



HOW-TO BOOKLET #3405

ENERGY EFFICIENT LIGHTING



TOOL & MATERIAL CHECKLIST

- Type A/Three-Way/Other Incandescent Bulbs
- Tungsten Halogen Bulbs
- Fluorescent Bulb Channel
- Compact Fluorescent Bulbs
- Fluorescent Light Tubes
- HID Light Bulbs
- Circle Fluorescent Tubes

Read This Entire How-To Booklet for Specific Tools and Materials Not Noted in the Basics Listed Above.

Lighting accounts for as much as 25 percent of the average residential electric bill. The percentage of energy wasted by inefficient light sources is high, but you can minimize waste by using the right light bulbs in your home.

Lighting stores and the lighting sections of home centers are brimming with choices. Select the proper bulbs, and you can beautify your home while cutting your electrical consumption at the same time.

FOUR BULB TYPES

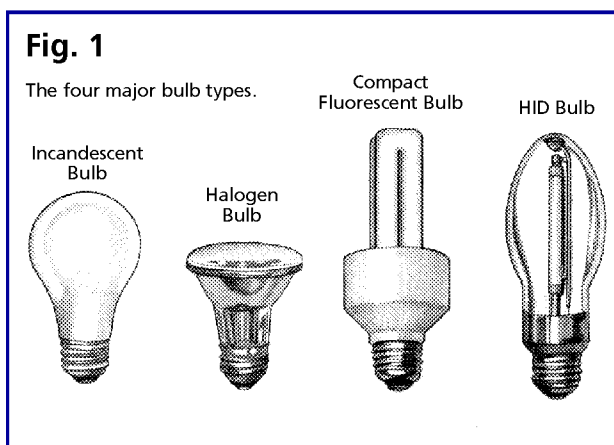
There are four common types of light bulbs generally available: incandescent, halogen, fluorescent (standard and compact), and high intensity discharge (HID). Each type has characteristics especially suited to different lighting needs. When you choose a bulb, weigh its efficiency, light output, and the expected lamp life to determine the best type for each job in your house.

Efficiency. Efficiency is a measure of lumens (amount of light produced) per unit of input power (watts). More efficient lighting sources give off more light for the same amount of electric power. For example, a standard 40 watt fluorescent lamp delivers 62 lumens per watt. For the same amount of visible light, you'd need three 75 watt incandescent bulbs. They deliver only 16 lumens per watt. **Figure 1** illustrates the different bulb types.

By improving the efficiency of the lighting in your home you are helping conserve valuable energy while saving money on electricity bills.

INCANDESCENT LIGHTING

The familiar incandescent light bulb is the most common source of lighting in the home. It's also the least efficient. About 90 percent of the energy used is given off as heat, not as light. Incandescents don't directly convert electricity to light. Rather, they use electricity to heat a coiled tungsten filament in a vacuum or inert-gas-filled bulb until the filament glows.



In addition to being the least efficient, the incandescent also has the shortest life. What's more, near the end of the bulb's lifetime, its light output decreases by 20 percent from its original level. The tungsten evaporates with use, releasing molecules of the metal. These coat the inner surface of the bulb, slowly darkening it. As a result, the bulb consumes almost the same amount of energy as it did when new, yet it emits less light. In addition, as the filament becomes thinner with use, the lamp's efficiency drops. The bulb eventually burns out when the filament ruptures.

A Bulbs. The most widely used incandescent household lamp is the pear-shaped A type light bulb. It produces light today in much the same way it did when Thomas Edison devised the first commercially feasible bulbs a century ago. As shown in **Figure 2**, tungsten filament is supported by a stem press, button rod, and support wires. As an electric current passes through the filament, it heats up to a glowing point and results in the cozy, yellow-tinted glow that we've come to associate with home lighting.

Long-life bulbs (which last from 1,500 to 3,500 hours) are less efficient than regular incandescents. To prolong bulb life, the filament is operated at a lower temperature. To conserve energy, use long-life bulbs only where replacement is difficult. Consider replacing or converting incandescent lamps to fluorescent bulbs, which have a life of more than 10,000 hours. Attempts to increase the

efficiency and extend the life of incandescent lamps have led to the development of so-called "energy saver" or "miser" bulbs. For example, at the 150 watt level, the ordinary incandescent bulb typically uses 180,000 watt hours over its life and gives 2220 lumens of light. The energy saver, at the 135 watt level, uses 162,000 watt hours over its life and gives 2330 lumens.

Light Levels for A Bulbs. Type A bulbs give various levels of light. Clear bulbs give the most light, but tend to create glare. They are generally used in fixtures with diffusers. Frosted or soft light bulbs have either etched or coated lighting surfaces to create less glare and to soften shadows. Some A bulbs have a soft pastel or deep pigment coating, which produces a colored illumination. Silvered-bowl bulbs have a silvery coating on the rounded portion of the bulb to reduce glare. Use them in hanging open-bottom lights where bare bulbs shine in your eyes.

Three-Way Bulbs. Three-way bulbs resemble the A bulb, however, they have two filaments. These filaments can be used separately or in combination to produce three levels of lighting intensities, all controlled from the same switch. One level can be used to provide subdued background lighting. The second level is for a medium intensity light. When both filaments are energized, the bulb is at its brightest. Requiring a special socket and switch, three-way bulbs are generally found in multi-use areas.

Chandelier Bulbs. Decorative chandelier bulbs are ideal for chandeliers, as the name suggests, and also sconces, coach lights, and similar fixtures. Some bulbs give the appearance of etched crystal, gaslight, or candlelight.

Globe or G Bulbs. Available in clear, white, smoked, colored, and silver and are used most often in decorative fixtures, such as strip lights around mirrors.

Directional Bulbs for Fixtures. There are a number of directional bulbs that aim their light in special ways.

▶ **Funnel Shaped Reflector (R) Bulbs** deliver the same amount of light but use less energy (watts) than standard A light bulbs in direction fixtures. They concentrate a beam of light so it can be directed more effectively. Reflector bulbs direct about 85 percent of the light they produce to where you aim them. Use them in directional reading lights or in track fixtures to focus a defined beam on a nearby work of art. Mini-spot R bulbs often are used in recessed-eyeball and track-light fixtures, as well as some portable lamps. Flood R bulbs produce a wide beam of light to illuminate a wall display.

▶ **Ellipsoidal reflector (ER) bulbs** have a silvered backing that focuses light two inches ahead of the bulb, then spreads the light outward. This design prevents light from becoming trapped inside the fixture. For this reason, a 75 watt ER bulb will deliver the same output as a 150 watt R or 200 watt A bulb.

▶ **Parabolic aluminized reflector or PAR bulbs** were originally designed to withstand outdoor weather conditions. PAR bulbs are also used indoors because of their variety of beam widths. They produce well-defined, focused beams of light that vary in width, depending on the bulb you select. All R, ER, and PAR bulbs require heat-resistant sockets (**Fig. 3**).

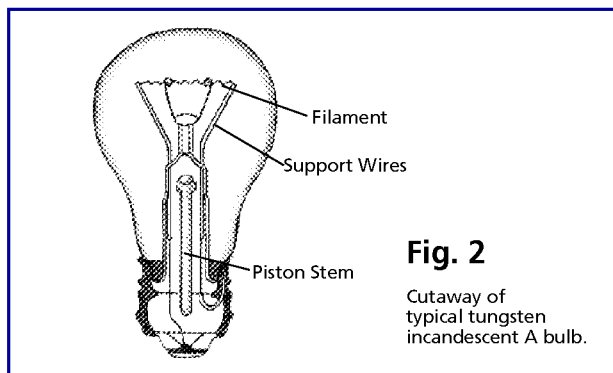


Fig. 2

Cutaway of typical tungsten incandescent A bulb.

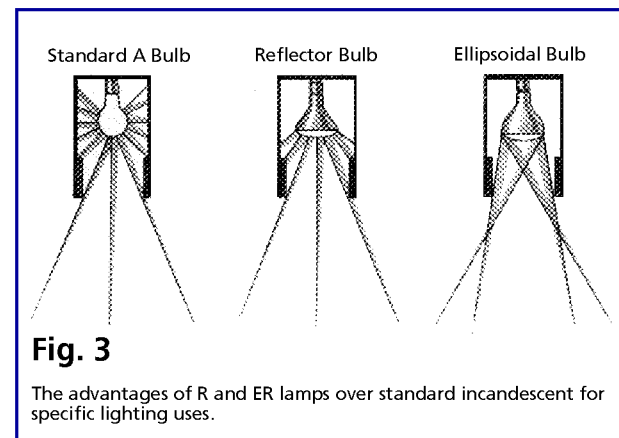


Fig. 3

The advantages of R and ER lamps over standard incandescent for specific lighting uses.

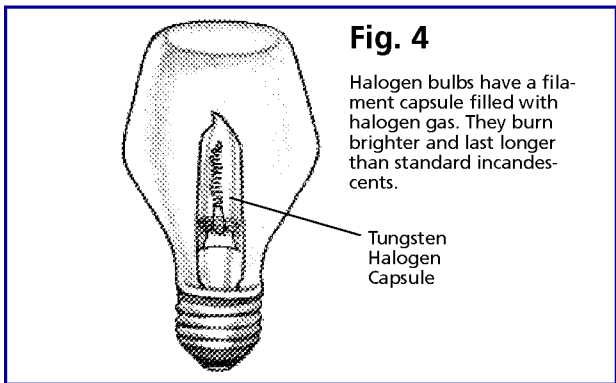
HALOGEN BULBS

Halogen bulbs are incandescent bulbs that give a brighter, whiter light than standard bulbs. Because they're brighter, halogen bulbs use anywhere from 15 to 70 percent less energy to produce the same amount of light as an ordinary incandescent bulb. They last up to three times as long, and save money on energy bills and replacement costs. Below is a comparison of a standard incandescent bulb and a halogen bulb.

	Standard Light Bulb	Halogen Bulb
Watts	100	100
Average Life	750 hours	2,250 hours
Average Lumens	1750	1925

The tungsten filament capsule inside a halogen bulb (Fig. 4) is filled with halogen gas. The filament evaporates at a slower rate than an incandescent bulb. As a result the glass bulb takes longer to darken. Lamp life is up to three times longer than a standard bulb. These longer lasting bulbs consume up to 40 percent less energy than their incandescent counterparts.

Tungsten halogen lamps have a higher lumen per watt rating and maintain 92 percent of their initial output. While some types of halogen bulbs require special fixtures, the typical household designs fit in regular lamp sockets. The halogen bulbs are also designed for spotlight and floodlight.



Caution: Don't use halogen bulbs in wet locations. Unlike incandescent lamps, they may continue to light after the bulb has been damaged from exposure to moisture or physical abuse. The inner glass capsule operates at high temperature and pressure, which could lead to sudden shattering.

FLUORESCENT LIGHTING

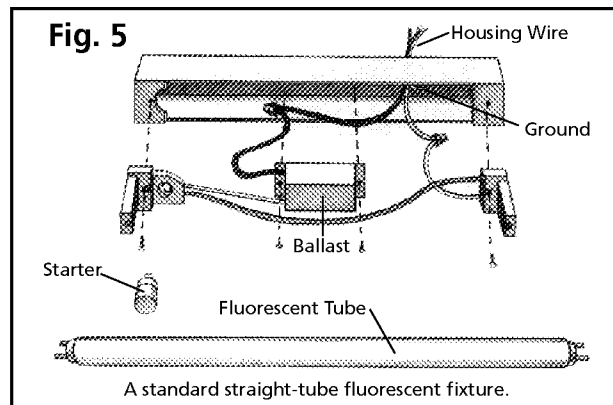
Fluorescent lamps convert electric power to visible light by using an electric charge to "excite" gaseous atoms. These atoms emit ultraviolet radiation, which is absorbed by the phosphor on the tube walls. The phosphor coating produces visible light.

Fluorescent lamps require a ballast—a small transformer that provides the high voltage necessary to initiate the charge. The ballast also regulates the current that flows through the tube. Fluorescent lamps convert electricity to visible light up to 5 times more efficiently than incandescent lamps and last up to 20 times longer.

Fluorescent Tubes. The traditional design used to produce fluorescent light is the tube. It is available in lengths from 5 to 96 inches, in three diameters, and in three types: rapid-start, instant-start, and preheat. The rapid- and instant-start tubes consume slightly more energy than the preheat type, but give a little more light.

Tube fluorescents require a special fixture. The fixture for the standard preheat tube consists of a metal channel that contains the ballast. If the fluorescent tube is not the instant-start variety, the fixture will also have a starter. The start-up delay associated with this type of fluorescent lamp is very brief. The lamp will flicker for a few moments when first turned on before achieving full illumination. The starter in a rapid-start model is built into the ballast, while the instant-start type has no starter and will reach full light output immediately (Fig. 5).

Compact Fluorescent Bulbs. The double or U-shaped compacts are 5 1/2 to 7 inches long—small enough to replace incandescent Type A bulbs in most fixtures. The ballast may be located



in the screw base or in a special adapter between the incandescent socket and the bulb.

As can be seen in the table, compact fluorescent light bulbs are so efficient, they can be used to replace ordinary incandescent bulbs of much higher wattage. Over the life of the bulb, the energy savings will be more than the purchase price. The long life of these bulbs means many fewer burned-out bulbs in the landfill.

Existing Incandescent Bulb		Compact Fluorescent Replacement		Savings
25W	(232 lumens)	7W	(400 lumens)	\$18.00
40W	(460 lumens)	11W	(600 lumens)	\$29.00
60W	(890 lumens)	15W	(900 lumens)	\$45.00
75W	(1210 lumens)	20W	(1200 lumens)	\$55.00
100W	(1710 lumens)	23W	(1550 lumens)	\$67.00

* Savings based on 10,000 hour bulb life at an energy cost of 10¢ per kWh.

Miniature Fluorescent Bulbs. The miniature fluorescent is a U-shaped compact bulb covered with a cylindrical or globular enclosure. The ballast is built in the base, which means that a miniature fluorescent can replace an incandescent without the use of an adapter. The efficiency of miniatures is slightly less than that of the compact types.

Circular Fluorescent Bulbs. These circle-shaped fluorescent tubes are affixed to a cone-shaped adapter so you can screw them into an ordinary light bulb socket. Since the 22-watt fluorescent

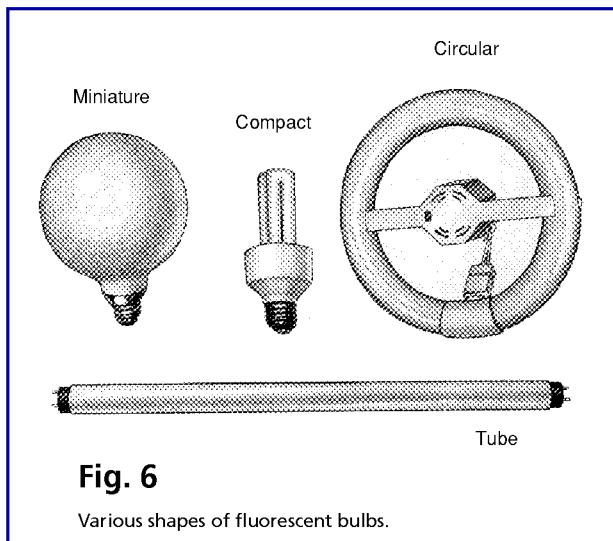


Fig. 6

Various shapes of fluorescent bulbs.

ring provides as much light as a regular 75 watt A bulb, you'll save energy. That, plus the estimated 15,000 hour life of fluorescent rings, makes them well worth their extra cost (Fig. 6).

Proper Selection. Additional energy and money may be saved not only by replacing incandescent lamps with fluorescent lamps, but also by choosing the most efficient fluorescent lamps for each lighting need. For instance, straight lamps are more efficient than circular lamps and standard color lamps are more efficient than deluxe color lamps.

FLUORESCENT COLOR RENDITION AND COLOR TEMPERATURE

Color rendition refers to an object's perceived color under a light source as compared to the perceived color of that object illuminated by an ideal source. Ideal sources are defined as incandescent lighting or daylight.

Fluorescent lamps commonly used in offices have a poor Color Rendition Index (CRI) of about 65. Consumers are reluctant to use fluorescent lamps in their homes because this CRI compares unfavorably

with an incandescent's CRI of about 95. But new fluorescent lamps have improved color rendition, which makes them as attractive as incandescent lamps. In fact, the broad- or full-spectrum fluorescent bulbs simulate almost the complete visible color ranges. These bulbs are typically used in medical facilities, treatment rooms, and art galleries, where color rendering is of the utmost importance.

Color temperature describes whether a light source has warm or cool tones. It is an aesthetic description, typically listed on the lamp label in phrases like "deluxe cool white" or "warm white." Low color temperatures emit warm or redder tones, while high color temperatures emit cool or bluer tones (see the table below). Low color temperatures are generally preferred for residential use as they are more flattering. High color temperatures create a more businesslike atmosphere.

Fluorescent Lamp Selection Guide				
	Effect on "Atmosphere"	Colors Strengthened	Colors Weakened or Grayed	Remarks
COOL WHITE	neutral to fairly cool	orange yellow, blue	red	blends with natural daylight
DELUXE COOL WHITE	neutral to fairly cool	all nearly equal	none	simulates natural daylight
WARM WHITE	warm	orange yellow	red, blue green	blends with incandescent light
DELUXE WARM WHITE	warm	red, orange yellow, green	blue	simulates incandescent light

HIGH INTENSITY DISCHARGE BULBS

HID bulbs were designed primarily for outdoor security or landscape lighting, but in recent years, their use has expanded to indoor applications. These bulbs are filled with sodium or mercury vapor and metal halides. Available for home use in 75, 100, and 150 watt sizes, they provide optimum lighting efficiency and a CRI of 75 to 90 (depending on the bulb model).

The most expensive of all light bulbs, the HID bulbs produce light by electrically exciting gas in the bulb. They require a special socket and ballast and do not immediately produce light when the switch is turned on, which may be inconvenient when entering a room (Fig. 7).

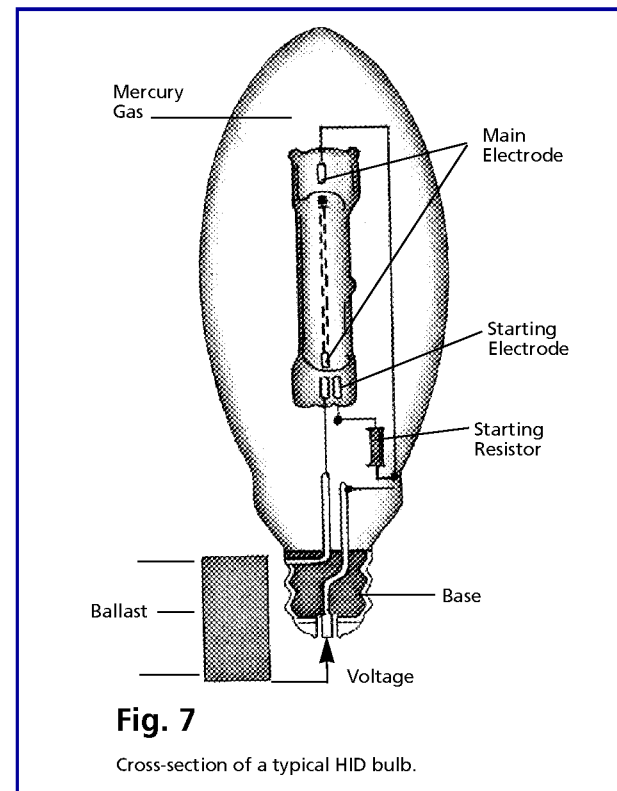


Fig. 7

Cross-section of a typical HID bulb.

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