

auto motor und sport

Finland Imk 17,-, France FF 22,-, Greece Dr 540,- Great Britain L 2.25,
Italy Lit 5.200,., Luxembourg lfr 120,-, Netherlands hfl 5.90, Austria öS40,- (incl. VAT),
Switzerland sfr 5,-, Spain/Canary Islands 450,-/475,-, Printed in Germany

Issue 19 September 9th 1988 DM 5,- E 1418D

24 Pages

Accessory Extra

Alloy Wheel Test for
BMW 3 Series and VW Golf

BMW 316i First Test

Mercedes 190E 2.5-16 First Test

Porsche
Speedster

First Test Drive Report

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Eleven Wheels

What about the quality of the light alloy wheels offered in the accessories trade? Eleven special wheels for BMW 3 Series and VW Golf in comparison.

One of the most attractive features of a car can be its light alloy wheels, according to a current BMW display. And, mind you, of the countless makes that are offered for sale in advertisements or in thick accessory catalogues, some products are ahead of others by a mile.

In order to find out what the quality of the light alloy wheels offered in the accessories trade actually looks like, auto motor und sport subjected eleven of them to an extensive test programme. Wheels in the dimensions 7J x 15 H 2 were selected for the comparison, the particular common feature of which is that they are approved for both the BMW 3 Series and the VW Golf.

For the original BMW light alloy wheel with "unbeatable material" mentioned in the advertisement text, the opportunity presented itself to duly demonstrate its qualities. The BMW wheel cast by Alumetall

1. O.Z. Racing 52705 BW 1, DM 695,-
2. D&W Silver-Line, DM 325,-
3. Fondmetal 2300 HB, DM 249,-
4. ATS 7058, DM 300,-
5. MSW 1968 D, DM 400,-
6. D&W Turbo-Line, DM 325,-
7. Ronal R 15, DM 308,-
8. BBS RZ 320, DM 350,-
9. King 2715.26, DM 364,-
10. BMW(Alumetall) DM 434,-
11. BBS RG 003, DM 650,-

In the laboratory:
Steps of the endurance test

Drumfire

How resistant is the paint to chippings? To simulate stone chip damage, each wheel is shot at with four to five millimetre steel grains at a pressure of 2 bar before the salt spray test.

Marathon

How's the strength? Preparation for the 20-hour rotating bending test at TÜV Bayern in Munich.

Wheel Test

in Nuremberg had to compete with six german-made special wheels as well as four competitors from Italy, three of which (Fondmetal, MSW, O.Z.) are from companies that also supply Formula 1 teams. The editorial team's wish to also include a reference wheel from the Golf range in the field of participants could not be realised, as VW does not currently have a seven-inch copy on offer as an optional accessory for its bestseller model.

The eleven test participants represent the diversity of the design variants: Five of them belong to the popular species of cross-spoke wheels, another five come up with a spoke styling, and one wheel presented a disc look. The BBS wheel with the type designation RG 003 represents the noble guild

of forged wheels, the other ten are produced either using the gravity casting process (aluminium metal), counterpressure casting process (BBS RZ 320) or the currently most frequently applied low-pressure casting process. The colourfully mixed selection of eleven wheels was the subject of a test programme covering a total of eight stages, which was mainly carried out on the premises of the Technischer Überwachungs Verein Bayern e.V. in Munich, which specialises in the testing of special wheels. Before the start of the multi-stage race, it was important to check, whether the light alloy wheels made of aluminium also lived up to their name, which promised reduced weight. The weight range reaches from 5.88 kilograms for the BBS forged wheel to 8.57 kilograms for the ATS wheel. At 7.09 kilograms, D&W's turbo wheel was the lightest in the selection of cast wheels - the following tests

Insight

Does the casting quality reach original equipment format? The screening on the X-ray machine makes micro cracks or cavities in castings ("blowholes") visible.

Under the Magnifying Glass

Does the salt spray test show a worrying frequency of bubbles over a period of 504 hours? The number of bubbles per surface unit and the degree of infiltration are assessed with a magnifying glass magnified two and a half times.

Technical Data: 45% Weight Difference

Manufacturer	Wheel Type	Weight in kg	press-in depth in mm		permissible wheel load in kg		circulating bending moment in Nm 75% MB max.	
			Report	Test	Report	Test	Report	Test
ATS	7058	8.57	25+-1	25.5	475	475	2087	2055
BBS (Cast)	RZ 320	7.42	24--1	23.6	515	475	2221	2049
BBS (Forged)	RG 003	5.88	25+-1	24.8	515	475	2228	2055
BMW	1 179 066	7.36	24+-1	23.6	500	475	2156	2049
D&W (Silver-Line)	132 705 B	8.18	28+-1	28.7	460	475	1991	2077
D&W (Turbo-Line)	214 705	7.09	25	25	460	475	1990	2055
Fondmetal	2300 MB	7.86	30+-0.5	30.4	470	475	2068	2090
King	2715.26	7.61	26+-0.5	27.3	515	475	2236	2063
MSW	1968D	8.35	26+-1	26.6	515	475	2236	2063
O.Z.-Racing	52705 BW1	7.69	15+-1	15.2	475	475	1985	1985
Ronal	15 714 031	8.04	25	25	515	475	2230	2055

Paint Resistance

How well does the surface protection adhere? The cutting side of a pocket knife blade is used to scrape off the top coat of paint up to the paint carrier. The subsequent assessment is carried out according to six quality levels.

Wheel Test

were intended to determine whether the renunciation of weight has an influence on the stability of these wheels. For comparison: a BMW steel wheel in the 5½J x 14 size weighs 7.5 kilograms. The X-ray test, which is obligatory for all special wheels at BMW and VW, for example, provides information about the manufacturing quality. The X-ray image reveals material weaknesses or micro cracks and enables the expert to determine whether cavities in castings are critical. For the majority of the test specimens, the diagnosis was "error-free". Only two wheels showed defects in the screening:

- Fondmetal: large blowholes in the transition spokes/rim bed;
- O.Z. Racing: several blowholes at the inner rim half.

[picture]

Wheel star completely cut out: D&W Silver-Line after impact test.

Whether these casting defects have an influence on the strength was to be shown by the fatigue strength test carried out at a later date (see page 156). Prior to this, the experts at TÜV Bayern carried through the "apparent evaluation" of the wheels. The quality of the surface is evaluated. In addition to the original BMW wheel, the ATS, BBS (forged) and Ronal wheels did not give any cause for criticism. The complaints with the remaining test specimens ranged from slight scores on the fixing holes (BBS cast, King), notches on the inside of the wheel (Fondmetal), gas pores at the inner spokes (MSW)

Impact-Test*: Two wheels failed

Manufacturer	Evaluation	Rating
ATS	170 mm long crack in the tyre seat, crack in the cap puncture and radial crack, three small cracks on the back of the spoke (90/20/10 mm long). No loss of air pressure.	o
BBS (Cast)	165 mm long crack in the tyre seat. No loss of air pressure.	+
BBS (Forged)	60 mm long crack in the tyre seat. No loss of air pressure.	+
BMW	Without a crack. Wheel however strongly deformed (very oval). No loss of air pressure.	+
D&W (Silver-Line)	Wheel star (disc) completely removed. No loss of air pressure.	-
D&W (Turbo-Line)	120 mm long crack in the tyre seat. No loss of air pressure.	+
Fondmetal	Two 30 mm long cracks on the back of the spokes and one five mm long crack. No pressure loss.	o
King	Horn torn off to 260 mm length. Sudden loss of air pressure.	-
MSW	Without crack. No loss of air pressure.	+
O.Z.-Racing	200 mm long crack in the tyre seat of the outer bed. No loss of air pressure.	+
Ronal	Two cracks, each five mm long, on the back of the spokes. No loss of air pressure.	o

* Energy test simulating curb contact; ** + = meets requirements; o = emergency running characteristics guaranteed; - = emergency running characteristics not guaranteed

Rim flange test: Ronal wheel with best results

Manufacturer	Energy absorption up to fracture or up to 15 mm deformation path in joules 1)				Rating
	on the spoke	between the spokes	at the valve hole	wheel interior	
ATS	232	235	252	195	o
BBS (Cast)	225	211	226	176	o
BBS (Forged)	391	394	382	343	+
BMW	204	195	206	185	o
D&W (Silver-Line)	438	415	455	305	+
D&W (Turbo-Line)	306	303	303	227	+
Fondmetal	276	273	293	200	o
King	215	171	204	207	o
MSW	337	302	317	364	+
O.Z.-Racing	155	145	155	257	o
Ronal	526	498	498	334	+

1) The required energy absorption on the rim flange is 100 joules on the outside of the wheel and 60 joules on the inside of the wheel in accordance with the guidelines for testing special alloy wheels;
2) + = clearly exceeds the requirements; o = meets the requirements; - = does not meet the requirements. In addition to the energy consumption, the course of the diagram was also taken into account in the evaluation.

Wheel Test

and at the mounting holes (O.Z.) up to cosmetic defects such as unrecognizable manufacturing dates (D&W Turbo) and faulty KBA marking (D&W Silver-Line). With exemplary manufacturing accuracy and exact compliance with the values specified in the drawing, the original BMW wheel as well as the forged wheel from BBS and the Ronal wheel were once again on display at the dimensional comparison test.

Endurance run: early end for turbo wheel from D&W

Manufacturer	Assessment after 2 million load cycles	Rating*
ATS	Cracks at the transition wheel contact surface to the wheel disc on the inside	o
BBS (Cast)	Without cracking	+
BBS (Forged)	crack at the spoke of the inside of the wheel	o
BMW	Without cracking	+
D&W (Silver-Line)	Without cracking	+
D&W (Turbo-Line)	after 24000 load changes test aborted due to numerous cracks in the spokes	-
Fondmetal	Without cracking	+
King	Without cracking	+
MSW	Without cracking	+
O.Z.-Racing	Cracks on two spokes on the inside of the wheel	o
Ronal	Without cracking	+

+ = clearly exceeds the requirements; o = meets the requirements; - = does not meet the requirements. The test was carried out uniformly for all wheels with a wheel load of 475 kg.

The other participants were criticized primarily because of dimensional deviations in the test aspects hobble circumference and press-in depth. Deviations in the plus range of the press-in depth can, for example, result in a too small distance to the brake and steering parts (example King wheel: plus 0.8 mm). An increased distance (D&W Turbo: plus 0.3 mm) makes tyre fitting more difficult.

The effects that a violent contact with the curb can have can be seen from the rim flange compression test required by the Technischer Überwachungs Verein for the granting of the General Operating Licence (ABE) as well as the so-called impact test, which is mainly practised in the USA and Japan. In the rim flange compression test, the outer rim flange is deformed on a special test bench by a stamp with a hemispherical impact surface. According to TÜV guidelines, "no dangerous cracks" may occur during the deformation. The impact test carried out with the tyre fitted, which is not obligatory in Germany and which only applies to wheels intended for export or for factory approval, provides an answer as to whether the air escapes suddenly in the event of an impact. This test is often regarded as very practical because a tyre is fitted and the impact surface is larger than in the compression test. In the impact test, a weight of 1010 kilograms falls from a height of 229 millimetres onto the rim edge. The test also allows conclusions to be drawn about the material properties and dimensional stability of the wheel.

The test also allows conclusions about the material properties and shape stability of the wheel. All the wheels were able to -more or less- significantly exceed the required minimum values - 100 Joule energy absorption on the outside of the wheel, 60 Joule on the inside of the wheel. Above average values were achieved in particular by the Ronal wheel and the D&W wheel type Silver-Line. In addition to the O.Z.-Racing wheel, which only achieves relatively low values due to its two-piece design, the original BMW wheel (see table on page 154) also fell short of expectations. Six of the eleven test candidates passed the impact test with ease. The wheels showed either no cracks at all (BMW, MSW) or only small cracks in the immediate impact area of the weight. Three specimens (ATS, Fondmetal, Ronal) showed cracks off the impact surface, but the air did not escape. The results for the King wheel and the D&W wheel type Silver-Line were poor: On the King wheel, the rim flange tore open over a length of 260 millimetres and the air suddenly escaped from the tyre.

The D&W cross spoke wheel produced by Centra was even worse hit: the wheel disc broke off completely after the impact. The hour of truth awaited the test specimens - the hardest test, a continuous run with a maximum of two million load changes. In order to determine the strength behavior of special wheels, TÜV requires a rotating bending test in which the transverse forces that occur when cornering are simulated. In this test, the wheel is rigidly clamped to the inner rim flange on the test bench and loaded with a rotating bending moment via the hub connection surface. The first part of the fatigue test provides that the wheels meet the minimum requirement of 200,000 load cycles with 75 percent of the maximum bending moment without cracking.

For the D&W wheel type Turbo-Line, however, the end came already after 24,000 - the machine stopped "because of numerous cracks in the spokes" (quote from the test report). To make sure it was not a mishap, a second wheel was subjected to the same procedure. Result: "The requirements of the Wheel Directive were also not met" (TÜV-Telex). The remaining wheels now went into the prolongation of the endurance run over two million load changes. The intensified testing over a period of 20 hours made it clear that they have extensive hidden reserves. All achieved the goal, albeit with different wounds. Seven wheels showed no damage after this torture; only the ATS, the BBS forged wheel and the O.Z. wheel showed cracks. Of the two wheels, which were found to have had a negative result in the X-ray test, the Fondmetal specimen passed this endurance test without any defects. The blowholes discovered on the X-ray had no influence on the strength.

In order to complete this special wheel test, a 504 hour salt spray procedure was carried out. Before the wheels were sprayed with an aggressive salt solution in the salt chamber, the paint layer was

	<p>Result:</p> <p>Four Wheels are at the top</p>	
<p>Borderline Case: Curb contact</p> <p>What happens with involuntary curb contact? The two-piece O.Z. Racing wheel has passed the Impact Test. The crack in the immediate impact area of the weight may occur in this test constellation. It is only important that the air does not escape suddenly.</p>		<p>above average BBS RG 003, drop-forged, multi-layer powder coating, extremely light wheel with high strength and exact manufacturing accuracy.</p>
<p>Wheel Test</p> <p>deliberately damaged in various places: Scratch test with knife blade, crosscut and shooting with lead grains provide information on the effectiveness of the paint adhesion and resistance to rolled chippings. Although the chemists responsible for the corrosion test noted differences between the individual test specimens, it became clear that they all have a comparatively high level of quality. In addition to the two specimens from BBS, the ATS wheel and the Turbo Line wheel from D&W were the most successful. The original BMW wheel was not quite as good as this quartet. Especially during the scratch test before and after the salt spray test the grading was worse. The D&W Turbo wheel did not benefit from the obviously very good corrosion protection in the end to the failed fatigue strength test.</p>	<p>The fact that the minimum requirements could not be met only allows the final result to be "below average". The second D&W wheel and the King wheel are spared the same lot only because the impact test, in which they both failed, is not part of the test guideline for the granting of a general operating permit in Germany. Both do not meet the requirements for possible approval by the car manufacturer. The remaining eight wheels, on the other hand, did not perform as bad - the BBS forged and cast wheel, Ronal R 15 and the BMW wheel earned an above-average final rating after a total of eight tests. The other test objects ATS, Fondmetal, MSW and O.Z.-Racing- also have qualities which label them as "average products".</p> <p style="text-align: right;">Klaus Wießmann</p>	<p>average MSQ 1968 D, low-pressure casting, three-coat powder coating, relatively heavy, very stable five-spoke wheel from O.Z. in Italy.</p> <p>below average D&W Turbo-Line, low-pressure casting, multi-layer powder coating, minimum TÜV requirements not achieved in fatigue test.</p>

<p>above average</p> <p>BMW (manufacturer: Alumetall), gravity casting, three-layer powder coating, high quality, very stable wheel with high elasticity.</p>	<p>above average</p> <p>BBS RZ 320, counter pressure casting, multi-layer powder coating, cross spoke wheel with very good stability and corrosion protection.</p>	<p>above average</p> <p>Ronal R 15, low-pressure casting, five-layer surface treatment, new five-spoke wheel with great stability and very good manufacturing quality.</p>	<p>average</p> <p>ATS 7058, low pressure casting, electrostatic powder polyester paint, stable, heavy disc wheel with very good corrosion protection.</p>
<p>average</p> <p>Fondmetal 2300 HB, low pressure casting, five layer powder wet coating, eight spoke wheel from Italy with good qualities in all tests.</p>	<p>average</p> <p>O.Z.-Racing 52705 BW 1, low pressure casting, three-layer powder coating, two-piece ten spoke wheel with good all-round qualities.</p>	<p>average</p> <p>D&W Silver-Line, low-pressure casting, multi-layer powder coating, cross-ribbed wheel with very good fatigue strength, failure in impact test.</p>	<p>average</p> <p>King 2715.26, low pressure casting, three-coat powder coating, cross spoke wheel from Italy with very good fatigue strength, failure at impact test.</p>

												Overall Verdict
<i>Final score: Four wheels with above-average results</i>		Price in DM	Weight	X-Ray	Visual Inspection	Dimensional Comparison	Rim Flange Compression Test	Impact Test	Fatigue Test	Corrosion Test		
<i>Manufacturer</i>												
BBS (Forged Wheel)	650,-	+	1)	+	+	+	+	o	+	+		Above Average
BMW	434,-	o	+	+	+	o	+	+	+	o		
BBS (Cast Wheel)	350,-	o	+	o	o	o	+	+	+	+		
Ronal	308,-	o	+	+	+	+	o	+	o			
ATS	300,-	-	+	+	o	o	o	o	+			
MSW	400,-	-	+	o	o	+	+	+	o			
Fondmetal	249,-	o	o	o	o	o	o	+	o			
O.Z.-Racing	695,-	o	o	o	o	o	+	o	o			
D&W (Silver-Line)	325,-	o	+	o	o	+	-	+	o			Average
King	364,-	o	+	o	o	o	-	+	o			
D&W (Turbo-Line)	325,-	+	+	o	o	+	+	-	+			Below Average

1) Test is not carried through for forged wheels, + = clearly surpasses the requirements, o = meets the requirements, - = does not meet the requirements

One failed the test

Eight of the eleven wheels didn't slip in any of the special stages and came up with very good / good quality. The D&W Silver-Line and the King wheel did not meet the requirements for the Impact Test, which is not mandatory in Germany. More serious is the failure of the D&W wheel type Turbo-Line. The lightest specimen in the circle of cast wheels did not achieve the 200 000 load changes "without cracking or breaking" required by the guidelines for the testing of special wheels in the fatigue strength test

