This document is occasionally updated as new techniques are developed. Please refer to my website to obtain the latest version. Thank You. Dave Gerold

Check out the "Do it Yourself" Wobble reduction by Spoke Shrinking document on the services page of my website. www.durableperformance.net

Straightening Model A Wheels

Twin Cities Model A Club
Technical Seminar Presented Feb.23, 2006
By: Dave Gerold

Jean and I were driving through Apple Valley, a suburb just south of the Twin Cities, at 6:00 am on our way to meet other club members for the start of our road trip to a Green Bay, WI National Meet when we had a close encounter. A young man pulled up beside us in a small car. As he leaned over the passenger seat, to get eye contact with me, he swerved towards us. He was pointing to the rear of the car and mouthing something I did not have time to interpret. We had to put our car up against the curb to avoid a collision. I pulled into the next available approach to see if something was falling off. Finding everything in order, I then pulled out my lug wrench and went around and checked all the lug nuts. They were all tight. What this young man was pointing to was a crooked wheel. I could have very easily lost control of the car when we hit that curb. Based on this experience, I can make the claim that having straight wheels is safer when you are on the road. Running down the road with straight wheels will also make a difference in the way a car "feels". I have noticed fewer problems with vibration and rattles and the steering feels smoother in the corners.

Shortly after restoring a '29 Phaeton, I began collecting wheels in an attempt to find 6 reasonably rust free and straight wheels that I would have powder coated. With little luck, I became frustrated in my search and started to consider building a machine to straighten the wheels I had collected. Off and on, over a period of a year, I sketched different ideas for a machine. After researching commercial wheel straightening businesses and the equipment they used, I continued to revise the sketches as I looked for, but could not find, a company that would straighten a welded spoke wheel like the "A's" were equipped with. Conceding that I could not find anyone with equipment or an interest to straighten my wheels, I ordered the plates that make up the table and base along with the heavy duty bearing blocks that support the cast iron rear hub for my wheel straightening machine. I spent a good part of the next winter's weekends in my workshop building a combination press and puller along with the required tooling to straighten 28-29 wheels. The tooling took a lot of time to develop and some of the early tooling has been replaced with improved versions. The 30-31 tooling was developed about 12 months after the 28-29 tooling and proved to be much simpler in design.

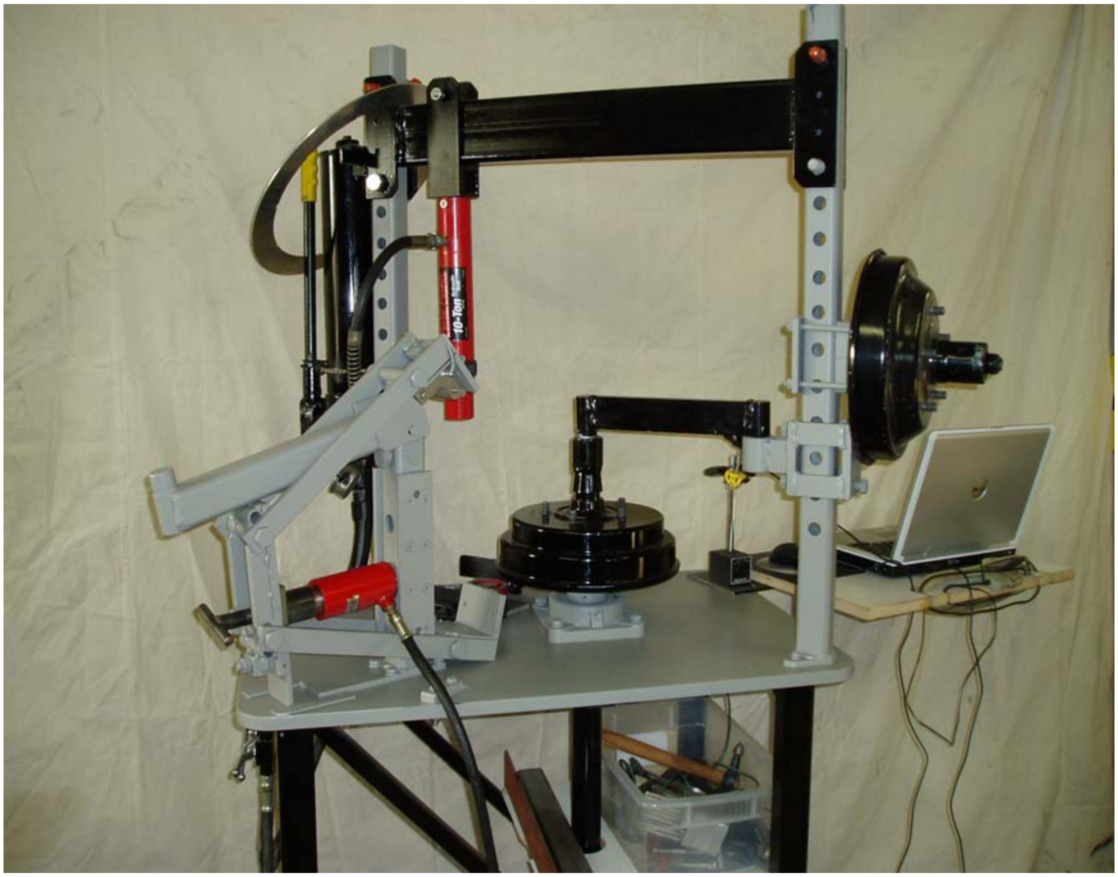
To date, I have straightened about (65) 28-29 and (30) 30-31 wheels for myself and club members. *(As of 5/1/10, over 220 wheels. I am getting tired of looking at wheels!)* I have found every 28-29 wheel a real challenge. Most 30-31's, by comparison, are a breeze to straighten. The difference in difficulty is due to the different shape of the bead areas and how the bead area design distributes the applied correction forces to the rest of the wheel. The 28-29 wheels constantly change shape every time you apply force to them. The rolled edge of the wheel creates a structural rigidity to that area that is incredibly resilient to applied forces. If one were to take the same mass of metal the bead area is constructed of and form it into a bar or section of flat metal and try to bend it, it would bend quite easily. This amount of metal, essentially rolled into a "pipe" creates a structural profile that is very resistant to bending forces. Now consider that the bending resistance is almost doubled because the rim has the same pipe shape at each edge of the wheel. This structural shape applied to both sides of the wheel makes it very difficult to apply localized force and have that force change only that particular area. This example might help you understand the complexity. Picture in your mind taking

a Hula Hoop and placing one side on the floor, step on it and hold the hoop in a vertical position as if it were a wheel mounted on a car. Push the top of the hoop down and then pull it up; the shape of the hoop, with either force, will become an oval. Keeping the hoop in the same position, firmly step on the hoop, locking it to the floor, grasp the hoop with two hands and apply the same downward and upward force while also applying a twisting force to the hoop. Now add a side to side rotational force to the hoop while applying all the previous forces. Change the intensity of any one of the forces and the hoop will take on a different shape. Now picture adding another hoop 4” along side the first with a semi-flexible membrane between the two hoops and apply the same pressure to one of the hoops. If you can picture the compound results in your mind, you understand why it is so difficult to correct the defects in a crooked 28-29 Model A wheel.
The 30-31 bead shape is more forgiving when applying a correctional force. The applied force changes the rim shape where the force is applied on the 30-31 wheels and does not transmit much of that change around the rest of the wheel. Another difference in the wheel construction between the 28-29 and the 30-31 is the thickness of the metal used in the outer portion of the wheel. The 30-31 wheels are formed/rolled from much thicker metal. Without the rolled edge and with the thicker metal, the 30-31 wheels have accumulated most of their defects in the outer portion or bead area of the wheel. Making corrections to this area can be accomplished with very simple tooling.

The following photos show the machine I use to straighten wheels.

The rams and hydraulic pump are standard “Porta Power” equipment. The individual rams and hand pump can be found on eBay quite regularly for a fraction of what new would cost. The bearings were purchased at a discount supply house. The 2” axel could be solid but I used a 2” heavy bushing stock that my metal supplier wanted to get rid of. The table is 1” thick allowing the components to be fastened directly to the table as required. The cast iron brake drum is a reproduction and is available from local Model A suppliers.

I am not set up to straighten “AR” wheels yet. I will adapt the machine when I get my first request.



Before starting the process of straightening any wheel:

Clean up the wheel…get rid of excess grease and dirt.

Check for cracks in the hub area.

A wheel with a cracked hub will not straighten. Repair the cracks first.

I use the following method: Follow the crack from the edge of the hub to a point where it appears to stop. Drill a very small hole at the end or just beyond the end of the crack to halt the travel of the crack. Clean up the surface of the crack on the inside (hidden area) of the hub. I remove about 1/3 the thickness of the metal with a die grinder following the crack just short of the drilled hole to the end of the crack. I then fill the area with weld and add additional welds to the sides of the first weld to distribute the pressures over a greater area. No one sees the welds, so they do not have to look great. The weld can not be too thick or it will not clear the outside of the brake drum, especially new cast iron brake drums which appear to have a greater outside diameter than original drums. Grind the welds to provide the needed clearance. I fill the hole and any visible crack on the outside of the hub with flexible auto body seam filler and paint over it.

The process of straightening a wheel.

28-29 (21”) Wheels

Note: Expect that every time you make a correction to an area of a 28-29 wheel, another area will change. By working the area with the greatest flaw first through to the minor last, you finish with a straight wheel. Because the process of correcting is so dynamic, I have found the only way to track the process is to take numerous readings and compare the columns of data side by side to each other in a spreadsheet.

(Left photo) Wheel mounted for spoke straightening. Straighten the spokes using a slide hammer and a plastic mallet. Bends near the center of the hub may require heat to remove the bend. Look at the spokes from a couple different angles to make sure they are straight. Use a straight edge to check your work. After the spokes are straight, tap them and listen to the tone. Pay particular attention to the tone of the ten long spokes. Abnormally low tones usually indicate a broken connection between the wheel components. (How to repair is detailed later.) Most of the time, higher than average tone indicates a spoke in tension, lower than average, indicates a spoke in compression. Mark the long spoke bases for tension or compression; this information will be helpful later.

(Picture above) This additional station was added to the machine after straightening the spokes on a few wheels that were mounted on the main arbor. The use of a slide hammer on a wheel mounted on the main arbor was just too much work. Mounted on the station as shown above allows for use of the slide hammer in a much more efficient manner.

(Right) Checking the width of the wheel

Note the areas that vary from the average width of the wheel.

(Left) Photo of wheel mounted on main arbor with indexing ring in place. The indexing ring is marked every 10 degrees and at each long spoke location. 0 degrees lines up with the inner tube stem hole. Tighten the lug nuts snug, so the wheel fully seats against the hub, but not as tight as you would on a car. 25 foot-pounds works very well.

The three photos above show wheel reading positions for the digital indicator. Readings are taken automatically every 10 degrees for each position as the wheel is spun. (A micro switch is tripped by notches on a metal disk mounted to the arbor every 10 degrees and sends the reading from the gauge to the computer. The disk is mounted below the table surface.) After taking the initial wheel readings, carefully study the wheel while slowly spinning it. Look for any areas of crushed bead surface and note this on the spread sheet. Check the readings on the spreadsheet; mark the high and low spots within the column. Study the highs, lows, bead width variances, crushed bead areas and long spoke pressures. Try to imagine the force that caused the wheel to bend. This is the most important assessment of the wheel. To straighten the wheel, the same force that bent the wheel needs to be applied to the wheel in a controlled manner, but applied, in the opposite direction to correct it. Keep notes as you make corrections, they are helpful as you proceed. Plan your corrections starting with the worst defects first and work down to the lesser. Just remember this simple thought; "Worst first". If wobble and run-out appear about equal in defect, start with wobble correction and switch over to run-out correction as that defect is noted to be greater.

(Picture to left) Group of tooling for 28-29 wheels.
The tool on the left is used to spread the width of the beads. Upper tool to right is used to straighten "wobble". It is shaped to the profile of the wheel. Lower tool on right fits into the jaws of the puller and also matches the profile of the wheel.

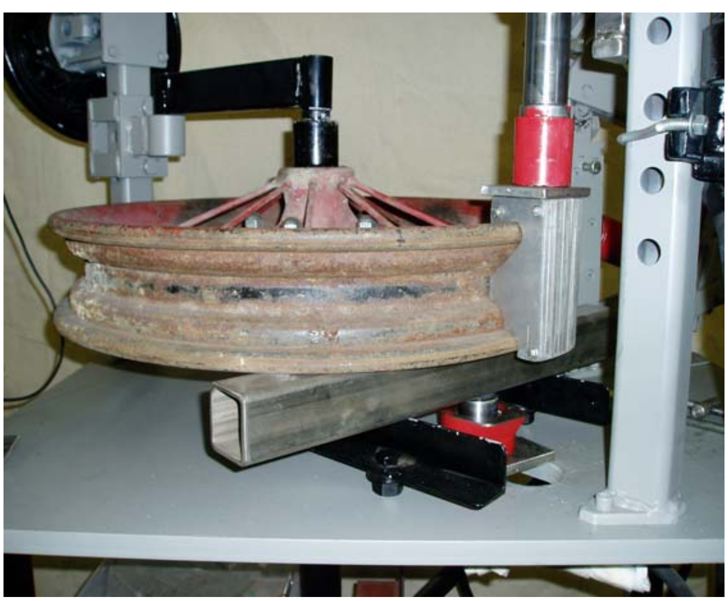
This photo shows how to increase the space between the beads. This particular setup will force the lower bead down. Reversing the top tool and pressing with a bar across the top of the wheel will move the top bead up.

(Left) Set up for unsupported press of the wheel. This setup is used to correct a wheel condition that indicates a wheel is high along one area of the wheel and low 180 degrees from the high. I call this "Harmonic Wobble". Note the support arm inserted into the collar protruding from the hub area of the wheel. A "must use feature" to keep the axle from bending while applying force.

(See additional photo of support arm on page 8)

Use the deflection gauge (right picture) to measure the actual deflection produced while applying force but more importantly, measure the change you produced after releasing the pressure and allowing the wheel to rebound. Repeat the process until you have achieved a rebounded deflection of 1/3 of the overall correction you were trying to produce. Any more than 1/3 and you may overcorrect. Remember, correcting one side of the wheel will produce almost an equal reaction, but opposite in direction, on the opposite side of the wheel. Zero the deflection dial indicator and make sure

you have almost full travel of the indicator prior to starting the press. The amount of deflection in an unsupported press can be as much as one inch. An indicator incorrectly set will be damaged from the pressures applied if it bottoms out. Take new readings with the digital indicator, recording them to the Excel spread sheet, after you have achieved your desired correction. Mark the highs and lows in the spread sheet and look for changes in the wheel readings from your previous readings. Plan the next press and repeat the process. After making an unsupported press, if the readings drastically change, visually check the long spokes 180 degrees opposite the area the force was applied for bent spokes. The forces applied caused the spoke under compression to bend, straighten and try again. If the spoke fails again, straighten it and apply 50% of the previous force (this will put the spoke in moderate compression) and then heat the base of the failing spoke from the outside of the rim until the metal around the spoke base yields and allows the spoke to push into the outer rim area. The amount the spoke pushes into the outer portion of the wheel will not be noticed after finishing the wheel. This is the simplest method to shrink the effective length of a stretched spoke. As you study the wheel markings, you will find that the most of the time, spokes you marked for low tone will be the spokes that need to be "shrunk". If after drastic reading changes, the spokes all look straight; check the spokes close to the last press position for failure in connection to the hub. Tap them and listen to the tone produced. All cases of failure to date have been the long spokes and their connection to the inner hub, close to where the hub cap is mounted. This failure is easily repaired by drilling out the metal below the base of the spoke, with a 3/16" drill bit, through the hub cap opening. Run the drill fully through the metal of the hub and into the base of the spoke 1/8th of an inch. Drilling slightly into the base of the spoke will allow for a stronger connection. Weld from the back side (through the hub cap opening) adding enough metal to the inside of the hub to distribute the force from the spoke over an area slightly larger (1/2") than the flared base of the spoke. Continue with your corrections.



Set up for supported press of wheel.

Note the tubing placed under the wheel. The lower ram is extended to bring the support tube to rest under the inner bead and then the valve to this ram is closed. The top ram is then used to apply force to the profile tool. This press setup is to correct a localized wobble or high area. Take new readings with the digital indicator and record them on the spreadsheet after each press and look for changes in the wheel readings. Plan your next press and repeat the process.

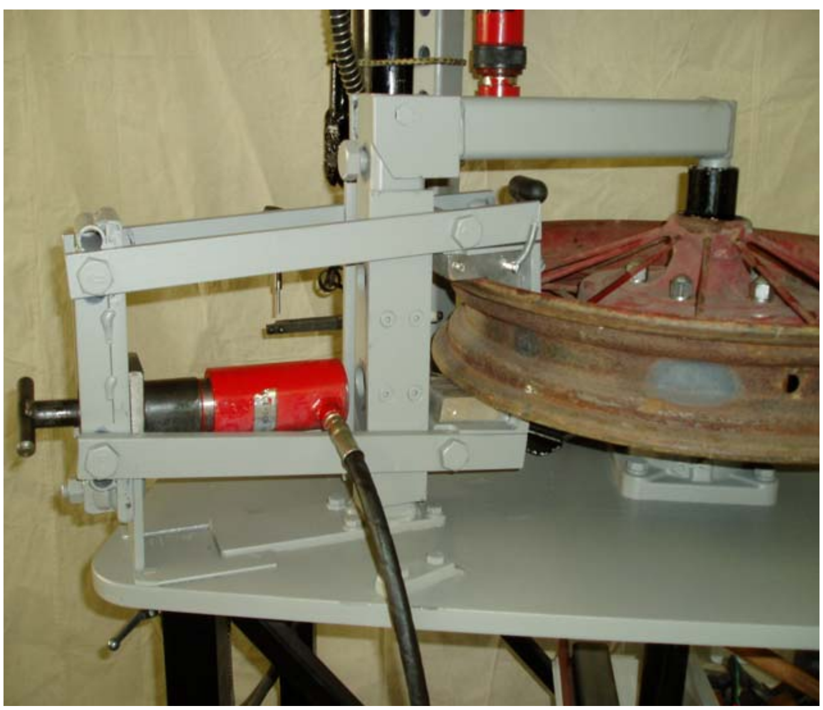
Set up for supported press of inside bead.
This setup is used to correct a localized low area. The support tube is held against wheel by the top ram and the lower ram is applying the correction force. More readings, next press…

Your patience is probably the limiting factor in how straight a set of wheels can be made. It can take over 40 set ups to take a mediocre wheel to very good.

Correcting "run-out"

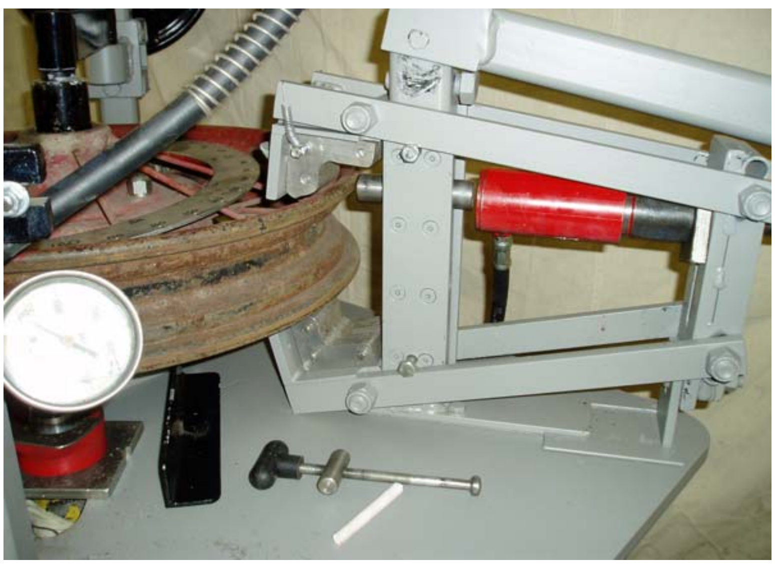
Remember; Correct the worst first!

I use the term "run-out" to describe the consistency of the distance from the center of the axle to the outer edge of the wheel. A wheel can be oval shaped, dented, or the entire outer portion of the wheel can be round, but off center with the center of the hub. All of these conditions are correctable by using the "puller" shown below.



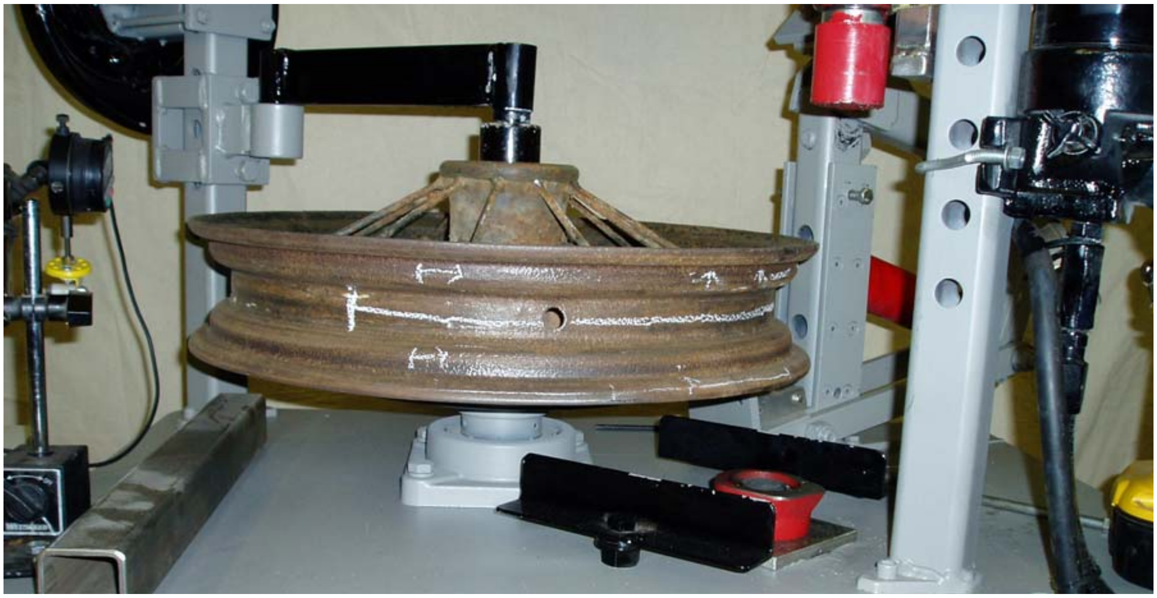
A typical set up to pull the outer portion of the wheel away from the center hub. Most corrections made for run-out problems are made from this setup. The ram can be positioned to apply a varied percentage of pressure to the upper or lower arms**.**
Caution: Extremely high hydraulic pressures are reached when applying run-out corrections. Wear safety glasses and leather gloves.

Minor corrections can be made to both the inside and outside bead areas at the same time. From the spreadsheet readings, note the required correction to each bead area, mentally calculate the required movement in relation to each other and set the ram up or down to direct more force to the side that requires more correction. Apply force noting the maximum hydraulic pressure and then release the pressure, remove arms and take new readings. Use of the deflection indicator is advisable during this procedure, but the tip of the indicator needs to be padded with a soft tip to avoid damage to the gauge. The shape of the hub is altered during this process and the movement when it occurs is sudden as the applied force overcomes the friction of the mating surfaces and the hub surface slides across the brake drum. Repeat the process applying more pressure until the desired correction is achieved. Increase pressures slowly, watch the deflection gauge closely, overcorrection will be a problem that is hard to fix. More than 90% of all run-out corrections are made using this method. If a large amount of correction is required, work one side at a time by setting the ram in line with the bead to be moved. Much safer hydraulic pressures are used when making corrections to one side at a time. The jaws of the puller are adjustable. If the amount of correction required is over a large area of the wheel, tighten the tooling snug to the wheel. This will transmit more of the force through the spokes to the center hub and create a broader correction. If the area to be corrected is about 3 times the width of the tooling or less, loosen the fit of the tooling to the wheel, adjust the jaw angle (set screws @ tooling saddle) to apply more force to the outer edge of the wheel and the correction will be more localized.



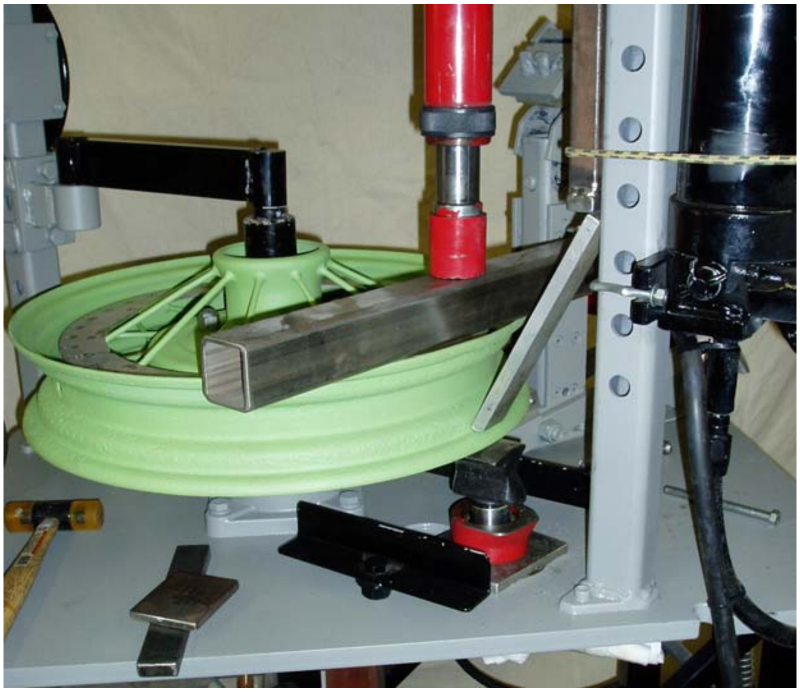
This picture shows the puller modified for removal of "high spots". The arms of the puller are pinned and are not contacting the wheel. The support arm, shown retracted in the picture, needs to be placed into position prior to applying pressure. A one inch shaft is inserted in the assembly and aligns with the outer edge of the wheel's bead area. Applying pressure to this shaft with the ram will force it against the wheel correcting any high spots. The shaft can also be lowered to align with the inner bead surface. Be careful with this correction. The rolled bead area of the wheel will easily crush and create a flat spot that is impossible to pull out. This method is used for final corrections and to fix "over corrections" from the previous setup with an additional tool tip that distributes the pressure over a greater area. Less than 10% of all run out corrections are corrected with this method. Use it to correct very minor high spots. Why only 10%? If you consider the possible damage a wheel would have received during use, very seldom will the bead area have a high spot or area that is pushed away from the center of the wheel. Most road damage, (potholes, logs and curbs) would have pushed the outer edge of the wheel toward the hub.

30-31 (19”) Wheels



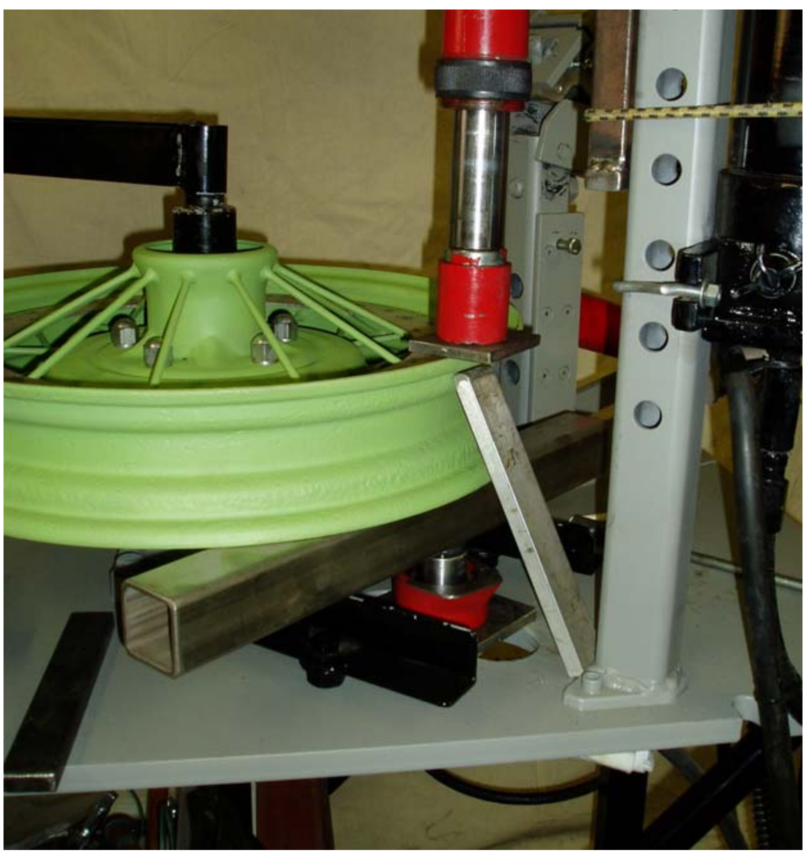
The wheel above is marked for the corrections required with chalk.

The picture below shows the simple tooling required to straighten 30-31 wheels.



Tool position to straighten the inside bead area.

This method concentrates most of the correction to the outside edge of the wheel. The tool shown resting on the lower ram has a rounded surface where it meets the wheel surface. This shape places the correction in a very small area and takes very little force to execute.
The lower side of the aluminum support bar has a rounded edge that matches the radius of the bead profile where it is positioned.

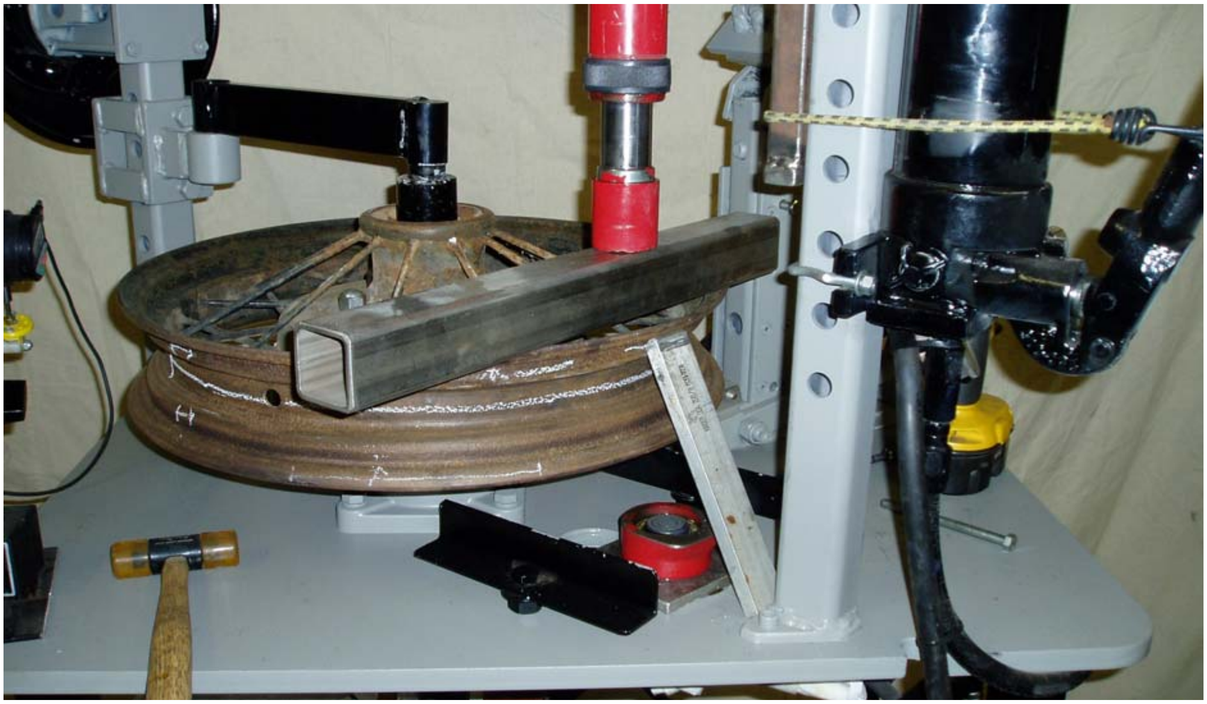


Tool position to straighten the outside bead area.

This set-up utilizes a piece of flat stock to distribute the force across a larger area. This tool position, like the previous picture also concentrates the correction area to the very outside edge of the rim.

Note that the lower ram's position can be varied by sliding it in the slot in the table surface. This allows for varying placement of tooling and supports and for the different wheel diameters between the years of production.

The set-up below is used to straighten a wider area of the outside bead.



The use of the digital indicator and spreadsheet are not necessary for 19" wheels. Check for wobble and run-out by using the top ram as a reference. Lower the ram until it just clears the top or edge of the wheel and spin the wheel watching the varying space between the wheel and the ram. Note the areas that need correction on the wheel with chalk. Correct wobble using the same methods as the 28-29 wheels. A wheel profile tool is not needed on the 30-31 wheels to execute the presses. The extra thickness of the metal used in the construction of the wheel allows for the forces to be applied directly to the edge of the wheel with the aid of bars and tubes to distribute the forces.

Closing thought: A lot of time and effort go into finishing a set of wheels that look good. With a little extra time, you can have both good looking and straight wheels for your restoration and driving pleasure.

Note: This article was written assuming the reader had access to the machine I built. I am letting members of the Twin Cities Model A Club use the machine with guidance. Understanding that other Clubs or individuals may want to fabricate a similar machine for their own use, I have included additional photos of the machine and tooling on the following pages.
For additional photos contact Dave Gerold at the following addresses:

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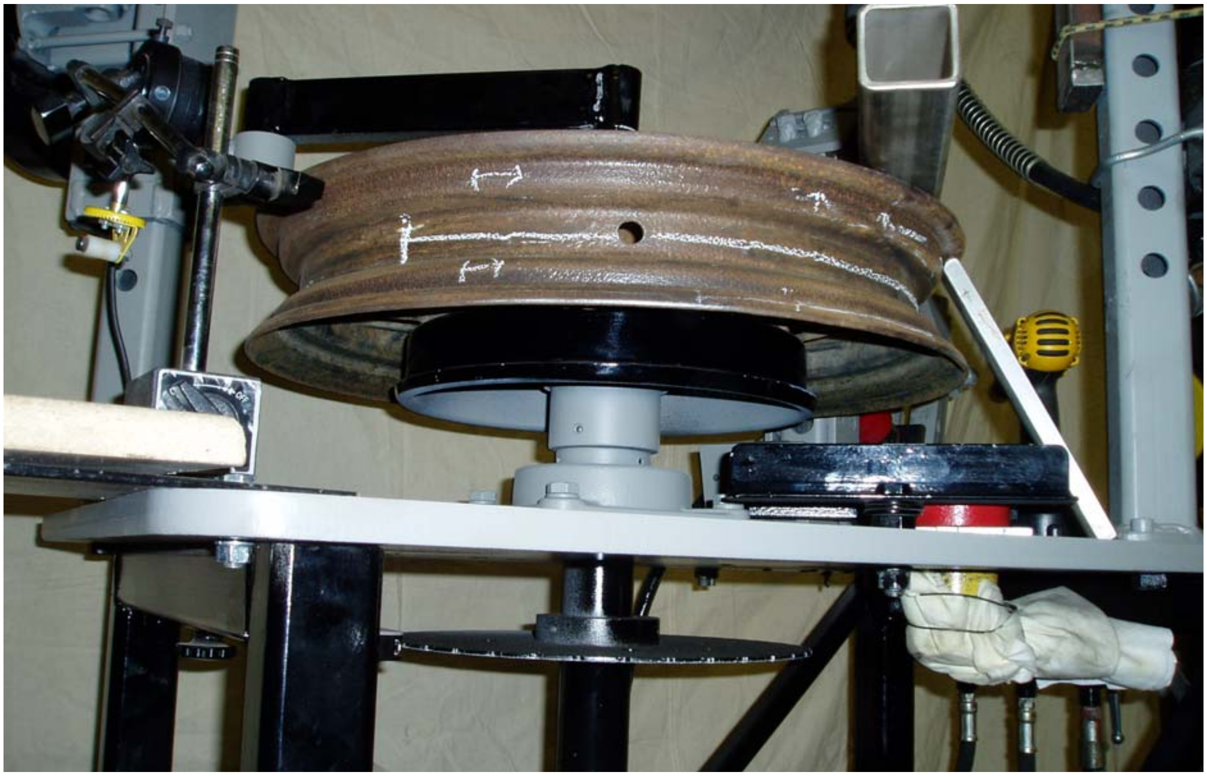
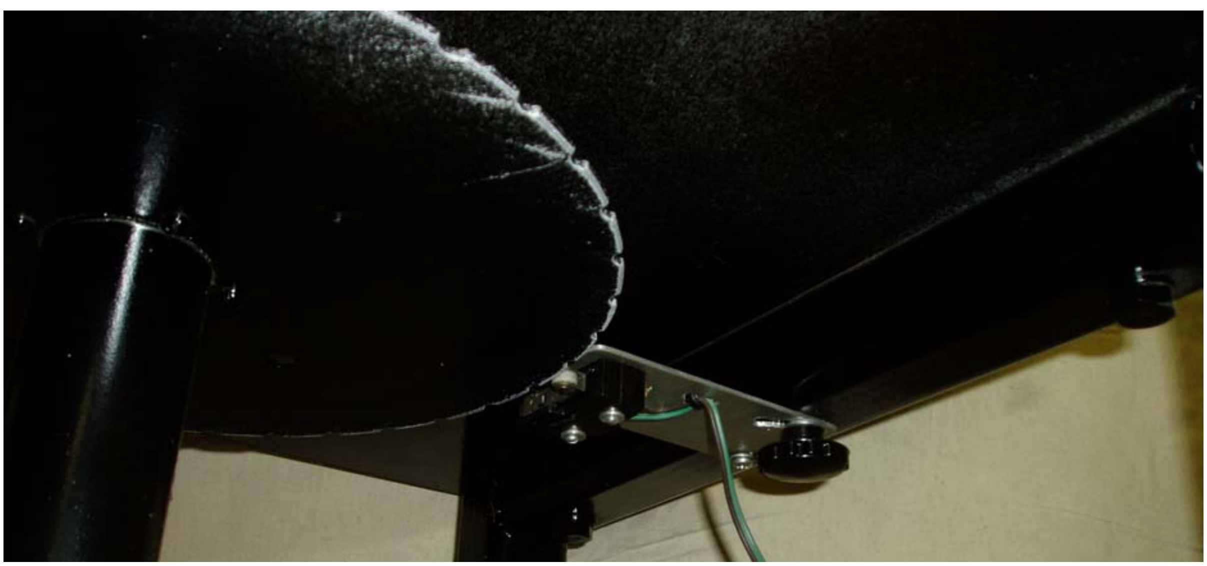


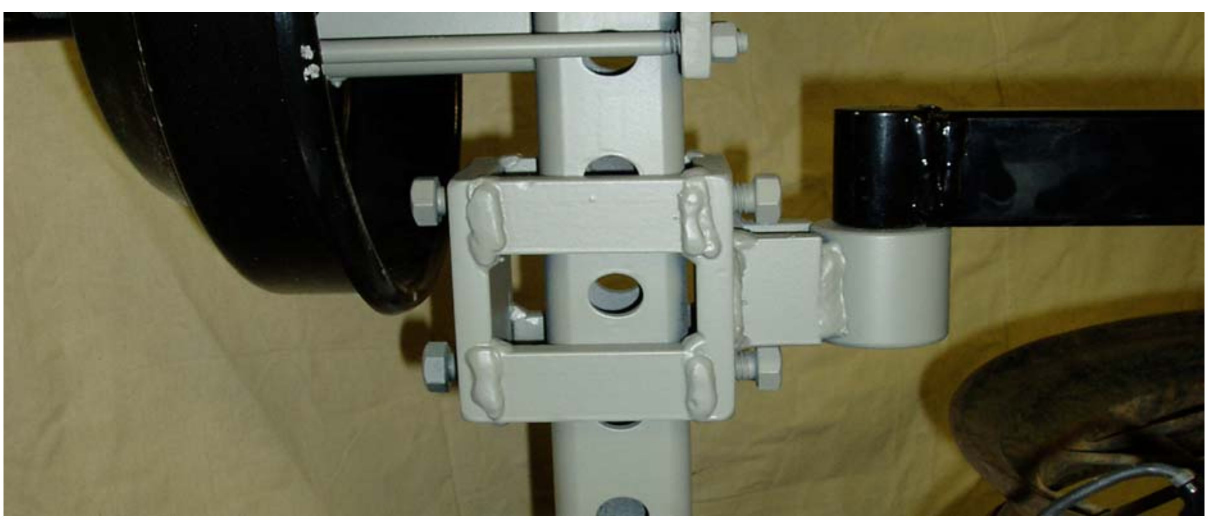
Photo above showing the cast iron drum mounted to the 2” heavy bushing stock axel with an additional machined bushing to fit the cast iron drum. The entire axel assembly was turned between centers to create an assembled accuracy of less than .001” for the wheel mounting surface of the cast iron hub. The used lower ram seals need rebuilding…thus the “diaper”.

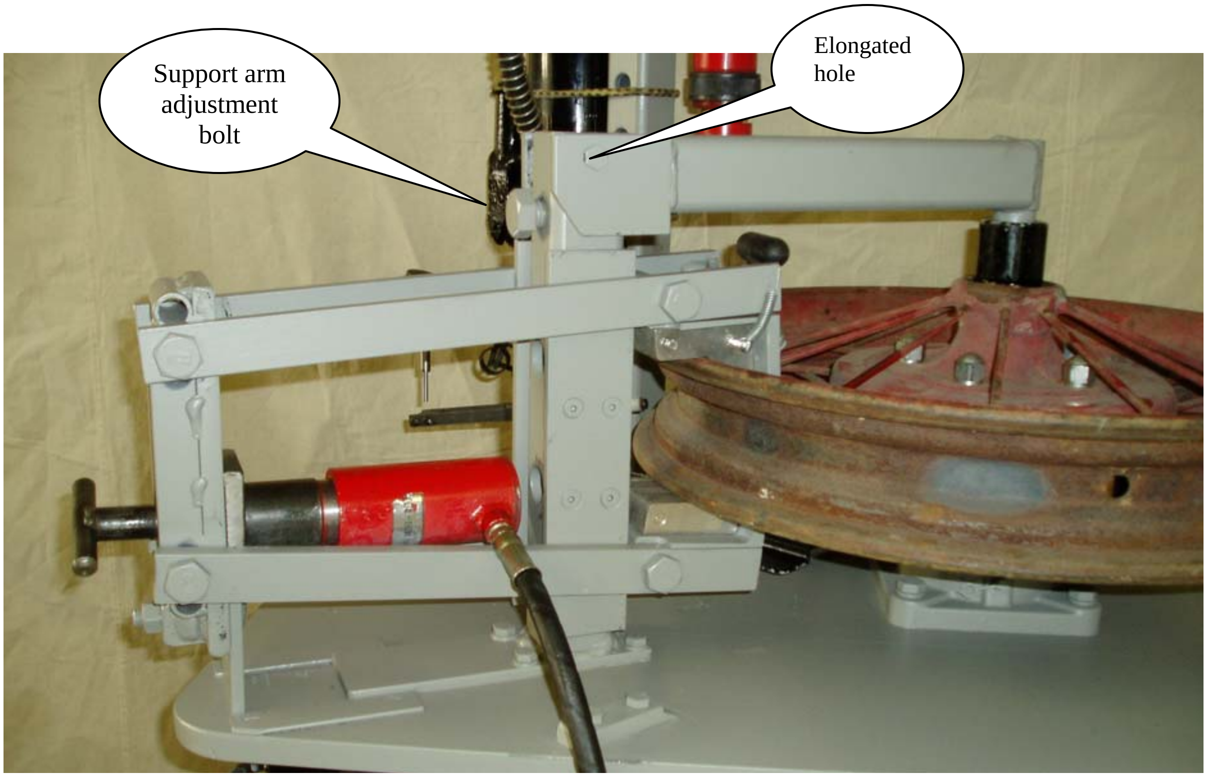


The picture above shows the micro switch equipped with a roller. The roller drops into a notch on a wheel fastened to the main arbor every ten degrees and causes the gauge to send a reading to a spreadsheet.

Indexing ring placed on a 21" wheel.

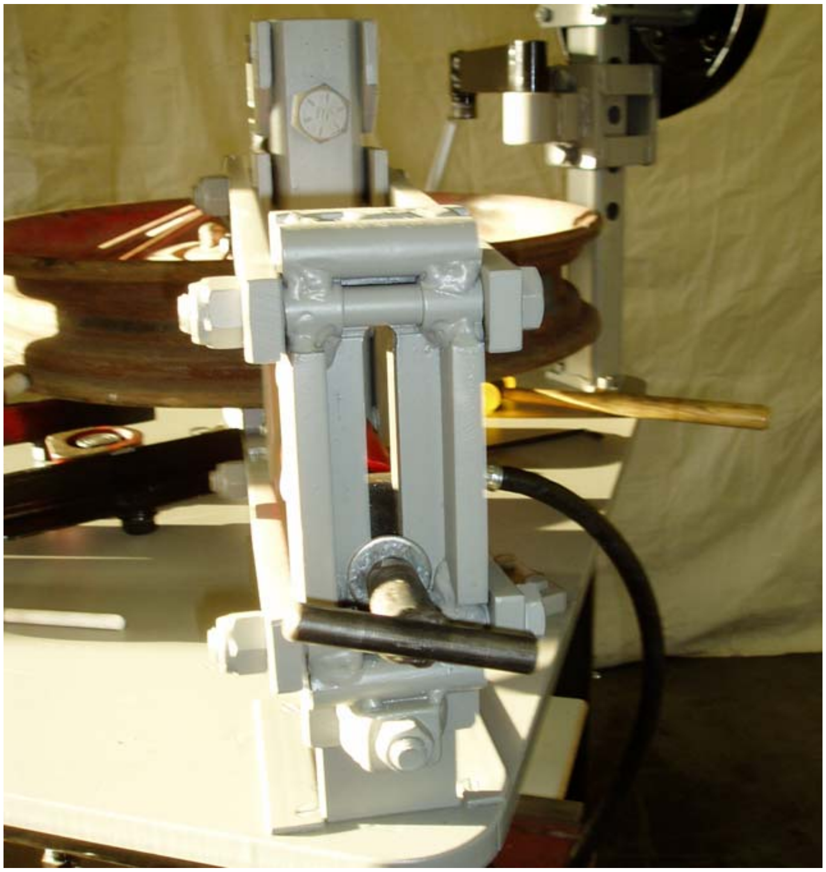
Photo below: Adjustment for support arm provides for exact positioning. The arbor must be straight to allow for accurate readings. This adjustable arm greatly adds to the rigidity of the components.





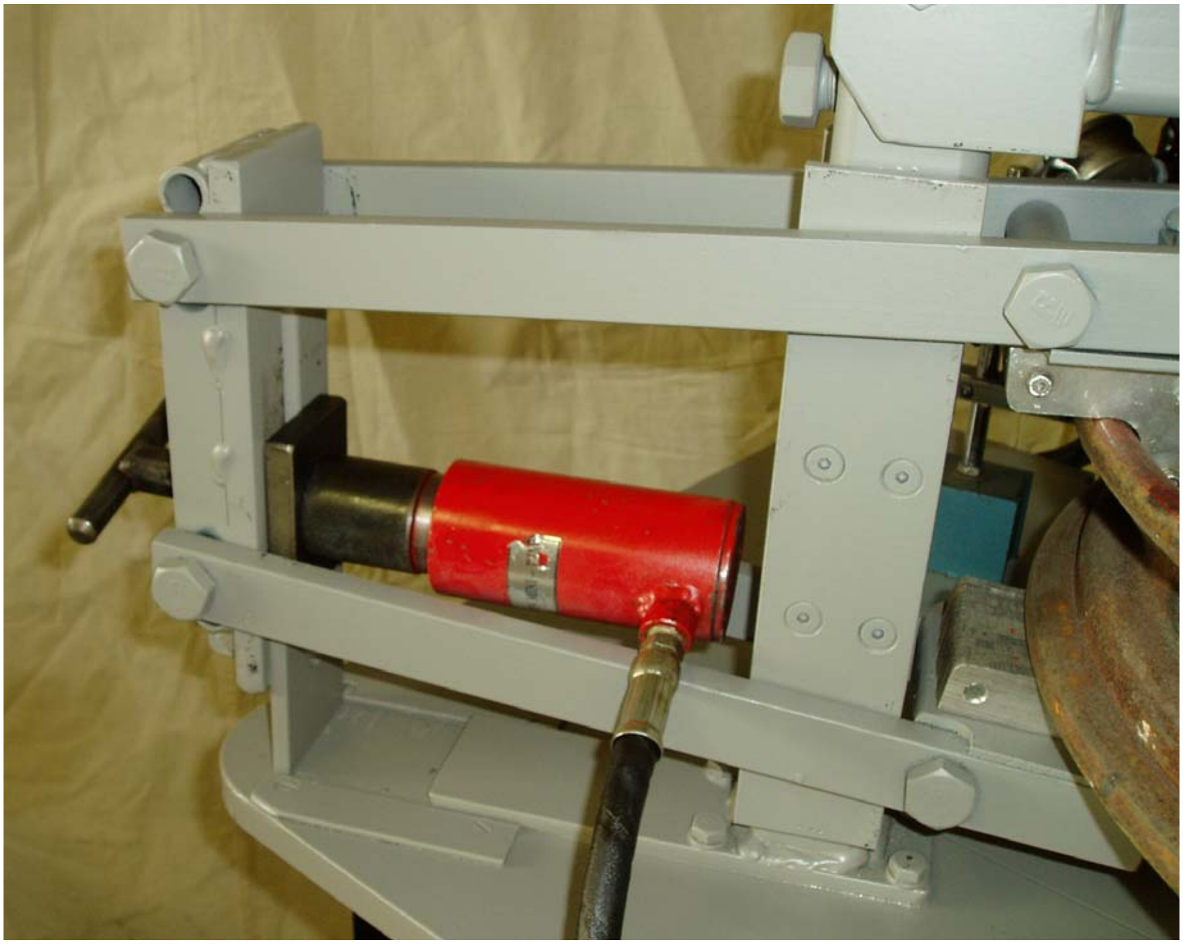
The run-out puller is in position to make a correction to a wheel. Note the arm that drops into the top of the arbor. This arm distributes the top half of the pullers force to the wheel. The bottom half is applied through the table and bearing. Extreme pressures are reached when applying run-out corrections. Without the use of the support arm, the arbor or vertical component of the puller would be damaged and no longer run true. The heavy bolt inline with the bottom of the support arm is the adjustment to position the arm correctly to align with and support the arbor. The pivot bolt hole is elongated to allow for this adjustment.

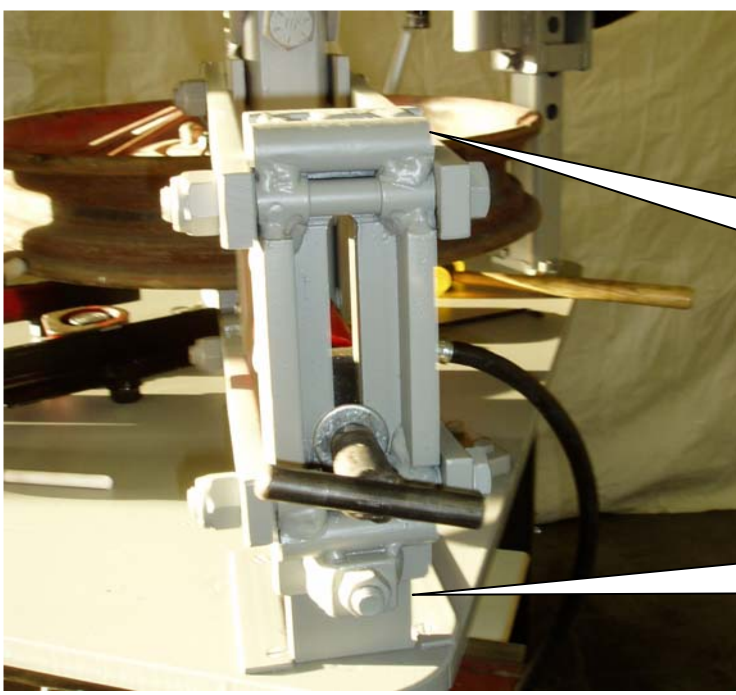
The puller locked into position with “T” bolt between the spokes. The spokes do restrict exact positioning of the tooling, but not enough to cause any problems.



Adjustment slot to raise and lower the ram. The threaded “T” handle allows for quick adjustment of ram position.

Valves provide individual control of the rams. The manifold is a 10“ length of 1¼” round stock drilled out and tapped to accept the valves.

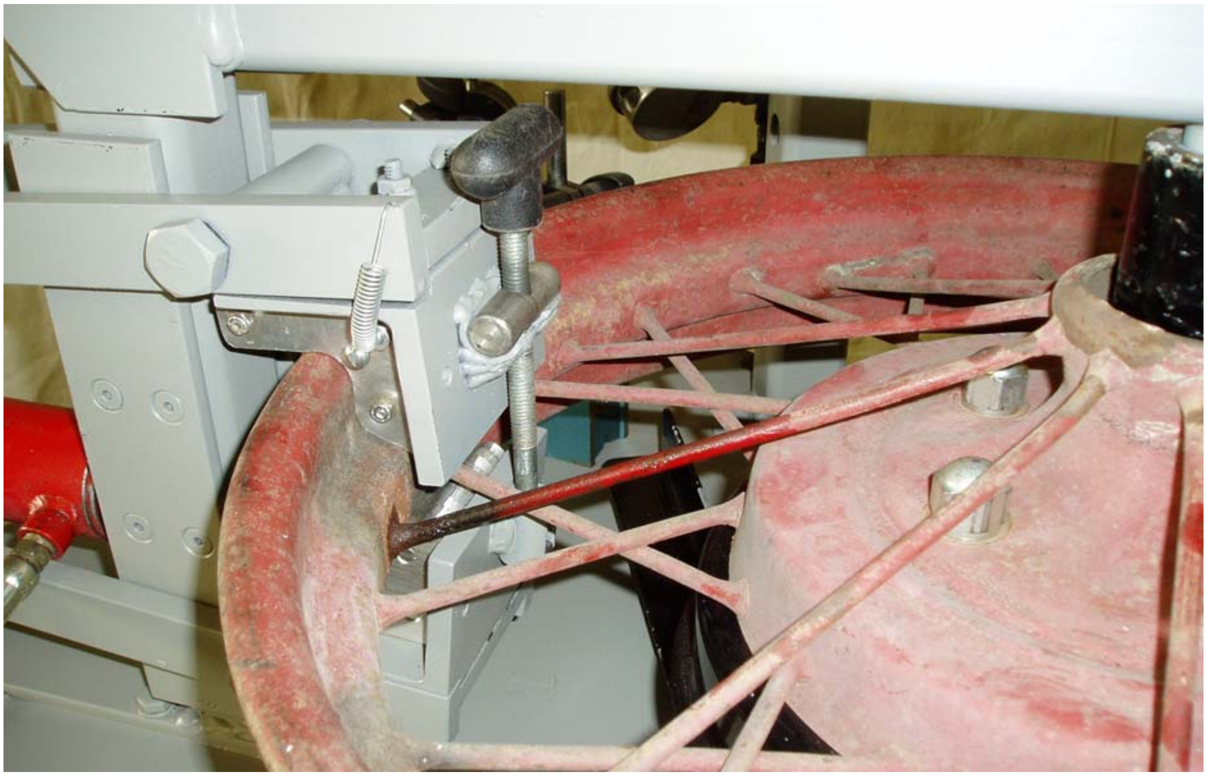




Ram is set to apply most of the force to the bottom edge of the wheel in both of these photos.

The arms can be relocated to change the angle of the laminated tooling against the wheel.

Adjustable height support with table guides to keep the puller in correct alignment.

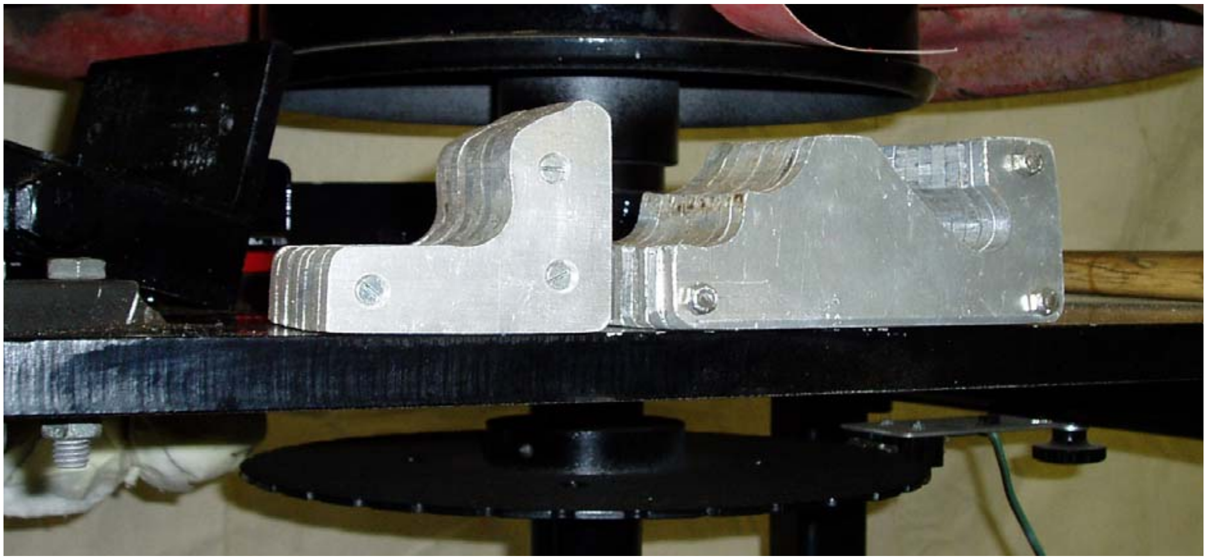


The end of the puller arm is adjustable to allow the aluminum tool to meet the wheel at different angles. Adjusting the angle will vary the pressure applied to the outer edge of the bead. Rotating the top tool clockwise and bottom tool counter-clockwise as viewed plus pulling the jaws tight with the locking bolt will apply more force to the base of the spokes resulting in a much broader correction.

Close up below of the adjustable end. The springs hold the aluminum tool in place

Close-up view of the locking bolt. Note the set screws just behind the handle of the locking bolt. These set screws adjust the angle of the tool saddle.

Laminated tooling for 21” wheels.



A pattern of aluminum was made to closely fit the wheel profile. This pattern was copied to additional pieces of aluminum by bolting the pattern to a rough shaped aluminum blank with a spacer between them. I rough cut the blanks to within 1/8” of final shape. A router with a carbide flushing bit was slowly run around the pattern and blank resulting in a copy. The holes used to produce the copy from the pattern are used to assemble the laminations into the tool. Washers of the appropriate thickness were placed between the laminations to create a tool surface that matches the radius of the wheel. The tooling was held against the wheel in appropriate position as the bolts were tightened to lock the laminations together. After the bolts were tightened, the surfaces of the tool that meets the press and puller components were machined flat to produce even pressure through the laminations to the wheel surfaces.