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Explanation of Wheel Sets and Track Related Parameters

Introduction

This section describes the parameters and their origin. For simplicity only the one and one half inch scale numbers will be discussed; however, the one inch scale numbers follow the same analysis. Use the following drawings as a reference: 320-002, 340-001,340-002, Figure Q, Figure V, and Figure W
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Wheelsets

The best place to start is where one would begin to machine a wheel. Let's assume the axle bore is done and the wheel is mounted on a mandrel ready to have the tread and flange finished. Often the tread and flange are machined in one operation.

> **WTW**: Full size wheel tread width is 5 ½ inches in and scales to 0.738. So, the commonly listed value of 0.750 is close enough and the extra 0.012, though small, helps when traversing frogs.
>
> **WTA**: Tread angle is a builder's choice of either a cylindrical or conical shape with an angle up to 3 degrees.

The flange profile is a complex shape as exemplified by full size practice which uses six radial and eight linear dimensions for a complete definition. The NMRA have simplified it a bit using three radial and linear dimensions.

Flange profiles should be easy to describe, easy to machine, and easy to measure. The last item is very important if a club decides to inspect rolling stock. Let's look at the flange profile.

> **WRR**: A common value for the wheel root radius is 0.094. It was originally set at 0.062, but was subsequently increased to 0.094. See Boynton Green's urging for an increase in his article in Live Steam, 1977. Here too we can check against the full size value which is 0.688 and that divided by 7.457 is 0.092. Another thing to bear in mind is that when the wheel is moved laterally, it should touch the rail head only in one point. That can happen only if the wheel root radius is larger than the rail head corner radius.
>
> **WFW**: The wheel flange width is a basic dimension with an agreed upon value of 0.156.

Next, look at Figure V for a common description of how to machine the flange profile. In Figure V, view A, the wheel blank ready for profiling. After turning the fillet, Figure V view B, the next step calls for cutting a 10° angle into each side of the flange. In one description the builder is advised to "file a contour" for the tip. But to what radius? In another description, the tip radius is given as 5/64, but the flange width is 5/32 so the sides couldn't possibly be anything but parallel.

However, if we ignore that contradiction and inscribe a circle tangent to the two sloping sides and the bottom, we get the profile as shown in Figure V, view C. After trimming off the excess parts of the sloping sides, all that's left of the two 10° lines are segments 0.036 inches long as shown in Figure V, view D. It hardly seems worth the bother of specifying and cutting sloping lines only to end up with such tiny line segments. Also, imagine checking such a profile to any inspection specification.

The following is a suggestion for a simpler definition:

WFD: Suppose we eliminate the sloping lines entirely, reduce the wheel flange depth to 0.172. The new, reduced value of the flange depth is still greater than the scaled full-size value which is one inch divided by 7.4 which is 0.135 so we should be OK.

WFTR: Make the tip radius 0.078. That produces a profile consisting only of easily defined parts of circles. See Figure W for the result.

WG: Wheel Gauge is a basic dimension equal to 7.438 inches.

WBB: Wheel Back-to-Back is a derived parameter that is completely controlled by wheel set axle. Usually the axle is turned with a increased diameter center section whose length is equal to the following expression

$$W_{BB} = W_G - 2W_{FW}$$
$$W_{BB} = 7.438 - 2\,x\,0.156$$
$$W_{BB} = 7.125$$

WCG: Wheel Check Gauge is a derived parameter found by

$$W_{CG} = W_{BB} + W_{FW}$$
$$W_{CG} = 7.125 + 0.156.$$
$$W_{CG} = 7.281.$$

WTG: Wheel Tread Gauge is a new parameter defined to rationalize the wheel set and track gauges. A wheel set should ride the rails in its tread and not on its flange root radius to prevent the wheel set from trying to separate the rails. Also, unless there is clearance, riding on the root radius will cause wear to the railhead and the wheel. Figure Q (a) shows a wheel running with adequate clearance between the flange root radius and the rail head corner radius. By adequate clearance is meant that the wheel flange is not rubbing on the rail.

The wheel tread gauge is defined as the sum of the wheel gauge and twice the flange root radius or

$$W_{TG} = W_G + 2W_{RR}$$
$$W_{TG} = 7.438 + 2\,x\,0.094$$
$$W_{TG} = 7.625.$$

Rails and Tracks

TGT: The Track Gauge, Tangent along with the Wheel gauge are two major parameters since they define the rolling stock and the track it rides on. The popular value of 7½ inch for 1 ½ scale along with a scaling ratio of 1:8 is not quite correct since full size gauge is 56½ inches and that divided by 8 is 7.063. We use 7.56 and that choice makes the scaling ratio

$$\eta = \frac{56.5}{7.56} = 7.471$$ or let's make it 7.4.

RHCR: Rail Head Corner Radius, has not been covered anywhere. Measurement of a common one inch high steel rail gives a value of 0.0625. This is the rounding of the corner of the rail head.

RFW: Rail foot Width is a measured quantity of 0.9.

RHW: Rail Head Width is a measured quantity of 0.5

RH: Rail Height is a measured quantity of 1.0

TTG: Track Tread Gauge is the distance from the right to left rail head tread and is defined by

$$T_{TG} = T_G + 2T_{HR}$$
$$T_{TG} = 7.563 + 2x0.0625$$
$$T_{TG} = 7.688.$$

Now we can check the clearance between the wheel tread gauge with the track tread gauge.

$$Tread\ Gauge\ Clearance = T_{TG} - W_{TG}$$
$$Tread\ Gauge\ Clearance = 7.688 - 7.625$$
$$Tread\ Gauge\ Clearance = 0.063.$$

When the wheel set is centered on the rails, there is approximately 0.031 clearance on each side. Using a wheel set with a root radius of 0.094 on a track with 7.500 gauge results in a clearance of zero.

RA: The rail angle is determined by the use of Rolls Model plastic tie plates that rotate the rails inward by about 1.4 degrees as well as approximately spacing the rails.

Lateral Turnout Parameters

FWY: The space between the rail and guard rail is the flangeway and is determined from

$$F_{WY} = W_{FW} + W_{RR}$$

$$F_{WY} = 0.16 + 0.09$$

$$F_{WY} = 0.25$$

The same value is used for frog flangeways.

TCG: Track Check Gauge is a calculated parameter defined by

$$T_{CG} = T_G - F_{WY}$$
$$T_{CG} = 7.563 - 0.25$$
$$T_{CG} = 7.313.$$

TS: Track Span is a calculated parameter defined by

$$T_S = T_G - 2F_{WY}$$
$$T_S = 7.56 - 0.5$$
$$T_S = 7.06.$$

Track Gauging In the Turnout

The most critical place for correct gauging is in the turnout. Now that we have discussed the wheel and track parameters, a closer look can be taken at the turnout gauging issues. The dimensions in the lateral direction are very critical for safe and smooth running of the turnout.

If there is a problem with derailments at a turnout frog, the first thing to do is verify that the track check gauge is greater than the wheel check gauge, but not so great that the track span becomes greater that the wheel back-to-back. Let's check the numbers.
The Check Gauge Clearance is the difference between the wheel and track check gauges

$$Check\,Gauge\,Clearance = T_{CG} - W_{CG}$$

$$Check\,Gauge\,Clearance = 7.313 - 7.281$$
$$Check\,Gauge\,Clearance = 0.032$$

What about wheel back-to-back and track span? The span clearance is the difference between the two or

$$Span\,Clearance = W_{BB} - T_S$$
$$Span\,Clearance = 7.125 - 7.062$$
$$Span\,Clearance = 0.063$$

Efforts to increase the check gauge clearance must not go so far as to reduce the span clearance to the point that the wheel backs bind on the guard rail and frog wing rail.

Finally, the wheel tread overlap, W_{TO}, indicates how much of the tread is engaged as the wheel passes from the wing rail to the frog point. It is defined by

$$W_{TO} = W_{TW} - 2F_{WY}$$
$$W_{TO} = 0.75 - 2\,x\,0.25$$
$$W_{TO} = 0.25.$$