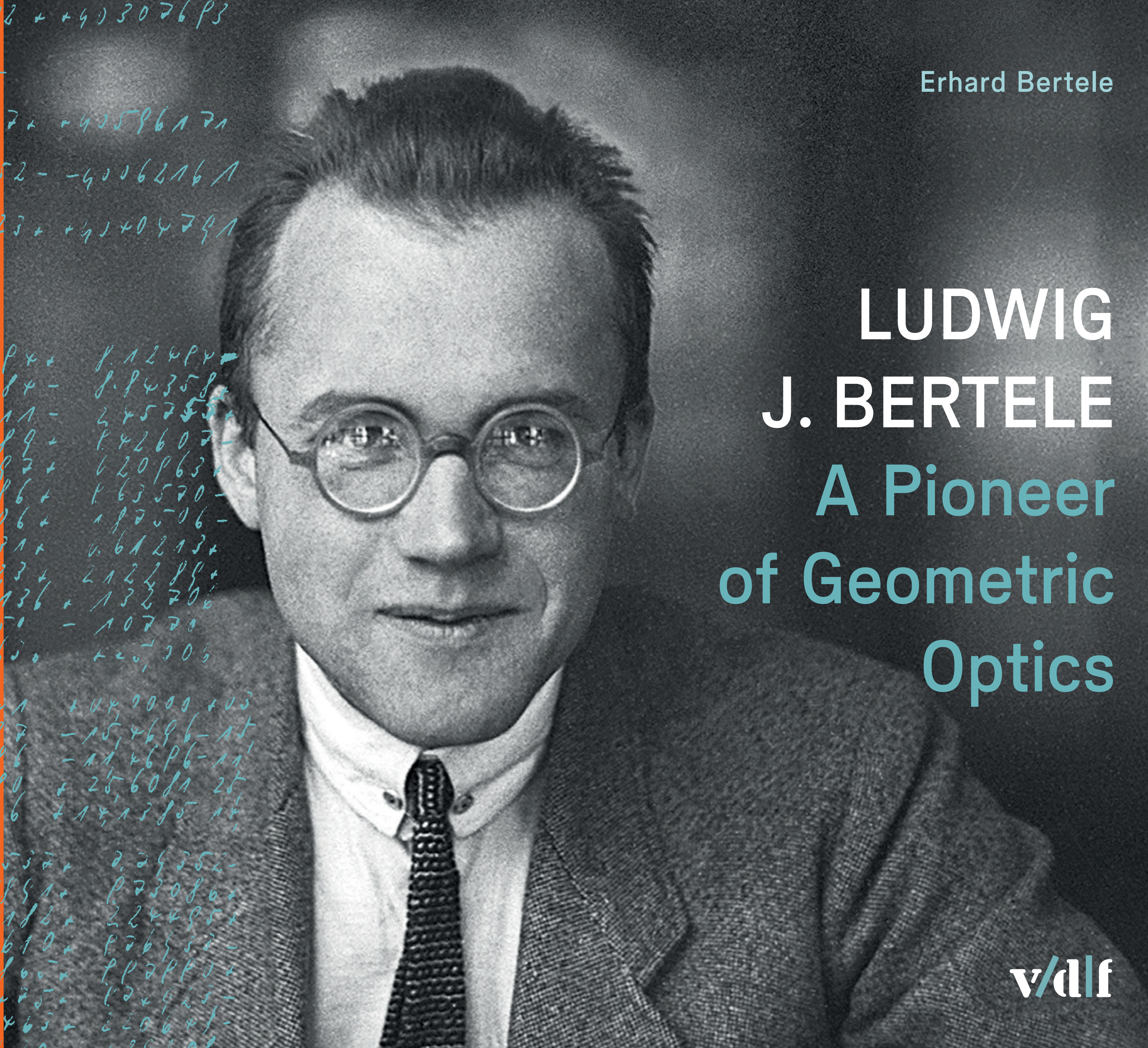
Erhard Bertele

LUDWIG J. BERTELE

A Pioneer of Geometric Optics



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Translated by:
Rolf Fricke, Oscar Fricke

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Preface

The idea of writing the life history of our father, and about his work and influence, had been considered since the time of his death in 1985. Early on my niece Sylvia Bertele transcribed the tape recording of a lengthy interview that had taken place around 1980 (1). This could have been the starting point for the project already at that time. Yet it took thirty years and an encounter with the photo historian Bernd Otto before I took on the project. Bernd Otto is well-known for his work which comprehensively describes all Zeiss cameras, and for his articles in the magazine PhotoDeal (2)

After I had finished with secondary school, my father invited me to do an internship in his computing department in Heerbrugg. I accepted, and under his guidance with the aid of logarithm and sine tables, devoted myself to the optimization of a simple optical system. A mental exercise, these repetitive calculations did not stimulate any enthusiasm on my part. This could not become my profession! In addition, I became enamored with one of his young computing ladies, which did not please him, and which clouded our relationship for a while. Instead of beginning a course of study in physics, which could have become the basis for a later specialization in the field of optics, as he had suggested to me, I became a chemist. Nevertheless, I remained interested in optics, albeit indirectly, thanks to his Contax with 50mm f/1.5 Sonnar. This he had given me early on and I became an enthusiastic amateur photographer.

Naturally I was always generally informed when he introduced a new design. But I never become fully aware of the trailblazing quality of his creations, because I was too immersed in my own professional activities. And so it happened that with the decision to review his legacy, I was able to connect with my father in an entirely new way. It was only by delving into his correspondence and his many patents (and his arguments with the patent examiners), that I became aware of the importance our father had achieved in the world of optics, and how he was revered as an extraordinary personality in professional circles. I was able to obtain some information from the interview mentioned above. But it pains me to realize that I had not been more curious during his lifetime and that I had not asked him more questions about his work, including his very early work. Thus there are unfortunate gaps that can no longer be filled. Contemporary witnesses from whom one could have obtained information have now also unfortunately passed away.

From the two companies for whom he produced his most important designs I was able to obtain much helpful information. In this context Carl Zeiss AG maintains a large archive in Jena that documents the company history. This is managed by the historian Dr. Wolfgang Wimmer. I am grateful to him for information and images. At Wild AG, which has since become Leica Geosystems AG, Roger Zellweger provided me with access to the collected issues of the former company magazine Opticus in a research-friendly digital format, thanks to his initiative. Another source of information was the website privately created by Jürg Dedual: “Virtual Archive of Wild Heerbrugg.” The collection of aerial photographs for which the Aviotar, Aviogon and Super Aviogon lenses were used unfortunately no longer exists.

In his modesty, our father hardly ever talked about his special achievements. More often, in conversations about his work, he expressed astonishment at the attitude of company employees who were more concerned about their own self-interests than in the company’s success. In an effort to achieve understanding, conversations sometimes turned to the psychological-philosophical. The question of the sense or nonsense of our existence also arose. He could not derive a satisfactory answer from his fundamentally scientific worldview. However, he did not want to dwell on the question, so the question became meaningless. He was satisfied with the challenge nature poses with its riddles. He was happy when scientific research once again solved such a riddle. In this context I occasionally received mail from him when he was particularly enthusiastic about one of the "Research and Technology" articles in the Neue Zürcher Zeitung (newspaper). He himself maintained this enthusiasm in his own field, and indeed with increasing age, with even increasing intensity: a life for optics.

After "writing with light", namely photography, became possible with the inventions of Niépce and Daguerre, one of the consequences, among others, was the development of optical imaging systems. After the pioneers Seidel, Petzval, and Abbe, who as mathematicians created the theoretical basis for the design of optical systems, and also after the early steps for such designs had been taken, the young self-taught Ludwig J. Bertele drew attention to himself around 1920 with one of his first remarkable designs. This first success was followed regularly by additional trailblazing achievements, so that his intensive creative activity shaped an entire epoch in the development of optics.

Before I discuss the life and work of Ludwig J. Bertele in the second part of this treatise, I would first like to attempt to describe how human curiosity, triggered by simple accidental discoveries, has over the centuries increased the understanding of the phenomenon of light, and with it of seeing, up to the discoveries which then made photography possible. By means of this first part, the achievements of our father will be put in context within the larger framework of scientific evolution. I think I would have received his approval for this

Development does not stand still. So it appealed to me to point out, in an epilogue, a few interesting developments in the post-LJB era.

Preface, English Edition

I received suggestions from various directions about translating the book into English, so that the story of Ludwig Bertele could be made accessible to those not fluent in German. I was pleased with this idea, and dared to ask Rolf Fricke if maybe he would like to tackle the project. Rolf had already translated a number of books in the realm of cameras and optics, including a recent biography of Oskar Barnack. Of course, my pleasure was great when he responded, in his typically humorous way, and agreed to take on the project. This happened quite a while back. Then there was a delay due to health problems. But thanks to the efforts of Rolf's son Oscar Fricke, the adventure was brought to a happy end! The reader can enjoy a perfect translation! I am much obliged to Rolf and Oscar, and also to Rolf's wife Judith Lardner.

It lies in the character of the languages that the English text is a bit shorter than the original German. This difference could not always be compensated for by graphic manipulation, resulting in occasional blank lines.

Charles Jonckheere, a former officer at the European Patent Office, found a few mistakes and omissions in the patents I listed in the first German edition. I am happy that thanks to his attentiveness these could now be corrected.

I also added a small chapter (page 49) titled "Ermanox and Ernostar in Literature." It was Gerald Piffl who drew my attention to this classic piece of science fiction literature.

Acknowledgements

In addition to Bernd Otto, mentioned above, and also my niece Sylvia, I wish to thank a number of additional persons who supported me in this project:

Conversations with my brother Jürgen were important and repeatedly led to further clarifications.

It was Andreas Eggenberger who taught me the basics of the InDesign program and who is responsible for the graphic styling.

While searching for photographs by Hans Böhm, the first Ermanox photographer, I came into close contact with Dr. Gerald Piffl of the Viennese photo agency Imagno, and received not only photographs, but also enlightening information.

Marco Cavina, Italian photo historian, has the distinction of having researched and described the design of prototypes and variations of the Sonnar lens. He provided me with much information in this regard, so much that I can only refer to his publications on the Internet. I also thank him for the photo of the Leica camera with a Sonnar lens (page 56).

I thank Dr. Wolfgang Wimmer, manager of the Zeiss Archives, for the friendly reception in Jena and for providing portraits of optical pioneers from the archives.

The former Wild AG company has become part of the Swedish Hexagon group and is now named Leica Geosystems AG. During my research Roger Zellweger very helpfully provided me with issues of the Wild company magazine Opticus, which he had collected and digitized. From former Wild employee Jürg Dedul I received illustrations of microscope optics. I am very grateful to both of them.

During a visit to Heerbrugg I experienced much goodwill and interest in the book project during my conversations with Jürgen Dold and Eugen Voit. At the same time, during a guided tour, I gained insight into the company’s current developments and products. It is remarkable how fast progress has been, especially thanks to computerization, in the years since the time of L. J. Bertele's activities. For this insight, I am of course also very grateful.

I am also thankful to Sibylle Obrist, Miriam Durscher, and Branco Ciganovic for an initial critical reading of the manuscript. Angelika Rodlauer, as editor with vdf-Verlag, subjected the german text to a very thorough review. She also did the final corrections of the english edition.

And last, but certainly not least, special thanks are due to my wife Susan, who actively assisted me in her own way.

Part 1:
A Look Back into History

The First Lens Grinders

From Transparent Quartz to Optically Useful Glasses

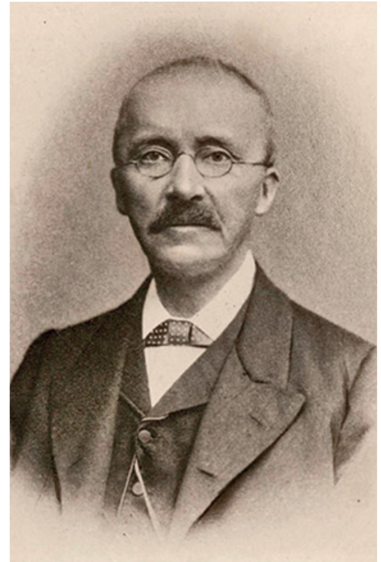
Deeper Insights into the Nature of Light Mathematical

Treatment of Optical Problems

The First Realization of Imaging Systems

The lens from Nineveh (called the Nimrud or Layard lens)

Sir Austen Henry Layard



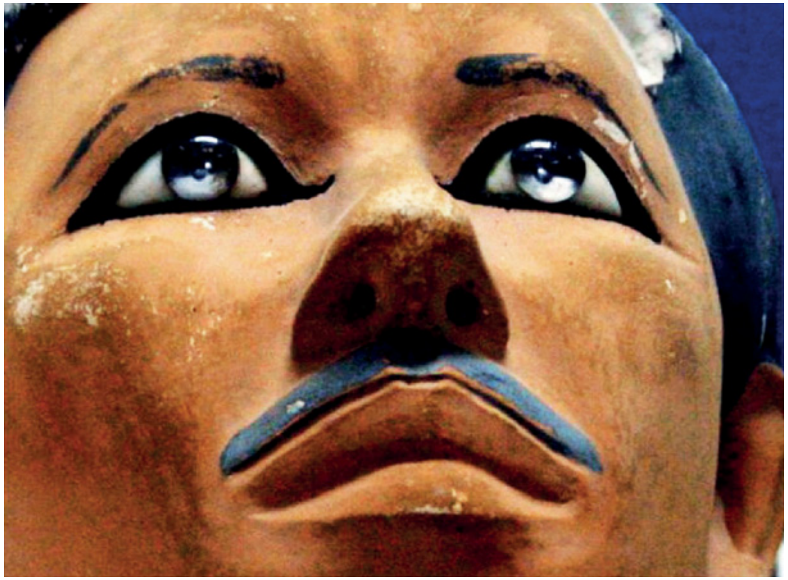
Heinrich Schliemann

Grinding Technology and First Optical Discoveries

In addition to the development of language, working with stone was another important factor in the evolution of human culture. Tools, cult objects and ornamental jewelry were created. In the creation of simple jewelry from colorless quartz (rock crystal), early stone grinders may have noticed optical effects after round surfaces had been polished. It is easy to imagine that this development led to colorless quartz being painstakingly ground into lens shapes. Looking through these polished stones made objects appear larger (magnifier effect), and when held in sunlight, the light could be focused into a bright hot point (burning glass effect).

The first "opticians" lived at least 3,000 years ago. During excavations in the Assyrian city of Nineveh (east of Mosul, in today's Iraq) in 1852, the archeologist Sir Austen Henry Layard found a lens ground from rock crystal into a plano-convex shape with a diameter of 34 x 40mm and a thickness of 6mm. Because of its toric shape the refraction varies between 4 and 8 diopters. The relatively poorly polished surface of the lens does not produce a very sharp focus, although this could certainly be improved by wetting the surface with water, grease, or oil. The lens today resides in the British Museum in London.

During excavations in Troy (1871–1873), Heinrich Schliemann found 48 plano-convex crystal lenses. These formed part of "Priam's Treasure," for a long time in The Museum of Prehistory and Early History in Berlin. After World War II the collection was transported to Russia as looted art. After being considered lost without trace for a long time, it now resides in the Pushkin Museum in Moscow (albeit not accessible to the public). The lenses are also stored there.



Rahotep; Egyptian Museum in Cairo

Ka’aper; Egyptian Museum in Cairo

The ancient Egyptians also knew how to grind lenses. In this context several statues show impressively lifelike eyes, such as Rahotep and Nofret, 4th dynasty (2639–2504 BC), the wooden statue of Ka’aper, 5th dynasty (2470–2458 BC), as well as that of Pharaoh Hor Awibre, 13th dynasty (1760–1732 BC). Egyptian artists achieved the remarkably vivid expression of the eyes by grinding the eyeball from non-transparent white quartz (alabaster). A small hole ground into the center and filled in black marks the pupil, and the plano-convex ground piece placed on top of it, made of transparent rock crystal, creates the illusion of the cornea. All of these examples reside in the Egyptian Museum in Cairo.

The importance of lens-shaped polished quartz crystals in antiquity was probably mainly in their use as burning glasses. A burning glass focuses sunlight onto a hot spot that makes it possible to start a fire. This clever way of creating fire was not only in use in the Greco-Roman realm, it was also used in ancient India and China. The Indologist Wilhelm Rau quotes (1), among others, the author Yāska (5th–4th century BC): “When someone focuses a polished precious stone on a 'pratisvara' (focal point), where there is dry cow dung, without touching it with the precious stone, then the dung will catch fire; in this way heavenly fire creates fire on earth.”

In Sanskrit the burning glass was called “sūryakānta,” meaning “friend of the sun.” The sinologist Berthold Laufer found in the annals of the Tang Dynasty (618–906 BC) in China first mention of quartz crystal lenses in sizes up to that of an egg (2). These lenses, called “huo chu“ (fire pearls), were imported from India, according to his research. Quartz as clear as water has been found in Kashmir. A technique had apparently been developed there for grinding and polishing stones into a lens shape.

What follows are some written evidence from the Greco-Roman era which describe and document the knowledge of that time concerning the properties of quartz lenses.

The Comedy "The Clouds" by Aristophanes

In this work the imaginative use of a burning glass plays an important role. The comedy was first staged in Athens in 423 BC. In one scene, Strepsiades looks for help from Socrates in erasing his debts. Socrates exposes him as a fool and forces him to think up his own ideas. After a sleepless night, Strepsiades comes up with an idea. We quote from a recent translation (3): „Strepsiades: Have you ever seen that lovely transparent stone at the chemist that is used for lighting fires? Socrates: You mean a crystal burning glass? Strepsiades: That's it! Well, what if I had one of those and when the clerk is entering the charge I stood a little way off with the sun behind me and simply melted the record?"

Rudolf Jettmar: Prometheus bringing fire to the people

The Burning Glass in Orphic Poetry

In the time around 400 BC the following text was written: "Take into your hand the shiny transparent crystal [hýalos]. If you wish to create fire without the flame forcing you to an effort, so I urge you to hold it over dry wood chips. Then when the sun shines on it, it will soon aim a delicate beam at the chips. When the beam touches the dry and plentiful material, first a smoke is created, then a small flame, which then creates a large fire." Quoted from Georg Brandes and Rolf Jarschel (4), and Frank Gnegel (5).

With today's knowledge about light refraction it is not easy to understand that in the past the effect of lenses was regarded as something mysterious. So it was imagined that the lens, the magical stone, transformed heavenly fire into earthly fire. Was that the deed of Prometheus which then became a myth? The fire in the temple therefore had to be ignited almost as a child of the divine fire, with concave mirrors or quartz lenses. The Olympic torch is ignited in such a manner to this day.

Pliny the Elder (23–79 AD) points to the medicinal applications of crystal lenses (6): "I find it stated by medical men that the very best cautery for the human body is a ball of crystal acted upon by the rays of the sun."

Lenses for Loupes and Telescopes?

In ancient times, that is, among the Greeks, Romans, Indians and Chinese, the need for crystals for the purpose of magnifying was probably not very great. There were no news-