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MECHANICS OF UNDERWATER NOISE

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Acoustical engineering
Vibration
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Underwater sound

Dedication

To my present and former colleagues, especially the many officers and men of the U.S. Navy with whom I've been fortunate to have spent time at sea.

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CONTENTS

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Preface

Like so many of my fellow workers in underwater acoustics, I entered the field with a background in physics and engineering but without any formal education in this specific subject. Following the theory that a good way to learn about any subject is to teach it, I have participated as much as possible in formal courses and professional meetings. Over the past sixteen years I have organized and taught graduate-level courses on underwater acoustics at M.I.T., Catholic University, American University and the University of California at San Diego in addition to industry-sponsored commercial courses.

While there now are a number of books covering various aspects of underwater sound, none covers the area of underwater noise in depth. Aware of this, and knowing that this aspect of underwater sound has been my particular interest, Marvin Lasky, then Head of the Acoustics Branch of the Office of Naval Research (O.N.R.), proposed that I write a book on this subject to be used as a self-education text and as a reference for workers in the field.

This is the book. It represents the culmination of thirty years of research and teaching and has been written over a period of three years with contractual support from O.N.R.

My approach has been to stress physical explanations of the basic mechanisms by which noise is generated, transmitted by structures and radiated into the sea. Despite the complexity of many of these phenomena, most can be explained in straightforward ways which emphasize dominant mechanisms and which have considerable practical application.

Chapter organization is by basic source mechanisms. Descriptions of practical manifestations follow discussions of the pertinent fundamental phenomena. Thus, the topic of wind-generated ocean ambient noise is treated in Chapter 4 following a discussion of splash noise, which in turn has been related to noise produced by oscillating gas bubbles. Similarly, ship-generated ambient noise is found in Chapter 8 on propeller cavitation noise which is its main source. The engineering topics of vibration isolation and structural damping are covered in Chapter 5 on structural vibrations. Flow noise, which often involves the excitation of plates by turbulence and their subsequent radiation, is treated in Chapter 6 on radiation by plate flexural vibrations. I have attempted to cover the field completely, and have at the same time placed particular emphasis on topics with which I am personally most familiar.

Much of the work done in underwater acoustics is classified and such areas have, of course, been omitted. Most of the topics discussed in the book have been the subject of articles in the open literature to which I have referred extensively.

In addition to acoustics, I have drawn from the disciplines of fluid mechanics, aerodynamics, thermodynamics, electrical, mechanical and marine engineering, and naval architecture. This breadth of material has led to occasional difficulty in selecting symbols to represent the more than

450 different quantities included in equations. Care has been taken to avoid confusion, but some problems may still exist for readers who are more familiar with these other fields than with acoustics. In this case, use of the lists of symbols and abbreviations in Appendix A will be of assistance.

To the extent that this book is more readable than my usual writings, full credit goes to the editing done by Nancy I. Ross.

San Diego, California
July 1976

Donald Ross

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I also wish to express my gratitude to Dr. Lloyd F. Bell, head of Tetra Tech's San Diego Office, and to Dr. Harry A. Schenck of the Naval Undersea Center, who made possible completion of this volume on a timely basis.