THE MOTOR VEHICLE

13th Edition

T.K. Garrett

K. NEWTON & W. STEEDS

BH

The Motor Vehicle

The MotorVehicle

Thirteenth Edition

T.K. GARRETT
CEng, FIMechE, MRAeS
Sometime Editor of Automobile Engineer

K. NEWTON
MC, BSc, ACGI, AMInstCE, MIMechE
Late Assistant Professor, Mechanical and Electrical Engineering Department,
The Royal Military College of Science

W. STEEDS
OBE, BSc, ACGI, FIMechE
Late Professor of Mechanical Engineering,
The Royal Military College of Science

Butterworth-Heinemann
Linacre House, Jordan Hill, Oxford OX2 8DP
225 Wildwood Avenue, Woburn, MA 08101-2041
A division of Reed Educational and Professional Publishing Ltd


A member of the Reed Elsevier plc group

First published by Iliffe & Sons 1929
Eighth edition 1966
Ninth edition 1972
Tenth edition published by Butterworths 1983
Eleventh edition 1989
Twelfth edition 1996
Reprinted 1997
Thirteenth edition 2001

© Reed Educational and Professional Publishing Ltd 2001

All rights reserved. No part of this publication may be reproduced in any material form (including photocopying or storing in any medium by electronic means and whether or not transiently or incidentally to some other use of this publication) without the written permission of the copyright holder except in accordance with the provisions of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency Ltd, 90 Tottenham Court Rd, London, England W1P 9HE. Applications for the copyright holder s written permission to reproduce any part of this publication should be addressed to the publishers.

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library.

Library of Congress Cataloging in Publication Data
A catalogue record for this book is available from the Library

ISBN 07506 4449 4

Contents

Preface to the thirteenth edition

Because of the continuing phenomenally rapid rate of progress in automotive technology, the revision for this the thirteenth edition of *The Motor Vehicle* has been on a major scale. No fewer than seven new chapters have been created. Of these, three are entirely new, while the remaining four comprise mainly new material that could not have been accommodated in existing chapters without making them too long and cumbersome.

Of the entirely new chapters, one is on electric propulsion which, owing to pressure of legislation is now beginning to be taken seriously by the industry. It covers all the alternatives, from conventional lead-acid, and other, battery-powered vehicles to fuel cells and hybrid power units. A second covers both static and dynamic safety which, again because of pressure of legislation, is a field in which enormous progress has been made. This progress, which embraces almost all aspects of automotive design, has become possible largely because of the development of computer aided control. The third of these entirely new chapters deals with wheels and tyres. Over the past few decades, wheels and especially tyres have moved on, from being simply components that the designer chose largely on the basis of dimensional and commercial considerations, to becoming an integral part of the tuned suspension system.

In the twelfth edition, only one chapter was devoted to the compression ignition engine. Now, owing to a major extent to the widespread application of diesel power to cars and light commercial vehicles, so much new equipment has been developed that it has now been expanded into three chapters. One of these comprises mainly the original subject matter, while the other two

engine mountings, which are desirable refinements for some vehicles, especially diesel powered cars. New material has been added on the subject of fuel filtration. Particularly interesting are the latest developments of the Merritt engine. By virtue of its recently developed novel ignition system, it can fire consistently from a b.m.e.p of 10 bar right down to idling speed on air : fuel ratios ranging from 30 : 1 to 137 : 1 respectively. Moreover, it might be possible even to dispense altogether with catalytic conversion of the exhaust gases, while still keeping within the stringent emission limits under consideration at the time of writing.

Most of the remarkable advances made, especially those over the past ten to fifteen years, have been rendered practicable by virtue of the application of electronic and computer technology to all aspects of automotive engineering, from design, through development, to production and actual operation of the vehicle. Many have been driven by new legislation aimed at increasing safety and reducing atmospheric and other pollution.

In general, the two original aims of the book have been maintained. In short, it remains, as the authors originally intended. First, it was intended to be a book that the student could buy that will furnish him or her with all they need to know, as regards automotive engineering; secondly, it will then serve as an invaluable a work of reference throughout the rest of their career. Granted, many students will require knowledge of other peripheral, though no less essential, subjects such as electronics, metallurgy, and production engineering, but these are aspects of general engineering that fall outside the sphere of pure automotive technology. Some details of, for example, electronic systems are given in this book, but it has had to be assumed that readers who are interested in them already have some knowledge of the relevant basic principles.

T.K. Garrett

Units and abbreviations

Calorific value	kilojoules per kilogram megajoules per litre	kJ/kg MJ/l
Specific fuel consumption	kilograms per kilowatt hour	kg/kWh
Length	millimetres, metres, kilometres	mm, m, km
Mass	kilograms, grams	kg, g
Time	seconds, minutes, hours	s, min, h
Speed	centimetres per second, metres per second kilometres per hour, miles per hour	cm/s, m/s km/h, mph
Acceleration	metres-per-second per second	m/s^2
Force	newtons, kilonewtons	N, kN
Moment	newton-metres	Nm
Work	joules	J
Power	horsepower, watts, kilowatts	hp, W, kW
Pressure	newtons per square metre kilonewtons per square metre	N/m^2 kN/m^2
Angles	radians	rad
Angular speed	radians per second radians-per-second per second	rad/s rad/s^2

Pressure	1 N/m^2 = 0.000145 lbf/in^2	1 lbf/in^2 = 6.895 kN/m^2
	1 Pa = 1 N/m^2 = 0.000001 bar	
	1 bar = 14.5038 lbf/in^2	1 lbf/in^2 = 0.068947 bar
Energy, work	1 J = 0.738 ft lbf	1 ft lbf = 1.3558 J
	1 J = 0.239 calorie	1 calorie = 4.186 J
	1 kJ = 0.9478 Btu	1 Btu = 1.05506 kJ
		(1 therm = 100 000 Btu)
	1 kJ = 0.526 CHU	1 CHU = 1.9 kJ
Power	1 kW = 1.34 bhp = 1.36 PS	1 hp = 0.7457 kW
Fuel cons.	1 mpg = 0.003541/100 km	11/100 km = 282.48 mpg
Specific fuel consumption	1 kg/kWh = 1.645 lb/bhp h	1 lb/bhp h = 0.6088 kg/kWh
	1 litre/kWh = 1.316 pt/bhp h	1 pt/bhp h = 0.76 litre/kWh
Calorific value	1 kJ/kg = 0.4303 Btu/lb	1 Btu/lb = 2.324 kJ/kg
	1 kJ/kg = 0.239 CHU/lb	1 CHU/lb = 4.1868 kJ/kg
Standard gravity	9.80665 m/s^2 = 32.1740 ft/s^2	