2.0.0 RIM.

2.1.0 DEFINITION.

The rim is the part of the wheel that has a suitable profile and is of suitable dimensions to be a seat for the tyre.

Passenger car rims are made up of three distinct areas, each of which performs a particular function:

- a dropped central part, which is necessary for the operations of mounting and demounting the tyre;
- two lateral flanges, which bear the axial thrusts;
- two conical seats, which serve as fastening seats for the tyre beads.

The profile can be symmetric as regards the central line.

Usually, however, it is asymmetric in order to leave more room for the braking equipment.

2.1.1 RIM DESIGNATION.

The dimensions of existing rim types are (further) expressed in **F.E.: 4 ½ × 12.**

New concepts or types have to be expressed in mm when mounted in combination with new types/concept of tyres.

F.E.: 365 × 150 TD, CT 450 × 150, PAX 145 × 360 A (Pict.1)

Most of the times, also the type of rim edge is mentioned:

F.E.: 4 ½ B × 12, 5 ½ J × 13 (see chapter 2.11.0 “Different Rim Edges).

Symmetrical rims are indicated with an additional **“s”**

F.E.: 4 ½ J × 13 - S

The symbol **“×”** indicates a “one-piece” rim:

F.E.: 4 ½ × 12

The symbol **“-”** indicates a “multi-piece” rim:

F.E.: 15 - 5 ½ F SDC.

The **“DIN”** and **“ETRTO”** sizing are putting first the rim width followed by the diameter:

F.E.: 6 J × 15.

The **“ISO”** sizing will put first the diameter.

Followed by the rim width and the type of edge:

F.E.: 15 × 6 J

Pict. 1

2.2.0 WHAT IS AN ALLOY WHEEL?

Alloy metals provide superior strength and dramatic weight reductions over ferrous metals such as steel, and as such they represent the ideal material from which to create a high performance wheel. In fact, today it is hard to imagine a world class racing car or high performance road vehicle that doesn't utilise the benefits of alloy wheels.

The alloy used in the finest road wheels today is a blend of aluminium/magnesium and other elements. The term "mag wheel" is sometimes incorrectly used to describe alloy wheels. Magnesium is generally considered to be an unsuitable alloy for road usage due to its brittle nature and susceptibility to corrosion.

The most common type of aluminium used in wheel manufacture is 356 alloy (also called T-6 aluminium, where the T-6 refers to its temper and does not tell anything about the chemical composition of the alloy). Following materials, in low or higher percentages, are composing the 356 alloy: titanium, zinc, magnesium, manganese, copper, iron, silicon,…

Magnesium alloys are about 33% lighter than aluminium. Two types are used commonly for wheel manufacturing: the "AZ91E" and the "ZE41A".

The magnesium AZ91E features a lower yield point than alu alloys, but a higher tensile strength. Under stress or impact it will start to bend sooner but will 'give' much later. It is withstanding heat very well and by limiting the percentage of copper, manganese, iron and nickel in its mix, corrosion potential is seriously reduced.

More refined and expensive is the ZE41A magnesium. It has a tighter grain structure (less likely it looses leak air) and will withstand twice the heat of the AZ91E. This type of magnesium uses more costly and rare materials as Cerium, Didium and Titanium.

2.3.0 MANUFACTURING PROCESSES.

Alloy wheels or parts are forged, cast or machined from billet stock.

2.3.1 FORGING.

Forging is forming the aluminium into a specific form under high pressure. There's cold and hot forging:

<u>Cold forging</u>: first, heat is used to render the metal more malleable after which high pressure is used to form the shape.

<u>Hot forging</u>: the alloy is maintained at a specific heat while it is formed to shape under high pressure.

Forged wheels are up to three times stronger than cast wheels and about 20% lighter.

2.3.2 CASTING.

Also in casting there are two types used commonly:

<u>Gravity casting</u>: also known under "low pressure casting". First a mould (or master) is made of wood, plastic, aluminium or a combination of these. The master mould then is used to make a sand impression using high quality sand of certain type. Molten alloy is then poured into the mould, which after a certain time of cooling is opened the release, the raw

casting.

The two types of casting mix mainly used are AlSi 7 Mg and AlSi 11. The AlSi 11 has good casting properties, but cannot be treated afterwards to raise the strength of the rim. The AlSi 7 Mg is used for rims with higher strength requirements as these rims can be treated afterwards to raise their strength. This treatment is done in three different operations:

1 the rim is heated up to 530°C for a certain time during which the hardening components are added;

2 fast cooling: most of time, a cold water bath is used to cool the rim fastly down;

3 for several hours, the rim is kept at a temperature between 140°C and 180°C to obtain the final material strength.

P.S.: Certain rim manufacturers are not performing the treatment described in point 1, 2 and 3 in order to save money. These rims are weak and easy deformable.

Counter pressure casting: Also here a mould is made, but this casting procedure needs a specifically formulated molten alloy, which is drawn into the mould by a super-high vacuum pressure. This type of moulding creates a less porous, thus stronger wheel.

2.3.3 MACHINED FROM BILLET DISC.

Wheels centres can be formed under extremely high levels of pressure by using aluminium billet discs. A press mould that determines the form of the wheel centres receives a billet disc on which a vertical press is using up to 1 million kg/cm² to slowly squeeze the aluminium disc into the mould. Most billet wheels are “two-piece” with the centre as the only part machined from billet stock.

2.3.4 STEEL WHEELS.

In most cases, these wheels are made up from two pieces: the disc and the wheel. Both components are welded together using different modern techniques.

2.4.0 SYNTHETIC / COMPOSITE WHEEL.

On the market since April ’99, this material offers some advantages over the “metal” wheels:

- Is not sensible for corrosion, can be used the whole year around.
- Is generating less dB when rotating.
- Is weighting approximately 20% less than an Alu rim of the same dimension.
- Contributes to keep the brakes cooler.

2.5.0 PERFORMANCE BENEFITS.

While many people choose light alloy wheels for their beauty, there are considerably more important performance benefits to be derived, including:

2.5.1 REDUCED UNSPRUNG WEIGHT.

Unsprung weight is one of the most critical factors affecting a vehicle's road holding ability. Unsprung weight is that portion of a vehicle that is not supported by the suspension (i.e. wheels, tyres, brakes) and therefore most susceptible to road shock and cornering forces.

By reducing unsprung weight, alloy wheels provide more precise steering input and improved "turning in" characteristics.

2.5.2 IMPROVED ACCELERATION/BRAKING.

By reducing the weight of the vehicle's rotational mass, alloy wheels provide more responsive acceleration and braking.

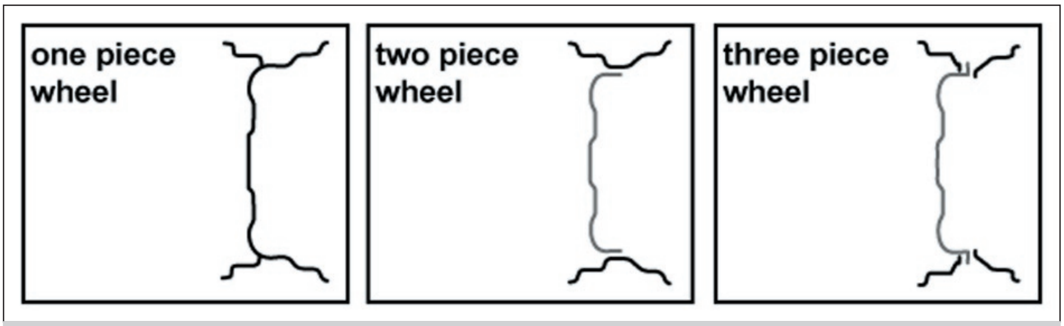
2.5.3 ADDED RIGIDITY.

The added strength of a quality alloy wheel can significantly reduce wheel/tyre deflection in cornering. This is particularly critical with an automobile equipped with high performance tyres where lateral forces may approach 1.0 g.

2.5.4 INCREASED BRAKE COOLING.

The metals in alloy wheels are excellent conductors of heat - improving heat dissipation from the brakes - reducing risk of fade under demanding driving conditions.

In the custom wheel aftermarket, there are three types of wheel constructions available:



Pict. 2

1 one-piece cast aluminium wheel

2 two-piece modular wheel

3 three-piece modular wheel

- The **one-piece cast aluminium wheel** is used as original equipment on many high-performance production cars. Because they are light and resist flexing, the handling of a vehicle may be improved. These one-piece wheels are usually less expensive than modular wheels, but they have limited applications and are made for a specific make and model of car.
- The **two-piece modular wheel** may provide superior performance to the one-piece wheel because it is lighter and you can assemble it for a very specific application.

This modular wheel is constructed of a centre section (made of aluminium or steel) fastened to an aluminium or steel rim. This design offers a greater variety of sizes and configurations to meet more application needs and tyre combinations than a one-piece wheel.

- The **three-piece modular wheel** offers the most versatility in size and application. It is constructed of two outer halves that make up the rim (made from aluminium alloy) and a centre section (made from magnesium or pressure-cast aluminium). The construction allows you to change the individual pieces to achieve the required offset and backspacing. It is very lightweight, so vehicle unsprung weight can be reduced which may improve handling. Also, a damaged section of this wheel can be repaired by the manufacturer at a cost much less than a new three-piece wheel. The disadvantages of the three-piece constructed wheel are the relatively high cost and the need for periodic re-torquing of the bolts. Also, if the seals are not perfect, they can leak air.

2.6.0 WHEEL EFFECT ON BRAKING.

When selecting custom wheels, it is important to consider the effect they will have on a vehicle's braking capacity. Three wheel design elements can affect braking efficiency:

1 weight

2 ventilation

3 material construction

Although the difference in **weight** among custom wheels is slight, lighter wheels will decrease the load on the braking system and result in more efficient braking.

Under heavy braking situations, heat build-up will cause fading and loss of efficiency. Therefore, some wheels can perform a major function in brake cooling by permitting **airflow** (**ventilation**) over the brakes, through the wheel's large open-space design. The form of the open-spaces or the "propeller" position of the Spokes is not helping the ventilation. Since solid wheels restrict air passage, separate air ducting may be required.

The increased wheel diameters obtained through the Plus 1/Plus 2 concept (see below) can also contribute to improved brake cooling by providing a larger area for air passage around the brakes.

Custom wheels are made with **different materials** by different methods to meet various driving objectives and budgets. Although all wheels flex to some extent, in regard to braking, stiffer wheels with little flex reduce the amount of total tyre/suspension deflection and increase vehicle performance. Remember, however, that every custom wheel must have an acceptable load capacity for the application involved.

2.7.0 PLUS 1 AND PLUS 2 SIZING.

One of the best ways to move customers up to a higher level of performance is to recommend Plus 1 and Plus 2 sizing. As the chart illustrates, this concept achieves increased handling capabilities by mounting tyres with wider section widths and lower aspect ratios to rims of 1, 2 and sometimes 3 inches greater diameter. The key is: whatever changes take place, the tyre's outside diameter will be the one constant, maintaining the car's original ride height and avoiding a re-calibration of the ABS-system if present.

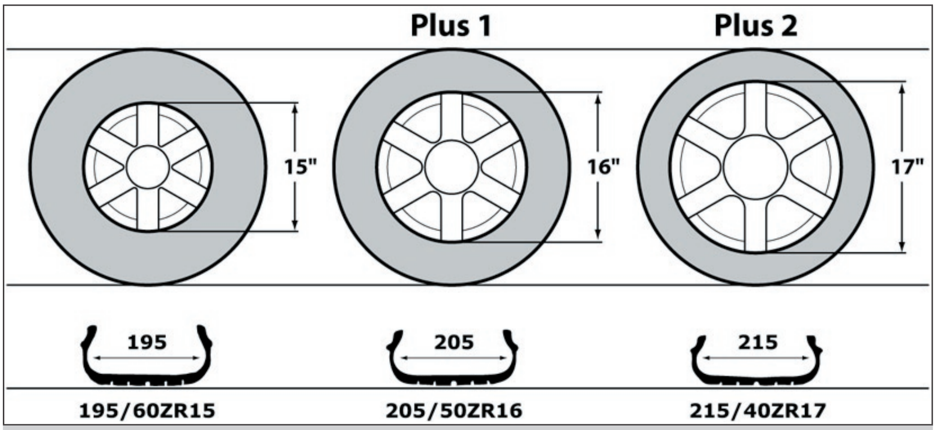
A Plus 0 fitment means that a wider tyre with the same outer diameter has been mounted.

Plus 1 and Plus 2 fitments must also retain nearly the same overall tyre diameter so that gear ratios and speedometer readings remain accurate. Equally important to proper Plus 1 and Plus 2 sizing is maintaining a load-carrying capacity that is equal to or greater than that of the original tyre.

Looking more closely at the concept shows how it achieves greater performance benefits. Wider section widths and lower profiles give tyres a wider footprint that increases the vehicle's steering response and overall cornering force.

It's important to select Plus 1 and Plus 2 wheels that meet recommended rim width range specifications.

A wheel that is outside the recommended width range can curve the tyre's tread surface, leaving the customer with less traction, less cornering force and less shock absorbing.



Pict. 3

Properly mounting the tyre may also prove difficult.

So, the three basic rules to control first before the Plus sizing are:

Plus 1 rule of thumb	Plus 2 rule of thumb
increase section width by 10mm	increase section width by 20mm
decrease aspect ratio by 10 points	decrease aspect ratio by 20 point
increase rim diameter by 1 inc	increase rim diameter by 2 inches

1 The new tyre should not come in contact with body and/or suspension parts.

2 Always check the load capacity of the tyre.

3 The new overall tyre diameter should not exceed more than 2% the original one

2.8.0 STYLE AND OTHER FACTORS.

While the styling of a wheel may be purely subjective, there are two very objective factors to be considered in choosing a light alloy wheel.

2.8.1 QUALITY OF MANUFACTURE.

Unless an alloy wheel offers superior benefits in terms of performance, strength, and weight reduction, it is not a wise investment. Before selecting an aftermarket wheel, investigate the manufacturer's reputation for quality and performance.

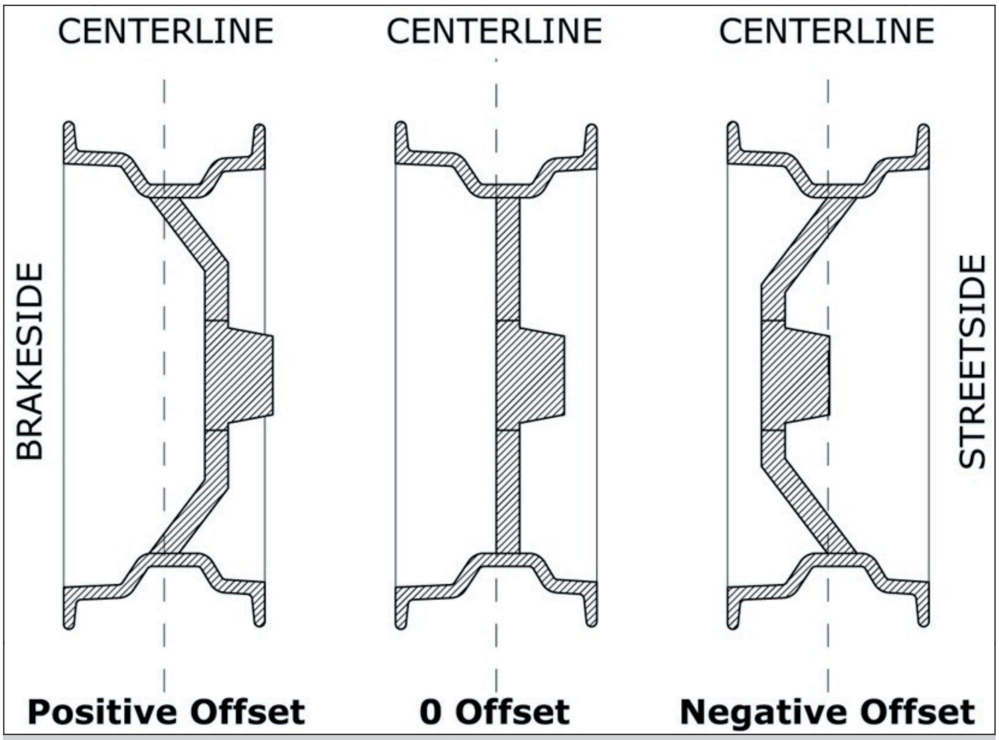
2.8.2 EXACT FITMENT.

In order for an alloy wheel to perform properly, it must be designed for a specific vehicle fitment. The dimensions critical for precise wheel fitment are:

- **Backspacing:** is the distance from the bolt pad mating to the plane of the inner rim edge. It is only important for inboard clearance.
- **Wheel offset.** In addition to selecting wheels with the correct bolt circle and rim width, you must also choose a wheel with the correct offset.

  Offset is a measurement that most people in the tyre business know something about, but may not fully understand. Simply, offset is the measured difference between the wheel's mounting face where it bolts up to the hub and the centreline of the rim. In other words, when the mounting face directly aligns with the wheel's centreline, the wheel has zero offset. When the mounting face is toward the wheel's streetside, the wheel has positive offset. Negative offset occurs when the mounting face is closer to the brake side of the wheel.

  The offset of the rim is what locates the tyre/wheel assembly in relation to the suspension. Front wheels usually have positive offset. Front-wheel drive vehicles have



Pict. 4

light positive offset wheels, which allow for proper clearance of the hub assembly within the wheel well.

On the front-wheel or all-wheel drive vehicles, it is important to keep the front axle offsets to the factory-designed specifications. Offsets that do not meet these specifications can increase steering effort, steering wheel kickback when accelerating around a turn and load on the wheel bearings.

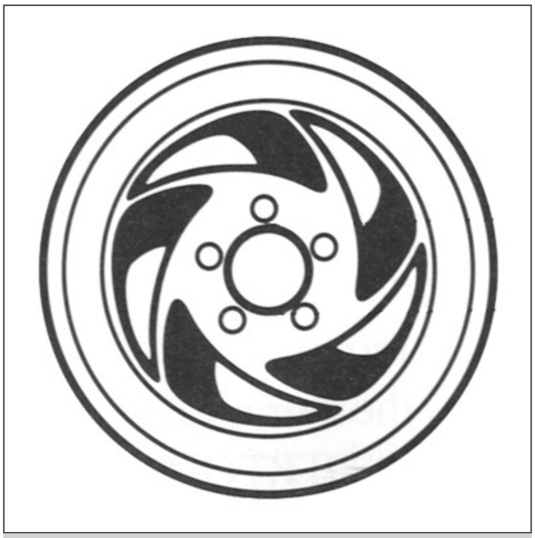
Using the proper positive or negative offset at the rear of the vehicle is important - but less so than using it at the front where the bearing load situation is critical.

Negative offset wheels also affect a vehicle's handling. At the rear of the vehicle, they can increase its track, improving stability and handling. Excessive negative offset increases steering wheel kick-back and places additional stress on wheel bearings and the vehicle's suspension.

- **Hub- and lug- centric wheels.** Wheels are manufactured to centre on a vehicle in one of two ways; otherwise a condition known, as radial run-out will occur which creates a nasty vibration:

1. **On the hub of the vehicle**

   The hub hole of hub-centric wheels is made to perfectly match the diameter of a vehicle's hub. For example, a hub hole that is 70 mm in diameter will fit perfectly on a 70-mm hub. Automakers use hub-centric wheels because they provide a more accurate fit. However, only the most expensive aftermarket wheels are hub-centric. In some cases, a wheel may fit a number of car applications with the only variable being its hub diameter. The adaptable wheel may be machined to receive the largest of these diameters. Centring rings are used to fit the other hub diameters. The material of these rings varies from inexpensive nylon inserts to high precision-machined alloy rings. Also the method of ring fastening to the centre hole varies to the wheel makers own design. Some ring brands are colour coded to allow easy recognition of the diameter. Wheels with oblong bolt circles or multiple bolt circles should be avoided.

   Pict. 5

   Wheels with oblong bolt circles or multiple bolt circles should be avoided.

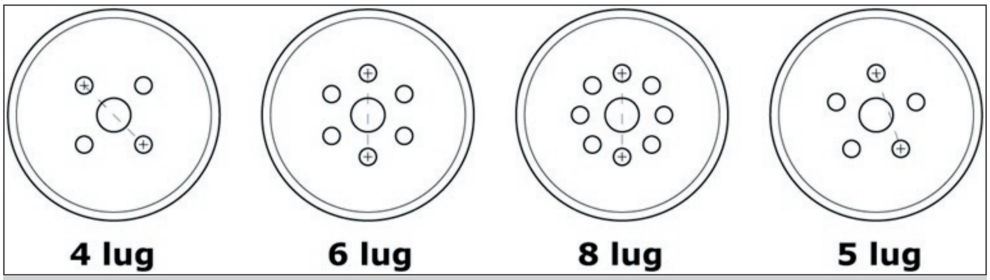
2. **On the lug nuts**

   When replacing a wheel, you must select a replacement with a bolt pattern or circle that matches that of the vehicle. A bolt circle is the diameter of an imaginary circle drawn through the centre of each lug nut hole. This is true of all lug patterns - 4, 5, 6 and 8.

   To determine the diameter of the bolt circle for 4-, 6- and 8-lug patterns measure from the middle of two holes that are directly across from each other. Using the 4-lug pattern as an example, the bolt circle is 100 mm in diameter. This is often referred to as "4 x 100 mm".

Since no two lug holes appear directly across from each other in a 5-lug pattern, determine the bolt circle diameter by starting at the back of one hole and measuring to the centre of a second hole that is on the opposing side.

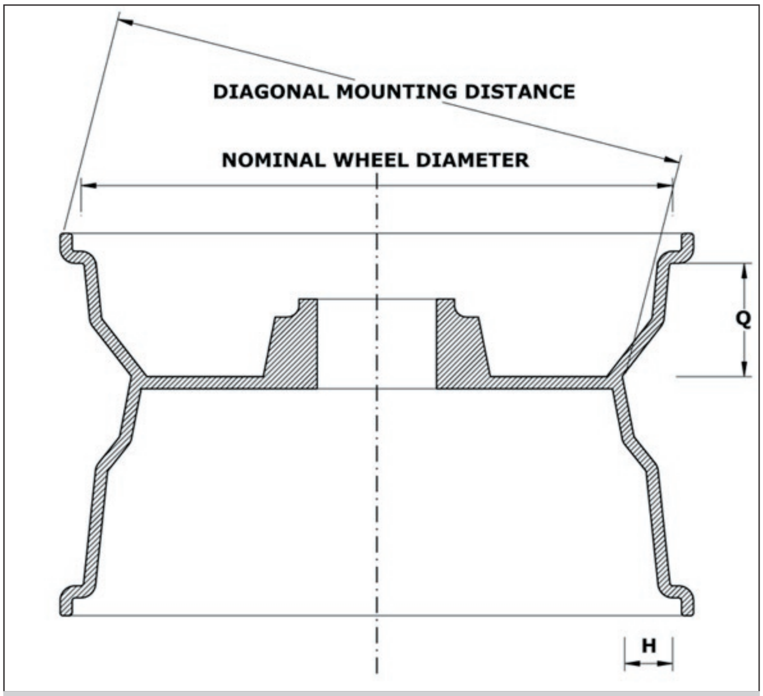
Wheels that rely upon lug bolts for centring should be avoided as they concentrate loads directly in the bolt hole area - the weakest section of any wheel. (This is the reason why tyre changers using a centre - hole - clamping as on a balancer, and using hydraulic bead breaker devices are easily damaging the disc of an alloy rim.



Pict. 6

2.9.0 MOUNTABILITY.

The minimum well depth (dimension H) can only be reduced, if at the same time the



Pict. 7

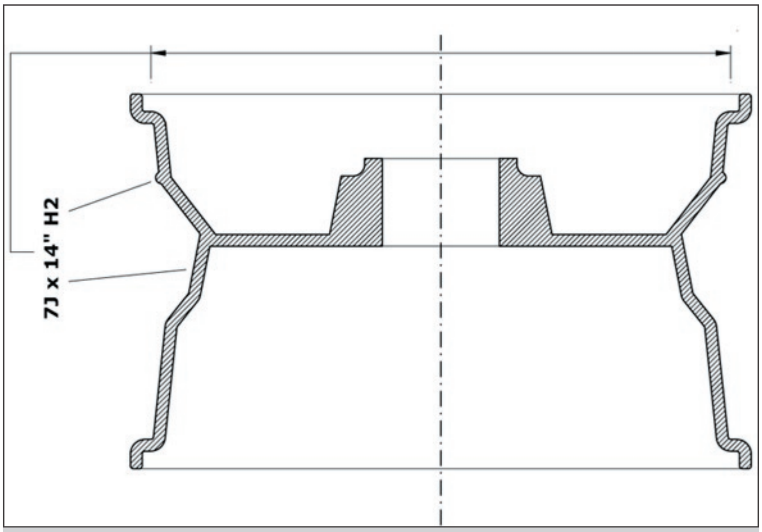
mounting dimension (Q) is reduced and the diagonal mounting distance will not be increased.

The mountability of a wheel (=tyre/rim) combination depends on several factors:

1. RIM:
    a) rim edge type and height
    b) length of the mounting balcony
    c) depth of the well
    d) bead seat tolerances
2. TYRE:
    a) bead thickness
    b) bead type
    c) bead tightness / pressure
    d) sidewall structure
    e) section height
    f) rim width / tyre width
    g) rim protector bar
3. TYPE OF TYRE CHANGER.

Pict. 8

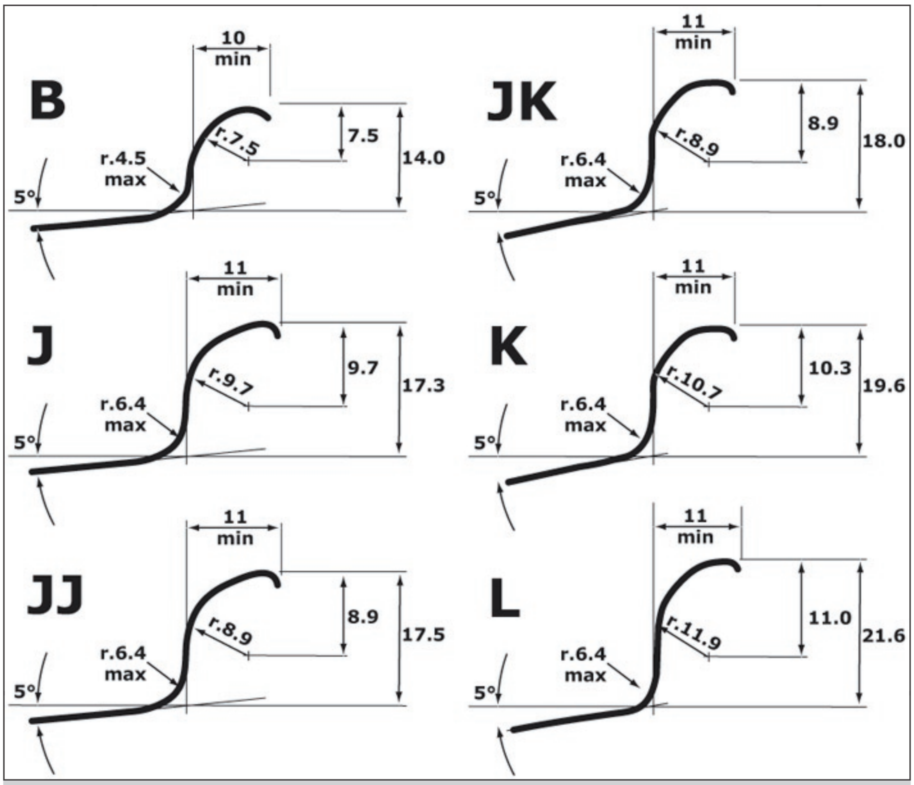
2.10.0 DIFFERENT HUMPS.



Pict. 9

BEAD SEAT CONTOUR			
DESIGNATION	***OUTSIDE***	***INSIDE***	***MARKING***
Hump Double Hump	Hump Hump	Normal Hump	H H2
Flat Hump Double Flat Hump	Flat Hump Flat Hump	Normal Flat Hump	FH FH2
Combination Hump Special Ledge	Flat Hump Special Ledge	Hump Normal	CH SL
Contre Pente Contre Pente	Contre Pente Contre Pente	Normal Contre Pente	CP CP2
Flat Pente Flat Pente	Flat Pente Flat Pente	Normal Hump	FP FPH
Asymmetric Hump Asymmetric Hump/Hump	Asymmetric Hump Asymmetric Hump	Asymmetric Hump Hump	AH2 AHH
Special Hump Extended Hump	Special Hump Ext. Hump	Special Hump Ext. Hump	SH2 EH2

2.11.0 DIFFERENT RIM EDGES.



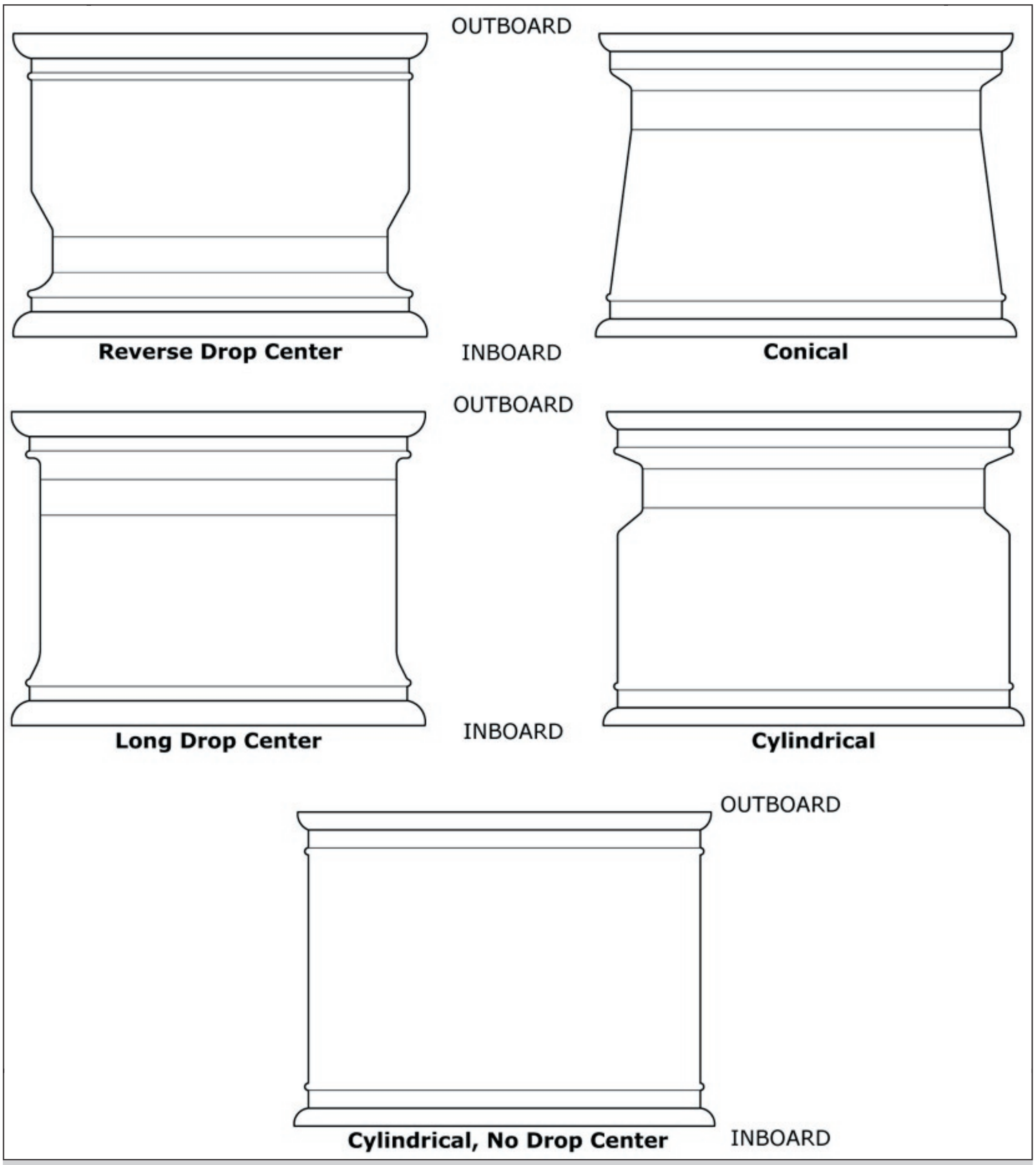
Pict. 10

Rim edges are important as they define the transition of the rigid bead seat into the flexible sidewall.

Rim edge **“B”** is used in general on 10, 12 and 13 inch diameter rims.

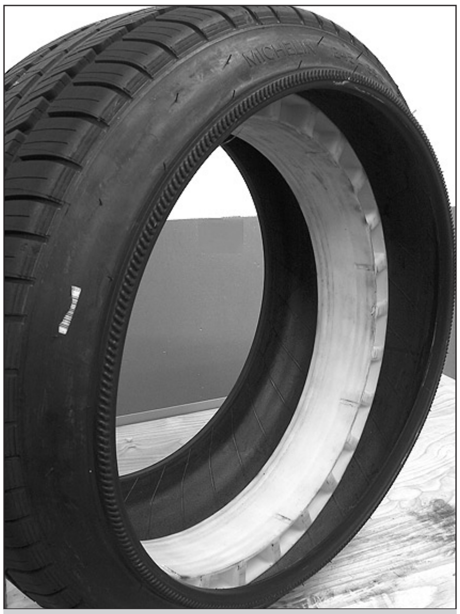
The **“J”** type on 14 inch and bigger. In stead of the **“J”** type, also a **“JK”** edge can be used. (**“JK”** is an American compromise between the **“J”** and the **“K”** edge).

2.12.0 DIFFERENT DROP CENTERS.

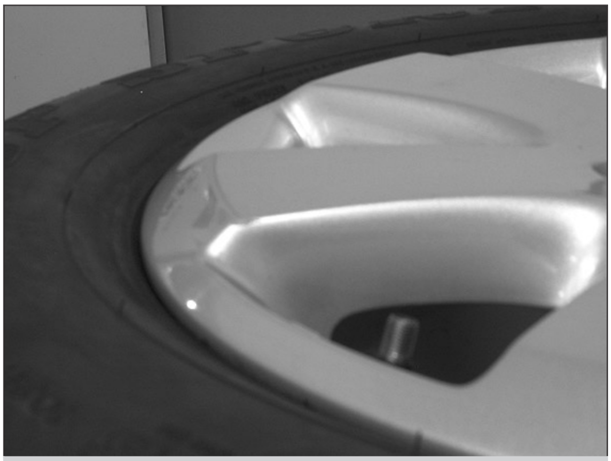


Pict. 11

2.13.0 NEW TYPES AND MODELS.


Pict. 12: PAX Tyre + Support


Pict. 13: PAX Wheel w/ press sensor


Pict. 14: Raised spoke wheel