TIRE FAILURES AND EVIDENCE MANUAL

ABOUT THE AUTHOR

R.W. (Bob) Rivers is a graduate of Northwestern University Traffic Institute's traffic accident investigation and police management training programs. He completed training with the Canadian Institute of Science and Technology in technical mathematics and areas of physics, studied psychology at the Okanagan Regional College, completed police administration training programs through the Canadian Police College and the University of Minnesota, and patrol management with the IACP. He developed the traffic accident investigation and traffic law enforcement training programs of the Royal Canadian Mounted Police and course training standards for the Canadian Police College, University of Alberta, and the British Columbia Institute of Science and Technology in technical traffic accident investigation. During his 33 years service with the Royal Canadian Mounted Police, Inspector Rivers was employed extensively in general police work, highway patrol, accident investigation, research and planning, and training and development. Since his retirement, Inspector Rivers has authored various internationally-recognized textbooks, acted as a consultant, and has assisted in traffic accident investigation training and research studies on an international basis. Since its establishment, he has been an adjunct faculty member and director of correspondence training with the Institute of Police Technology and Management (IPTM), University of North Florida (see web site: nanaimo.ark.com/rivers~/).

TIRES FAILURES AND EVIDENCE MANUAL

For Traffic Accident Investigation

By

R.W. RIVERS

Charles C Thomas
PUBLISHER • LTD.
SPRINGFIELD • ILLINOIS • U.S.A.

Published and Distributed Throughout the World by

CHARLES C THOMAS • PUBLISHER, LTD.
2600 South First Street
Springfield, Illinois 62704

ISBN 0-398-07232-9 (spiral) paper

Library of Congress Catalog Card Number: 2001041453

With THOMAS BOOKS *careful attention is given to all details of manufacturing and design. It is the Publisher's desire to present books that are satisfactory as to their physical qualities and artistic possibilities and appropriate for their particular use.* THOMAS BOOKS *will be true to those laws of quality that assure a good name and good will.*

Printed in the United States of America
MM-R-3

Library of Congress Cataloging-in-Publication Data

Rivers, R. W. (Robert W.)
Tire failures and evidence manual : for traffic accident investigation / R. W. Rivers.
p. cm.
Includes bibliographical references and index.
ISBN 0-398-07194-2
1. Tires--Identification. 2. Automobiles--Tires. 3. Traffic accident investigation 4. Evidence (Law) I. Title.

HV8077.5.T57 R58 2001
363.12'565--dc21 2001041453

PREFACE

At-scene traffic accident investigators and reconstructionists have a responsibility to determine whether or not a tire contributed to a vehicle accident. This manual will prepare investigators and analysts to meet the high standard of performance and expertise expected of them in these investigations. It is designed not only for use as a handy reference manual, but also to be of assistance as a training document for use in the various police training schools that teach tire failure examinations as part of their curriculum or as a special topic in their various field training programs.

The manual covers a wide variety of tire failure investigation topics, including tire manufacturing; markings and identification; tire and wheel nomenclatures; tire load and speed ratings; tire-roadway behavior; at-scene investigations; and evidence recognition, collection, and interpretation. Each chapter and a comprehensive appendix provide clear definitions of and statements about the topics the manual contains, with graduated commentary and copious diagrams and photographs arranged so as to present a natural development and understanding of the subject matter.

Considerable emphasis is placed on at-scene evidence recognition, its interpretation, and collection. At the same time, it outlines the importance of an at-scene investigator knowing his or her limitations in terms of making tire failure determinations and also, in the event the at-scene investigator is not a tire failure expert, when a tire should be referred to an expert for an in-depth examination and failure analysis, generally in a laboratory setting. Of equal importance is the fact that many professional tire failure analysts never attend accident scenes immediately after a crash occurs, while the vehicles are still in their resting place and fresh evidence is observable and obtainable. Rather, their analyses is in an after-the-fact laboratory setting where they often depend to a great extent on the scene evidence that is reported to them and/or make assumptions as to what happened at the

scene, in the course of the collision, to cause certain damage to a tire. This manual addresses all these issues. As such, it no mere condensation of ordinary text material, but rather it is a comprehensive, all-encompassing approach to determining tire status at the time of a vehicle collision.

R.W.R.

INTRODUCTION

For many years, at-scene traffic accident investigators and reconstructionists have had a responsibility to determine whether a tire on a vehicle contributed or did not contribute to a vehicle accident. For the purposes of overall professionalism in the field, it is essential that these investigators be trained and experienced to a sufficient level of competence to responsibly serve the greater public need. This includes knowing what evidence to look for, how to gather and protect such evidence, and the assistance that can be provided by qualified technicians or analysts who are qualified, through training and experience, to give *expert* evidence in a court of law. In many cases, this *expert*, because of his or her training and experience, will be the at-scene investigator.

This manual has, therefore, been prepared to help investigators and analysts meet the high standard of performance and expertise expected of them. It has been designed not only for use as a handy reference manual, but also to be of assistance as a training manual for use in the various police training schools that teach tire failure examinations as part of their curriculum or as a special topic in their various field training programs.

Each chapter and a comprehensive appendix provide clear definitions of and statements about the topics it contains, with graduated commentary arranged so as to present a natural development and understanding of the subject matter. A number of suggestions/hypotheses using examples and photographs have been prepared with the view to assisting the at-scene investigator or analyst in the interpretation of items of evidence that might be discovered *at-scene.* As such, it is no mere condensation of ordinary text material, but rather a comprehensive approach to determining tire status at the time of a vehicle collision. An additional benefit to the reader is an index that is prepared in such a way that almost any term or designation that can be attached to an item contained in the manual can be quickly and

easily located.

In the preparation of this manual, various international research materials and publications have been referenced and studied. Additionally, considerable emphasis has been placed on actual at-scene investigations most often carried out by police officers where evidence is clearly observable, fresh and available for interpretation rather than possible later hypothetical or theoretical at-scene determinations by those who may later be involved in an in-depth analysis of only the tire, but nevertheless attempt to provide at-scene probabilities. In this regard, however, considerable effort has been given to outlining the importance of the at-scene investigator knowing his or her limitations, and when a tire should be referred to an expert analyst for an in-depth examination and failure determination. This manual addresses all these issues, and will therefore also be found to be a invaluable document by laboratory examiners.

It is recognized that at present, English does not have third-person singular personal pronoun that can be used to refer to someone of either gender. While several methods purporting to overcome this deficiency are in vogue, they tend to be either cumbersome or restrictive and are often grammatically annoying to readers of both genders, particularly when applied in a lengthy text covering many diverse topics.

In some cases, the third-person masculine singular pronoun forms *he*, *his*, *him* are used in the text to refer to a person of either gender. However, such use is in no way intended to suggest that the subject matter is the exclusive preserve of men or that women are less adept than men in this particular field. It is appreciated that there are a great number of women investigators, and the author asks their understanding in regard to the sometimes-grammatical usage in the text.

The successful use of this manual is based upon the supposition that the reader has experience equal to or has completed at least a recognized basic traffic accident investigation course, such as those offered by the Institute of Police and Technology and Management, University of North Florida; Traffic Institute, Northwestern University; The Texas A&M University System (TEEX), College Station, Texas; or those offered by police in-service training programs.

DISCLAIMER

Various published works and technical papers have been studied, consultations with experts in this field have taken place, and participation in many field tests made in the preparation of this manual. The information and practices set out herein are, to best of the author's knowledge, experience, and belief, the most current and accurate in the traffic accident investigation and reconstruction profession. However, the authors, contributors, publisher, and editors expressly disclaim all and any liability to any person, whether a purchaser of this publication or not, as a consequence of anything stated, done or omitted to be done, whether in whole or in part by such person in reliance upon any part of the contents of this publication.

It is recommended that investigators and analysts pay particular attention to the safety recommendations contained in the manual; however, every acceptable procedure may not be presented, and some of the circumstances of a given case may require additional or substitute procedures. Also, since statutes, ordinances, and organizational policies and procedures differ widely in various jurisdictions, those of the particular jurisdiction should govern when there is any conflict between them and the contents of this book.

Tire specifications can be found in the following U.S. Code of Federal Regulations:

49CFR393.75 Subpart G-Miscellaneous Parts and Accessories and Appendix G Minimum Periodic Inspection Standards 49CFR569 Regrooved

49CFR570.9 Vehicle in Use Inspection Standards, Tires

49CFR571.119 New pneumatic tires for vehicles other than passenger cars

These documents can be purchased in book format from U.S. Government Printing Offices. See also web site: http://www.access.gpo.gov/nara/cfr/index

ACKNOWLEDGMENTS

I wish to acknowledge my gratitude to J.R.E. (Ed) D'Aoust and Don LeComte, vehicle accident investigation and reconstruction specialists, for their detailed suggestions regarding the initial preparation of this manual. I wish also to acknowledge with thanks the following additional traffic accident investigation specialists and tire and rubber manufacturers and associations for their time and effort in obtaining and making available in the interests of traffic safety, written materials, photographs, and diagrams that were used for purposes of research in the development of this manual:

Peter Bellion
Brunswick, Victoria
Australia

Bridgestone/Firestone
Mississauga, Ontario
Canada

British Rubber Manufacturers' Association Ltd.
London, England

Peggy Fisher
Rochester Hills, MI

Goodyear Tire and Rubber Company
(Canada and U.S.A.)

Rex J. Grogan
Birmingham
England

International Tire and Rubber Association, Inc.
Louisville, Kentucky

Brian Lapp
Parksville, British Columbia
Canada

The Maintenance Council
American Trucking Associations
Alexandra, VA

Ray L. McEdward
Madera, California

Michelin Tires (Canada) Ltd.
and
Michelin Tire Corporation (USA)

Ryan Rivers
Sorrento, B.C.
Canada

Rubber Manufacturers' Association
Washington, D.C.

John Ruller
Bellbowrie, Qld.
Australia

Phil Sack
Kenmore, New York

Tim Schewe
Parksville, British Columbia
Canada

Tire Retread Information Bureau
Pacific Grove, California

Barry D. Walker
West Chester, Ohio

CONTENTS

TIRE FAILURES AND EVIDENCE MANUAL
FOR TRAFFIC ACCIDENT INVESTIGATION

Chapter 1

INTRODUCTION TO TRAFFIC ACCIDENT TIRE EXAMINATIONS

Tire History

1.001 History shows that there have been many stages of refinement from the time of the very first tire being manufactured over 100 years ago. The wheel itself dates back some five thousand years. In 1845, Robert William Thompson, an Englishman, invented the first pneumatic tire, which was made of a rubber-coated canvas-tube covered by leather. The first major use of this type of tire was for bicycles and later for Horse-drawn vehicles. In the latter part of the 19th century, the main demand was for solid rubber tires. With the coming of the motor vehicle in the 20th century, the demand for a more durable, safe, and reliable tire saw many changes where the main demand was for single-tube pneumatic tires which were completely bald. Even at the relatively slow speeds of that day, a motorist could not expect to travel more than 100 miles (160 km) without a tire failure. As the number of vehicles grew, tire manufacturers continued to improve their product. The radial tire was invented in 1913 when a British patent was granted to Messrs. Gray and Sloper and was commercially produced in the 1930s. However, it did not gain popularity in the North America until the mid 1960s.

THE MANUFACTURING PROCESS

How a Tire Is Made

1.002 The tire industry is doing its utmost to keep pace with the demand for tires and has been able to offer several advanced tire designs that increase performance and durability in all areas, includ-

ing radial-ply and bias-belted tires to meet the demands for special applications such as off-road, snow, truck, trailer, and racing tires of almost every conceivable type and size.

1.003 The manufacture of tires is a highly complex and technical process, the intricate details of which are beyond the scope of this manual. Expressed in a general way, however, the process may be stated as follows:

1. As many as two-hundred different raw materials combine into a unique mix of chemistry, physics, and engineering to give consumers the highest degree of comfort, performance, efficiency, reliability, and safety modern technology and creativity can provide.

2. The production process begins with the selection of several types of rubber along with special oils, carbon black, pigments, antioxidants, silica, and other additives that will combine to provide the exact characteristics wanted. Separate compounds are used for different parts of the tire. A machine called a banbury mixer combines the various raw materials for each compound into a homogenized batch of black material with the consistency of gum. The mixing process is computer-controlled to assure uniformity. The compounded materials are then sent to machines for further process into the sidewall, treads, or other parts of the tire.

3. Then the task of assembling the tire begins. The first component to go on the tire building machine is the inner liner, a special rubber that is resistant to air and moisture penetration and takes the place of an inner tube. Next come the body plies and belts,

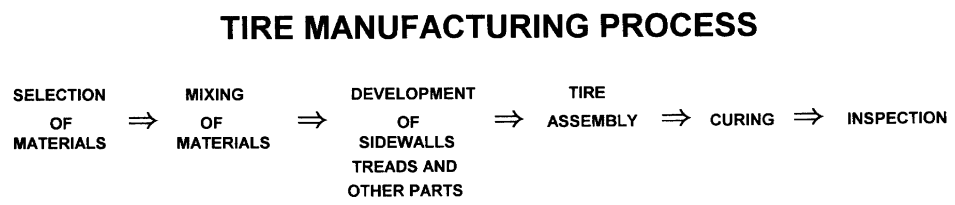

Figure 1-01. A diagram depicting the tire manufacturing process.

which are often made from polyester and steel. Plies and belts give the tire strength while also providing flexibility. The belts are cut to the precise angle and size the tire engineer specifies to provide the desired ride and handling characteristic. Bronze-coated strands of steel wire, fashioned into two hoops, are implanted into the sidewall of the tires to form the bead, which assures an airtight fit with the rim of the wheel. The tread and sidewalls are put into position over the belt and body plies, and then all the parts are pressed firmly together. The end result is called a *green* or uncured tire.

4. The last step is to cure the tire. The *green* tire is placed inside a mold and inflated to press it against the mold, forming the tread

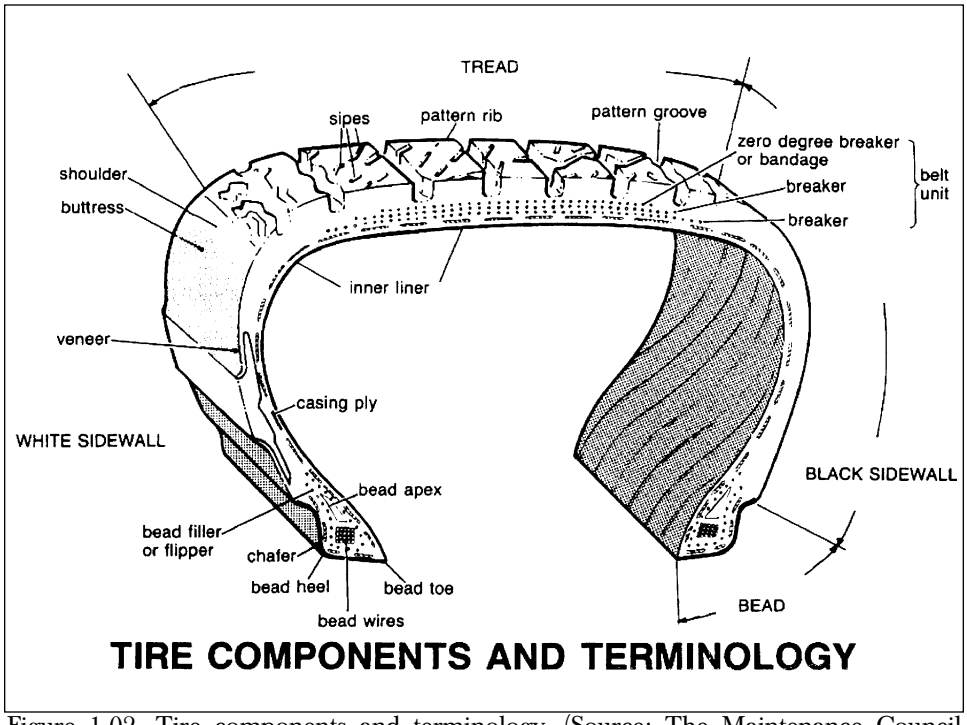

Figure 1-02. Tire components and terminology. (Source: The Maintenance Council (TMC) of the American Trucking Associations, from page XII of TMC's *Radial Tire Conditions Analysis Guide*. To order this TMC manual, contact TMC at 2200 Mill Road, Alexandria, VA 22314; Phone (703) 838-1763.)