MAKING REAL WIRE WHEELS IN ALL SCALES

Jürgen Kowalski, July 2013
Document layout by Joaquín Sánchez, January 2020

The appearance of otherwise outstanding builds in 1/12 or smaller is completely spoilt if modelers fit those plastic "wire" wheels of the kit. Even the best kit rims (in 1/24 Fujimi and, surprisingly, Protar) have thick spokes entirely out of scale.

You could replace them by aftermarket photoetched parts if you happen to find the appropriate size for your project, if you are willing to pay a lot of money, and if you think that adding purchased parts to nowadays almost perfect kits can still be called modeling.
Otherwise you might be interested in my following technique.

I. What can my technique do?

It is applicable to any scale between 1/16 and 1/43. I am sure it works in 1/12 too.
The making is fast and, once understood, a routine job.
The wheels are delicate but very sturdy.
You can replicate any wheel design you need.
A set of wheels will cost you almost nothing.
Last but not least you can say you made them yourself.
You can expect results like these:

1/24 standard rim i. e. with spokes on 2 levels

1/24 racing rim with spokes on 3 levels

1/24 drop center rim

1/24 motor-cycle rim

1/16 standard rim

1/20 standard rim

II.The basic principle of my technique

When I was interested in 1/35 military modeling around 1980 there were some nice motor-cycle models. They were well-detailed but had spoke wheels that looked absurd. I found a fast and easy way to replace the thick plastic spokes by real wire spokes. I described it in this German magazine article that was published in 1984.

Modell Fan MILITÄRFAHRZEUGE

J. Kowalski, Pinneberg

Drahtspeichen contra Plastikspeichen

Die sonst recht guten Motorrad-Bausätze von Italeri und Tamiya im Maßstab 1:35 leiden sehr unter den gußtechnisch wohl nicht besser zu gestaltenden dicken Radspeichen. Ich habe nun ein Verfahren herausgefunden, welches das fertige Modell entscheidend verfeinert. Ich verwende zur Herstellung von neuen Speichen ganz feinen Draht. Der Zeitaufwand pro Rad kann etwa zwei Stunden betragen. Einem geübten Anfänger ist diese Arbeit ebenfalls zuzumuten.

1. Arbeitsfolge:
Das Originalrad wird halbiert, so daß zwei gleiche Ringkörper entstehen. Die Plastikspeichen werden entfernt, die Außenseiten der Naben abgerennt und aufbewahrt.

2. Arbeitsfolge:
Auf eine Grundplatte wird ein Ring mit Innendurchmesser des Außenmaßes vom Reifen aufgeklebt. Genau zentrisch wird ein kleinerer Ring aufgeklebt, dessen Innendurchmesser dem Außendurchmesser der zukünftigen Radnabe entspricht. Um den äußeren Ring werden je nach gewünschter Speichenzahl Draht stifte mit gleichen Abständen eingeschlagen.

3. Arbeitsfolge: Eine Radhälfte mit Schnittseite nach oben und eine neue Radnabe aus einem kurzen Plastikrundstück (aus Grabbelkiste) werden in den vorbereiteten Ringen auf der Grundplatte eingedrückt. Ein etwa 60 cm langer dünner Draht (vielleicht aus einem Modelleisenbahnkabel) wird am Anfang in einer Kerbe der Grundplatte befestigt und in einem Zug von einem Nagel zum anderen gespannt, so daß die Nabe eingebunden wird. Mit wenig Sekundenkleber wird der Draht an der Nabe und auf der Radhälfte fixiert. Danach wird der überstehende Draht an der Reifen-Lauffläche weggeschnitten und das fertige Stück der Vorrichtung entnommen. Der Vorgang wird mit der anderen Hälfte wiederholt.

4. Arbeitsfolge:
Beide Radhälften werden nun zusammengeklebt. Die verklebte Fuge in der Felge wird durch Einstäuben von Sekundenkleber geschlossen. Der Spalt im Reifen an der Lauffläche wird verspachtelt. Auf die neue Nabe können außen noch die vorher abgetrennten Teilchen aus der 1. Arbeitsfolge aufgeklebt werden. Die Vorbildnähe des Motorrad-Modells hat sich nun frappierend erhöht; wenn die Speichen völlig unverdeckt sind, wie bei den Ersatzrädern und den Seitenwagenrädern. Solch ein Drahtspeichenrad wirkt sehr filigran und durchsichtig.

hier sieht man den gravierenden Unterschied zwischen Draht- und Plastikspeichen am Modell.

You can see that here the spokes were applied directly to the plastic wheel halves.

This technique is okay for very narrow rims as bikes, motor-cycles and very few vintage cars, where all spokes are fixed very close to the centerline of the rim well, but on all other cars this looks completely unrealistic. This method is so obvious that it seems to be re-invented from time to time.

The difference to my technique I use since the mid-eighties for cars is to remove a radial section of the kit rim including spokes and hub and to replace it by a self-made unit.
I described this technique in an article that was published in April 1995 in FSM. I asked them for permission to show this old article in a German forum together with an update but never got any answer. That was not very polite, was it?

This is why I write this complete new how-to-do here.

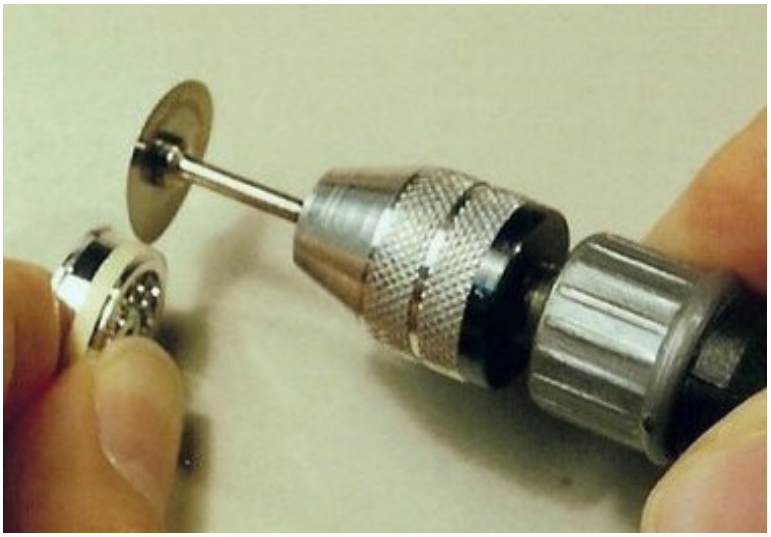
III. What abilities are required?

This is certainly nothing for the novice but if you are able to make simple conversions you will cope with all problems. Some knowledge in geometry is essential and if you tend to miscalculate you might have a problem.

IV. Tools required

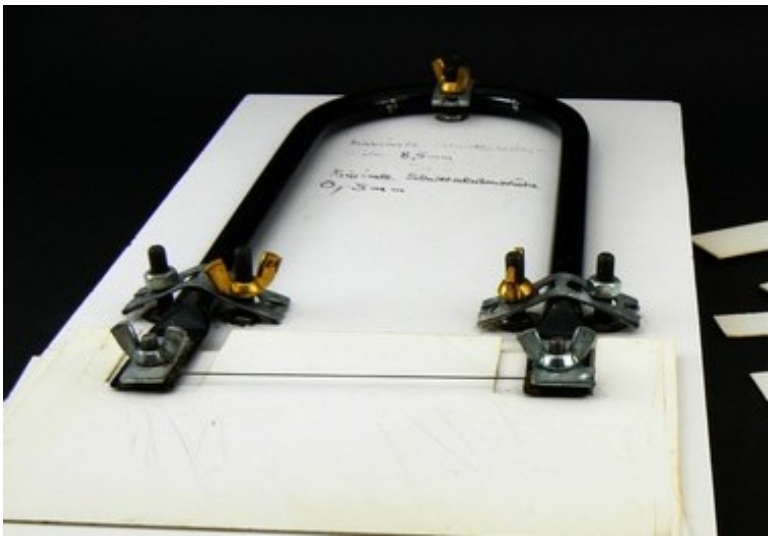
Indispensable is a caliper with electronic or mechanical dial because you have to take a lot of inside and outside diameters. You need a plastic drawing triangle (as you used it at school) for drawing exact angles and a compass.

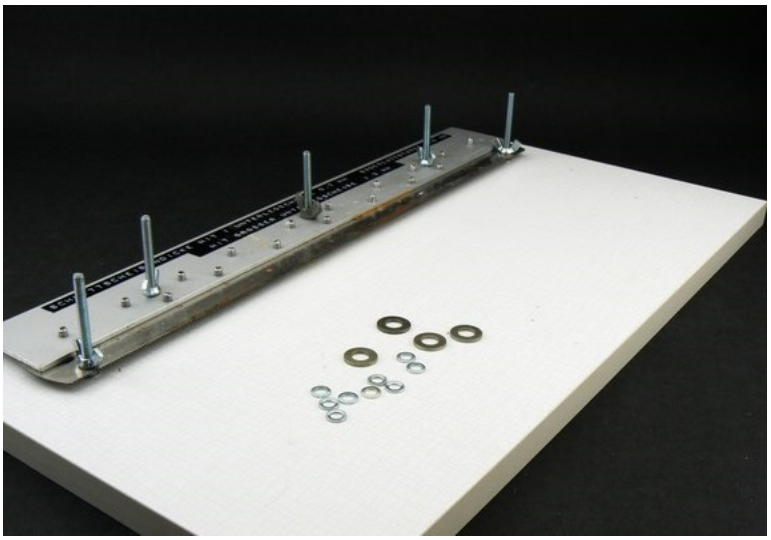
The final appearance of your spoke wheel depends a lot upon how exactly you divide the kit rim radially. You need **either**



A rotary tool with circular saw blade if you have a very steady hand; mark the line on which you intend to cut with a narrow strip of tape (least recommended).

Or a self-made construction that could be called "lying fretsaw " Here you determine the thickness of the cut by shimming the saw blade up with more or less washers.

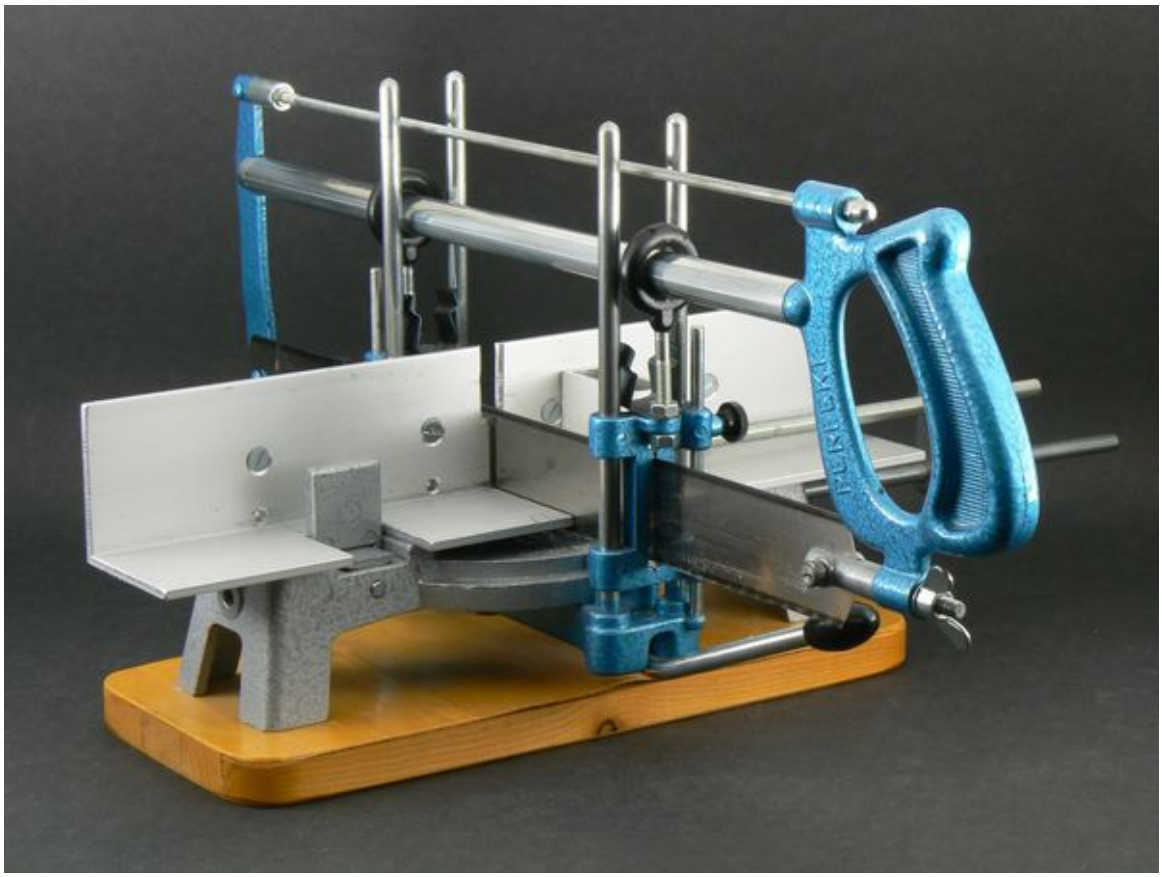


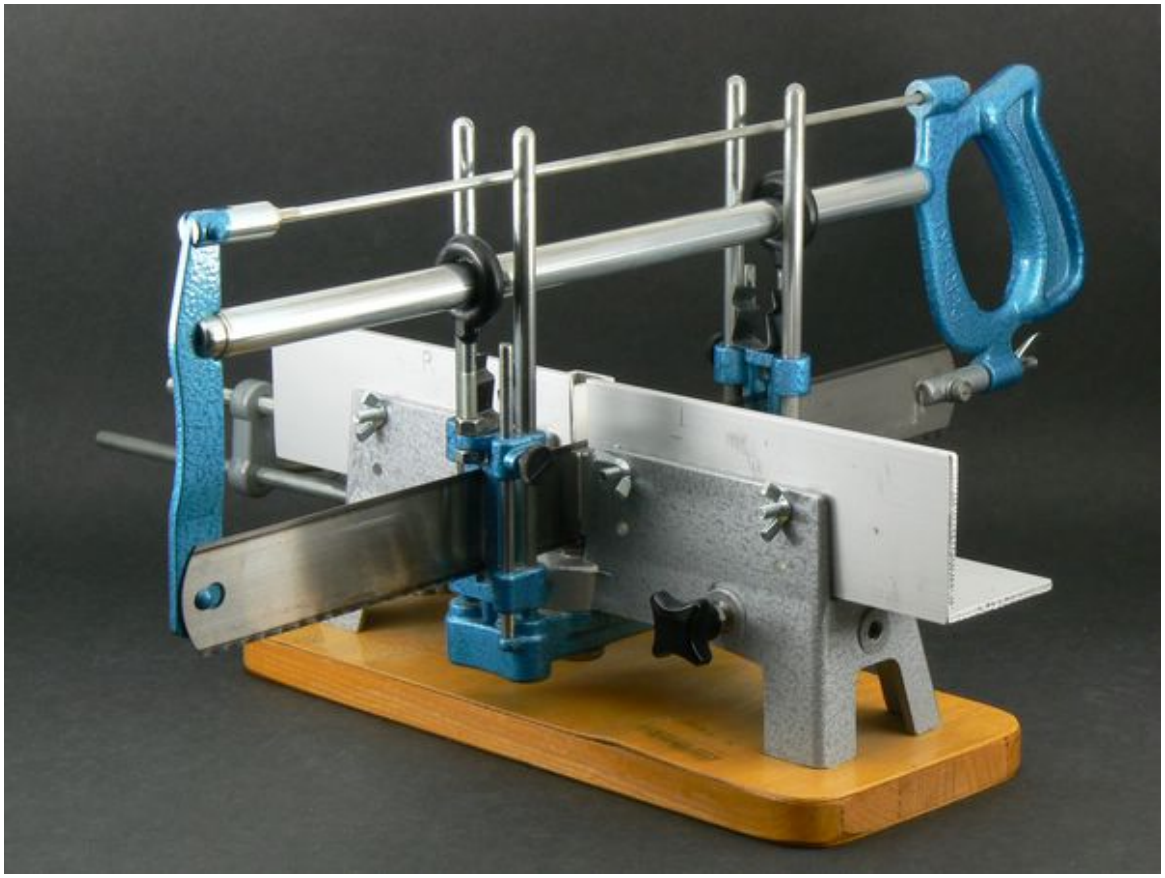


Or a similar self-made construction you could call " lying saw blade"

Or a converted small drill press with rotary tool and circular saw blade. This is the fastest and most exact way. By turning the vertical wing screw you can adjust the level of the saw blade by fractions of a millimeter.

Last you need a manual full-size miter saw (stay away from the flimsy small plastic Dobson Miter Rite) for cutting absolutely vertical rings of equal width from a tube. Originally meant for large pieces of material the surface of the "table" is often ribbed. Simply bolt on a piece of angle as I did. You will have to spend about 50 $, but you get a most versatile tool. Besides making wire wheels I use mine almost daily.





V. Material required

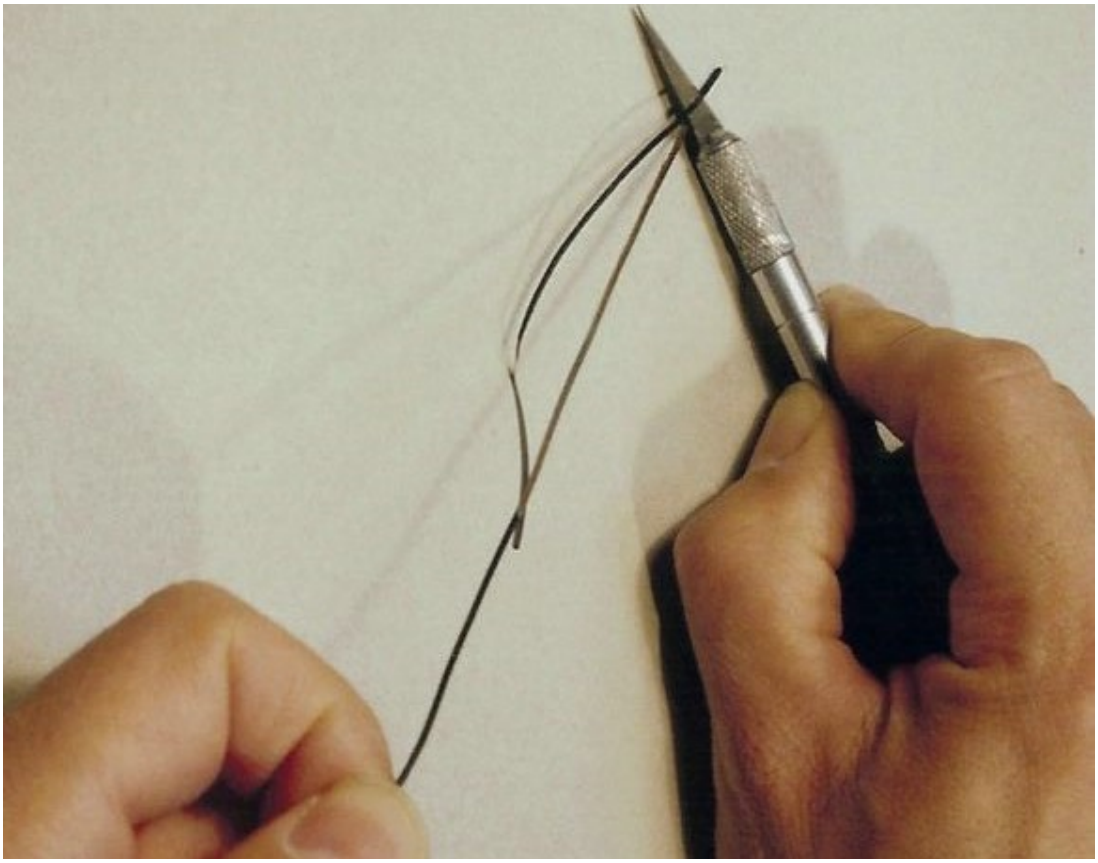
1. A handy piece of white chipboard (or something similar) of 10x10cm up to 20x20cm as a base for a spoke jig.

2. 2 telescoping plastic tubes. The small tube must have an **inside** diameter slightly larger than the smallest inside diameter of the kit rim. You find telescoping tubes f. e. at Plastruct. I prefer, however, inexpensive plastic tubes sold (in Germany) at house improvement stores or hardware stores in the electrical supply departments; they are meant to protect and to fix electric wirings if these are not covered by casting f. e. in garages and cellars. In English they should be called conduit. If you cannot obtain the suitable small tube you should buy a larger diameter and reduce its inside diameter with a strip of sheet plastic; this is much easier than enlarging a diameter too small. If you cannot obtain the large tube it may be replaced by a stopgap I will mention later.

3. Approximately 50cm of scrap wire approximately 1mm thick

4. If you want to keep the stubs at the ends of the kit axles (meant to bear the kit wheels) you need a piece of metal tube that fits exactly onto these stubs. If you cannot find a fitting tube or if these stubs are too thick simply cut them off, drill holes instead and insert a piece of sturdy wire.

5. Material for your spokes. There are 3 alternatives:
   - At first glance nylon monofilament (= fishing line) seems perfect. It is inexpensive, easy to obtain in many gauges and extremely strong but it is very difficult to glue and requires additional measures. Therefore, I cannot recommend it for my technique.
   - Usually I use copper wire. You find it in various gauges in almost any scrap cable. For 1/24 scale 0.13mm is a convincing diameter. I take this diameter from inexpensive model railroad wiring. One spool at a few Dollars gives enough wires for a modeler's life. Simply strip the insulation this way:



- Spokes made of copper wire that thin are, however, bent very easily, so you have to touch your wheels with utmost caution. Once bent it is almost impossible to realign them properly. If you want to eliminate this risk buy a spool of stainless steel wire.

VI. 4 golden rules for making wire wheels

1. Check if the size of the kit wheels looks correct. If not look for replacement wheels from your spares box or another kit. After spending much time and effort it would be very frustrating to see that your nice wire wheels look odd fitted to the car.

2. If you want to use the kit tyres your wire wheels must keep the original dimensions. Otherwise the tyres will not fit properly. Therefore note down all dimensions of the kit wheel before starting work.

3. ***Always*** make a large (f. e. 10/1) section scale drawing of the planned wire wheel including the hub first. Check your drawing and all calculations several times. This makes annoying planning mistakes very unlikely.

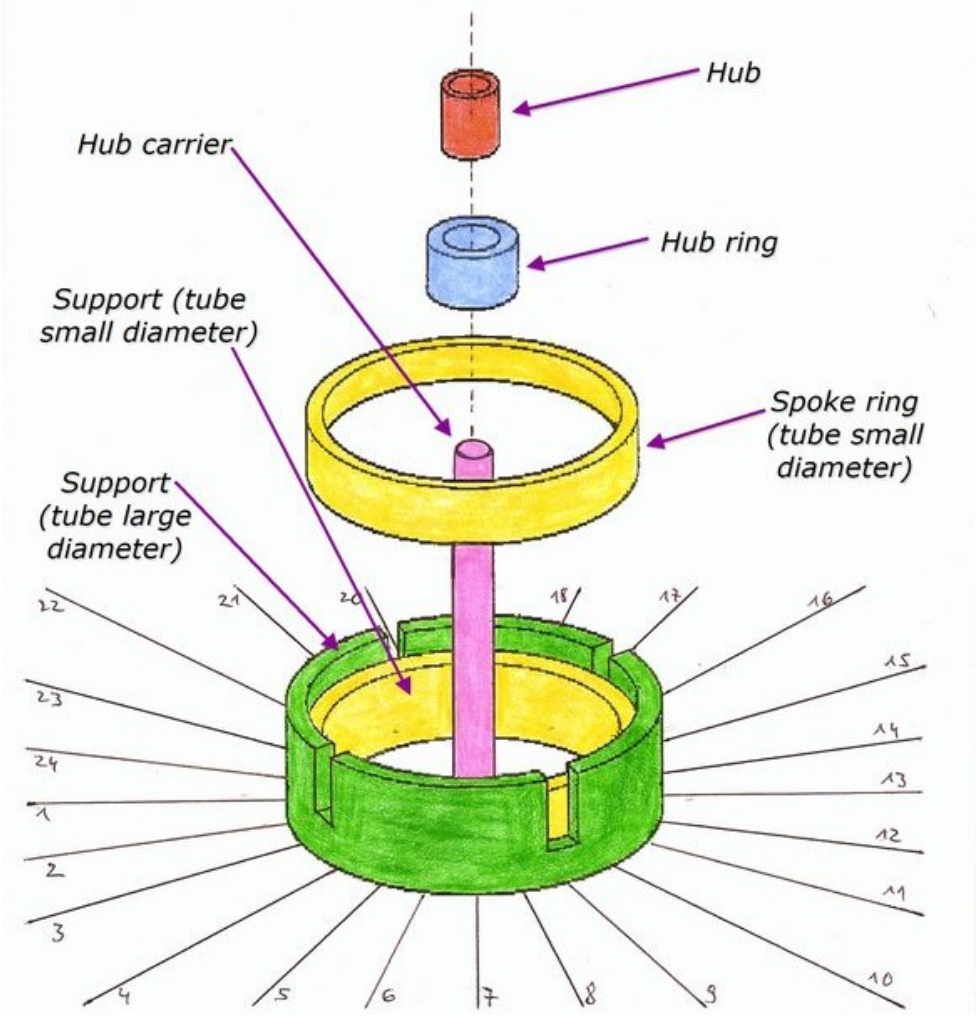
4. ***Never*** use liquid super glue. By capillary attraction it will be sucked into the gaps between the spokes near the hub and the rim well. You would realize the fact that your work is spoilt not before you spray the finished wheel. Only use gel type super glue and apply it with a pointed match.

VII: Embarking on your first wire wheel

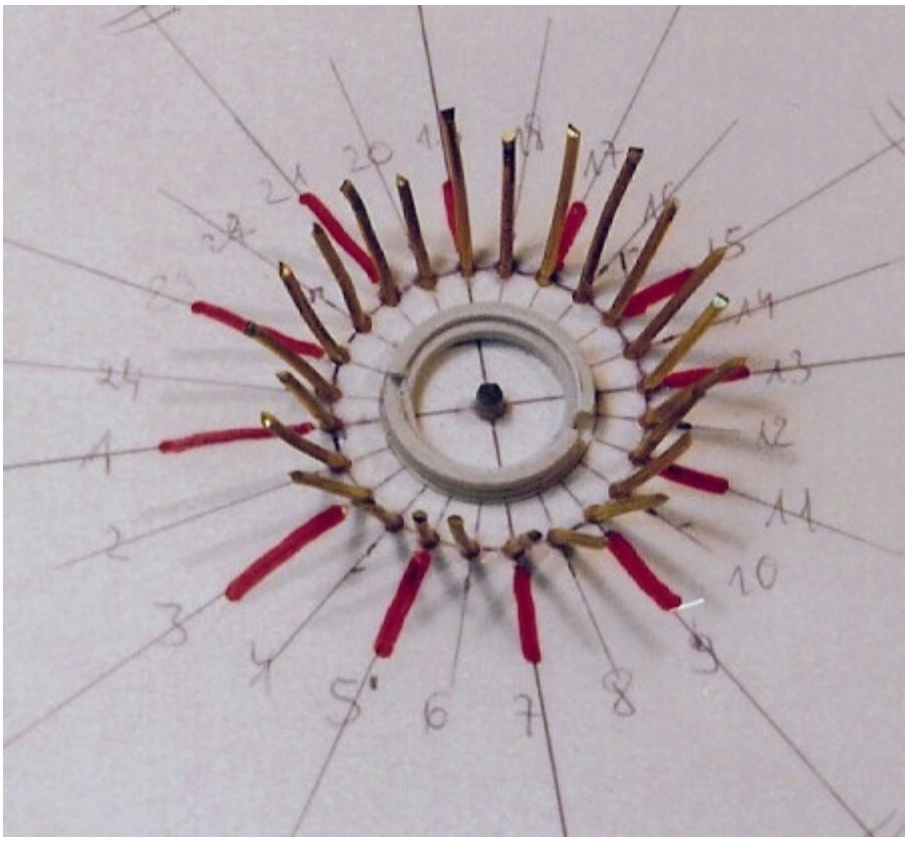
The easiest type of wire wheel is a drop center rim as seen on the picture at the beginning of this thread. Compare it with the pictures of the standard rims. On standard rims the outside spokes have a considerable inclination between the hub and the rim well, and the hub is clearly visible. The outer spokes of the drop center rim however stand almost vertical on the hub and the rim well, and the recessed hub is nearly invisible. This makes planning very easy and it does not matter if your hub is crude.

Step 1: Making the spoke jig

- In 1/24 up to 1/16 scale a total of 72 spokes per wheel look convincing, that means 48 inner spokes and 24 outer spokes.
- Take your piece of chipboard and mark a point approximately in the center. Draw 12 straight lines through this center point. These lines must be exactly 15 degrees apart so that your drawing shows 24 angles of 15 degrees each (24 x 15° = 360°). Number each end of these radiating lines from 1 to 24. Now your drawing looks like a 24-hour-dial of a clock. With you compass draw 2 concentric circles around the center point; the first circle must have exactly the same diameter as the **outside** diameter of your small tube, the diameter of the second circle should be approximately two or three times as large.
- Next, with your miter saw cut a ring at least 5mm wide from your small tube and glue it as concentrically as possible into the small circle (on the drawing below this ring is called "support [tube small diameter]").
- Then, with your miter saw cut a ring from the large tube 1mm or 1.5mm wider than the first ring, slip it over the first ring just glued and glue it too (on the drawing below this ring is called "support [tube large diameter]").
- Where the large circle and your straight lines meet drill holes with the diameter of your scrap wire, glue pieces of about 2cm into these holes and bend them moderately to the outside.
- Measure the diameter of the stubs of the axles (see above). Drill a hole into the marked center point of your jig with exactly this diameter and glue a piece of fitting rod into this hole (no matter if metal or plastic). The end of this rod should be the highest point of your jig (on the drawing below this rod is called "hub carrier").
- Last, make 4 slots into the larger ring down to the surface of the smaller ring.
- Your jig is finished now. May sound difficult, but is simple. Look at this schematic drawing, it should be self-explaining.



This photo shows a real jig. Ignore some non-essential differences.



Step 2: Making the hub unit

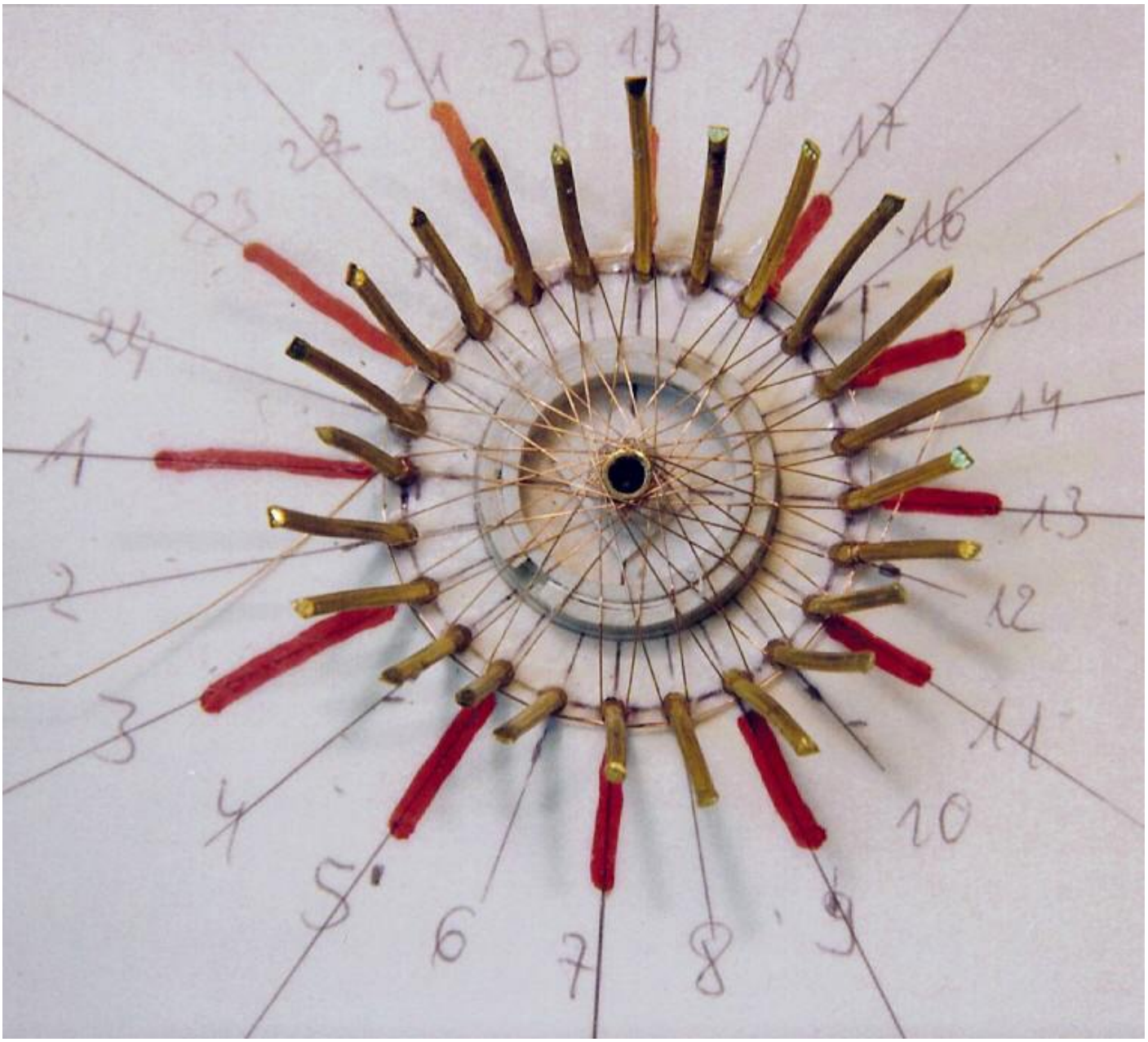
Keep in mind that all measurements given here are approximate. All actual measurements will be determined by the kit rim you want to modify. Your scale drawing gives you all measurement exactly.
As already said the hub of a drop center rim may be crude.
Cut off a piece of about 4mm from the metal tube mentioned in V.4. (on the drawing this piece is called "hub").
Next look for a plastic rod or sprue of about 5 to 6mm diameter and slice about 2mm from it (on the drawing this piece is called "hub ring"). Drill a concentric hole with the diameter of the just mentioned metal tube and insert the piece of metal tube. It should protrude on one end a little bit more than on the other. Secure with liquid (!) super glue. Now your hub unit is finished. Keep in mind that the end with the larger protrusion will belong to the inside of the wire wheel, the end with the smaller protrusion will belong to the outside.

Step 3: Making the spoke ring

Cut a ring about 1.5mm wide from the small plastic tube. Sand both surfaces. This ring is called "spoke ring" on the drawing. Put it into the jig. Slip the hub unit onto the hub carrier making sure that the end with the larger protrusion sits on top. The upper surface of the hub ring (the former sprue) must be at least on the same level as the upper surface of the spoke ring, so shim it up f. e. with washers or pieces of plastic.

Step 4: Lacing the spokes

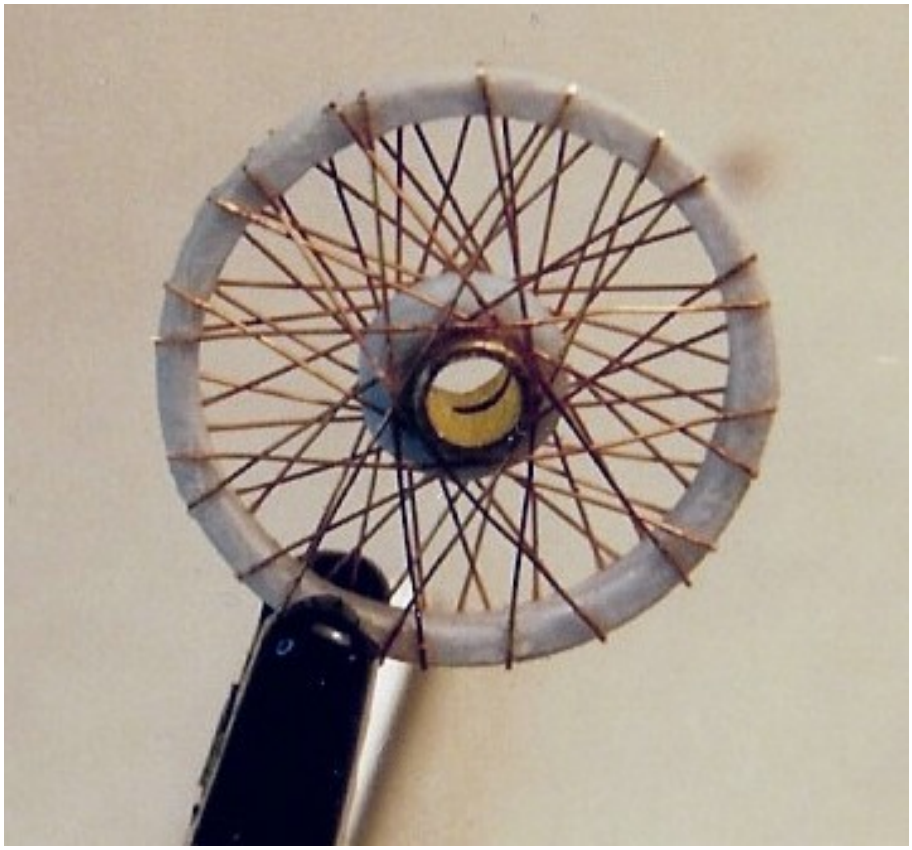
Remember we build a wheel with 48 inner spokes and 24 outer spokes. Always lace the inner side of the wheel (48 spokes) first. This is the reason why the end of the hub unit with the larger protrusion must sit on top: 48 spokes need more space on the hub unit than 24.
The inner side: Take a generous piece of 0.13mm wire (but you can patch up) and fix it with a simple knot to scrap wire #1, stretch it onto the surface of the hub ring and wind it around the opposite #13, and return to #1. In order to avoid pressing the hub unit to one side do not continue with the nearest #2 but go to #7 (that means 90° or 6 hours on your "dial"). Again stretch the wire onto the surface of the hub ring, wind it around the opposite #19 and return to #7. By this wire cross the hub unit has no one-sided pressure. Continue lacing until all scrap wire pieces are used, any order is okay. Last secure the end of the wire by winding it several time around two scrap wires forming an "8" as sailors do(?). Now you have this result



If you look very closely you will realize that I forgot #6 and #18 on this sample, so check your wheel!

Fix the spokes on the wheel hub and on the spoke ring with gel type super glue applied with a pointed match. Use it sparingly, too much will show after spraying! Don't glue the spoke ring to the jig unintended! Let the glue dry thoroughly, then check if all spokes are firmly fixed. Cut all wires between spoke ring and scrap wires with small scissors. Remove spoke ring and hub unit from the jig very cautiously, the 4 slots will help. Last, cut off all protruding wire ends as cleanly as possible.
You have now a semi-finished "spoke insertion".

The outer side: Put the spoke insertion back into the jig, but this time upside down. Again shim the hub unit up. Otherwise you will press it down by lacing the outer side.
Now lace the outer side of the spoke insertion in exactly the same way you did before, but use only the scrap wires with uneven numbers because we want only 24 spokes on this side. Finish the insertion as you did before. Now it looks like this



Step 5: Finishing the rim

The rest is a trifle. No matter if your kit rim consists of one or two pieces, measure the width of your finished insertion (by the spokes and the glue it will be wider than the spoke ring alone) and remove exactly this width from the kit rim.
If the kit rim is chromed and you want to keep the chrome, spray the insertion first silver, than fix the remaining halves of the kit rim with gel type super glue. If you want an entirely painted rim fix the halves first. In any case spray sparingly, because too much paint generates small drops on the spokes.
Last add the knock-off. If the hub (= the metal tube) protrudes too much file it down very, very cautiously.

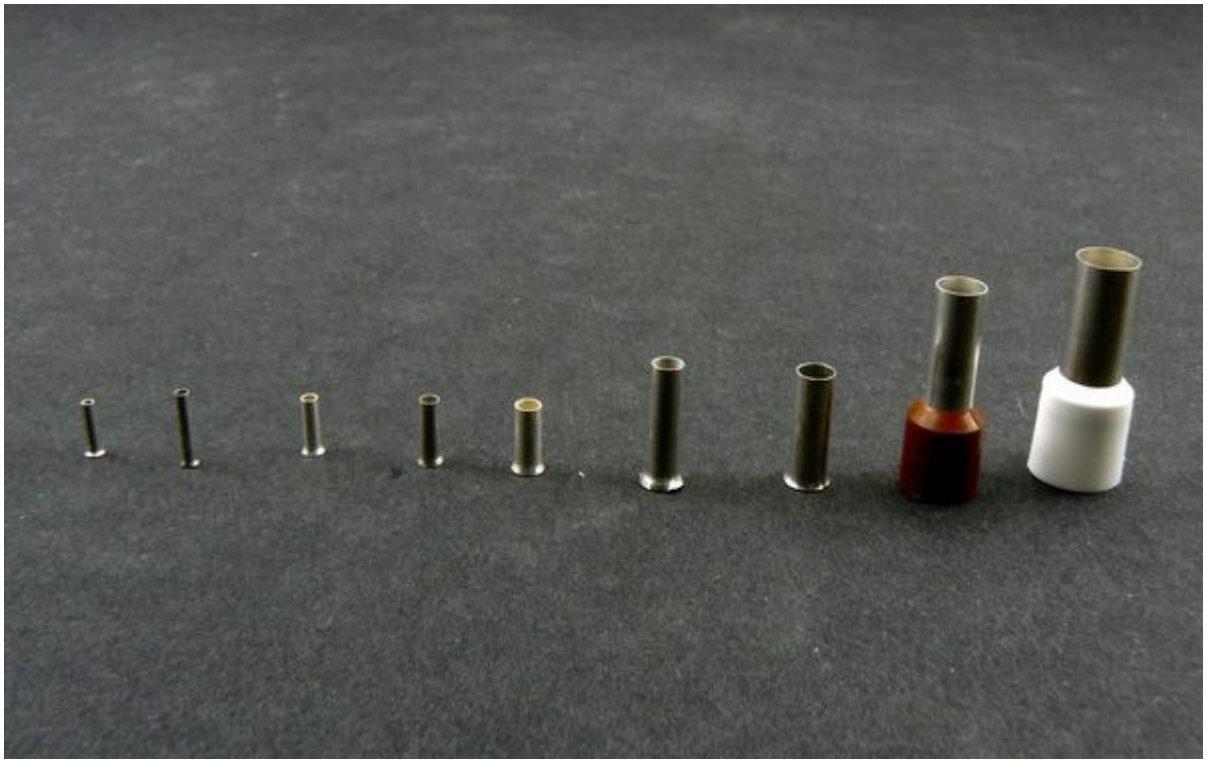
VIII. Standard rims

In most cases you will make standard rims as shown on the photos at the beginning of the thread.

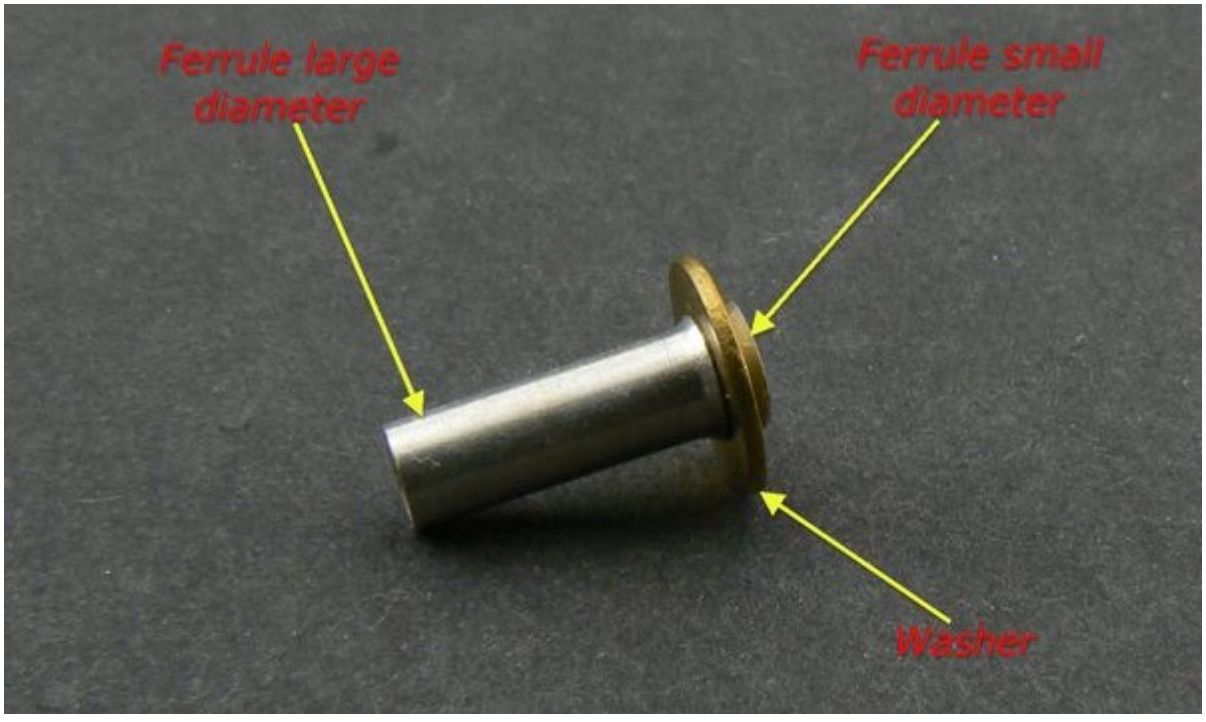
- Even more as with drop center rims a scale drawing is *t h e* key to a rim that looks exactly as you want. I have made about 130 wire wheels with my technique, but even now I would not be able to build one without drawing.

- Since the outside spokes of standard rims are, as already said, inclined from the hub to the rim well you have to bevel this surface of the spoke ring accordingly - otherwise the superglue cannot fix the inclined spokes properly. This is simple: paint the surface with a permanent marker, and with a #11 blade scrape until you see a bevel that seems sufficient. Don't overdo, leave a small strip of paint. This guarantees that you will not see ugly ups and downs in the spoke ring when the wheel is finished.

- On standard rims the hub unit can be seen very clearly, so it has to look authentic. There are several ways but the best and easiest result is achieved with these inexpensive parts electricians use



As far as I know they are called "wire end ferrules" in English. Instead of stabilizing the end of a cable by soldering electricians slip on such a ferrule and crimp it. Since they are obtainable in various diameters and more or less telescoping, it is very easy to make realistic hub units. For this photo I have assembled two ferrules and a washer provisionally to make clear what I mean.



You see these parts on almost all my rims.
I can assure you that understanding my awkward description is the only difficult thing about my technique. Take the trouble and try to understand the technique. I am optimistic that - once understood - you will find it worth-while.

Three minor additions:

1. In V.2. I mentioned a stopgap for the case that you cannot obtain the larger of the two telescoping plastic tubes, but then I forgot to tell what it is. Remember that you need this larger tube only for making the green "support (large diameter)" on the drawing. You can substitute it by vertical pieces of plastic glued down to form a circle. This will be sufficient to hold the spoke ring in the jig.

2. You may find it useful to choose a different lacing order. I usually prefer to stretch the wire not to the scrap wire exactly opposite. Instead I go f. e. from #1 to let's say # 15 or #17 (and not to opposite #13). This has two advantages: The lacing wire grips the hub unit firmly and the tendency of the lacing wire to slip from the hub ring while lacing is eliminated.

3. Your wire wheel looks much more realistic if you give the hub (= the small metal tube) at the end of the inner side a considerably larger outside diameter. By this the pattern of the 48 inside spokes will become clearly different from the pattern of the 24 outside spokes. Simply glue on any fitting ring before lacing.