

Making Resistance Wheel Sets for Occupancy Detection

By Dick Bronson

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Narrative

Now that we have our detectors in place we will need some way to detect every car on the layout. (at least to do things prototypically) The main requirements are simplicity, speed, and cost effectiveness. Remember even a modest layout will have hundreds of wheel sets to convert.

Using commercial resistance wheel sets was just not an option for me. Besides, some of them have over sized axles that will not fit properly into my trucks. The most common metal wheel sets on my layout are Kadee. They are made of sintered zinc, and it is not possible to solder to them.

A second problem that I noticed is that many of my freight cars have little if any clearance from the coupler pockets to the axles of the outer wheel sets. Under frames often limit the clearances on the inner wheel sets. My six wheel passenger trucks have even less clearance to the axles than the freight trucks do.

The Kadee axles are apparently made of Delrin or some similar engineering plastic. This makes it hard to reliably glue anything to them.

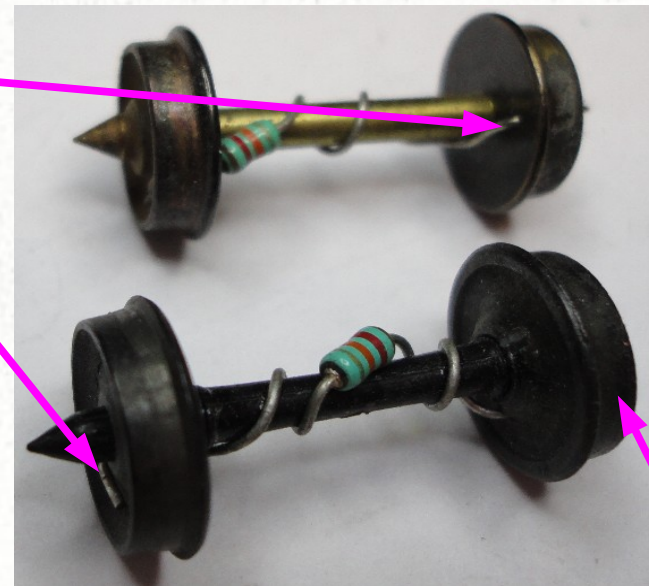
Narrative

I have seen people use small resistors with the wire wrapped around the axles and fed through small holes drilled in the wheels, then bent over. This is not reliable for long term use. In time the connections will corrode and the resistors will no longer be connected to the wheels.

Here are two examples of resistor connections using the drill and crimp method that have failed over time.

This type of resistor, even in very small sizes, may also easily interfere with draft gear.

Simply adding a drop of conductive paint to each hole when they were originally constructed would probably have solved any issue of corrosion. It appears that the blackening was not removed from the Kadee wheel treads.



Narrative

Many folks have found that polished metal wheels seem to remain much cleaner and do not pick up junk from the rails as easily. I do not bother to paint over the resistance paint, as it is a dark gray, almost black. However, you may do so if you want to. Be sure to test your paint on one wheel set first if you do decide to paint over the resistance paint. Some paint solvents might effect the resistance. You probably will want to paint over any metallic conductive paint. Again be sure to test first.

I put one conductive wheel set at each end of a freight car, and from experience, I place two conductive wheel sets on any three axle truck. The reason for this is that usually one out of the three axles in a typical truck is not carrying any weight, and that is the axle I seem to pick for the conductive wheel set. By using two axles, at least one is always carrying some weight for good contact. (unless the track is really uneven) Using 100% resistance wheel sets would probably improve reliability slightly, especially if a single car is just barely pushed over a block boundary, but the extra cost and time is probably not be worth the effort.

Making Resistance Wheel Sets for Occupancy Detection

- Materials
- Tools
- Preparing the wheel sets
- Installing the resistors
- Checking out the installation

Materials – Rubberized CA Adhesive

IC-2000 Rubber Toughened CA Adhesive

About \$10.00 on E-Bay.



Materials – CA Adhesive

Quick Dry Nail Glue (CA Adhesive)
#SBS-164408

About \$5.00 at Sally Beauty Supply.



Materials – Bare Conductive® Electric Paint

Bare Conductive® Electric Paint
#PMNK_P0002879

About \$10.00 at RadioShack (2760267)

This product claims it “Can be removed with soap and water” which makes me question its long term suitability for our purposes.



Materials – CA Adhesive

Brush-On Nail Glue (CA Adhesive)
#SBS-527006

About \$4.00 at Sally Beauty Supply.



Materials - Resistors

10K 0805 Resistors.

\$0.08 each.

\$10.00 / 5,000



Materials - Wheel Set

Athearn Wheel Set

\$1.00 each.

Plastic wheels, metal axles. Not suitable due to plastic wheels, and probably steel axles. (not good around uncoupling magnets)



Materials - Wheel Set

Herpa Wheel Set

\$0.50 each.

\$39.00 / 100

Plastic wheels, brass axles. Not suitable due to plastic wheels.



Materials - Wheel Set

InterMountain Wheel Set

\$1.00 each.

\$70.00 / 100

Machined blackened brass wheels, brass axles, one side insulated. Excellent option for trucks with plastic side frames.



Materials - Wheel Set

Kadee Wheel Set

\$1.20 each.

\$9.00 / 12

Blackened sintered zinc wheels, plastic axles. The blackening is an insulator and must be removed for resistor wheel sets. Do not use plastic axles in plastic side frame trucks. OK for metal side frames.



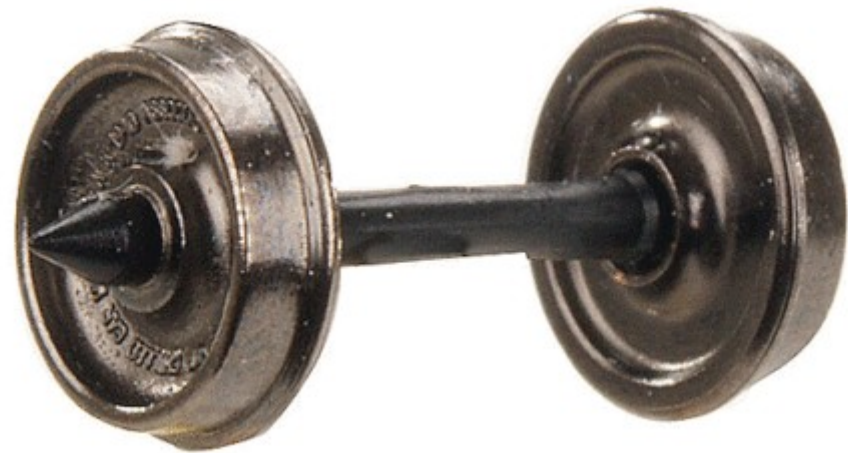
Materials - Wheel Set

Proto 2000 Series Wheel Set

\$1.00 each.

\$11.00 / 12

Sintered zinc wheels, plastic axles. The coloring is an insulator and must be removed for resistor wheel sets. Do not use plastic axles in plastic side frame trucks. OK with metal side frames.



Materials – Conductive Paint

MG Chemicals 840-20G

\$10.00 each.



Materials – Conductive Paint

GC Electronics 22-207

2 FL. OZ. \$36.78 each.



Materials – Conductive Paint Pen

MG Chemicals 841-P

\$11.45 each.



Materials - Resistive Paint

M.G. Chemicals #838-340G

Be sure to shake very well in order to disperse the carbon evenly. Shake between uses.



Tools – Wire Wheel

Stainless Steel 3/4" Wire Wheel for Dremel
or similar motor tool

\$5.00 each – \$5.00 / 10 (ebay)



Tools - Tweezer

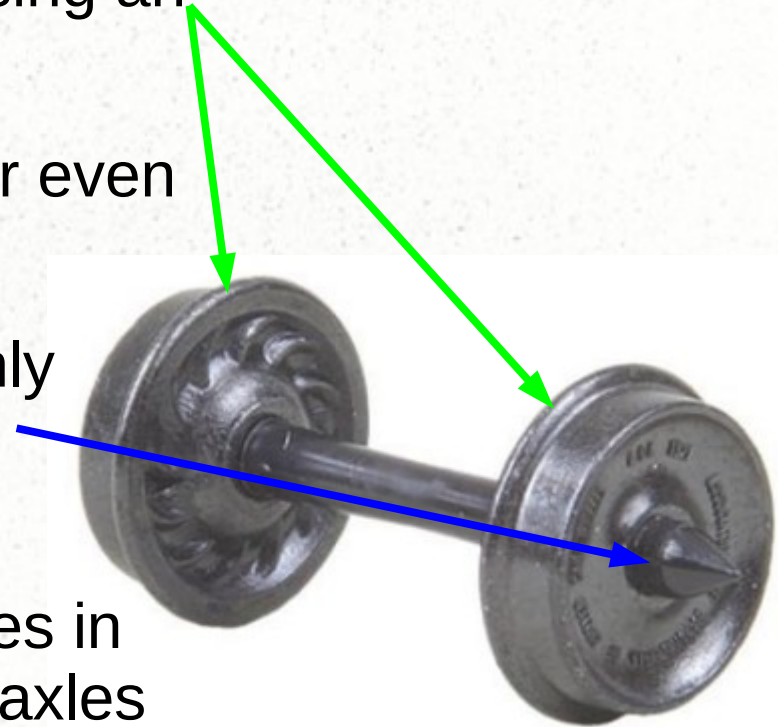
Stainless Steel Tweezer

\$1.00 – \$5.00 each (ebay)



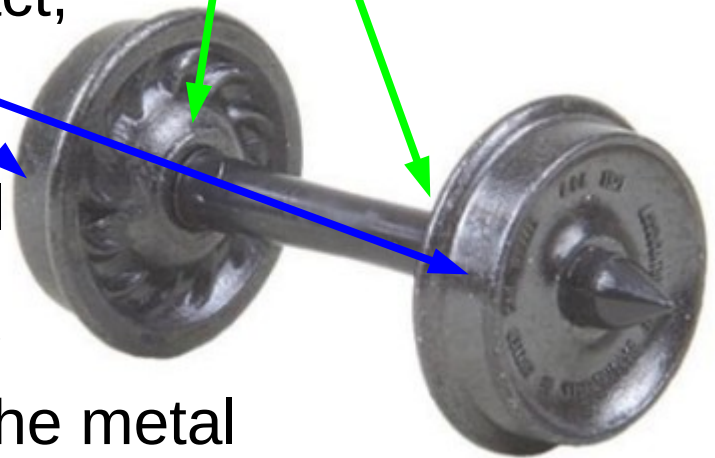
Preparing the Wheel Set

- First check the Wheel Spacing using an NMRA gauge.
- Correct the spacing and check for even rolling before adding resistors.
- Check that the axle extends evenly from both wheels and fits your trucks.
- For minimum wear use metal axles in plastic side frames, and plastic axles in metal side frames.



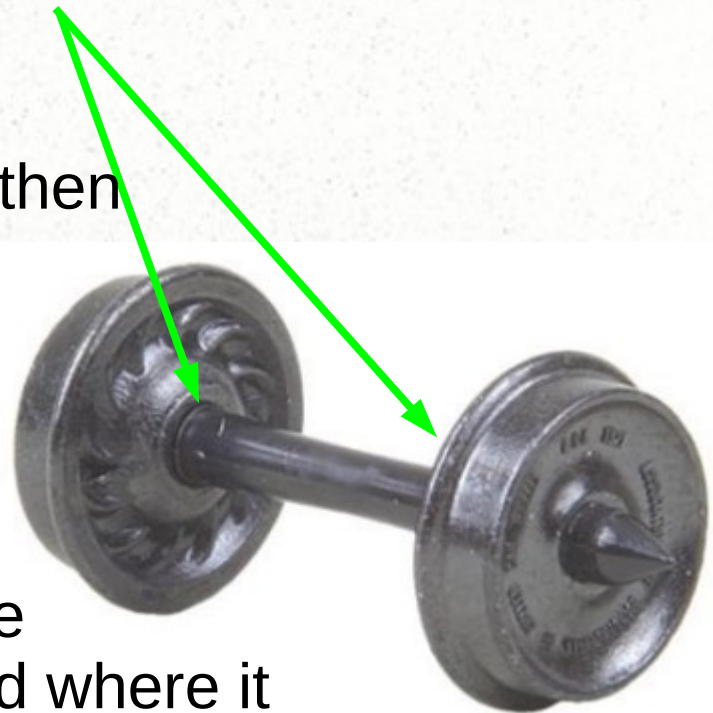
Preparing a Proto 2K or Kadee Wheel Set

- For P2K or Kadee wheels we must first remove the insulating chemical blackening from the back of the wheels where we will connect the resistance.
- We also will polish the wheel treads. This not only improves the contact, but also improves the looks.
- Using a wire wheel in your Dremel tool gently polish these places while letting the wheel set slowly rotate in your fingers. Go easy, the metal is soft. **Use eye protection!**



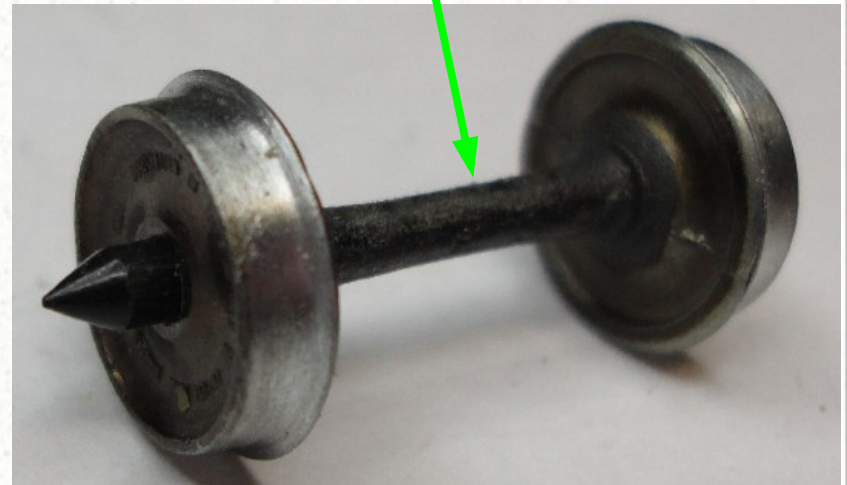
Preparing a Proto 2K or Kadee Wheel Set

- For P2K or Kadee wheels we must also fill the groove between the axle shoulders and the wheels themselves.
- If these grooves are not prefilled, then the conductive paint may crack as it dries and cause a failure.
- Use a tiny drop of CA adhesive and let it flow into the crack. Be sure not to get adhesive onto the areas that you have just polished where it may interfere with the resistance connection.



Kadee and Proto 2000 Wheel Sets

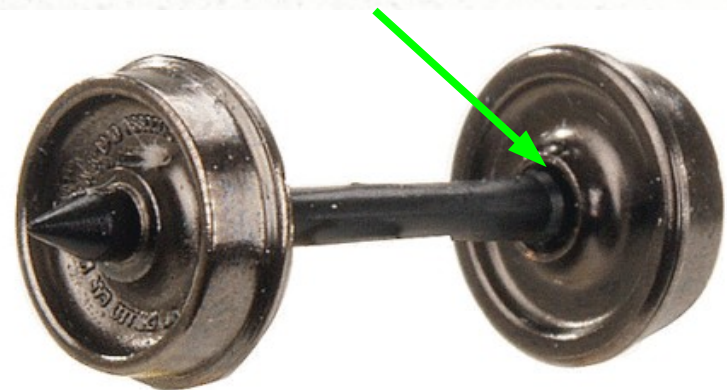
- Both Kadee and Proto 2000 wheels use plastic axles and metal wheels .
- We have two options for these wheel sets, resistance paint, or resistors and conductive stripes.
- Resistive paint has the advantage of being quick and non-invasive. Other than for the polished wheel treads, this Kadee wheel set with resistive paint is not noticeably different than the original.
- The disadvantage of resistance paint is a lack of consistency. This wheel set measures 26K ohms, and needs repair.
- Resistors will give consistent results, but may hit coupler boxes, especially on freight cars with clunky designs.



Resistive Paint for Plastic Axle Wheel Sets

- To use resistive paint first be sure that the grooves have been filled and there is no longer any crack at the wheel hubs.

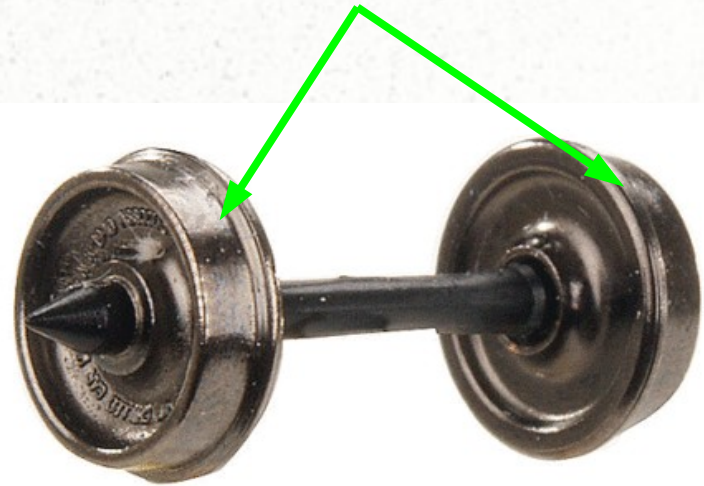
- Next line up a row of wheel sets and tape them to a piece of cardboard. Face the buffed area up. Apply the tape so that it protects each wheel tread but still allows access to the axles and wheel backs.



- Make two even spray passes, one aimed at each wheel back about even with the hubs. When you are done with the spray paint, BE SURE to turn the can upside down and clear the nozzle of graphite particles. (voice of experience speaking)
- Allow the paint to dry normally, or use a hair dryer for faster results.

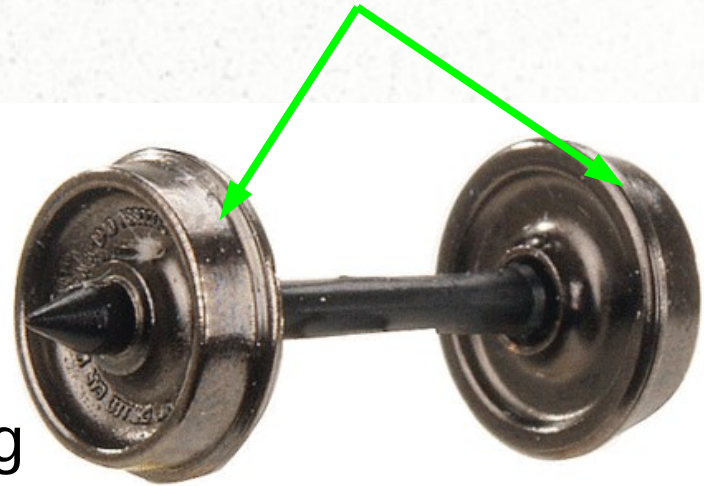
Resistive Paint for Plastic Axle Wheel Sets

- Once the paint is dry use an ohmmeter to check the resistance between wheels.
- You are looking for a value between 5-15K ohms.
- If the resistance value is too low you can sand or scrape some paint from the sides of the axle.
- If the resistance value is a little bit too high you can try burnishing the paint, or else spray on another layer.
- If the resistance reads ∞ then there is a break someplace in the paint surface from one wheel to the other, the paint is not yet dry, or the blackening was not well removed. Check with your ohmmeter to locate the break. Repair with a drop of conductive Paint.



Resistors for Plastic Axle Wheel Sets

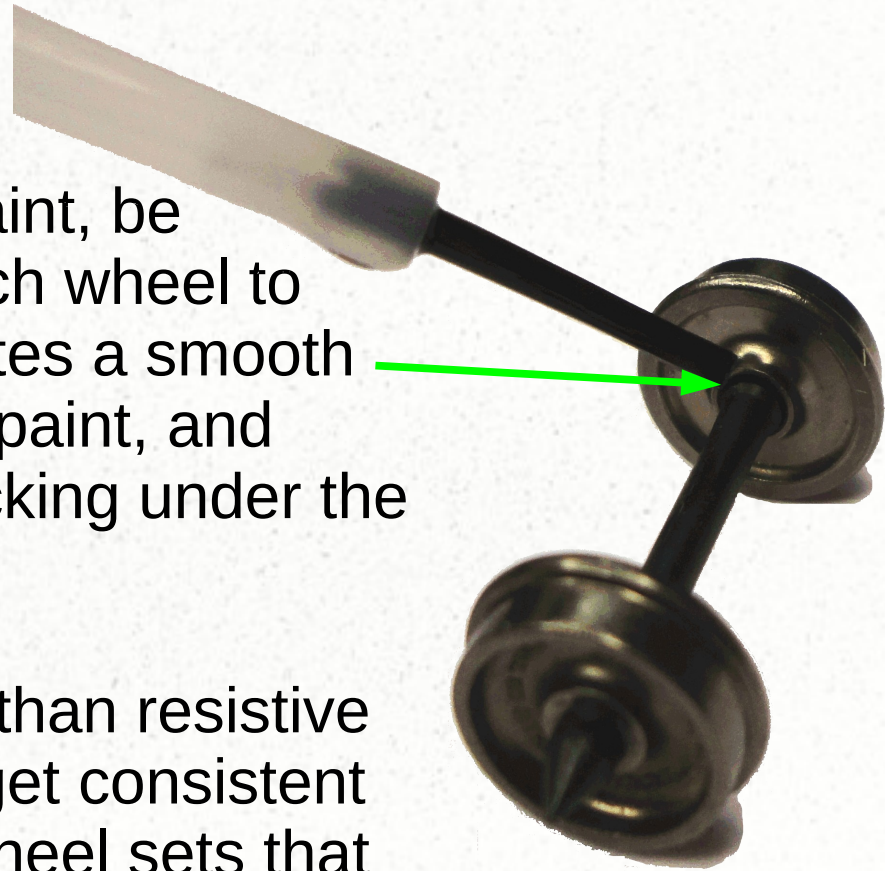
- The other option for axles is to install individual resistors on each wheel set. Our RR-CirKits detectors are designed for 10K wheel resistors, and will detect a single wheel set that is making good contact with the rails.



- Resistors are more bulky than resistive paint, but are easier to get consistent results with. For wheel sets that utilize metal axles they are the only practical method to use.

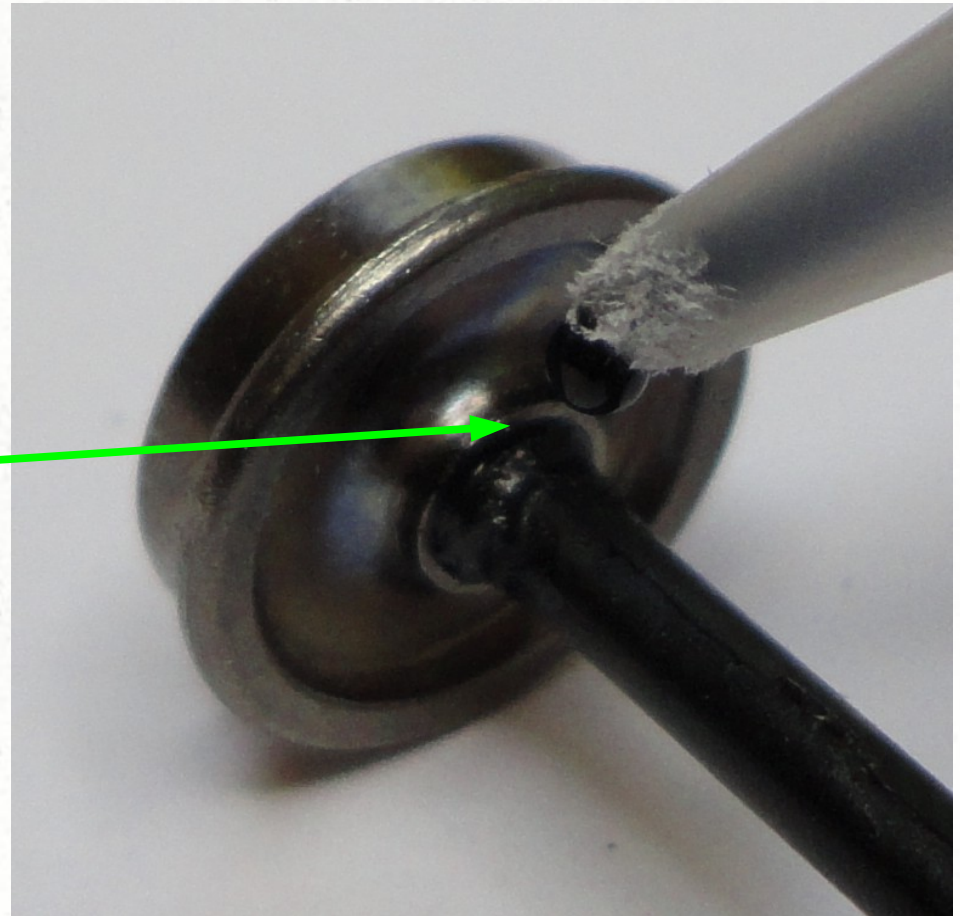
Resistors for Plastic Axle Wheel Sets

- Like we do for resistive paint, be sure to fill the gap at each wheel to axle joint. The filler creates a smooth base for the conductive paint, and helps prevent it from wicking under the resistor.
- Resistors are more bulky than resistive paint, but it is easier to get consistent results with them. For wheel sets that utilize metal axles they are the only practical method to use.



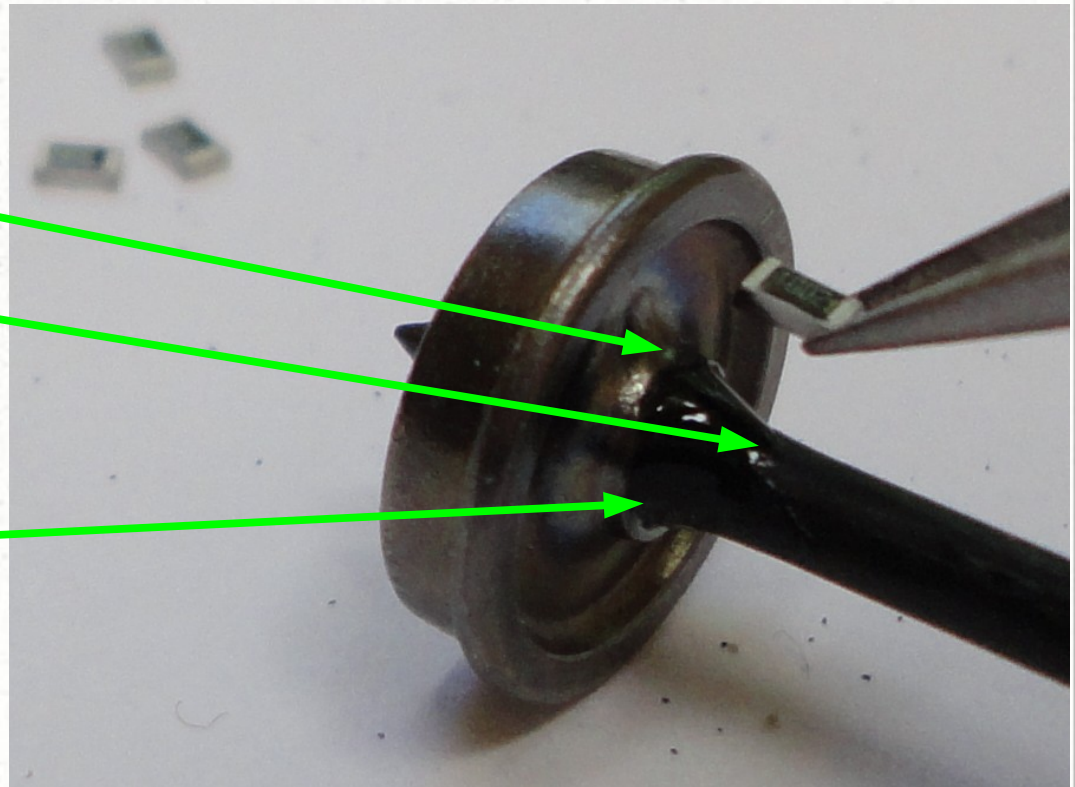
Resistors for Plastic Axle Wheel Sets

- Collect enough resistors to do the wheel sets you have prepared.
- Place a small drop of the IC-2000 Tire Glue at the corner between the axle and the wheel.
- Be sure that you clear the nozzle after use to prevent clogging, or else use a toothpick to place the drop of glue.



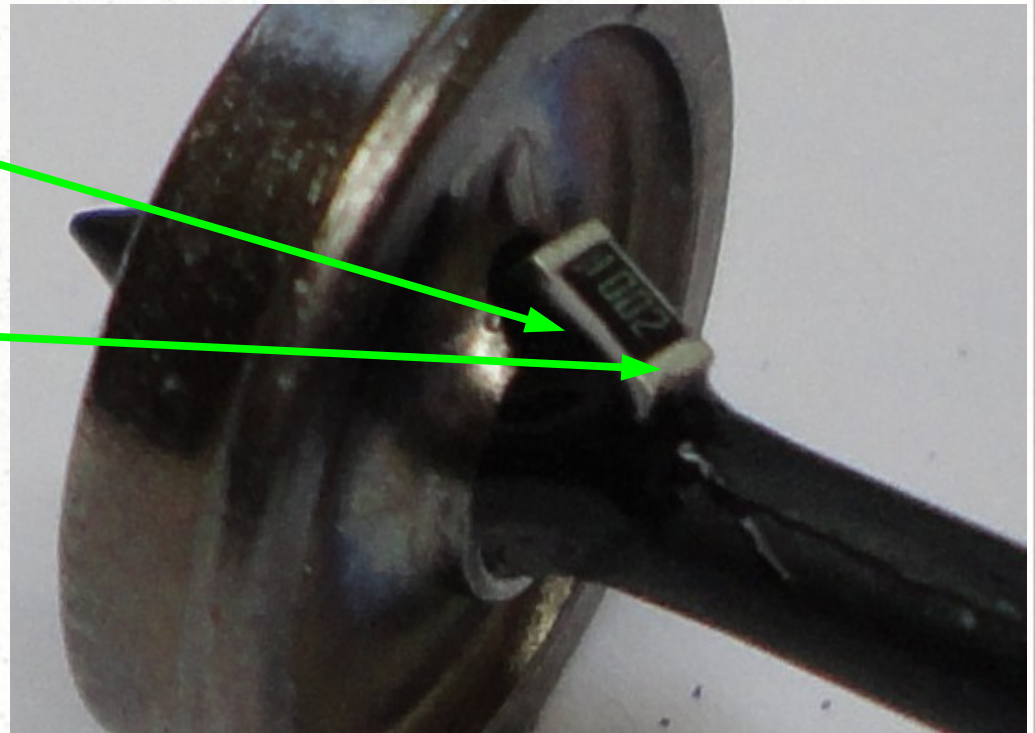
Resistors for Plastic Axle Wheel Sets

- Using a tweezer, position a resistor so it sits on the drop of glue at a approximate 45° angle between the wheel and the axle.
- Note that the joint at the axle has been filled in to create a smooth mounting surface.



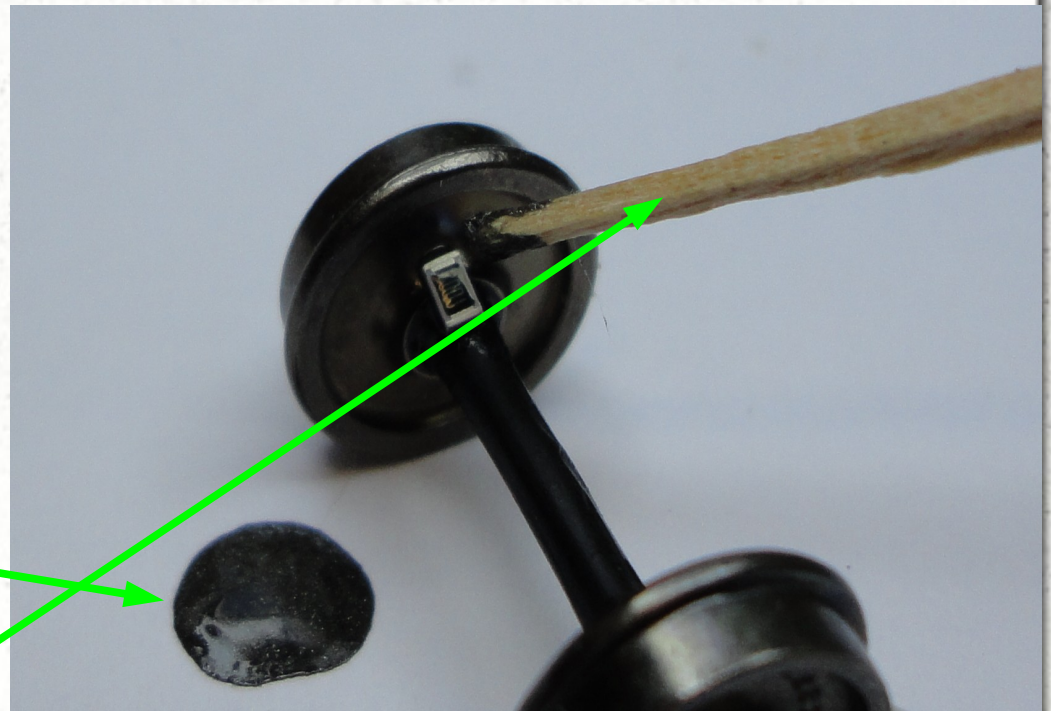
Resistors for Plastic Axle Wheel Sets

- Important! Be sure that the Tire Glue flows completely under the resistor, but that it does NOT cover the top of the metal end caps.
- If the glue does not cover the back of the resistor completely, then the conductive paint may wick under and short circuit the wheel set.



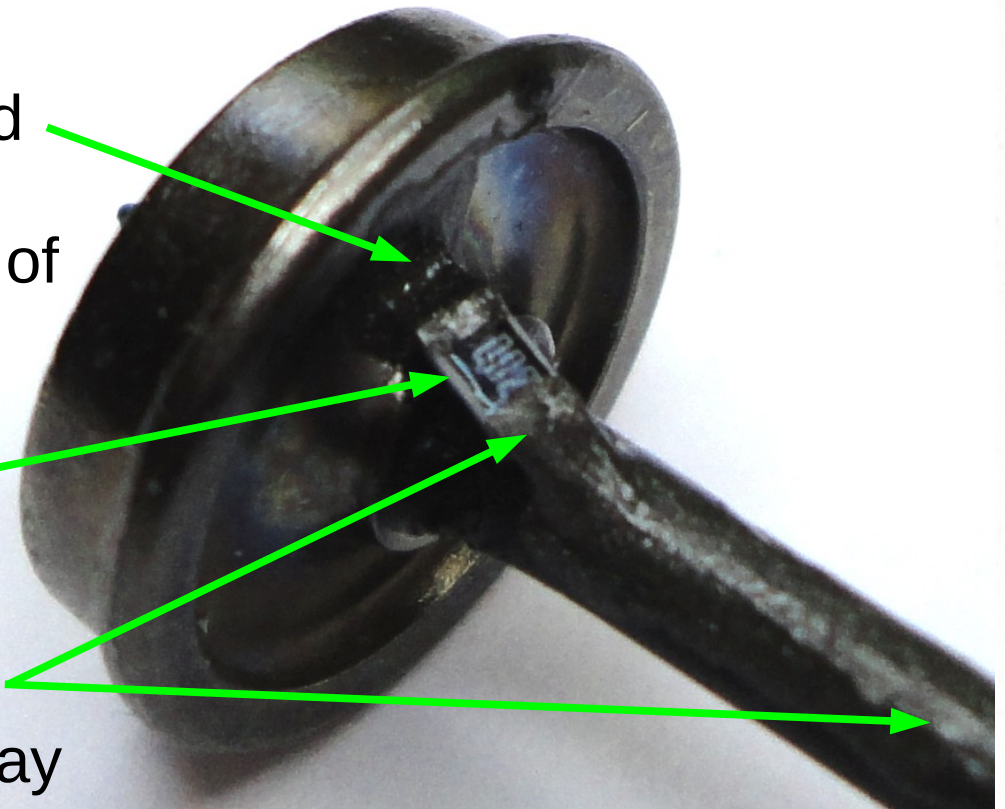
Resistors for Plastic Axle Wheel Sets

- Once the glue has set you can add the conductive paint. Be sure to shake the paint vigorously and often to keep the metal flakes in suspension.
- I find that placing a drop of conductive paint on a work surface, then using a toothpick as an applicator works well.



Resistors for Plastic Axle Wheel Sets

- Shake the paint again!
- Note that the conductive paint covers the metal end cap of the resistor and extends up onto the back of the wheel in a fan shape.
- Be sure that no paint is on the central portion of the resistor.
- Note that the paint stripe covers the 2nd metal end cap and extends all the way to the opposite wheel.

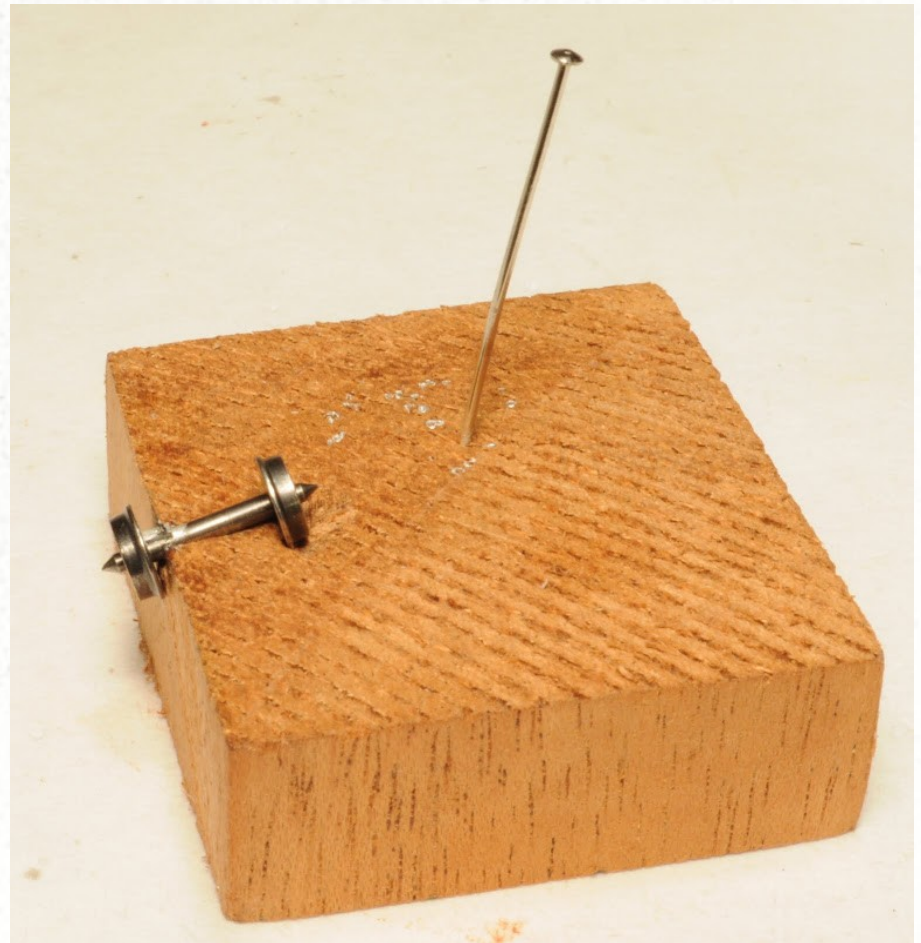


Tricks and Tips

- I mentioned shaking the paint often because if it is not thoroughly mixed, then it may not be conductive when it has dried.
- Conductive paint is ordinary paint binder with a conductive pigment such as carbon or metal flakes. If there is insufficient pigment in the mix, then the particles will not be able to touch one another even after it has dried, and it will not be conductive.
- All conductive paint is an insulator until the paint itself has dried. As it dries the paint film shrinks down and the conductive particles come in contact with one another. Always wait until the paint has dried before testing your wheel sets.

Tricks and Tips

- I found this simple wheel holding jig from Ed Kapuscinski on The Railwire forum.
<http://www.therailwire.net>
- It appears to be balsa and not only holds the wheel set itself, but also the pin used to apply the conductive paint.
- A slot is filed in the edge to grab the axle. Obviously it could easily be built to hold multiple wheel sets for mass production.

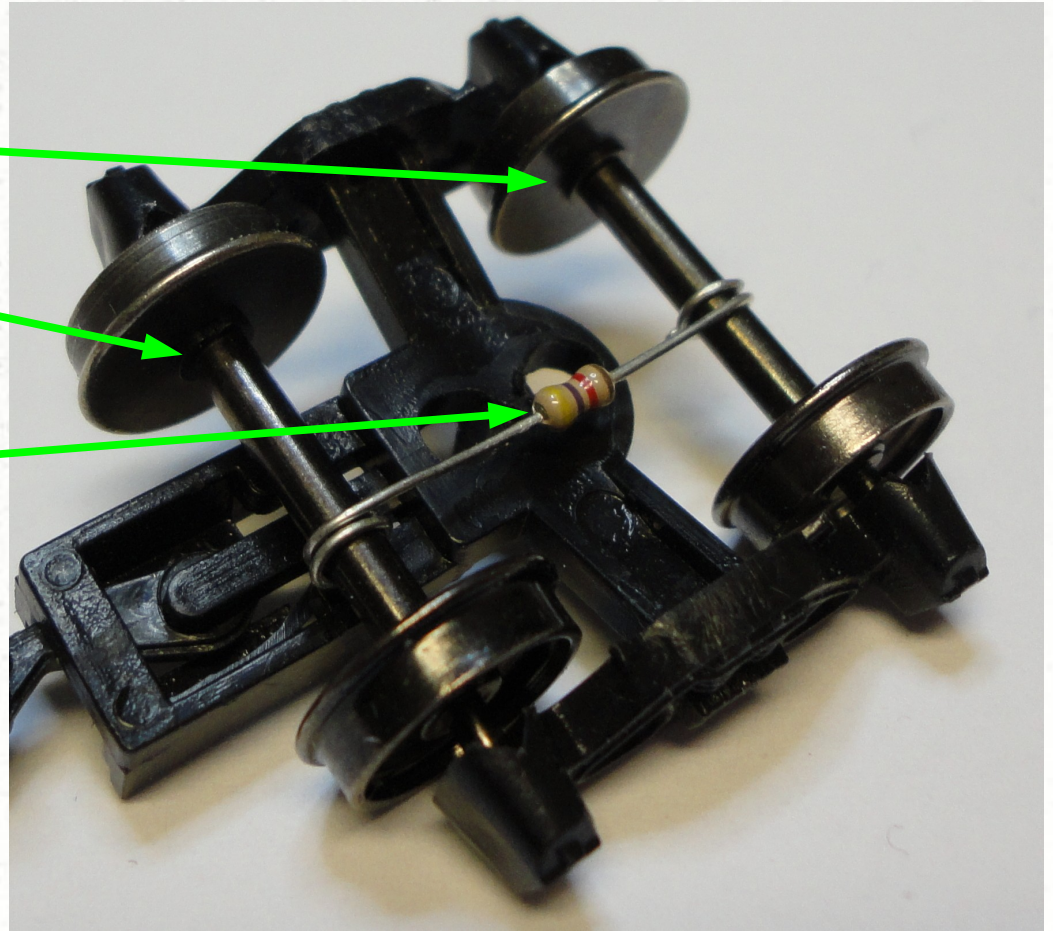


Resistors for Metal Axle Wheel Sets

- Metal axle wheel sets require resistors, not resistive paint, because the length of the insulation is very short. Of course the resistor must cross over the insulation and each end needs to be connected to its corresponding circuit.
- One way that you may be able to do this is an option if your cars have metal axles and plastic side frames. Simply take one wheel set and reverse it in the truck. Then take a resistor with leads and wrap one lead around one axle and wrap the other lead around the second axle. The resistor simply hangs between the axles, and connects from one to the other.

Resistors for Metal Axle Wheel Sets

- Reverse one axle.
- Insulated bushing.
- Uninsulated side.
- Resistor hangs between axles.
- Do NOT try this method with a metal side frame truck.



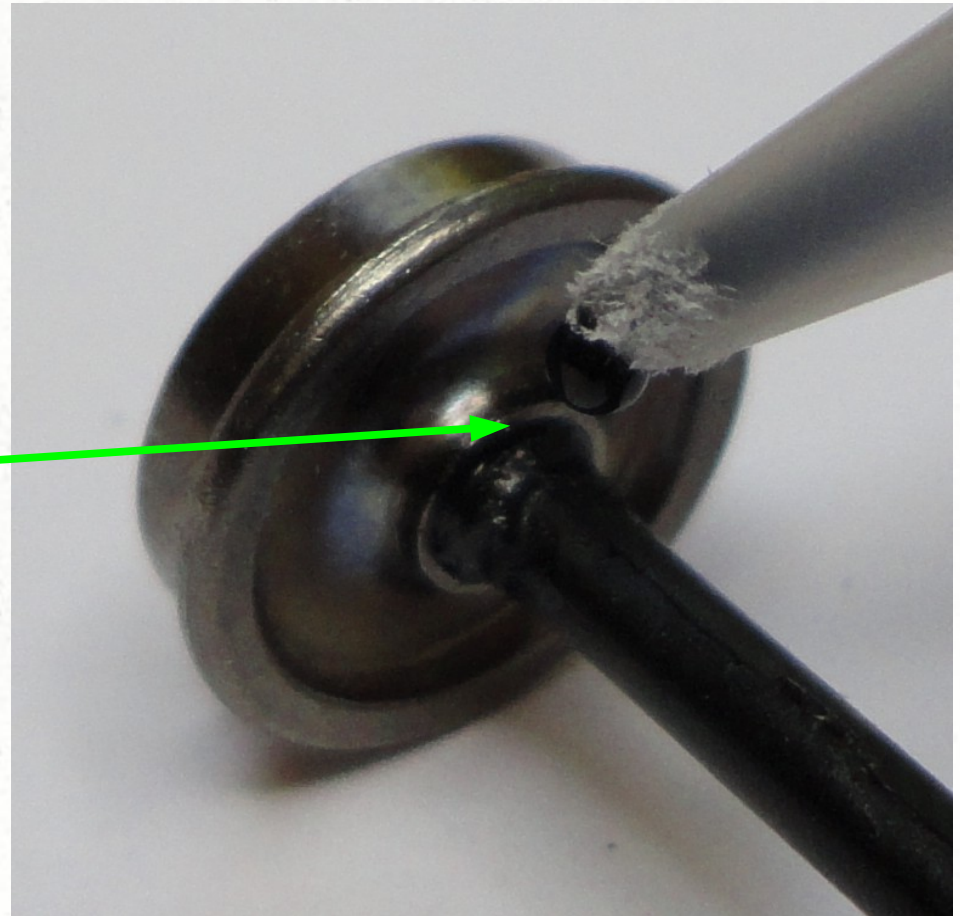
Resistors for Metal Axle Wheel Sets

- Collect enough resistors to do the wheel sets you have prepared.
- Buff any blackening from the back of the wheel and the axle on the insulated side.



Resistors for Metal Axle Wheel Sets

- Collect enough resistors to do the wheel sets you have prepared.
- Place a small drop of the IC-2000 Tire Glue at the corner between the axle and the wheel.
- Be sure that you clear the nozzle after use to prevent clogging, or else use a toothpick to place the drop of glue.



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