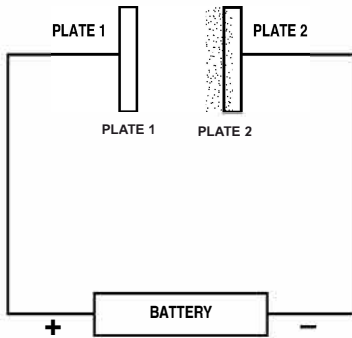
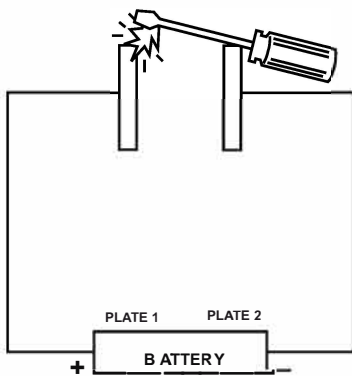


## WHAT IS A CAPACITOR?

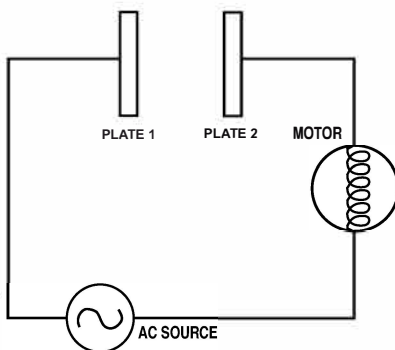
Very simply, a capacitor is a device that stores and discharges electrons. While you may hear capacitors referred to by a variety of names (condenser, run, start, oil, etc.) all capacitors are comprised of two or more metallic plates separated by an insulating material called a dielectric.



A very simple capacitor can be made with two plates separated by a dielectric, in this case air, and connected to a source of DC current, a battery. Electrons will flow away from plate 1 and collect on plate 2, leaving it with an abundance of electrons, or a "charge". Since current from a battery only flows one way, the capacitor plate will stay charged this way unless something causes current flow.



If we were to short across the plates with a screwdriver, the resulting spark would indicate the electrons "jumping" from plate 2 to plate 1 in an attempt to equalize. As soon as the screwdriver is removed, plate 2 will again collect a charge.



Now let's connect our simple capacitor to a source of AC current and in series with the windings of an electric motor. Since AC current alternates, first one plate, then the other would be charged and discharged in turn.

First plate 1 is charged, then as the current reverses, a rush of electrons flow from plate 1 to plate 2 through the motor windings. When the current reverses again the electrons will rush back to plate 1.



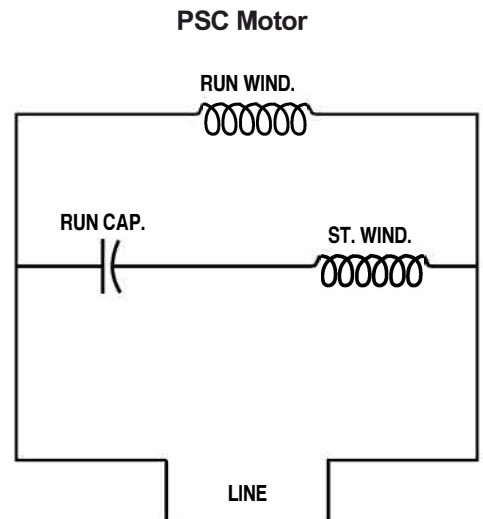
*Note that electrons do not pass through the capacitor but rather travel back and forth, from one plate to the other, through the motor windings. This rush of electrons, first one way then the other, has a desirable effect when applied to certain motors.*

## WHAT EFFECT DOES A CAPACITOR HAVE ON A PSC MOTOR?:

### Permanent Split Capacitor (PSC) Motors:

This type motor is a split phase motor with the addition of a run capacitor in series with the start winding. No starting switch is used, so the capacitor and start winding are in the circuit at all times. The run capacitor provides additional starting torque by increasing current during the start cycle through the start winding. The motor is so constructed to allow for this without burning the start winding. A PSC motor has low starting torque but is very efficient in operation and generally costs less than a capacitor start-capacitor run motor.

To increase starting torque, most PSC motors can be fitted with a so called "hard start kit" comprising of a potential relay and start capacitor. The development of positive temperature co-efficient resistors (PTCR) has allowed solid state technology to be used to increase starting torque in PSC motors in place of the traditional hard start kit.



## TYPES OF CAPACITORS & CONSTRUCTION:

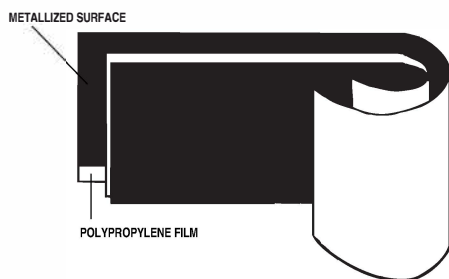
A capacitor, as mentioned previously, is comprised of two metallic plates separated by some insulating material commonly called a dielectric. The ability of a capacitor to store electrons is known as its capacitance and is rated in microfarads, abbreviated mfd. A microfarad is one millionth of a farad.

The capacitance is dependent on the area of the plates, the distance between plates, and the stability of the insulation. Of these, the area of the plates, is most important in determining capacitance. All else remaining constant, an increase in plate area will yield an increase in capacitance.

Since we have already seen that capacitors are used for different purpose, i.e.: motor start or motor run, there are different methods of construction used to produce capacitors. They are usually referred to by either type of dielectric employed or by the function they perform.

### Impregnated Metallized Capacitors:

The newest technology in capacitor design is metallized film capacitors. In operation and application, they serve the same purpose as conventional run capacitors, but their construction is very different. Rather than using sheets of foil separated by several layers of paper to create the plates and insulation, metallized capacitors use sheets of polypropylene film onto which is "sprayed", or metallized, a thin layer of metal. Two metallized films are then wound together very tightly to form the capacitor. The resulting roll is very hard and cannot be squeezed into a traditional oval shape.



Therefore, many metallized film capacitors are round. They are, however, much smaller than conventional run capacitors. A 35 mfd, 440 volt metallized capacitor is 50% smaller than an oil paper capacitor. It also weighs 60% less because there is much less liquid in a metallized capacitor. Many oval shaped run capacitors are now metallized film. The "roll" is small enough to fit into the oval can previously used for film/paper

construction. Retaining the oval shape is important for the replacement market.

We learned previously that run capacitors are filled with a liquid that serves to strengthen the dielectric characteristics of the paper and also to dissipate heat. In a metallized capacitor, the liquid is only used as a heat sink. The polypropylene film is an excellent dielectric and requires no assistance. In fact, the capacitor "roll" is wound so tightly that the liquid never penetrates between layers.

### ***Impregnated Metallized Capacitors (cont.)***

The core of a metallized capacitor is surrounded by many layers of plain polypropylene film. This provides excellent insulation between the plates and the metal case and, therefore, no marking is necessary to indicate the neutral terminal.

Finally, metallized capacitors “self heal”. The most common cause of capacitor failure is a breakdown of the insulation between plates which leads to a short. If a hole occurs in the metallized film, an arc will jump between the plates. The heat from this arc will vaporize the metal surrounding the hole and self extinguish, thus preventing the short.

### **Dry-Type Capacitors:**

Dry-Type capacitors are similar in construction to oil-filled, but do not use an oil impregnant. The advantages of dry-type construction are savings in size, and weight. The possible disadvantage is a lower tolerance to high current failure conditions. Dry-type capacitors are finding their way into more applications as engineers resolve difficulties encountered in field and life testing situations.

### **TROUBLE SHOOTING RUN CAPACITORS:**

A shorted run capacitor has the effect of keeping the start winding in the circuit at all times. The motor typically draws high amperage, runs hot and may cycle on overload. It will run at about 3/4 speed. To check, disconnect one side of the capacitor while the motor is running, taking care to avoid electrical shock. If the speed increases and the motor appears to run as normal, the capacitor is shorted and must be replaced.

With a multiple capacitor hook-up, testing for shorted capacitor is the same for parallel or series connection. In parallel, if one shorts, the total capacitance of the system is decreased and the motor will start slowly. In series, if one shorts, the capacitance increases but the voltage capability of the circuit decreases and, as a result, the remaining capacitor soon fails.

An alternate test for a shorted run capacitor is with an OHM meter. A shorted capacitor will register zero resistance.

An open run capacitor may have little apparent effect on the motor, which will appear to run near normal performance. To test, disconnect one side of the capacitor and start the motor. Take a reading of the current drawn with an ammeter. Now connect the capacitor. If the capacitor is good, the amps should drop. If there is no change in amperage, the capacitor is defective and must be replaced.

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**CAUTION:** *When working with capacitors, always remember that they store an electrical charge. To prevent electrical shock, never assume that a capacitor is discharged until you have manually discharged it. This can be done by touching both terminals with the blade of a screwdriver having an insulated handle. This sudden surge of electrons can, however, sometimes in itself damage the capacitor. A better way is to have a bleed resistor connected to insulated leads and use this to jump the terminals. Use a 15,000 OHM resistor for starts and a 220,000 OHM resistor for runs.*

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