



**BOSCH**

**4<sup>th</sup>**  
EDITION

(R11VDT).  
Management: Dipl.-Ing.(FH) Ulrich Adler.

**Editor in chief:**

Dipl.-Ing.(FH) Horst Bauer.

**Editors:**

Ing.(grad.) Arne Cypra,  
Dipl.-Ing. (FH) Anton Beer,  
Dipl.-Ing. Hans Bauer.

**Production management:**

Joachim Kaiser.

**Layout:**

Dipl.-Ing.(FH) Ulrich Adler,  
Joachim Kaiser.

**Translation:**

Editor in chief:

Peter Girling

Translated by:

Ingenieurbüro für Technische und  
Wissenschaftliche Übersetzungen

Dr. W.-D. Haehl GmbH, Stuttgart

Member of the ALPNET Services Group

William D. Lyon

**Technical graphics:**

Bauer & Partner GmbH, Stuttgart.

Design, front cover, front matter:

Zweckwerbung, Kirchheim u.T., Germany

Technische Publikation, Waiblingen

**Distribution, 4th Edition:**

SAE Society of Automotive Engineers

400 Commonwealth Drive

Warrendale, PA 15096-0001 U.S.A.

ISBN 1-56091-918-3

Printed in Germany.

Imprimé en Allemagne.

4th Edition, October 1996.

Editorial closing: 31.08.1996

be used as the basis for design, in-  
tion, and scope of delivery. We und  
no liability for conformity of the co  
with national or local regulations.

We reserve the right to make chan

The brand names given in the co  
serve only as examples and do not  
sent the classification or preferenc  
particular manufacturer. Trade mar  
not identified as such.

The following companies kindly  
picture matter, diagrams and other  
native material at our disposal:

Audi AG, Ingolstadt;

Bayerische Motoren Werke AG, Mu

Behr GmbH & Co, Stuttgart;

Brose Fahrzeugteile GmbH & Co. K

Coburg;

Continental AG, Hannover;

Eberspächer KG, Eßlingen;

Filterwerk Mann und Hummel,

Ludwigsburg;

Ford-Werke AG, Cologne;

Aktiengesellschaft Kühnle, Kopp un

Kausch, Frankental;

Mannesmann Kienzle GmbH,

Villingen-Schwenningen;

Mercedes-Benz AG, Stuttgart;

Pierburg GmbH, Neuss;

RWE Energie AG, Essen;

Volkswagen AG, Wolfsburg;

Zahnradfabrik Friedrichshafen AG,

Friedrichshafen.

Source of information for motor-v

specifications: Automobil Revue K

1995.

Acoustics	66	Commercial vehicles	66
Heat	66	Agricultural-tractor requirements	66
Electrical engineering	70	Environmental stresses	66
Electronics	86	<b>Internal-combustion (IC) engines</b>	
Sensoren	102	Operating concepts and classification	
Actuators	122	Thermodynamic cycles	
Electric machines	130	Reciprocating-piston engines	
Technical optics	135	with internal combustion	
<b>Mathematics, methods</b>		The spark-ignition (Otto) engine	
Mathematics	142	The diesel engine	
Quality	150	Hybrid processes	
Engineering statistics, measuring techniques	156	Gas exchange	
Reliability	164	Supercharging/turbocharging	
Data processing in motor vehicles	166	Power transfer	
Control engineering	170	Cooling	
<b>Materials</b>		Lubrication	
Chemical elements	174	Empirical values	
Terminology and parameters	178	and data for calculations	
Material groups	180	Reciprocating-piston engine with	
Material properties	184	external combustion (Stirling engine)	
Lubricants	224	The Wankel rotary engine	
Fuels	232	Gas turbines	
Chemicals	244	<b>Engine cooling</b>	
Corrosion and corrosion protection	250	Air and water cooling	
Heat treatment	260	Charge-air cooling/intercooling	
Hardness	266	Oil cooling	
<b>Maschine elements</b>		<b>Intake air, exhaust systems</b>	
Tolerances	271	Air filters	
Sliding and rolling bearings	274	Turbochargers and superchargers	
Spring calculations	282	Exhaust systems	
Gears and tooth systemsg	288	<b>Engine management for spark-</b>	
Belt drives	298	<b>ignition (SI) engines</b>	
Threaded fasteners	302	Control parameters and operation	
<b>Joining and bonding techniques</b>		<b>Ignition</b>	
Welding	311	Basics	
Soldering	313	Components	
Adhesives	314	Ignition coils	
Riveting	315	Spark plugs	
Pressurized clinching	316	Ignition systems	
Punch riveting	317	Conventional coil ignition (CI)	
<b>Sheet-metal processing</b>	318	Transistorized ignition (TI)	
<b>Tribology, wear</b>	321	Capacitor-discharge ignition (CDI)	
		Electronic ignition (ESA and DLI)	
		Knock control	

354	KE-Jetronic	466	Glows glow unit	53
356	L-Jetronic	468	<b>Starting systems</b>	
	LH-Jetronic	471	Starters	54
358	<b>Other engine-control functions</b>		Starter protection devices	54
359	Idle-speed control	473	<b>Alternative drive systems</b>	
	Electronic throttle control (ETC)	474	Electric drives	54
361	Electronic boost-pressure control	474	Hybrid drives	55
364	Variable-geometry intake manifold	476	<b>Drivetrain</b>	
368	Evaporative-emissions control system	477	Basics	55
373	Exhaust-gas recirculation (EGR)	477	Clutches and couplings	55
374			Transmissions and gearboxes	55
378	<b>Integrated engine-management system, Motronic</b>		Final-drive units	56
382	Detection and processing of measured variables	479	Differentials	57
398	Motronic system	480	All-wheel drive (AWD)	57
	System configuration	483	Traction control (ASR)	57
400	Racing applications	483	<b>Chassis systems</b>	
412	<b>Engine test technology</b>	484	Suspension	58
	<b>Exhaust emissions from spark-ignition (SI) engines</b>		Suspension linkage	58
414	Combustion products	486	Wheels	59
416	Emissions control	487	Tires	59
	Lambda closed-loop control	490	Steering	60
418	Testing exhaust and evaporative emissions	494	<b>Braking systems</b>	
420	Test cycles and emission limits	496	Definitions, principles	61
421	Exhaust-gas analyzers	500	Legal regulations	61
	<b>Internal-combustion (IC) engines for alternative fuels</b>		Design and components of a braking system	62
422	LPG systems	501	Braking-system design	62
424	Alcohol operation	504	Braking-force apportioning	62
430	Hydrogen operation	505	Braking systems for passenger cars and light utility vehicles	62
	<b>Engine management (diesel engines)</b>		Control devices	62
434	Fuel metering	506	Wheel brakes	62
	Fuel-injection pumps, in-line	508	Braking-force distribution	62
439	Fuel-injection pumps, control sleeve	514	Antilock braking systems (ABS) for passenger cars	62
440	Fuel-injection pumps, distributor type	515	Braking systems for commercial vehicles	64
	Fuel-injection pumps, distributor-type, solenoid-controlled	518	System and configuration	64
445	Time-controlled single-pump systems	519	Braking-force metering	64
448	Common-rail system	521	Wheel brakes	64
450	Injection-pump test benches	523	Parking-brake systems	64
451	Nozzles and nozzle holders	524	Retarder braking systems	64
454			Components for compressed-air brakes	65

Vehicle handling	669	Navigation systems	7
Control system	670	Mobile radio	7
System realization	676	Board Information Terminal (BIT)	7
<b>Road-vehicle systematics</b>		<b>Safety systems</b>	
Overview	678	Seatbelt-tightener systems	7
Classification	679	Front airbag systems	7
		Side airbag systems	7
<b>Vehicle bodies, passenger car</b>		Rollover protection system	7
Main dimensions	680	<b>Comfort and convenience systems</b>	
Body structure	684	Power windows	7
Body materials	685	Power sunroof	7
Body surface,		Seat and steering-column adjustment	7
body finishing components	686	Central locking system	7
Safety	688	<b>Automotive hydraulics</b>	
Calculations	692	Basics	
<b>Vehicle bodies, commercial vehicles</b>		Gear pumps and motors	
Commercial vehicles,		Piston pumps and motors	
delivery trucks and vans	694	Valves	
Medium and heavy-duty trucks		Cylinders	
and tractor vehicles	695	Tractor hydraulics	
Buses	696	Hydraulic accumulators,	
Passive safety	698	auxiliary drives	
Noise reduction in commercial vehicles	699	Hydrostatic fan drives	
		Hydrostatic drives	
<b>Lighting</b>		<b>Automotive pneumatics</b>	
Legal regulations	700	Door operation (buses)	
Main headlamps	701	Radiator louvers	
Headlamp range adjustment	714	<b>Electrical system and power supply</b>	
Fog lamps	715	Symbols	
Auxiliary driving lamps, lights and lamps	716	Circuit diagrams	
Visual signalling devices	722	Conductor-size calculations	
Headlamp aiming devices	723	Electrical power supply in the vehicle	
Bulbs	724	Controller Area Network (CAN)	
		Starter batteries	
<b>Signaling devices and alarm systems</b>		Battery chargers	
Acoustic signaling devices	726	Alternators	
Theft-deterrent systems	727	Electromagnetic compatibility (EMC)	
		and interference suppression	
<b>Windshield and headlamp cleaning</b>		<b>Passenger car specifications</b>	
Windshield-wiper systems	730	<b>Road traffic legislation</b>	
Rear-window wiper systems	731	<b>Miscellaneous</b>	
Headlamp cleaning systems	732	Alphabets and numbers	
Drive motors	732	<b>Index of headings</b>	
Washing systems	733		
Windshield and window glass	734		
<b>Heating, ventilation, and air-conditioning (HVAC)</b>			
Heating systems using engine heat	736		

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.