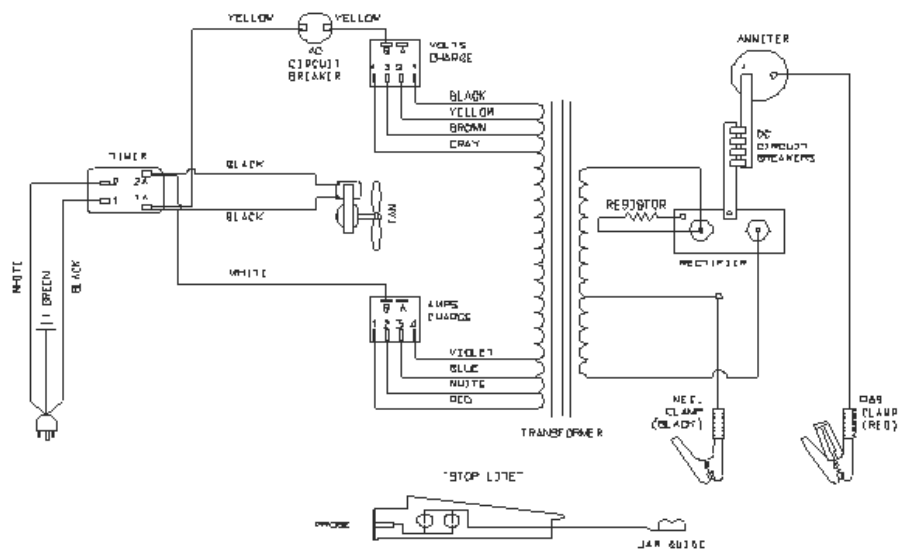


# ASSOCIATED EQUIPMENT CORPORATION



# TROUBLESHOOTING AND MAINTENANCE GUIDE



*Celebrating over 60 years of Quality American Manufacturing*



## TROUBLESHOOTING & MAINTENANCE GUIDE

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Manuals, Wire Diagrams, and additional information may be found on our website:  
<http://www.associatedequip.com/support>

Additional technical help is available by emailing:  
[techservice@associatedequip.com](mailto:techservice@associatedequip.com)

### CONCEPT OF A BATTERY CHARGER

In its most basic function, a battery charger uses a typical household voltage of 120 volts AC and steps it down to a lower AC voltage before converting that AC into DC to charge a battery. This is done by feeding the higher input voltage into the primary side of the transformer and the lower output voltage is produced on the secondary side of the transformer. The primary of the transformer consists of at least two inputs (or taps) and may contain several more. Each input tap is designed to produce a calculated voltage on the output windings called a secondary. Various switches are employed to change these taps in order to get the desired output levels and timers are often used to govern the length of time on charge. The lower secondary voltage of the transformer is then connected to the rectifier (or diodes) which clip the top half of the AC (alternating current) sine wave resulting in DC (direct current) voltage. This is the voltage used to actually charge the battery. Additional safety mechanisms of input and output circuit breakers are used to protect the charger and diminish fire hazards. Meters are used to for monitoring and providing state of charge information to the operator. A more elaborate design may include additional elements such as a microprocessor controlled circuit board for controlling the charge cycle so that it conforms to a particular charging profile. Because certain batteries can be damaged if the method of charging is not carefully observed, selection of the proper charger for the application is vital. Understanding the principles of how a battery charger works is an essential part of knowing how to repair one should it need service. If you are unsure of the individual components in the charger and their purpose, Please see the COMPONENT FUNCTIONS section of this document for parts identification and their respective functions before attempting to service your battery charger.

This guide addresses the manual type chargers using a manual timer or on/off switch. While this document does not specifically address the repair of microprocessor controlled chargers, many of the troubleshooting steps are fundamental in determining the source of problems in these types of chargers as well.



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### MAINTENANCE & CLEANING INSTRUCTIONS

1. Worn clamps and jaws should be replaced. Worn parts can lead to poor connections and present a safety hazard. See parts list for part number of jaw and clamp kits. Any Maintenance or repair of this unit that involves disassembly of the cabinet should be done only by a qualified service person.
2. Incorrect reassembly may result in a risk of electric shock when the unit is subsequently used. To clean, wipe with a soft damp cloth. Avoid the use of chemical and abrasive cleaners. Wipe up spills immediately.
3. Furniture polish may be used to maintain a bright sheen on the cabinet and cables, but avoid spraying directly onto the metal and apply to a cloth and rub it in.
4. When not in use, this unit should be stored upright, in a dry location.
5. If there are signs of cabinet damage, have the unit checked by a qualified service person before using.



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### EQUIPMENT NEEDED

You will need to have the following to disassemble and adequately test the output of the charger.

- Digital multi-meter capable of measuring AC/DC voltage with a diode checking function.
- Handheld Load Tester (recommended model 6029 or equivalent)
- Good Battery – important to have a known good battery & not a suspect one.
- Nut Driver set (SAE)
- Socket set (SAE)
- Flat Blade Screwdriver
- Phillips Blade Screwdriver

Additional helpful items to have:

- Alligator clips for Digital Multi-meter (for hands-off measurements)
- Clamp on amp meter
- Jumper leads that have alligator clips on each end (for hard to reach places)
- Flashlight or trouble light



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### TROUBLESHOOTING INSTRUCTIONS

**WARNING: Troubleshooting involves working with live voltages! Only Qualified personnel or an experienced electrician should attempt to repair this unit. If you are not comfortable with this process, do not attempt it.**

Troubleshooting is a process that starts at the source of input and ends at the output. The direction in finding the problem is performed much like following a flow chart, making measurements along the way to find the source of the problem. Understanding how each component in the battery charger operates is crucial to solving a problem with the charger and will also help in solving the problem much quicker. If you are not familiar with the parts in this charger, please see the COMPONENT FUNCTIONS section of this document for parts identification and their respective functions before attempting to service your battery charger. The testing methods in this guide are written in such a way that it minimizes the disassembly of the charger. Please take the time to familiarize yourself with the wire diagram before getting started.

There are some very basic tests to initially perform to determine if service is required on the charger before having to remove any panels. These tests can be performed without exposing the operator to any potentially lethal voltages. Visual and audible clues during this process will also help identify any problems you may be having. Although not always possible, first hand information from the operator will many times give a good indication as to the failure of the charger. Ask lots of questions, such as:

- By what means have you determined the charger to be defective?
- How long has the charger been in service?
- Has the charger ever worked or is this an out of box failure?
- How was the charger being used? (charging, jump starting, etc.)
- What is the application of the charger? (automotive garage, junk yard, truck shop, etc.)
- Did you hear, see or smell anything prior to the charger failing?
- Was the charger working and just quit, or was it not working from the time you plugged it in?

The usage of the charger or other clues can give direction on where to start looking for the problem. For instance, if the charger is used in a truck shop and frequently used to jump heavy vehicles, one may quickly start to look at a burned out rectifier as the source of trouble.

Using a little logic, one can pretty quickly ascertain direction in diagnosing the failure of a charger. For instance, if the fan motor was not running, then we can make some initial guesses to the source of the problem. Since the fan is on the primary side of the transformer, we need not waste time starting on the secondary side of the transformer. Sometimes a charger may have more than one problem and require repeating some troubleshooting steps to make sure everything is working properly.



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To determine if the charger is working, perform the following preliminary steps.

1. Make sure the charger is off.
2. Isolate the black and red clamps from one another so they cannot touch.
3. Using the diode function of the multi-meter, measure across the two clamps in each direction. Red to red and black to black should show an open circuit; black to red and red to black should show .3 - .5 voltage drop across the two clamps.
4.
  - a. Plug the charger into the wall outlet.
  - b. Isolate the clamps from one another so they cannot touch.
  - c. Set the rate switch(s) to 12 high
  - d. Turn the timer or power switch (if applicable) to the on position. (The amount of time is not relevant.)
5. Can you hear the fan motor running? (This will help determine if the charger has proper power connected to it)
6. Change the rate switch to different positions and listen for an audible change in the transformer hum. The change in pitch is not always discernable but if it is present, is a good sign the transformer is working properly.
7. Set the charge rate to high and measure the DC voltage across the black and red clamps. This voltage should be between 12.6 volts and 17 volts DC depending on the charger model.
8. Turn charger OFF.
9. If you measured good voltage in step 7, then use a known good battery and connect it to the charger. (measure the battery voltage before connecting and make a mental note of the voltage.)
10. With the battery connected to the charger, connect a DC volt meter to the battery using the charger clamps to hold them in place.
11. Set the rate of the charger to high and turn the power on.
12. Note the display of the amp meter and the attached voltmeter. If the charger is producing voltage and current, you should see an increase of voltage on the battery from the previous measurement in step 8. The current displayed on the amp meter will vary depending on the voltage of the battery. If you are reading voltage and current, then the charger is working. You may still need to test for full output however.

If the charger fails at any one point of these steps, you will need to remove the side panels and/or top panel in order to troubleshoot further and then proceed to the DIAGNOSING FAILURES section.

### DIAGNOSING FAILURES

#### RECTIFIERS –

Symptom(s): The fan on the charger runs, but there is little or no output. When changing the rate switch(s) an audible change in pitch may be noticed. The charger has previously been working fine. There is a “pop” sound when the charger is turned on or a flash. There is a burning smell or smoke is emitted from the charger.

Statistically, the rectifier has proved to be the most commonly failed item in a charger. A rectifier can fail for many reasons, but if the charger is used properly, the rectifiers should last for many years.

General use information to protect the rectifier:

- Never touch the clamps together. Use a meter to determine if there is voltage present on the clamps. Touching the clamps together creates a direct short on the output.
- Always pay careful attention to the polarity of the battery when connecting the clamps. Connecting a battery in reverse polarity not only has the potential to damage the charger, but also has a great risk of battery explosion that can cause severe injury to the operator.
- When jump starting vehicles, always set the charger on high and charge for a minimum of 5 minutes before attempting to start the engine. This allows the battery to absorb a surface charge so that when the key is turned to start the engine, it is pulling some power from the battery and not demanding all of the starting capacity from the charger. This will create a lesser strain on the diodes when attempting to start a vehicle and will also ensure a greater success in starting.

Testing the rectifier:

- If the charger exhibits any of the symptoms described above or if the diode test in step 2 showed an open or a short in both directions, you will need to take both side panels off for further evaluation.
- With the sides removed, set the rate to 12 high and measure the AC voltage across the two secondary windings of the transformer. (the two that connect to the rectifier assembly). You should read between 25-35 volts. Next, switch the meter to DC and measured from the center tap of the transformer to the main plate of the rectifier. You should read 13.5 – 14.5 volts. if you read good AC voltage into the rectifier and no DC voltage out of the rectifier, then the plate is bad and should be replaced.
- Sometimes the charger will have output but will not produce much current and it make take longer than normal to charge a battery. The rectifier may have one or more diodes that have failed. Sometimes a visual inspection of the rectifier will provide enough evidence, other times additional testing is necessary.
- Connect the charger to a known good battery. Using a handheld tester (recommended model 6029), connect the tester to the battery in addition to the charger clamps. (there will be two clamps on each terminal). Turn the charger on high and press the load test button momentarily while observing the amp meter. The amp meter should peg to its highest reading. If it does not the rectifier should be replaced.



### DIAGNOSING FAILURES (Continued)

#### DC CIRCUIT BREAKER –

Symptom(s): you hear a “clicking” sound. The charger turns on and you see current on the amp meter, but then cycles off shortly into the charge. The charger continues to cycle on and off and the amp meter jumps up and then falls to zero repeatedly.

Usually, the DC circuit breaker trips for one of two reasons. Its rating is being exceeded, or it is a weak breaker and needs replaced. Check the rating of the charger to make sure the meter is not exceeding the maximum continuous output rating. If so, set the rate of the charger down so that the breaker stays engaged. If the breaker is cycling out at a current lower than the rated output, then it is weak and needs replaced.

#### TIMER –

Symptom(s): The charger is connected to a battery and the timer set to a specified time. When the battery is checked, the charger is still running and the timer has not turned off. There is a foul smell and/or the battery has boiled over or swelled.

- This is usually an issue where the timer fails to turn off.
- Some units do not use a timer at all, and it is up to the operator to determine when the battery is fully charged and shut the charger off.
- If the charger uses a mechanical timer, you can typically hear a ticking sound when the timer counts down.

(!) Make sure the timer is not over-tightened when setting the time for charge. Many of the timers are spring loaded and if over-tightened will count down close to zero, but not have enough spring tension to turn off.

Testing the timer:

- Test the timer by using an ohm meter across the switch terminals of the timer. When the timer is on, there should be zero ohms across the switch terminals, and it should read open when the timer is off. Turn the timer past 20 minutes and note the time. Check the timer after the set time has lapsed and use the ohm meter to see if the timer has turned off. If the dial indicator has not reached zero, or if the ohm meter does not show an open circuit, the timer needs to be replaced.

### DIAGNOSING FAILURES (Continued)

#### **RATE SWITCH –**

##### Symptom(s):

There is no output from the charger and no audible hum can be heard when the rate switch is turned. The charger works on some charging positions but not on others. The rate switch becomes hard to turn or turns freely.

(!) Some rotary rate switches have 8 positions but are off in every other position and are only on in the 3, 6, 9, & 12 o'clock positions.

##### Testing the Rate Switch:

- The easiest way to test the switch is while it is still connected in the charger. Using a voltmeter set to AC, measure the voltage across the secondary leads of the transformer (the ones that connect to the rectifier assembly). With the charger on, start the rate switch(s) in the lowest position and note the voltage on the meter; it will be different from charger to charger. Ramp the switch(s) up to the next level and look for an increase of voltage on the meter. If the switch(s) are working, then you will be able to watch the voltage increase every time you adjust the rate switch higher and see the voltage decrease when the switch is adjusted lower. If on any switch position there is not voltage or an increase from the previous position, then the switch is bad and should be replaced.
- Sometimes it is not feasible to test the switch in the charger. In this case remove the switch and using an ohm meter, measure from the common input of the switch to each output terminal making sure the ohm meter reads zero ohms across the connection. If there is a high resistance connection or open circuit across the terminals, the switch should be replaced.

#### **AMP METER –**

##### Symptoms:

The charger appears to be charging correctly, but the amp meter never moves even when the battery is deeply discharged. The meter shows incorrect amperage compared to another meter. The needle is showing current even when the charger is off and unplugged.

##### Testing the amp meter:

- The amp meter is most easily tested by passing current through it and measuring that current using a clamp on amp meter. Alternatively, you can use the current measurement function of some handheld meters. This measurement is made inline and is highly accurate, but most handheld meters can only measure current up to 10 amps. Regardless of the method you use, the two readings can be compared for accuracy. If the meter does not read in close proximity to secondary means of measurement, then it should be replaced. If the meter uses an external shunt, then the shunt should be checked for accuracy.

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### DIAGNOSING FAILURES (Continued)

#### **Fan Motor –**

##### Symptom(s):

There is not output from the charger. No sound can be heard from the fan. The fan is visibly not moving.

(!) Remember, the purpose of the fan is to cool the rectifier. If the fan has not been functioning for a while, the rectifier may be damaged also. Recheck from step one after resolving the fan issue.

##### Testing the fan motor:

- If the fan motor is not moving, then you must first determine if it has power. The fan motor uses 120VAC for power. Turn the charger on and measure the voltage on the input terminals of the fan; if voltage is present, the motor is bad and will need to be replaced.)
- If there is no voltage across the fan terminals, then check the timer to be sure the switch contact has closed to provide power to the fan. If the switch contact of the timer is closed, check to be sure the charger has power from the wall outlet.

#### **Transformer –**

##### Symptom(s):

The fan runs, but there is no output from the charger. You smell something burning or see smoke emitted from the charger.

The transformer is robust and is usually one of the last components in the charger to fail.

(!) Some transformers use a thermal fuse embedded in the primary wire. This type of fuse is not resettable and must be replaced if it is blown. Check the wire diagram.

##### Testing the transformer:

- Testing the transformer consists of verifying input voltage on the primary and checking the output to see if voltage is present. With the charger turned on, measure the AC voltage on the secondary windings (the ones that connect to the rectifier assembly), and verify the presence or lack of voltage. Turn the rate switch(s) and see if there is any change. If there is voltage on some switch positions and not others, it may just be a bad switch. If there is no voltage present at all, then check across the primary leads to verify input voltage is present. If there is no voltage, check the AC breaker. If voltage is present on the primary leads and no voltage is present on the secondary leads, replace the transformer.

In each instance; once you solve one problem, go back to step one and start again.

### COMPONENT FUNCTIONS

This section is intended to familiarize the operator with the individual components of a battery charger and how those parts work together to make a completely functional unit.

#### **Circuit Breakers:**

Circuit breakers come in a variety of styles and ratings for protecting both the input and output of the charger. The basic purpose of the circuit breaker is to limit the amount of current that passes through it in order to protect the components from exceeding their electrical ratings and presenting a fire hazard. Circuit breakers are designed to carry 100% of their rated current while allowing a short burst of peak current before interrupting the circuit. A circuit breaker has two electrical connections that allow one side of the AC line to be broken and the circuit breaker inserted between the break. A circuit breaker acts like a security guard to the entrance or exit of a gated compound. When a circuit breaker detects a force greater than its rating, it interrupts the operation by creating an open circuit in the charger. Once the circuit breaker cools down, it closes the circuit again allowing current to pass through it again. Other types of units, especially older models use a fusible link or a one time type of fuse that must be replaced if it opens. While these devices still offer the same protection, it requires a more labor intensive approach to bring the charger back online. One can easily see the benefit of a self-resetting circuit breaker.

A circuit breaker is generally tested by checking it with an ohm meter. It should read zero ohms across the two terminals of the breaker. Circuit breakers must be measured by disconnecting them from the circuit so a false reading is not obtained. The measurement of an AC and DC breaker is the same. Some times a breaker may read "good" with an ohm meter leading the technician to believe it is working, but once a load is passed through it, it opens up. In this case the technician would need to measure the current passing through the breaker to see if it exceeds the rating of the breaker and if so, then replace it.

Since the input of the charger contains AC, you will likely find this type of breaker used close to where the electrical connections first enter the charger in order to protect the valuable components downstream from it. The output of the charger produces DC voltage and a DC type of breaker is used to protect the charger from producing too much current for an extended period of time and damaging the components upstream from it. Both types of breaker work in conjunction with each other to minimize fire hazards while limiting damage to the charger and helping reduce the cost of repairs.

Figure 1 is a typical AC circuit breaker used in Associated Equipment chargers.



fig.1

Figures 2 and 3 are typical DC circuit breakers used in Associated Equipment chargers.



fig. 2



fig. 3

There are times where multiple breakers are used in parallel with one another to create a higher rating of protection than a single breaker can offer by itself. Figure 4 represents typical usage of multiple breakers in a parallel array.

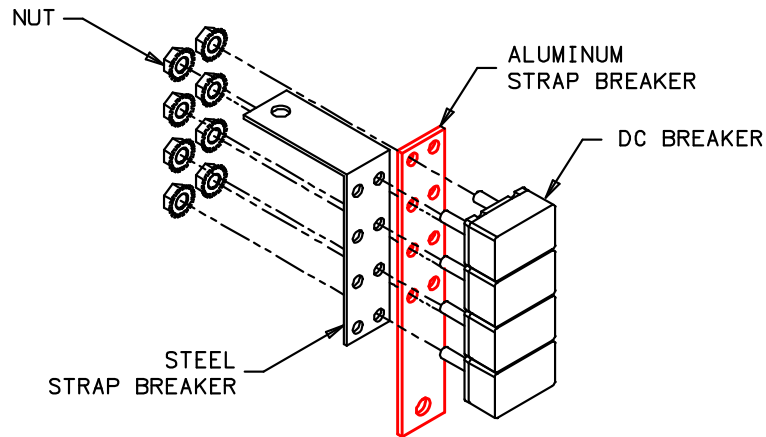


fig. 4

### Rectifiers / Diodes:

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. The terms rectifier and diodes are used interchangeably among repair technicians. Associated Equipment chargers use a full wave bridge rectifier.

A full-wave bridge rectifier is essentially two half-wave rectifiers, and can be made with two diodes and a center tap on the transformer. The positive voltage half of the cycle flows through one diode, and the negative half flows through the other. The center tap allows the circuit to be completed because the current cannot flow through the other diode. The result is still a pulsating direct current but with just over half the input peak voltage, and double the frequency.

See figure 5 for the typical usage of a full wave bridge rectifier in a battery charger application. Note the AC voltage source on the left and the DC output supply on the right.

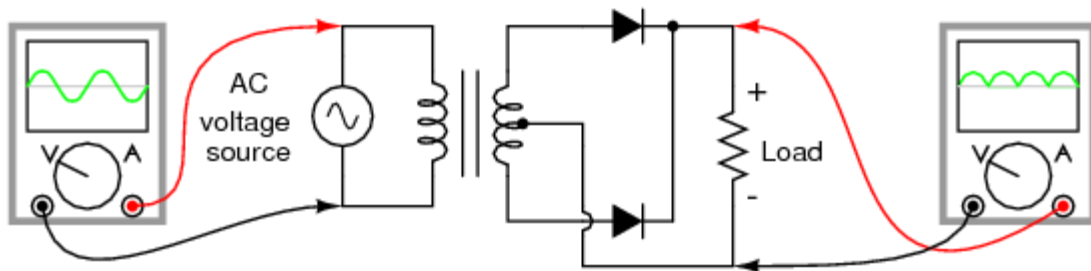


fig.5

Diodes come in a variety of shapes and sizes to fit the individual needs of an application. Below are some of the types used in Associated Equipment chargers but all serve the same function.



fig 6



fig. 7

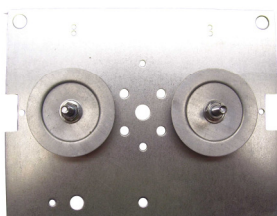


fig 8

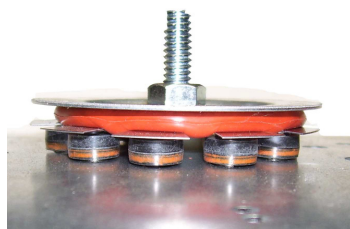


fig 9

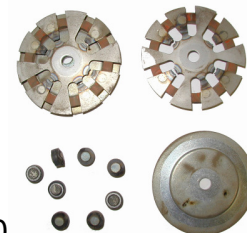


fig 10

Button diodes are used in many of our chargers (fig.9). Utilizing multiple diodes in a parallel array allows one or more diodes to fail while the remaining diodes continue to provide power to charge the battery until the diodes can be replaced. Figure 10 shows the burned fusible links on the star ring of a disassembled rectifier assembly.

**Amp Meters:**

An ammeter is an instrument that measures electric current, usually in units of amperes (or milliamps or micro-amps when very small currents are involved). Both the magnitude of direct current (DC) and alternating current (AC) can be measured, though with ammeters of different types.

The moving coil ammeter has three basic parts: a permanent magnet, a coil, and a coil spring. When current is passed through the coil it creates a magnetic field that is opposite that of the permanent magnet, causing the coil, and its attached pointer, to pivot. The coil spring not only limits the distance the coil can rotate, but the amount of tension it exerts depends on the strength of the force turning the coil.

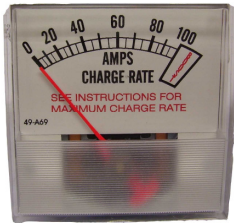


fig 11

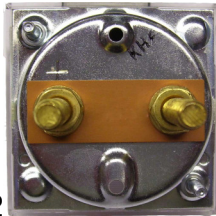


fig 12

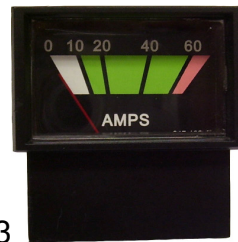


fig 13



fig 14

**Timers:**

A timer is a specialized type of clock. A timer can be used to control the sequence of an event or process. In the case of chargers, it is used to govern the amount of time that a battery receives a charge. This is especially useful if the operator will not be present during the charge cycle so as to eliminate the possibility of overcharging the battery. Associated Equipment timers are 0-90 minutes.

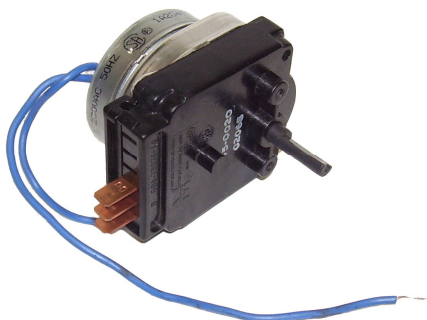


fig 15

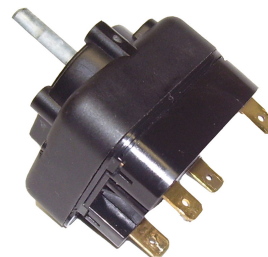


fig 16

Figure 15 shows an electric timer which uses electricity to power a small motor that turns the gears that count down till shutoff. Figure 16 is a mechanical timer that operates much like a stovetop timer. It does not use electricity to run, but rather it uses a spring that is wound when setting the time. It has a ticking sound when counting down.

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### Transformers:

Alternating current in the primary winding creates an electromagnetic field that induces a current in the secondary winding when the field changes. Small transformers use enameled wire for their windings, while large transformers use insulated copper wire. Transformers can be single winding, center-tap, or multi-tap. Center-taps have a terminal at the middle point of the secondary winding, which has half the voltage of the end terminal. Multi-taps have many terminals along the winding, whose voltages depend on their locations. The purpose of the core is to direct the electromagnetic field through the secondary winding.

A transformer transfers electrical energy between two circuits. It usually consists of two wire coils wrapped around a core. These coils are called primary and secondary windings. Energy is transferred by mutual induction caused by a changing electromagnetic field. If the coils have different number of turns around the core, the voltage induced in the secondary coil will be different to the first. The primary taps are connected to the rate switch(s) on the charger. Multiple primary leads allow multiple voltages on the secondary (output) leads for 6, 12, 18, 24 volt chargers.

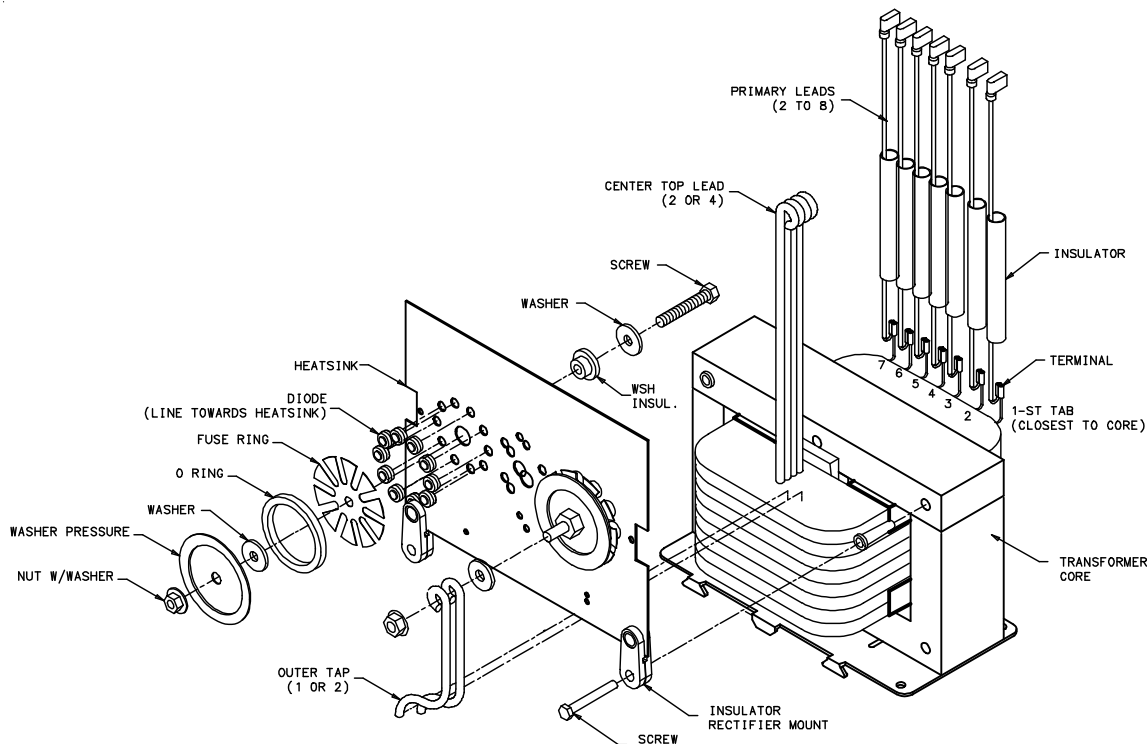


fig 17

Figure 15 shows the transformer and the typical connection to the rectifier assembly in an Associated Equipment charger.



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**Rate Switch:**

A rotary switch is a type of switch that is used on devices which have two or more different "states" or modes of operation, such as a three-speed fan. In the case of battery chargers, it is used to adjust the output voltage up or down depending on the battery size and voltage.

A rotary switch consists of a spindle or "rotor" that has a contact arm or "spoke" which projects from its surface like a cam. It has an array of terminals, arranged in a circle around the rotor, each of which serves as a contact for the "spoke" through which any one of a number of different electrical circuits can be connected to the rotor. The switch is layered to allow the use of multiple poles, each layer is equivalent to one pole. Usually such a switch has a detent mechanism so it "clicks" from one active position to another rather than stalls in an intermediate position. It has a common input with multiple outputs that correspond with the position it is set to.

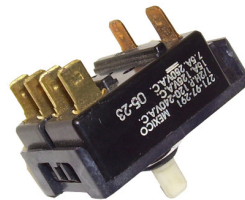
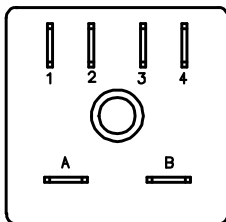
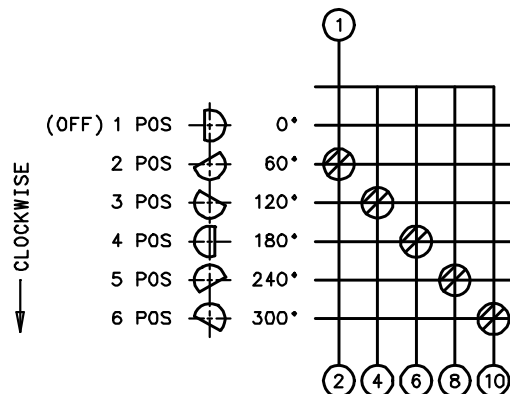
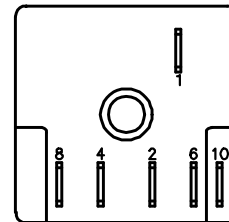


Fig18



ANGLE	CONNECTION
0°	A - 1
45°	OFF (NO CONN.)
90°	A - 2
135°	OFF (NO CONN.)
180°	A - 3
225°	OFF (NO CONN.)
270°	A - 4
315°	OFF (NO CONN.)

CIRCUIT



CIRCUIT