable for large, permanent parts that must be ruggedly build. Other materials are also used for special purposes, but by and large, when we think of electric wires, switch parts, and the like, we think of copper.

Conductance or the ability to carry electricity increases as the diameter or area of the conductor increases. Conductance decreases as the length is increased.

Insulators

An important rule to remember is that electricity will always follow the **path of least resistance**. Some sort of insulation is necessary to prevent the current flowing through the conductor from short circuiting - that is, escaping into other channels. This “short” may result in severe shock to anyone coming in contact with the new and unprotected channel of flow. Because it may offer little resistance, this new channel may allow a higher current that the legitimate circuit was designed to carry, thereby causing damage to it.

Just as there is no material that 100 per cent conductive, so there is nothing that has 100 per cent insulative properties, but there are many materials that serve various practical purposes. Glass and ceramics are excellent for small permanent parts such as sockets and switches, and asbestos is used where heat is involved. Rubber and plastic also have good insulative characteristics. Another useful insulator is dry air.

Electric Units of Measurement

Volt

The volt is the difference in electrical potential between two points in a circuit. Voltage is also called the electromotive force (EMF) and its symbol is E. Voltage can be thought of as the pressure behind the flow. An ordinary flashlight battery has an output voltage of 1.5 volts, while the voltage at the wall socket is about 120 volts.

Ampere

The ampere is the rate of flow of current through a conductor. The symbol for the amp is the letter I (for intensity of current flow). Amperage is used to describe the circuit's electrical capacity.

Watt

The watt is the rate of doing work, whether it is turning an electric motor, heating an electric iron, or causing a lamp to glow. Its symbol is P, for power. Wattage can be thought of as "consumption" of electricity.

The Power Formula

The power formula is important to remember because it expresses the relationship between wattage (P), amperage (I), and voltage (E). It states that the rate of doing work is equal to the product of current flow and potential.

WATT = Amperage (I) x Voltage

Amperage (I) = $\frac{\text{Watt(P)}}{\text{Voltage (E}}$

$\frac{1000W}{120V} = 8.3$

Ohm

Every substance offers some resistance to the flow of current. Some, such as copper, offer very little while others, such as rubber, offer a great deal. The ohm is the measurement of such resistance and its symbol is R.

Wire Measurement and Color Coding

Wires are either single, solid, small diameter-rods, or several solid wires twisted together. Cables are pairs or groups of wires. Permanent wiring such as stage circuits may have a solid copper core wire through which the current flows, but the temporary wiring cable used to attach various lighting instruments has a core made up of a number of small strands of wire.

This is to provide proper flexibility in handling and laying. Standard cable consists of two or three such cores, each surrounded by a strong rubber insulation. For physical strength, tough fiber cords are laid alongside, and whole surrounded by either a rubber or a fiber sheathing. Wire comes in different sizes (diameter/area), or gauges. The measuring scheme is inverse; so that a “#0” wire has ten times the area of a “#10” wire.

National electrical codes now specify that all new electrical installations be grounded. Grounding requires that a circuit or cable have three rather than two wires. The third, the ground wire, is designed to offer an emergency path through which the current can flow in case of a short circuit. The wires of a cable or circuit are always covered with rubber insulation color coded as follows:

- **Red or black** = ***Hot*** line
- **White** = ***Neutral*** or ***Common*** line
- **Green** = ***Ground***

Care must be taken in wiring plugs onto cable that the ground wire is attached to the proper pin on the plug.

Electrical Safety

Like most everything else, electrical safety is a matter of common sense. If you don't know what you're doing, don't do it. Attention to the following points will be helpful:

- Always remember that electrical current will follow the path of least resistance and that your body could be that path.
- Insulation is a good thing. Tools should be insulated with plastic or rubber handles. Soles of shoes should provide good insulation.
- Electrical fires are most commonly caused by heat build-up caused by arcing or a short circuit.
- Know the locations of the fire extinguishers that can be used for electrical fires.
- Fuses and circuit breakers protect equipment and insure circuit safety. Never attempt to bypass them.
- Be particularly wary of damp or wet conditions. Water is a good electrical conductor.
- Strain relief in electrical connectors is important.
- **Green** is ground (mostly).
- Electricity *KILLS*.