Engine Revolutions:

The Autobiography of

Max Bentele

SAE Historical Series

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**To
Magda
and our children
Rose-Marie, Ursula and Brigitte**

Foreword

Rarely does one experience the good fortune to read of major engineering achievements through the eyes of a person who not only participated in them, but whose contributions helped make them a success. Max Bentele's career has encompassed almost all forms of the internal combustion engine: reciprocating and rotary, two- and four-stroke cycle aircraft and automotive, and the gas turbine for both air and ground applications. Max is one of those unique individuals who tells his story from an insider's viewpoint with candor and humor. His witty insights of the many notable engineers and entrepreneurs with whom he worked or who crossed his path are given without antagonism.

The primary aim of Engine Revolutions is not to focus on the personal accomplishments of the author. Max's own efforts are told more to show how he and his colleagues worked to solve engineering problems, whether to discover why aircraft turbochargers failed in flight or how seals on the Wankel engine could be improved. The lessons he and his co-workers learned through their developmental trials and tribulations offer encouragement to engineers of later generations who suffer the inevitable failures encountered in perfecting any new design.

Possibly of even greater value is the opportunity for engineering students to better understand what their chosen profession is all about. Too often a technical paper or company publication has been "sanitized" to avoid any mention of the strenuous efforts and outright failures which so often occur during a product's birth and early years. In Max's story one hears the setbacks along with the successes. There is as well the interplay between people of differing ideas and philosophies. Although he uses terms and explanations that may sometimes be beyond the experience of the reader, the essence of what is described and the lessons to be learned are never left in doubt. His story's appeal is not limited to his peers!

Fortunately, Max could be persuaded to include more of his personal side along with professional involvements. Much of what makes this book compelling reading is how the world-shattering events through which he lived guided his career and affected his private life. However, what follows is, by choice, more a reflection on the accomplishments of striving engineers.

It was a pleasure for me to assist Max during the last stages of his writing and an honor when he asked me to add these few words. As an elected Fellow of the

Society of Automotive Engineers, Max Bentele typifies an SAE member who has enriched his Society's legacy. He and I are both indebted to SAE for publishing his story as a part of our Historical series. By means of this series, SAE preserves the heritage of its members and provides a way to relate how practicing engineers throughout the world created the technologies that we accept as essential to our daily existence.

Lyle Cummins
SAE Historical Committee

Preface

This book was started as a project of the SAE Historical Committee. I had given a verbal, *ad hoc* interview describing my professional career at the 1987 SAE Congress. A year later, the Committee Chairman, C. Lyle Cummins, Jr., discussed with me an expansion of this program. His plan was to document the history of the modern automotive technology in books to be prepared by SAE members and Fellows. I found that to be an excellent idea for a number of reasons.

Politicians, public figures, writers, artists and entertainers customarily write autobiographies upon their retirement; scientists and engineers seldom do so. Books on technology are sporadic; they deal mostly with organization and management rather than with engineering. The latter kind can be counted with the fingers of one hand or two. Examples are:

Sir Harry Ricardo (1885-1974) Memories and Machines: The Pattern of My Life, 1968; Theodore von Kármán (1881-1963) The Wind & Beyond, 1967, mainly aerodynamics; Robert Bosch (1861-1942), written posthumously by Theodor Heuss, 1946; The Memoirs of Ernest C. (Cliff) Simpson (1917-1985), Aero propulsion pioneer, sponsored by the Aero Propulsion Laboratory of the Wright-Patterson AFB, it was written posthumously in 1987; S.D. Heron (1891-1964) actively contributed to and wrote History of the Aircraft Piston Engine published by the Ethyl Corporation. Recently, other engine development histories were compiled and published; an excellent example is Internal Fire (19th Century IC engines) by C. Lyle Cummins, Jr., 1976 and 1988.

In contrast, most books on significant developments reflect second-hand information resulting in misconceptions and controversies. Daily, weekly and monthly publications report failures and catastrophes, while encyclopedias focus mostly on accomplishments.

With this lack of documentation, concern about problems is restricted to specialists. General awareness on a broad base, however, is necessary in order to address potential dangers before they lead to catastrophes. A case in point is the fatal crashes of the first commercial jetliner, the De Havilland Comet in 1953. Full-scale experiments traced the cause to fatigue failures in the fuselage skin. These catastrophes and expensive, comprehensive investigations were then reported

worldwide. The Comet is hailed but its calamities are usually ignored in encyclopedias. No wonder that their reoccurrence after 30 years surprised all but those familiar with the history of aviation.

Lyle and I agreed that the SAE should pursue such vital history documentation. Then he surprised me with his invitation to write the first book of this series. I accepted, feeling highly privileged and honored.

I was blessed with the good fortune to have participated in the pioneering development of two new powerplants, the jet engine/gas turbine (1941) and the rotary Wankel engine (1958). I conducted my work in three different countries, under five governments, and in six companies, by fate not by design. To borrow Dean G. Acheson's words, "I was present at the creation," in the trenches as well as in the headquarters, experiencing both the agonies and ecstasies of the real world.

Since my college days, I was active in professional societies, disseminating my work and participating in debates on pertinent developments with my peers and the general public. I also tried to elevate the engineer's status in society.

Never considering my work as routine, I always searched for and applied the basic principles for each engineering task. Two problems drew my special attention, vibrations and gas leakages, each a *Leitmotif* throughout my career. They would hardly be known to laypeople but for recent headline-generating events: The metal fatigue cracks and failures of airliners and the leaking O-rings of a booster rocket which caused the tragic disaster of the space shuttle *Challenger* in 1986.

It is said that the most engaging powers of an author are to make *new* things *familiar*, and *familiar* things *new*. Although I was probably unable to achieve that quality, I did the best I could.

It is my wish to take this opportunity to thank all the fine people who have helped and advised me in my career. I am deeply grateful to them!

Apart from those mentioned in the book, I first recognize mentors and friends who have departed from this earth: Professor Dr.h.c. Wilhelm Buschmann (1886-1979), co-founder and publisher of *Motortechnische Zeitschrift* (MTZ); Professors Dr. Richard Grammel (1889-1964), Dr. Wunibald Kamm (1893-1966) and Dr. Karl Wellinger (1904-1976) of my alma mater in Stuttgart; the SAE Past Presidents Milton J. Kittler, Andrew A. Kucher, Leonard Raymond and C. G. A. Rosen, and the SAE Fellows Peter Altman, John Dolza, Sr., Paul H. Schweitzer and Arthur F. Underwood.

Then I express my sincere thanks to Lyle for his faith in me and his continual help and inspiration, and to the SAE Publications Group for their good work. Finally,

I think of all my other colleagues and friends who are still with us; they are too numerous to list. I hope they will enjoy reading this book and accept my sincere gratitude for their support and contribution.

To become an author instead of retiring puts a strain on family life. I am happy to report that my family was with me all the way. The written accounts of our lives in Germany, England and the United States revived many memories. My wife Magda, our daughters and their families provided valuable suggestions and assisted in putting the manuscript together. From the bottom of my heart, I thank them for their patience, encouragement and love.

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Introduction

My Path to Combustion Engines

My birthplace, Jungingen, is situated a few miles north of Ulm on the Schwäbische Rauhe Alb (Swabian Rough Alb). The term “rough” refers to its blustery but healthy climate. Outsiders often apply this characteristic to the Swabians who live there, including me. Other traits of the Swabians are their frugality, sense of humor, and “Wanderlust” (roving spirit).

Born in 1909, I received my schooling in Jungingen and Ulm where I graduated from high school in 1927. Following a mechanics apprenticeship, I studied mechanical and electrical engineering at the Stuttgart Technische Hochschule (TH, Institute of Technology, now University) and graduated as Diploma Engineer in 1932. I was fortunate to obtain various jobs that provided the opportunity to further my education with doctoral work, first as an operation engineer at the Stuttgart radio station, then as a research engineer at the central radio laboratory in Berlin. During that time I met my future wife, Magda Pfister; in November 1937 we were engaged to be married.

My doctoral thesis, completed in 1937, specifically treated gas vibrations in pipelines. At that time, the field of noise abatement offered few job opportunities. Consequently, I tried to expand my work from the intake and exhaust system of internal combustion engines to the engine itself. In early 1938 this chance materialized with a position in the Instrumentation and Measurement Laboratory of the Brandenburgische Motorenwerke (Bramo), located in Berlin-Spandau, the town that ten years later became famous for its old prison. Bramo, a subsidiary of the Siemens Group, produced the then well-known small Siemens & Halske engines and had started to develop and manufacture larger engines.

That Bramo employment represented the real start of my career in the engine industry. (The Biography at the end of the book includes further details of my family background, education and life.)

There were two pleasant interruptions of my daily grind. My fiancée and I attended in February 1938 a show in the Deutschlandhalle, a new indoor sports arena. Hanna Reitsch (1912-1979), the famous aviatrix, entered the cockpit of a helicopter, Model FW-61, designed and built by Henrich Focke (1890-1979) and

powered by a Bramo SH 14a engine. Under her command the aircraft ascended vertically, hovered motionless in the air, moved ahead, sideways or in reverse, then flew circles over the audience and finally landed safely in the middle of the hall. This historic event, headlined in the press with “Flug im Saal” (Flight in a Hall), was an exciting adventure for both of us; it raised my enthusiasm for being active in the aircraft engine field. (A Bramo colleague, on loan to the Focke company, remarked to me, “a helicopter is not a flying but a vibration machine.” At that time I did not imagine that 30 years later I would actively pursue the development of helicopter gas turbine engines and still have to solve vibration problems.)¹

The other happening confirmed even more firmly that I made the right choice. I attended a Joint Meeting of the Deutsche Akademie and the Lilienthal Gesellschaft für Luftfahrtforschung (the German Academy and the Lilienthal Society for Aeronautical Research). More than 3000 participated, including 400 visitors from 24 nations.

My story is essentially presented in chronological sequence. In some instances, to avoid confusion, I chose to deviate from this rule to preserve continuity of the subject.

¹ To the best of my knowledge, flying a helicopter inside a building was never done again. In 1970 efforts were underway to fly one inside the new Houston Astrodome; however, the venture was finally abandoned.