Systematic Survey on 35 mm High End Camera – History from Leica to SLR –

4

Kosho Miura

■ **Abstract**

The history of photography spans almost 200 years, and the cameras which capture them have also been around just as long. However, early cameras were large wooden boxes in the style of furniture, not precision instruments as are today's cameras. Although they became smaller thereafter with the evolution of photosensitized material, the box shape was still the norm at the end of the 19th century. It took a certain amount of time since the invention of the photograph for the camera to break away from the box and become an object which is all-metallic, compact, and precise.

The prototype built by the genius Oskar Barnack as a hobby using 35 mm film changed the course of camera history. This report covers the history of camera before this event in chapter 2, and the sequence of events after the birth of this camera prototype in chapter 3. This camera was put into mass market after World War I under the name Leica. This small camera, with a feel of precision far from the norm of the day, became widely used as people embraced its portability and ease of use. This innovation came to affect the design and the technology, even of today, about 100 years since its birth.

Other companies followed with competing models. The field developed dramatically as Contax, a rival model introduced by camera industry leader Zeiss Ikon, competed with Leica. Chapter 4 of this report covers the sequence of these events.

Competition in developing Leica and Contax was fierce. Meanwhile, the world was heading toward World War II. Its dark shadow brought a major influence on the evolution of cameras as compact optical military weapons. In Japan, as well, the foundation was laid for compact camera development, as Leica copies were produced as required by the military or imitations were made out of curiosity. This came to be the budding of compact precision cameras in Japan.

During the war, production of cameras for civilian use was interrupted. However, manufacturers appeared after the war, resuming production or changing their course from the optical weapon industry, making use of accumulated technology. They were joined by those attempting camera production for the first time. Perhaps the feeling of precision and the presence exuded by the camera touched the heartstrings of the Japanese. A pragmatic aspect of this was that camera production, high in added value compared to the raw materials, was perfect for Japan, a resource-poor country.

Aided by special demand generated by the Korean War, the Japanese companies were closing in on the German companies, which had been forging ahead at the forefront of compact precision cameras. However, they were given a harsh awakening at Photokina 1954 with the release of Leica M3. Facing the reality that they were outperformed by a few paces in almost all areas, Japan was given a great shock. Yet again, the Japanese camera industry was saved by the changing times. As the photography culture diversified, the tide turned away from rangefinder models like Leica toward single-lens reflex cameras (SLRs). 35 mm SLRs also originated in Europe, however, since skillful mechanisms were required to overcome their shortcomings, development in Europe progressed slowly. The outcome was that SLRs made great strides in Japan after the shock of Leica M3. Conquering the various shortcomings of SLRs one by one with idea and effort and continuing to supply low-cost, high-quality product in harmony with the craftsmanship in their nature resulted in Japan gaining the top global share of the camera industry by the 1960s, ahead of West Germany. However, it is also true that, during that process, many manufacturers inferior in originality or development capability were eliminated. Such processes of migration to SLRs and the background of the times are covered in chapter 5.

Chapter 6 examines the evolution and development of the many SLR functions led by Japan, especially the path to automation, from the viewpoint of functions. The original vertical-travel shutters, downsizing of cameras, automatic exposure, autofocus technology—these were independently developed by Japan, solidifying its position. This place has not changed in recent days since the times have moved on to digital cameras.

Of the long history of cameras, this report is restricted to the 35 mm focal-plane shutter models which started with Leica. It was written avoiding a technical report format throughout, with the intention for it to be easy to read for many people with an interest in cameras.

■ Profile

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1977	Bachelor of Science, Division of Precision Engineering, Hokkaido University
1979	Master of Science, Division of Precision Engineering, Graduate School, Hokkaido University
1979	Joined Nippon Kogaku Kogyo Co., Ltd. (currently Nikon Corporation), assigned to Camera Design Division, mainly engaged in mechanical design of SLR cameras
2004	Temporarily transferred to Sendai Nikon Corporation, engaged in SLR camera production technology
2009	Returned to Nikon Corporation, assigned to Imaging Product R & D Laboratory, mainly engaged in planning and development of digital SLR cameras
2017	Retired from Nikon Corporation
2017	Joined the Camera & Imaging Products Association, continue as a member to date

■ Contents

1 Introduction

From the end of 2016 to the following year, a special exhibition “Lascaux: The Cave Paintings of the Ice Age” was held at the National Museum of Nature and Science in Ueno, Tokyo. The animal paintings on the walls of the Lascaux Cave in France, rendered by unknown Cro-Magnon artists with limited rock paints and primitive tallow lamps, overwhelmed the viewers with their vivid likenesses that looked as though the depictions would start moving at any moment.

What inspired the artists to produce such imagery was their passion for keeping a faithful record of what they saw before them. About 20,000 years later, perhaps with that same passion, a Frenchman invented a means for automatically and permanently recording images, and the images taken remain as the oldest photographs in the world. Over the course of the next 190 years, the camera developed as a tool for capturing images of equal fidelity.

Looking back at the history of the camera, in the early days, large box-shaped cameras were used by professional photographers. The equipment set was large and heavy, and taking photographs was also an ambitious task, and hence, out of reach of the general public. As the handling of photosensitive materials became easier and sensitivity improved, cameras gradually became smaller. It was around the end of the 19th century that Kodak popularized small box cameras at low prices for the purpose of popularizing photography. As the culture of photography permeated the general public, folding cameras evolved to increase portability. These cameras differentiated into various types as the variety of photosensitive materials increased.

In the first half of the 20th century, new trends such as compact precision cameras that use 35 mm film such as the Leica, twin-lens reflex (TLR) cameras that use medium format film such as 120, and spring cameras emerged, and cameras evolved into high-precision machines. Around this time, Germany, with its cutting-edge optical and precision processing technologies, emerged as a world leader in the camera industry.

The most notable in this period of history is the Leica. About 100 years ago, a camera handcrafted by Oskar Barnack, who worked for Ernst Leitz in Germany, using parts on hand in the corner of his own laboratory for developing cine-camera technology was, at the beginning, used by Barnack as a hobby, but in 1925 was released as the compact precision Leica camera in the wake of the recession after World War I.

The camera, featuring such a strange and unique style to the eyes of the people of that time, gradually gained acceptance and positioned itself as the compact precision machine that would usher in the present age. Following the Leica, many camera manufacturers began to manufacture cameras emulating its style. The industry giant Zeiss Ikon competed for the title with the Contax and, with these as inspiration, the emergence of compact precision cameras began in Japan. The Japanese set about on a program of acquiring and accumulating knowledge of Western technology and, with a spirit of ingenuity, dexterity, and perhaps a natural aptitude for camera production, brought about the blossoming of the camera industry in the desolate post-war environment.

At first, the cameras of Japan were nothing more than imitations of German cameras represented by the Leica. But, while following Germany’s lead, Japan soon found a way into the single-lens reflex (SLR) genre and, in the 1960s, turned the tables on Germany in terms of production volume, and jumped to top global market share holder in the camera industry. In the 1980s, the production volume of 35 mm cameras with focal-plane shutters, mainly domestically produced SLR cameras, reached as high as about 75% of the global market share[1)] and, while the automobile and other industries suffered from trade friction between Japan and the United States, export barriers were nonexistent due to the lack of rivals, and the industry grew to the point of being called an ideal model for exported industrial products. That trend continues to this day and, even after camera technology transitioned from silver halide to digital, Japan continues to dominate the global market share.

This paper first touches on the history of the camera, then focuses on the process of the birth of the Leica, the archetype of modern compact precision cameras, and describes important aspects of its innovative technology. Next, the paper attempts a bird’s-eye-view systematic analysis of the Contax, which made its debut following the Leica, and the blossoming of prewar domestic compact precision cameras, the camera industry launched after the war and, starting from Chapter 5, the transition to and progress in the development of SLR cameras, mainly in terms of technical aspects.

The passion of the Cro-Magnons in Lascaux Cave, whose artistry vividly portrayed animals with rock paints and tallow lamps, must have been passed down to their descendants through their DNA. Niépce of France left the first photograph of mankind, Barnack of Germany gave birth to the Leica and, triggered by these, the manufacturing power of Japanese engineers developed the compact precision camera.

The development of compact precision cameras lies in the pursuit of automation, high speed, and high accuracy in order to increase the size of the imaging area and improve convenience. The developers solved problems gradually, but with steady efforts. I would like to describe the technological development process of these developers in terms of not only technical aspects but also the historical context and various human narratives. It is my hope that these descriptions will serve as inspiration for future camera development.

There are various forms of cameras, and it would be very interesting to add the 35 mm lens shutter (diaphragm shutter) camera, TLR camera, spring camera, and the like to this systematic analysis, but such an endeavor would be a huge task. This paper, therefore, focuses on rangefinder cameras and SLR cameras that use 35 mm film as per the Leica, and those

equipped with focal-plane shutters. However, this paper also, as an exception, touches on the lens shutter-equipped cameras found in early SLR cameras. As for digital camera technology, a technology systematization survey[2] has already been completed and is available for your reference.

References and citations

1) Japan Camera Industry Association, *Nippon Kamera Kōgyōshi* [The History of the Camera in Japan], (Japan Camera Industry Association, 1987), p.386.
2) Ōkawa, Motokazu. "Historical Development on Digital Still Cameras" in *Heisei 19-Nendo Gijutsu no Keitō-ka Chōsa Hōkoku* [2007 Survey Reports on the Systemization of Technologies] (Tokyo: National Museum of Nature and Science, 2008).

2 History of Photography – Overview

2.1 Birth and Development of Photography

In ancient times there must have been a strong human desire to devise methods for retaining images projected on the human retina that would last far into the future. One answer to this desire is painting. Eventually, humans noticed that a small hole in the wall of a dark room projected a bright outdoor image on the opposite side. Furthermore, it must have been a short time after the invention of the lens itself that humans realized that using a convex lens instead of a hole would give a brighter and clearer image. Based on this principle, a device for producing a painting in sketch form was born. This is the camera obscura, which refers to a "dark room."

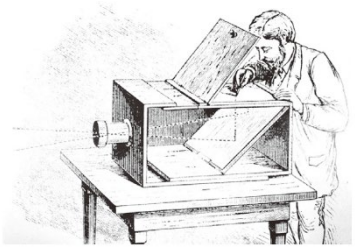
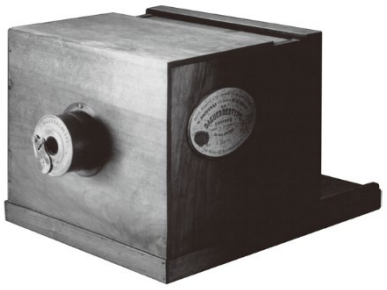


Figure 2-1 Sketch of Camera Obscura[1)]

As a development of this, it is natural to want to automatically record a projected image as is. Attempts toward this end were made and, in 1825, it was the French inventor Joseph Nicéphore Niépce who succeeded in leaving behind an optical image as a record. This involved thinly applying a layer of asphalt to a polished metal plate and recording the image via the hardening action of the asphalt. This technique is called heliography and, although it seems somewhat strange to equate it to photography which is a recording of light, his photograph called "View from the Window at Le Gras" remains the oldest photograph known to history.

Photograph 2-1 View from the Window at Le Gras [2)]

Collaborator Louis Jacques Mandé Daguerre, who replaced Niépce following Niépce's unexpected death in 1833, devised a new method and published it in August 1839. In this method, a sharp image is recorded by depositing iodine on a silver-plated copper plate and forming an image of the subject projected by a lens on the plate. The camera used by Daguerre is called the daguerreotype after his name, and was released as a set of Giroux Daguerreotype cameras by Alphonse Giroux & Cie. of France. This huge "box" was the first camera on the market. Daguerreotype photography spread throughout the world in an instant, was introduced to Nagasaki in 1848, and the photograph of Lord Shimazu Nariakira taken in 1861 remains the oldest daguerreotype image in Japan.



Photograph 2-2 Giroux Daguerreotype Camera
(Provided by JCII Camera Museum)

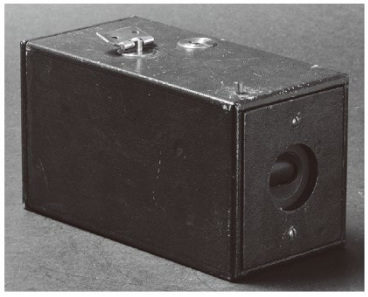
In 1841, William Henry Fox Talbot of England announced a negative-positive method called calotype, which made it possible to duplicate many photographs from a single original plate. This is the basic method of the current silver halide photography system.

The calotype was inferior in sharpness because it used paper as the negative of the original plate, but in 1851 Frederick Scott Archer of England developed a collodion wet plate photography method of applying collodion (viscous liquid) to glass and adhering silver nitrate, which is a photoconductor, thereto. This method, which is less expensive than silver plate and offers better image quality than calotype, was widely accepted, but had a drawback in that the wet plate had to be made at the photoshoot site, and many techniques were sought to overcome this drawback. Among these, the most practical was the dry plate.

The dry plate was obtained by applying a gelatin silver bromide emulsion to glass and drying the application, and offers good storability and relatively high sensitivity. Improved storability led to industrialization and increased availability, driving the dry plate's popularity. Even now, the dry plate is used not only for recorded photographs but also,

because it can realize complicated patterns in detail and has good flatness, is utilized for industrial applications such as the manufacture of electronic parts.

Attempts were also made to apply the emulsion to a flexible substrate rather than glass to improve portability. While research on roll film based on synthetic resin celluloid had been promoted since the 1880s, it was paper-based roll film that was put to practical use first. The Kodak, a box camera released by Eastman Dry Plate & Film Company in 1888, was sold with a pre-loaded 100-exposure roll of paper-based film. After taking photographs, the user would send the camera back to the company and later receive the developed photos and the camera refilled with new film. Along with the catch phrase of the time, "You press the button – we do the rest," this box camera concept was well-suited for the social situation at that time when, unlike the present, a proper infrastructure was not yet in place, and was a big hit. The Kodak represented an epoch-making business model that led to the modern, one-time-use camera represented by "QuickSnap."



Photograph 2-3 The Kodak
(Provided by JCII Camera Museum)

The Eastman Dry Plate & Film Company released the No. 1 Kodak following the Kodak, and subsequently commercialized a series of variant models from the 1890s to the 1910s featuring improvements such as a film celluloid base and a better loading method, picture size, and shutter mechanism.

The company, which was renamed Eastman Kodak Company in 1892, diversified its roll film as its achievements in breakthrough performance increased. A number was assigned to each type of photosensitive material and, while the company started with type 101, there are now more than 30 different types. Of these, type 135 is the type with the 35 mm film loaded in a predetermined cartridge, which is still used today.

Originally, the 35 mm film was developed for movies and, as the name implies, has a width of 35 mm and perforations (feed holes) on both edges. The film was put to practical use on Thomas Edison's kinetoscope in 1891, which subsequently became widely accepted for entertainment purposes and spread throughout the world, bringing the 35 mm film much popularity as well.

Starting from the primitive heliography of Niépce, photography transitioned through the daguerreotype, calotype, wet plate and dry plate, finally reaching the 35 mm film. That is the fertile soil that would produce the Leica and subsequent SLR cameras. In the following sections, I would like to look at the process of evolution of the camera as a photography tool, staying close to the historical flow of photography development.

2.2 Development of Camera Equipment with the Evolution of Photography

2.2.1 Evolution of the Box Camera

Cameras similar to the Giroux Daguerreotype camera described above are called box cameras because of their large wooden box shape, and are more like furniture than precision machinery. In fact, furniture craftsmen often made them using walnut wood used for furniture construction.

The sensitivity of the silver plate, which is a photosensitive material, is extremely low, and requires several tens of minutes of exposure even in fine weather. The shutter, therefore, was simply the opening and closing of the lens cap. To make one, a craftsman would simply fabricate a wooden box that does not leak light, attach a lens to the side of it, and provide a slide mechanism for focusing and a silver plate holding mechanism on the opposite side. Then, similar to the camera obscura, the craftsman would prepare a mirror tilted at 45 degrees to guide the light beam to the focusing screen, which is on the upper side, for checking the focus. This is already the principle of the SLR camera.

The silver plate itself after a photo was taken was for ornamental use, making it necessary to use a somewhat large silver plate from the start, which inevitably made the size of the camera exceptionally large. The Giroux Daguerreotype camera, while having a picture size of 162 x 216 mm[3], which is almost the same as the current full-plate format used on field or studio cameras, involved a substantially large physical camera equipment setup.

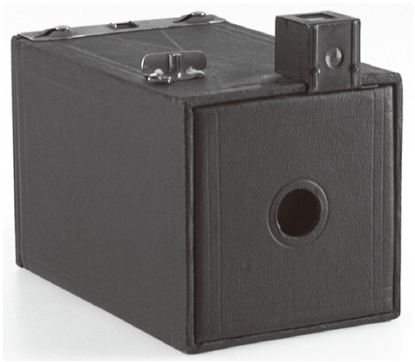
In the era of wet plate photography, the number of users increased, the photo-shooting area gradually expanded, and the equipment became smaller and lighter for outdoor photography expeditions. In fact, it was around this time that photographs were actually taken at the summit of Mont Blanc, Yosemite and the Grand Canyon[4].

With the advent of the era of dry plates, resolution and sensitivity improved dramatically, and mobility further increased. This is because the dry plate, which offers good storage stability, is suitable for carrying around, and allows selection of various sizes as needed. In addition, the improved resolution gave way to sufficient endurance for recording keeping and ornamental use, even if the captured image was not so large, and the improved sensitivity helped facilitate handheld photography.

2.2.2 Eastman Kodak's Success and the Spread of Small Box Cameras

With the success of the Kodak, small box cameras and roll films became widespread, and Eastman Kodak continued to expand its variations of film. At the same time, with the development and sale of new products, various models emerged. For example, Eastman Kodak released the Pocket Kodak in 1895, successfully downsizing the camera by reducing the film and picture size. The picture size is approximately 4 x 5 cm.

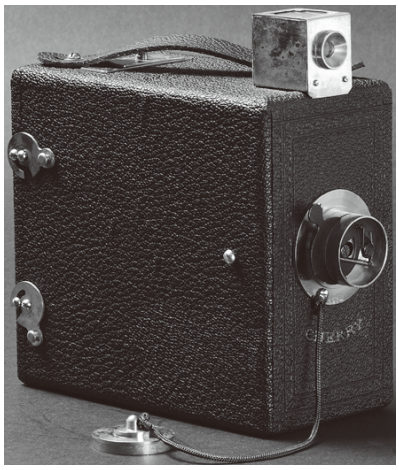
In 1900, the Brownie camera was released for only $1. The picture size employed in this camera of approximately 6 x 6 cm is the so-called 6 x 6 format still widely used today.



Photograph 2-4 Brownie Model B (First model)
(Provided by JCII Camera Museum)

The trend of box cameras for amateurs, which originated in the Kodak, also affected Japan, and in 1889 Arita Shokai released the domestic box camera "*Keiben Shashinki* (Light and Convenient Camera)." This camera used a quarter-sized (83 x 108 mm) dry plate.

The No. 1 Kodak, a roll film-type box camera, was imported by Asanuma & Co., Ltd., a long-established photographic material specialty store, in 1890, and production of Japan-made cameras (with imported lenses and dry plates) began around this time. The camera recognized as the first domestic mass-produced camera for amateurs was the Cherry Hand Camera released by Konishi Honten (later Konishiroku Honten, Konishiroku Photo Industry, Co., Ltd., Konica and currently Konica Minolta) in 1903[5].



Photograph 2-5 Cherry Hand Camera
(Provided by JCII Camera Museum)

This camera is a cartridge type that is pre-loaded with six small-sized (54 x 83 mm) dry plates, allowing photographs to be taken in sequence while replacing the dry plates. Because it was small and lightweight, records indicate that, together with the quarter-sized format released the following year, about 100 units were sold per month[6].

2.2.3 Debut of the Folding Camera

The definition of a folding camera is somewhat ambiguous due to its many variations. From a structural point of view, some sources classify such cameras as clap cameras, self-erecting cameras, spring cameras, view cameras and field cameras, but the precise boundaries are not clear and this paper does not aim to redefine them. Herein, a camera that can be made smaller than the size during use by employing a bellows or something similar is called a folding camera, and among the folding cameras, a camera that can be transformed from a folded state to a shooting state with a single touch is called a spring camera.

Starting from the "furniture-like" camera era, cameras were made into a foldable type using the elasticity of a bellows or into disassembly type called an Assembly Dark Box in order to reduce both size and weight. Yet, even after the emergence of the roll film, the box camera represented by the Kodak continued its unaesthetic box-shaped design. This seemingly stemmed from both Eastman Kodak's policy that, rather than devotion to the camera for its own sake, low cost is the shortcut to making photography popular among the general public, and the national character of the American people, the main market, who valued practicality over aesthetic considerations.

That said, a type more portable than the box type also emerged, and the No. 5 Folding Kodak released in 1890 and the Folding Pocket Kodak released in 1897 were more compact in size through the use of folding mechanisms that utilized a bellows.

Photograph 2-6 Folding Pocket Kodak
(Provided by JCII Camera Museum)

The resolution and sensitivity of photosensitive materials gradually improved, driving picture size and lens size reduction and hence camera miniaturization and weight reduction. The blockbuster in this line was the Vest Pocket Kodak, released in 1912.

Photograph 2-7　Vest Pocket Kodak
(Provided by JCII Camera Museum)

The so-called vest picture size of 4 x 6.5 cm that used Eastman Kodak's 127 type film made exclusively for this camera is a size that can tolerate contact printing, and above all fits inside the pocket of a vest as the name suggests when the camera is folded. With the success of the Vest Pocket Kodak, this camera form and the 127 type film enjoyed a worldwide boom, and similar cameras were produced in each country.

As an aside, the early Vest Pocket Kodak used a single-lens (two lenses per group) meniscus lens, which required a lens hood due to spherical aberration. However, photos taken purposefully with the hood removed produced a soft focus effect, and this photography method became famous in Japan.

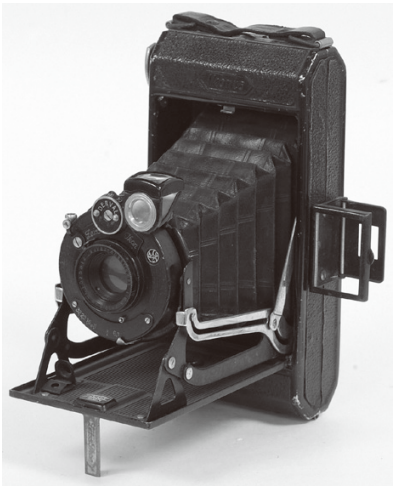
In response to the success of Vest Pocket Kodak, in Japan, the long-established Konishi Honten released the Pearlette, the Japanese version of this camera, made by its own manufacturing factory, Rokuosha, in 1925. The Pearlette subsequently became a long-selling product provided with continuous improvements for over 20 years.

Photograph 2-8　Pearlette
(Provided by JCII Camera Museum)

2.2.4　Spring Camera

1925 is the year the first 35 mm compact precision camera, the Leica, was released. While this paper focuses on the systematization of compact precision cameras that originated in the Leica, the period from the 1910s to the late 1940s, that is, from World War I to the end of World War II, was a period of remarkable development for other camera types as well. With this in mind, I will address the main subject in the following chapters and momentarily touch on cameras of forms different from the Leica. In fact, in terms of sales volume, this was an era when other camera types overwhelmingly boasted higher figures than the expensive 35 mm compact precision camera. In addition, looking at the history of camera development in Japan, while there were many manufacturers that launched cameras modeled after the Leica, some manufacturers accumulated experience with popular lens shutter cameras, spring cameras or TLR cameras and then entered the SLR camera market without ever pursuing the Leica form, including manufacturers that abruptly started production with the SLR camera. From this point of view, it is meaningful to discuss matters such as the historical context and sequence of events.

In Germany, Carl Zeiss merged four leading German camera manufacturers and established Zeiss Ikon in 1926 to counter the recession after World War I, and in 1929 released the Ikonta, the original spring camera. This release sparked the significant boom of the spring camera, a type of folding camera.



Photograph 2-9　Ikonta I
(Provided by JCII Camera Museum)

As the name suggests, the spring camera utilizes a spring to make it possible to open and close the camera with a single touch and immediately start shooting. Note, however, that the name of “spring camera” is used mainly in Japan and is not common in foreign countries.

In the early days, this type of spring camera was often a 6 x 9 format camera like the Ikonta in the early days, but 6 x 6 format and 6 x 4.5 format cameras gradually became mainstream in Japan.

Domestic manufacturers that entered the market with the

spring camera include Takachiho Seisakusho (later Olympus Optical Co., Ltd., currently Olympus), which was founded in 1919 with the manufacture of microscopes and started camera production with the Semi-Olympus I in 1936, and Mamiya Kōki Seisakusho(later Mamiya Optical, Mamiya-OP, Mamiya Digital Imaging and currently Phase One Japan), which simultaneously entered the camera business and released Mamiya Six in 1940 with funding from the manufacture of money registration machines.

Also, as the name implies, the Nichi-Doku Shashinki Shoten (Japan-Germany Camera Company), which launched operations in 1931 with the cooperation of German engineers, commercialized models such as the Arcadia and Minolta Vest after being renamed to Mechanismus Optik und Linsen von Tashima (later Chiyoda Kogaku Seiko Co., Ltd., Minolta Camera, Minolta, and currently Konica Minolta), and released the first domestic 6 x 4.5 format camera, the Semi-Minolta I, in 1935.

Photograph 2-10 Semi-Minolta I
(Provided by JCII Camera Museum)

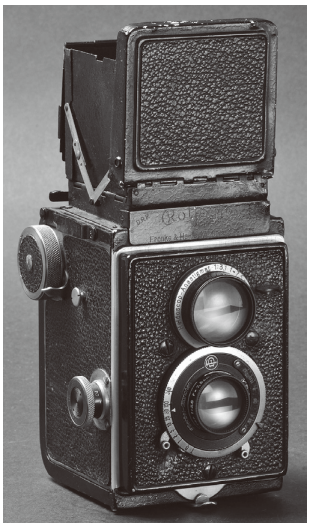
Many manufacturers entered the spring camera market during this period for the reason that the lens and the camera body where film is loaded are mechanically separated by merely the bellows, making the camera easy to make, and the body structure offers the manufacturing advantage of requiring only the stamping of sheet metal.

In addition, from around 1930, manufacturers specializing in shutter manufacture emerged in Japan, and the purchase of these shutters further facilitated camera manufacture and led to the breakthrough of the spring camera.

In this way, the prewar to postwar period was a period of increase in the number of domestic manufacturers entering the camera industry from various backgrounds and, with the addition of newly established manufacturers, a period of accumulation in development and production technology for later rangefinder and SLR camera development.

2.2.5 Emergence of the TLR Camera

In 1929, Germany's Franke & Heidecke released the Rolleiflex Original, a TLR camera with lenses having the same focal length on the top and bottom.



Photograph 2-11 Rolleiflex
(Provided by JCII Camera Museum)

The upper lens of the TLR camera is used for the viewfinder, and the lower lens is used for photography. The waist-level finder offered the advantage of allowing the photographer to observe an image from a favorable perspective, and the structure, which utilized ample metal, conveyed a high-precision feel and won great popularity. While the frame was a 6 x 6 format and initially used 117 film with six frames on a roll, soon 120 film with 12 frames on a roll became available.

The features of the TLR camera are utilized in portrait photography. With the waist-level finder, the photographer assumes a posture of slightly bowing to the person who is the subject, which is perceived as less aggressive.

After the release of the Rolleiflex, the Rolleicord, a low-priced version, was released in 1933, ushering in the TLR boom. The Minolta Flex Automat was released in Japan in 1941 and, after the war, due to the simplicity of the structure of the TLR, the number of manufacturers entering the market increased rapidly and an uneven mixture of brilliant and mediocre cameras came and went. There is even a famous anecdote that “J, U and X are the only acronyms for TLR camera names not used among the 26 letters of the alphabet.” In 1948, the Mamiyaflex Junior, the longest domestic series, was released.

There was a notable movement in domestic cameras. The Ricohflex III, a TLR camera released by Riken Optical (currently Ricoh) in 1950, was released at an ultra-low price of 5,800 yen, compared to the general camera price of tens of thousands of yen at that time. On the day of release, customers seeking this camera queued up, surrounding the Ginza San-ai Building of the distributor.[7)]

Photograph 2-12 Ricohflex III
(Provided by JCII Camera Museum)

The domestic TLR camera had shortcomings and, while efforts were continually made to address them, including the introduction of new mechanisms such as lens interchange by Mamiya Optical, the production of the Mamiya C330S in 1994 was virtually the last to be discontinued. Ten years after the end of the war, spring cameras and TLR cameras, which enjoyed such incredible success, gradually saw a downward trend. The instigator of this trend was the rapid entry of a group of compact precision cameras that used the 35 mm film originating from the Leica into the market.

2.3 Advances in Mechanisms in Modern Cameras

While the previous sections have described the evolution from the box camera to the folding camera and the emergence of the spring camera and the TLR camera with the advent of the roll film and improvements in sensitivity and resolution, the following sections touch on the technological evolution of various mechanisms inside the camera, from prewar to postwar, which is closely related to discussions on the 35 mm compact precision camera, the theme of this paper.

2.3.1 Lens Shutter and Focal-Plane Shutter

While daguerreotype photography takes several tens of minutes of exposure even during the day, deeming a shutter such as that of a modern camera unnecessary and the opening and closing of the cap in front of the lens sufficient for picture taking, the increasing sensitivity of the wet plate and dry plate made dedicated shutters necessary.

In the early days when cameras such as the Kodak started to become popular, a plate with slits was simply driven in a guillotine manner with springs or rubber. This form of shutter is called a guillotine shutter or a drop shutter. This shutter involves a long travel distance, so the camera itself has to be large. For this reason, in response to the demand for camera miniaturization, a roller blind type shutter was devised by replacing the plate with a flexible curtain and winding the flexible curtain to improve space efficiency. In addition, a rotary shutter also emerged in which, instead of operating linearly like a guillotine shutter, a fixed shaft was provided with a light-shielding plate that rotated around it. From then on, the roller blind shutter was developed individually as a focal-plane shutter via a cloth curtain retractable Thornton shutter, and the rotary shutter was developed individually as a later lens shutter. Figure 2-2 shows the transition of shutter development.

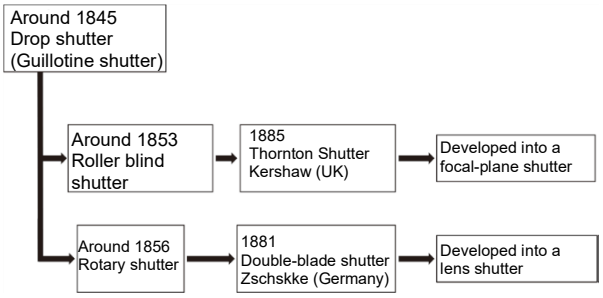


Figure 2-2 Transition of Shutter Development

The development of the focal-plane shutter will be described in subsequent chapters, and here, in this section, the lens shutter widely used in spring cameras and TLR cameras will be briefly described.

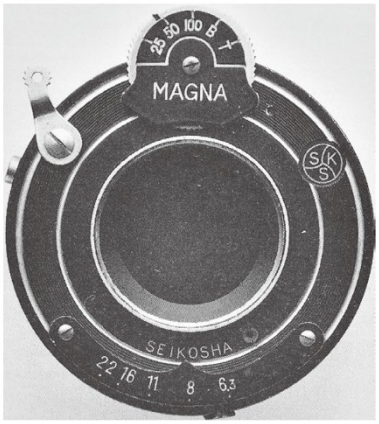
The rotary shutter is a shutter that uses a spring or the like to rotate a disc provided with a hole, momentarily allowing imaging light to pass through the hole. The shutter that consists of two blades, rather than one disc, that open and close on both sides at the same time was invented by Zschskke in Germany in 1881.[8)]

This form of shutter in which multiple blades open and close in coordination evolved into the lens shutter of today. During this time, companies such as Bausch & Lomb and Wollensak of the United States and Deckel and Gauthier of Germany competed to make technological improvements such as extension of the shutter time, installation of a self-timer, a combined shutter blade and aperture, and a more compact and thin size, releasing improved lens shutters one after another, which greatly contributed to the development of shutter-equipped folding cameras, spring cameras and TLR cameras.

It should be noted that lens shutters can be classified into before-the-lens shutters placed in front, behind-the-lens shutters placed behind and between-the-lens shutters placed between a group of lenses, depending on the installation position with respect to the shooting lens. The current convention is the between-the-lens shutter because it enjoys the great advantage of being able to double as an aperture, and a regular lens shutter refers to this type.

In Japan, K. Hattori & Co., Ltd. instructed its affiliate Seikosha (currently Seiko Precision) to manufacture shutters

by utilizing its watch manufacturing technology. In 1930, the company succeeded in developing the Magna, the first domestically produced lens shutter modeled after a German shutter.



Photograph 2-13 Magna[9)]

The Magna was incorporated into the Toko anastigmat lens manufactured by Tokyo Optical Co., Ltd. (currently Topcon Corporation, hereinafter referred to as Tokyo Optical) and, after being installed in the First hand camera of Minagawa Shōten, was employed in many domestic cameras. Seikosha continued to accumulate capabilities while releasing different types of shutters, and in 1958 escaped the confines of being a mere imitator of Germany, developed the #00SEIKOSHA-SLV based on its own technology, and contributed to the commercialization of many domestic SLR cameras incorporating lens shutters.

A division of Kobayashi Seiki Seisakusho in Nagasaki, Toshima-ku also started to develop shutters and completed a prototype in 1946, which was first installed in the Olympus Six I. This shutter division was spun off as Copal Koki Co., Ltd. (later Copal Co., Ltd, and currently Nidec Copal Corporation), and became a shutter manufacturer that greatly contributed not only to the development of lens shutters but also to the development of focal-plane shutters.

In addition, Citizen Watch Co., Ltd, has been developing lens shutters since around 1950. It is remarkably interesting to note that, in terms of the concurrent development of industrial structure, the watch industry utilized its specialty of precision machining technology to embark on the development of shutters, giving a strong boost to the camera industry.

2.3.2 Automatic Winding Stop Mechanism

In a camera that uses roll film, it is necessary to wind the film to the next shooting position every time a photograph is taken. If the film is wound too much, a useless interval results and the user can no longer take the predetermined number of photographs. If the film is insufficiently wound, the frame overlaps with the previous frame. In early cameras such as the Kodak, the backside of the roll film was marked at regular intervals, and a small back window was placed on the back of the camera, making the marks visible. The user would then wind the film to a position where he or she could see the mark on the back of the film. This back window is often red and is therefore called a “red window” in Japan. This is because film is practically insensitive to the color red, and utilizing this quality of film prevents light leakage. This principle is still in use today, and the active international standard ISO 1203 defines the dimensions of the back-window position of medium format cameras.

Instead of such a primitive principle, the automatic winding stop mechanism automatically prevents further winding when a predetermined amount of winding is performed via the operation of a knob or lever for winding. In this method, the amount of movement of the film is measured with a roller or the like, and when the film is moved by a predetermined amount, the winding stop is applied.

While the rise of the so-called spring camera is largely due to the success of the Ikonta series, which was first released in 1929 by Zeiss Ikon, the automatic winding stop mechanism was already employed in the 1930s. In Japan, in 1933, Konishi Honten released the Pearl that adopted the same mechanism. Of note is the Mamiya Six, released by Mamiya Kōki Seisakusho in 1940. In addition to its automatic winding, this camera was also famous for its back-focusing mechanism, which showed much originality in that focus adjustment was by moving the film plane of the camera in and out. With the employment of back-focusing, a coupled rangefinder can be easily realized, which is proof that Japanese camera development technology was already trying to break away from mere overseas imitation at this time.

Photograph 2-14 Mamiya Six
(Provided by JCII Camera Museum)

2.3.3 Self-Cocking Mechanism

Self-cocking is a technology related to the interlocking of film winding and shutter charge. In early roll film cameras, the shutter was charged and the film was wound independently, but this independent method results in the risk of the film being wound without the shutter being released and thus the waste of a frame or, the reverse, the shutter being operated without the

film being wound and thus a double image. The self-cocking mechanism eliminates these dangers by charging the shutter together with the winding of the film.

While the self-cocking mechanism was already employed in models such as the Leica I released in 1925 and the Rolleiflex – the original TLR camera released in 1929, such a mechanism could be relatively easily installed in these cameras since the camera bodies had an integrated structure, making it easy to interlock the winding mechanism and shutter charge mechanism.

On the other hand, in a spring camera, due to its folding structure, the lens, that is, the lens shutter and the film winding mechanism are separated, which makes interlocking difficult. Self-cocking with a medium format spring camera was realized for the first time with the Mamiya Six mentioned in the previous section. In other words, the Mamiya Six is the one-and-only camera that realized it all: automatic winding, back-focusing and self-cocking. Mamiya Seiichi, the developer of the Mamiya Six, was an engineer involved in the development and trial production of cash registers, and was also a photo enthusiast. Lamenting that many domestic cameras at that time lacked durability, Mamiya Seiichi designed the Mamiya Six by himself, and his originality and passion are something to be remembered.

References and citations

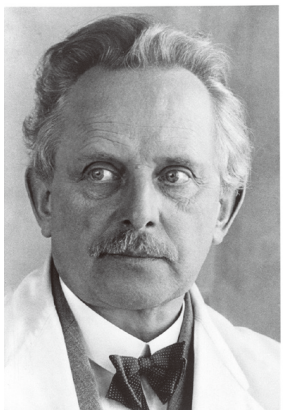
1) JCII Camera Museum, Kamera Q&A Kamera ga Wakaruten [Camera Q&A Understanding the Camera], Pictorial Record (JC11 Camera Museum, 2013), p.2.
2) JCII Camera Museum, Shashin Gekijō Firumu to Kamera no Monogatariten [Phototheatre: The Story Behind Film and the Camera], Pictorial Record (JCII Camera Museum, 1994), p.3.
3) JCII Camera Museum, Kaku Jidai ni Miru Gamen Saizu [Picture Sizes Viewed Era by Era], Pictorial Record (JCII Camera Museum, 1999), p.8.
4) JCII Camera Museum, Shashin Gekijō Firumu to Kamera no Monogatariten [Phototheatre: The Story Behind Film and the Camera], Pictorial Record p.6.
5) JCII Camera Museum, Nihon Kamera Souseiten [Creation of the Japanese Camera], Pictorial Record (JCII Camera Museum, 2003), p.4.
6) Kamei, Takeshi (Ed.). Nihon Shashinshi heno Shōgen (Ge) [Testimony to the History of Japanese Photography (Volume II)] (Tankosha, 1997), pp.163-164.
7) Kurashikku Kamera Senka No. 3 [All about Historical Cameras No. 3], Sengo Kokusan Kamera no Ayumi [History of Domestic Cameras After the War], (Asahi Sonorama, 1983), p.155.
8) JCII Camera Museum, “Hai Chīzu” Shunkan wo Toraeru Shattāten [Shutters that Capture that “Say, Cheese!" Moment], Pictorial Record (JCII Camera Museum, 2002), p.4.
9) Nakagawa, Tadashi. Seikosha Shattā Monogatari [The Seikosha Shutter Story], (Asahi Sonorama, 1998), p.9.

3 The Birth of the Leica

3.1 Oskar Barnack

Oskar Barnack was born in Germany on November 1, 1879. After completing compulsory education in Germany, Barnack worked in various factories and continued his career within the apprenticeship system, which was a common practice at the time, in order to develop his specialty in mechanical technology. In later years, Barnack won second place in a local chess tournament, so he undoubtedly had a knack for science and mathematics. His hobby was photography. With his heart set on becoming a landscape painter as a child, Barnack enjoyed a strong artistic sense, and his extraordinary talent in landscape photography is evident from the work he left behind.

Being a photography-loving mechanical engineer, he must have felt a great sense of accomplishment when he landed a job at Carl Zeiss at the age of 22. However, Barnack could not become a full-time employee at Zeiss. While normally talent breeds success, his frail health held him back. One or two months out of the year, he had to rest to treat his chronic bronchial catarrh[1].



Photograph 3-1 Oskar Barnack
(Provided by Leica Camera Japan Co., Ltd.)

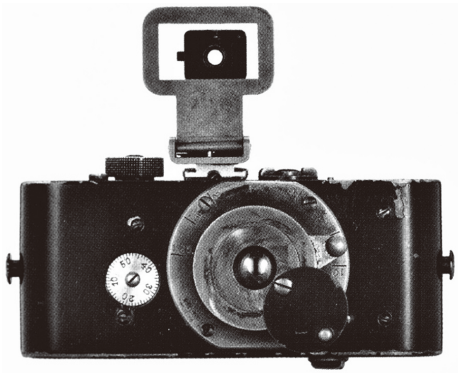
In 1909, ICA AG was founded by the merger of leading German camera manufacturers Huttig, Wünsche, Krugener and Carl Zeiss Palmos, led by Carl Zeiss. Barnack was temporarily transferred to ICA AG for a period of about two months in 1910. Barnack presented Mengel, who was the director of ICA AG at that time, with the idea of a compact camera that used 35 mm film, but Mengel was not interested. It was in the spring of 1910 that Barnack was temporarily transferred to ICA AG and the fact that he retired within the year may be due to his disappointment that this project was not adopted.

Barnack was invited to join Leitz on January 1, 1911, partly because he was recommended by his Zeiss-era friend Mechau, who had previously transferred to Ernst Leitz (currently Leica Camera AG, hereinafter Leitz). The business at Leitz was projector-related development, and seemingly close to trial production. There is no doubt that Leitz had high expectations as they arranged, at the time of Barnack's transfer, a home with good environment near his workplace and took care to ensure he would return home and rest during lunch breaks[2].

After transferring to Leitz, Barnack's talent blossomed. He developed a prototype of the Ur-Leica (meaning the prototype of the Leica) described later, which was commercialized after World War I and generated a lot of buzz at the time. This product saved Leitz from the hyperinflation that hit Germany and the subsequent Great Depression, and was continually improved, establishing a solid genre of compact precision cameras.

3.2 Ur-Leica

Barnack, whose hobby was taking landscape photographs, experienced physical difficulties on shooting expeditions. This was an era when a large camera and its supporting tripod were required for a large, beautiful photo with high resolution, and this equipment was difficult to carry for Barnack who lacked physical strength. In the back of his mind, perhaps there was always an image of a compact camera completely different from the conventional camera. After transferring to Leitz, Barnack was fortunate to be in an environment where 35 mm film was used, and soon a prototype materialized that would later be called the Ur-Leica. At the same time, he came up with ideas for getting big prints from small negative films, and started taking advantage of these innovations in his hobbies.



Photograph 3-2 Ur-Leica[3]

While this is the story that is commonly told today, some disagree. Barnack is said to have developed a cine-camera for in-house use in the creation of test film for projectors, but the sensitivity of the 35 mm film at that time was unstable, and whether or not the exposure was suitable was not known until the image was taken. For this reason, a portion of the film to

be used needed to be cut out and exposed in advance to gauge the sensitivity. With the sensitivity known in advance, development conditions and the like could be changed and failures in production avoided. The theory is that a "film sensitivity confirmation device" prototyped for that purpose evolved into the Ur-Leica.

The fact that the shutter time of the Ur-Leica is only a single speed of 1/40 of a second works in favor of this theory. This is because the cine-camera is single speed. Further, the magazine "Die Leica," published in 1931, also mentions "for test shooting of film" in Barnack's own recollection[4], thereby perhaps supporting this theory of the film sensitivity confirmation device.

However, this theory contradicts the fact that Barnack presented Mengel with the idea of a compact camera at ICA AG before joining Leica. Further, to check the film sensitivity for a cine-camera, it would be natural to make the picture size the same as the 17 x 24 mm size of the cine-camera, but oddly the size of the Ur-Leica is 24 x 36 mm.

Ultimately, perhaps the only conclusion that can be drawn is that there were various ideas and prototypes before the Ur-Leica. While there may have been a 17 x 24 mm format, in consideration of resolution, the format was probably 24 x 36 mm to enable use with hobby photography as well. While the original idea may be backdated to the idea presented earlier by Barnack at ICA AG and, after Barnack's transfer to Leitz, could have been used for business purposes to confirm film sensitivity in advance, the outcome of the various improvements made to ensure availability for personal use as well was most likely the Ur-Leica.

In any case, the Ur-Leica was completed by the hands of Barnack in 1914 (there are various theories about the year being another year, 1913 also being likely). There were two Ur-Leica prototypes made by Barnack. One source indicates three prototypes, but the third one was made after the decision to put the product on the market, and is fairly advanced. One of the two Ur-Leica was given to Ernst Leitz, the President of the company, and the other was used by Barnack himself for photography.

3.3 Ur-Leica Features

The question, "What kind of camera was the Ur-Leica?" gives us a glance into Barnack, "the mechanical engineer who loves photography" and, with deep interest, I will consider this question below.

3.3.1 Outer Appearance and Design

The outer appearance of the Ur-Leica is amazingly simple. The housing is horizontally long and, when viewed from above, is an oval extended into a long circular shape. Modern film cameras have a back cover (rear cover) that opens and closes to make it easier to load the film, but the Ur-Leica is a closed oval, and thus the film must be inserted from the bottom. In return, the camera, not requiring a large opening, is durable. Barnack most likely thought that bottom film loading was acceptable as long as he could get used to it, and prioritized strength and ease of manufacture. At this time, there was no film cartridge yet, and the film required for photography was loaded in a dark room.

In a cross-sectional view, the body is simple and can be drawn by connecting left and right semicircles with two straight lines, one above and one below, something an ordinary designer could draw in ten seconds. It is amazing that this basic design has been handed down as far as the modern Leica successor group (including digital cameras). While today's cameras are designed with ergonomics and the like in mind and thus have a complex outer appearance that cannot be hand-drawn and is defined by three-dimensional data, the universality of the outer design of the Leica, which can be drawn with paper and pencil in minutes, is nothing but impressive.

The housing having an oval shape is said to have been made by crushing an aluminum pipe. Perhaps two round bars of a predetermined diameter and a block of that same thickness were placed inside the pipe, and the aluminum pipe was crushed with a hand press machine provided at a prototype site. Calculating from the size of the Ur-Leica, it seems that a pipe with a diameter of about 100 mm was used. If a thicker pipe were used, the housing of the Ur-Leica would also be larger, which could have influenced the size of the camera to the present day. Or, conversely, was the thickness calculated first and then a pipe chosen accordingly?

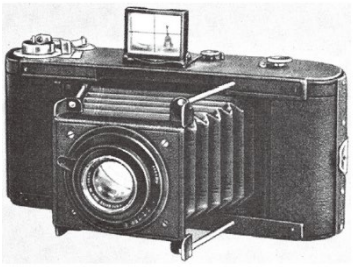
The housing was completed simply by providing holes for lenses and the film counter, holes for screws to support other internal mechanisms, and the like. It seems as if Barnack, who was not good with drawings, made the camera effortlessly through an intuitive process of physical manipulation.

A removable bottom lid was prepared for the bottom of the housing, and the upper side was closed with the upper cover after the mechanical parts were inserted. The layout was such that a knob for adjusting the driving speed (curtain speed) of the shutter to some extent and a shutter release button were placed on the upper cover, but that was it. The reason why the outside is blackened as a whole is probably to prevent the influence of reflection since the device is basically a test device related to light.

It should be noted that the position of the lens is shifted to the right when facing the front. This is because the winding shaft of the shutter curtain is placed on the left side as described later, which proved successful in improving the hold feeling with the right hand, and this asymmetry became the basis of the camera design that continues to the present day. This is proof of Barnack's true sense of taste.

This design and layout by Barnack seem to be a product of

creative inspiration, but there is a theory that there may be a precedent for these attributes. Carl Zeiss Palmos, a company that merged with ICA AG, launched the Palmos Rollfilm-Camera in 1901 around the time of its predecessor, the Palmos. This camera was the world's first focal-plane shutter roll film camera, and offered a self-cocking mechanism as well. While, above all, the size was different, the appearance, except for the lens part, was similar to that of the Ur-Leica.



Photograph 3-3 Palmos Rollfilm-Camera[5)]

Barnack, during the Carl Zeiss era, seems to have been temporarily affiliated with the former Palmos factory[6)], and it is possible that he saw the Palmos Rollfilm-Camera at that time. Perhaps it was this camera that inspired the evolution of the Ur-Leica.

As a mechanical designer involved in camera development, I can agree with this theory. Personally, when I was struggling to come up with an idea, a mentor told me that a good idea is rarely something that strikes you like lightning, rather it is something that is wrung out after accumulating knowledge and experience, and thinking about and agonizing over a problem day and night. Perhaps, for Barnack as well, the Palmos Rollfilm-Camera existed as a latent, subliminal image in a corner of his mind filled with the experience and knowledge he had acquired as a mechanical engineer, and the idea naturally emerged like beads of sweat, organically manifesting itself in the compact camera. Even the talented Barnack could not create a masterpiece out of nothing.

3.3.2 Shutter

The structure of the focal-plane shutter mounted on the Ur-Leica is simply a slit in a yet primitive rubberized cloth curtain. The arrangement is something to behold. As mentioned above, the shaft around which the shutter curtain is wound and remains in standby mode is positioned on the film winding knob side, thereby improving the holding feel of the right hand, and the film winding shaft and the shutter are close to each other, making interlocked charging possible. This is truly an arrangement that kills two birds with one stone.

In addition, the so-called horizontal travel method in which the shutter travels in the direction of the long side of the picture frame was adopted so that, with the shutter winding shaft and film winding shaft arranged in parallel, a spur gear could be used, which has the effect of improving the transmission efficiency of the mechanical system. This arrangement also made it possible to reduce the number of parts of the interlocking mechanism, and thus perhaps can even be said to kill four birds with one stone.

The shutter speed is basically a single speed of 1/40 second, but can be changed slightly by turning the adjustment knob on top to change the tension of the shutter operating spring. This is most likely a specification made by Barnack with his photography expeditions in mind.

When the decision was made to commercialize the camera as the Leica I after World War I, the shutter was improved from the primitive standard of the Ur-Leica to a more practical one, providing various shutter speeds, a self-capping mechanism (mechanism in which the shutter slit is automatically closed during charging) and the like.

3.3.3 Film Winding Mechanism

The Ur-Leica required that the film be put in and taken out in a dark room since the film magazine had not yet been adopted, but included a combination of a sprocket and a spool, which was subsequently adopted by most cameras, as the film winding mechanism. A sprocket is a gear in which teeth are cut in correspondence with the perforations of the film, and a spool winds up the film fed out by the sprocket.

The film perforation has a pitch of 4.75 mm, and the film is pulled out 38 mm when fed in an amount equivalent to eight pitches, resulting in a picture frame width of 36 mm after subtracting the interval of 2 mm between adjacent images. The Ur-Leica is provided with an eight-tooth sprocket, making it possible to wind one picture frame in a single rotation. A single operation of the shutter winding shaft is substantially equivalent to one rotation, making interlocking extremely simple. Barnack's rationality is demonstrated here as well.

3.3.4 Shutter Release Button

The shutter release button, which causes the shutter to travel in order to take a picture, is provided coaxially with the winding knob. In subsequent commercial Leica models, the shutter release button is provided coaxially with the sprocket shaft. These “coaxial” designs seemed to be Barnack's preference, helping to simplify operating parts and offering space-efficiency and rationality as internal mechanisms, thereby here again confirming Barnack’s aptitude for design and his good sense of taste.

3.3.5 Accessory Shoe and Eyelets for the Strap

The top cover of the Ur-Leica has a shoe seat for attaching accessories. Barnack had installed a sports viewfinder here for checking composition, but as the times progressed, optical viewfinders and flash devices were also mounted here. Along with these developments, shoe seat dimensions were standardized (ISO 518), and the latest digital cameras today also have a shoe seat with substantially the same dimensions. Eyelets for the strap can be seen on the left and right ends of the camera, but the idea of attaching a strap here is a modern one and the result appears quite natural, without a sense of incongruity even in modern camera designs. These eyelets were omitted in the early days of commercial models, but were revived with a more modern design with the Type III and subsequent models.

Barnack's foresight, apparent in the fact that these specifications are used in many cameras even today, more than 100 years after the design of the Ur-Leica, takes my breath away.

3.4 Camera Industry after World War

One of the two produced Ur-Leica prototypes was used by Barnack, and the other was given to Ernst Leitz I, the President of Leitz, but he was not very interested. Barnack himself seems to have used the camera on a daily basis, and various photographs have been left behind. The famous ones include “Flood in Wetzlar,” a series of photographs taken in 1920.

Photograph 3-4 Flood in Wetzlar
(Provided by Leica Camera Japan Co., Ltd.)

These photographs of the city of Wetzlar, home to the Leitz, when damaged by the flooding of the Lahn, look like normal photos to the modern eye. Yet, given that the general camera at that time was large in size, these immersive photographs, most likely taken in situations where a tripod could not be set, were clearly innovative. It truly is proof of the high mobility of the Leica.

World War I broke out in 1914 when the Ur-Leica was used habitually by Barnack. Leitz no longer had time to be involved in Barnack's camera, and was preoccupied with the war effort, hurriedly producing military optical devices and the like.

In 1918, the war ended with Germany's defeat. Due to the significant depreciation of the mark, German camera products, which were originally highly acclaimed for their good quality, became easy to buy in other countries, and exports greatly increased. The German camera industry developed rapidly, companies were pressed to increase production, and competition intensified between emerging manufacturers. Nevertheless, clouds always follow sunshine, and the depreciation of the mark was sharply resolved by Germany's drastic monetary policy, causing the bubble of the German export industry to burst as if all was a dream in the night, and the number of camera sales plummeted, leaving the warehouses of each company piled high with inventory.

At this point, Carl Zeiss Foundation made a bold move. It merged ICA AG, Contessa-Nettel AG, Ernemann and Goerz to create Zeiss Ikon. ICA AG itself was originally a merger of several leading camera manufacturers as mentioned above, so Zeiss Ikon was an immensely powerful camera manufacturer indeed. Such a merger was at a level that would most likely be stopped by the Antimonopoly Act of Japan if existent, but being a turbulent period, was unproblematic.

On the other hand, Leitz faced adverse circumstances. The company was not a camera manufacturer and so did not benefit much from the increase in exports due to the depreciation of the mark, and its sales of other optical products were sluggish. Layoffs was one path to survival, but the second generation who succeeded Ernst Leitz I, either through sympathy or foresight (probably both), did not dismiss the company’s talented workers, including field workers, and tried to survive the crisis by launching something new to create work. One new potential product that was selected was the Ur-Leica, also called the “Barnack camera” within the company.

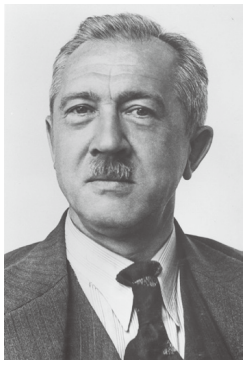
In 1920, the Ur-Leica No. 3 was completed and featured a variable shutter speed, making the product more commercially viable. Then, in 1923, approximately 30 monitor samples (there are various theories on the quantity), which were later referred to as the Null Leica series (also known as the 0 series since null means zero in German), were built at the so-called mass production prototype level.

Photograph 3-5 Null Leica
(Provided by JCII Camera Museum)

The reputation of the Null Leica, both inside and outside the company, was not good. In the era of large-format photography, no one thought that a camera that takes pictures slightly larger than a stamp would sell. However, a word from Ernst Leitz II settled the course of action. It was decided at this point that the "Barnack camera" would be released onto the world stage. It is an unwavering historical fact that this decision was a major turning point for Leitz and the subsequent global camera industry.

3.5 Max Berek Lens

No matter how good the Leica camera is, the camera would not sell if the shooting lens performance was poor. Moreover, the Leica concept of making large prints from small negative film required a lens having an extremely high resolution. It was optical designer Max Berek who rose to meet this challenge.



Photograph 3-6 Max Berek
(Provided by Leica Camera Japan Co., Ltd.)

Even the mechanical design genius Barnack found optical design beyond his reach. If you trace the history of the camera, it is evident that there is a pattern of collaboration between excellent mechanical designers and optical designers in the creation of famous cameras. For example, the Olympus XA was developed by the duo Maitani Yoshihisa and Hayamizu Yoshisada. It was fortunate for Barnack that Berek spent about the same time at Leitz as Barnack.

Berek joined Leitz in 1912, the year after Barnack joined. He was seven years younger than Barnack, but his hobbies of playing chess and mountaineering were the same, making the two a good match from the beginning. Most likely, Berek understood Barnack's requirements and offered the best solutions.

The first Leica on the market was initially equipped with the same Leica Anastigmat as the Null Leica, but since anastigmat is a general noun for an aberration-corrected lens, the lens was soon renamed to Elmax, a Leitz proprietary lens. EL is an acronym for Ernst Leitz, MAX is taken from Berek's name. Comprising five elements in three groups, the Elmax was an excellent lens. However, the productivity of the rear group, which required the bonding of three elements, was not so good, and thus a new design, the Elmar, with four elements in three groups emerged. The Elmar name is said to be a combination of Elmax and the ending of the mainstream Tessar used at that time. All of these were designed by Berek and have a focal length and open aperture of 50 mm and F3.5, respectively.

Berek subsequently continued to provide guidance on optical design and optical designers for Leica lenses, and launched treasures such as the Hektor, Summicron and Telyt. Without the Berek lenses, no matter how good the Leica was as a camera, it would never have been able to compete with "the great" Carl Zeiss. It should be noted that Hektor seems to be derived from the name of Berek's pet dog, delightfully revealing his playful side.

3.6 Names and Classifications of the Leica Models

The Leica I, released in 1925, has such a number of variations to the extent that each could be called a different camera. These variations were given different model numbers in Japan and the United States. Japanese A, B and C types correspond to the I type in Germany. The A type is a fixed lens type, the B type uses a lens shutter instead of a focal plane, and the C type is an interchangeable lens type, all with completely different specifications. In this paper, we will distinguish these models as I(A), I(B) and I(C), which are relatively well-established as general names. Note that the design and concept up to the IIIg, which follows the style of the early Leica, is called the Barnack Leica, and the 1954 M3 and later models are called the M-type Leica. There is, however, a period of overlap between the two, with the release of the IIIg being in 1957 after the M3.

Barnack Leica is classified into Type I, Type II and Type III. Roughly speaking, the classification depends on the presence or absence of a rangefinder-coupled viewfinder and the presence or absence of a low shutter speed. Type I has neither, Type II has only the former, and Type III has both (with exceptions; for example, Type Ig does not have the former but has the latter).

Each type has been improved, with Type III including models III and IIIa to IIIg, each reflecting some form of model change. Even for cameras of the same type number, an attempt to describe the variations in detail, such as the presence or absence of the famous IIIf self-timer, would be an endless task, and thus this paper describes the typical and characteristic specifications, technologies and functions of each model and touches on the scale of improvement as needed.

3.7 Emergence of the Leica I

In 1925, the Leica I(A) was released. This first commercial Leica, without interchangeable lenses yet and without a built-in rangefinder, was not exactly a rangefinder model, but could be provided as a set with a rangefinder as an accessory.

Photograph 3-7 Leica I(A)
(Provided by JCII Camera Museum)

In consideration that this was an era in which rangefinders as well as the 35 mm film itself were not common in the world and prints were contact prints, Leitz was prudent to simultaneously release film-developers and simple enlargers. At first, the Leica, with all of its innovation, made the public take a step back and view it at a distance, but there is a document[7] indicating that the camera became profitable in 1928, a few years after its release, revealing favorable sailing. In fact, looking at the trends in sales (Figure 3-1), the number of sales doubled from 1928 to 1929. Note that the slowdown in 1930 is thought to be due to the Great Depression, the impact of the launch of the rival Contax in 1933, and the war situation after 1937.

Figure 3-1 Transition in Unit Sales of the Leica[8]

3.8 Leica Shutter Mechanism

The most innovative part of the Leica I(A) is the shutter mechanism. The model offered a variable shutter speed and self-capping during shutter charging, which was not possible with the mass-produced prototype Null Leica. Of course, a self-cocking mechanism was also installed.

The Barnack Leica, excluding the Leica I(B), a lens shutter type, uses a horizontal focal-plane shutter. As shown in Figure 3-2, the shutter is equipped with a front curtain and a rear curtain that operate independently.

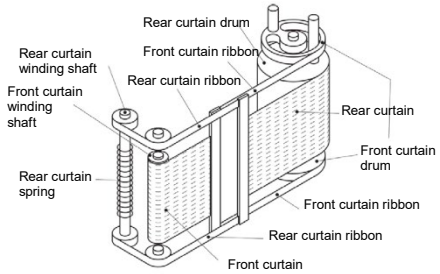


Figure 3-2 Structure of Focal-Plane Shutter

In the charged state, the rear curtain is wound around the rear curtain drum, and the upper and lower ribbons of the front curtain are wound around the front curtain drum. The front curtain and the rear curtain are pulled to the left (shutter travel direction) by a torsion spring of the winding shaft on the left side in the figure and, although not shown, travel when their respective locking hooks are released.

The shutter speed can be changed by shifting the timing at which the hooks are released. The principle behind the operation is explained in Figure 3-3. This figure shows the principle behind a slightly advanced focal-plane shutter, not the focal-plane shutter in the early stages.

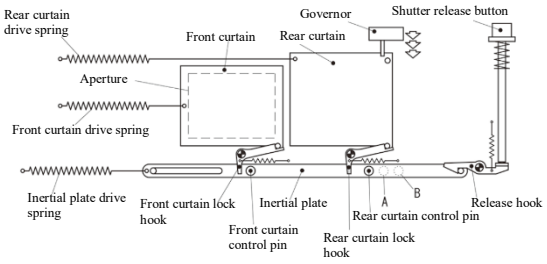


Figure 3-3 Operation Principle Diagram of Focal-Plane Shutter

The aperture (opening) is the picture frame, which is closed by the front curtain when the shutter is charged.

When the shutter release button is pressed down, the release hook and the inertial plate are unlocked, and the inertial plate starts to travel to the left by the force of the inertial plate drive spring. Two pins are provided on the inertial plate, and the front curtain control pin on the left side first unlocks the front curtain lock hook, causing the front curtain to travel to the left and the shutter to open. Subsequently, the rear curtain control pin on the inertial plate unlocks the rear curtain lock hook and closes the shutter. This completes the exposure.

By shifting the position of the rear curtain control pin on the

inertial plate, it is possible to change the timing at which the rear curtain is unlocked. For example, the timing at which the rear curtain starts to travel is slightly delayed when the pin is at position A, and further delayed when the pin is at position B. That is, the shutter speed can be changed according to the position of the rear curtain control pin. Turning the shutter dial is equivalent to changing the position of this rear curtain control pin. As an aside, there are various ways to call this inertial plate, and one shutter manufacturer called it the “drive control cam.” My co-workers called the inertial plate “kansei-tai” in Japanese. The Japanese word “kansei” has two meanings: “control” or “inertia.” I recall when I was a new employee, perplexed on whether the Japanese characters used were those for “control system” or for “inertial body,” asked my boss which characters to use. His response was that both are correct in meaning, thus at one's discretion, leaving me completely bemused.

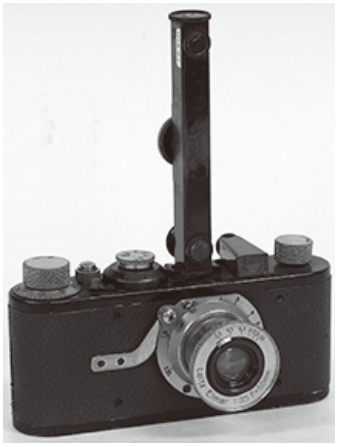
The governor in the figure is for low shutter speeds and, by varying the insertion amount, hinders the travel of the rear curtain even after the rear current lock hook is unlocked, making it possible to delay the timing at which the rear curtain starts to travel in a stepwise manner. This made it possible to extend the low shutter speed, which was up to 1/25 through Type II, to 1 second in Type III and subsequent models.

However, in the case of the Leica, it was necessary to set the low-speed shutter with the low-speed shutter dial provided on the front of the camera, a shutter dial different from the shutter dial on the top of the camera. Since the shutter speed is set in two locations, this type is sometimes called a biaxial type. However, this name can be easily mistaken for two winding shafts of the shutter structure, so caution is required.

Also, with the Barnack Leica, a pin for changing the shutter speed is provided directly on the shutter dial (though it is simple), so when the pin is released and the shutter travels, the shutter dial also rotates. If a finger by chance touched the shutter dial during shooting, shutter unevenness would occur. A “uniaxial non-rotating equidistant shutter” in which the shutter dial does not rotate (non-rotating), high speed and low speed are set with a single dial (uniaxial), and the spaces between shutter speeds are equidistant was non-existent in the era of the Barnack Leica and, for such a feature, we would have to wait for the Leica M3 in 1954.

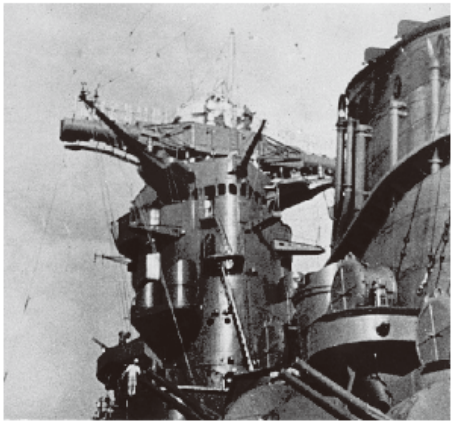
3.9 Coupled Rangefinder Mechanism with Leica II and Subsequent Models

The Leica I was not equipped with a rangefinder, but a rangefinder that would attach to the top of the camera was available as an accessory. The range scale of the lens is adjusted to the distance to the subject read by the rangefinder. Rangefinders were used by battleships to measure the distance to enemy ships, and this principle was applied to cameras.



Photograph 3-8 Leica with Rangefinder
(Provided by JCII Camera Museum)

Nippon Kogaku Kogyo Co., Ltd. (currently Nikon Corporation, hereinafter Nippon Kogaku), which later became a leading camera manufacturer, is also famous for its rangefinders. At the time of the Russo-Japanese War, the rangefinder was not yet domestically produced and was made in Britain. However, naturally, during World War II, orders were given for domestic production. Since the rangefinder uses the principle of triangulation, the longer the distance between the left and right lenses (this is called the baseline length), the higher the accuracy. The rangefinders mounted on the battleships *Yamato* and *Musashi* were the largest in the world at that time with a baseline length exceeding 15 m, while the baseline length of the rangefinder mounted on the battleship *Mikasa*, which was used in the Russo-Japanese war, was around 1.5 m. The rangefinder protruding to the left and right at the top of the bridge in Photograph 3-9 is that rangefinder.



Photograph 3-9 Battleship *Musashi* Rangefinder
(Provided by Yamato Museum)

While an external rangefinder was prepared for the Leica I, the possibility existed that the rod-shaped object would interfere with the operation dial when placed horizontally, or hit something when placed vertically as shown in Photograph 3-8. For this reason, the Type II released in 1932 had a rangefinder built into the camera. This is a true “rangefinder” camera. However, due to restrictions on the location of the optical system, the baseline length became as short as about 38 mm. This shortness would prove to be a weak point in comparison to the rival Contax later, but this design that coexists well with operation systems such as the shutter dial and winding knob is superior to the rugged Contax. Above all, the structure in which the rangefinder optical system for verifying composition is arranged between the rangefinder left and right lenses is truly rational in terms of space efficiency, design and functionality. Although rights for this invention of “installing a rangefinder between the rangefinder left and right optical systems” could not be granted in Germany due to Zeiss's prior application, the invention was registered in Japan as a utility model with a wide range of rights, causing much trouble for manufacturers in Japan when dealing with it.

This rangefinder is linked to distance adjustment of the lens. The principle is illustrated in Figure 3-4.

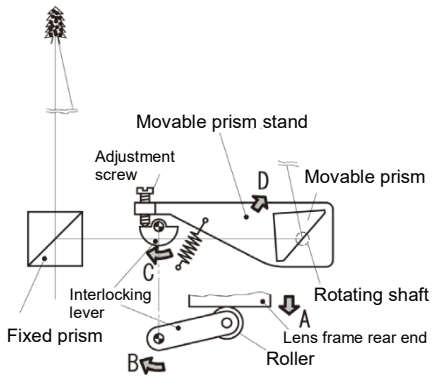


Figure 3-4 Coupled Rangefinder

When the distance ring of the lens is turned, the lens frame rear end moves back and forth. The amount of displacement is then read by a roller provided inside the lens mount on the camera side, the movement is reduced by the coupling lever, and the movable prism of the rangefinder is slightly rotated. The movable prism moves in the order of the arrows A to D in the figure, and the distance ring of the lens and the movable prism are coupled. Since the shooting distance of the lens is related to the amount of change in the angle of the movable prism, all a user has to do is turn the distance ring of the lens while looking through the rangefinder and take a photo at the position where the left and right images align.

While it may seem difficult to replace the lens with a lens having a different focal length, this is non-problematic because the displacement of the rear end of each lens coincides with the shooting distance. Simply put, there are helicoids (screws) in two places on the distance ring (this configuration is called a double helicoid), the combined movement of both helicoids due to the rotation of the ring is used for distance adjustment, and the movement of the rear end due to one helicoid is used for the rangefinder.

The basic principle of the coupled rangefinder mounted on the Leica II is an extremely long-lived technology that has been adopted even in the Leica M-A (typ127; released in 2014), which is a remote descendant.

3.10 Destination of the Barnack Leica and Features of the Type III

In 1933, the Leica III featuring, for the first time in Leica history, a low shutter speed of up to 1 second was released. The Type II was released the previous year, so it was most likely a marketing strategy to release the cameras together, one with and one without a low speed range. Since then, sales formats that respond to user needs continued, such as, for example, the release of the IIIc followed by market introduction of the competitively priced IIc and the Ic models reflecting IIIc improvements, and are still relevant today.

Photograph 3-10 Leica II
(Provided by JCII Camera Museum)

As explained in Figure 3-3, the low-speed shutter is realized by delaying the start timing of the rear curtain using a slow-speed mechanism called a governor. Since the governor is simply an addition without requiring a change in the shutter mechanism itself, the effort required for development was minimal. In addition, although it is a minor improvement, the Type III has a safety mechanism that prevents shutter operation during rewinding and a diopter adjustment mechanism in the finder. The Type III series started with the IIIa and reached the IIIg released in 1957 (e is non-existent), seven model numbers in total, and a very wide variety of improved versions including variations within each model were released. However, none of the models reflect a full model change and, just like the addition of a low-speed shutter, each feature partial improvements and/or mechanism additions. Here as well are glimpses of Barnack's development philosophy.

The main improvements in the Type III series are briefly described below. In the Type IIIa, the high-speed shutter was reduced to 1/1000. This would be a rival to the Contax. From the IIIc on, aluminum die-casting was adopted for the body chassis. While aluminum die-casting was adopted from the start with the Contax and was the standard for compact

precision cameras even in later cameras, the Leica had a sheet metal stamped chassis through the IIIb.

The adoption of sheet metal also seems to be a product of Barnack's rationality. While aluminum die-casting allows complex shapes, which increases the degree of freedom in design, the mold is expensive and, once made, difficult to modify. In that respect, sheet metal stamping offered a relatively inexpensive mold that was easy to make small-scale corrections to, and thus fitted Barnack's way of camera improvement, which was through a series of small modifications.

The IIIc was released in 1940 and, with Barnack no longer among the living, the successor designer chose die-casting, which can be more productive and stronger, but the size of the camera slightly increased in width and height. Since the IIIc was produced during the tumultuous postwar period, the quality of the parts was not consistent, causing many individual products to be somewhat problematic. Yet, this model boasts the second largest production numbers following the IIIf. The IIId, while produced in small numbers, is simply the IIIc equipped with a self-timer.

The IIIf was the highest seller among the Barnack Leicas, and is still a popular model today. For the first time in Leica history, a synchro terminal was installed and a flash device could be used. Each specification was refined, such as the adoption of ball bearings in the internal mechanism. The IIIf was released in 1950 and, having overcome the turmoil after the war, the quality of the parts was more consistent, so the overall quality of the camera was also higher. A model with a self-timer was also introduced midway through the series, and is still treated symbolically as a Barnack Leica.

Photograph 3-11　Leica IIIf
(Provided by JCII Camera Museum)

The IIIg was the last Barnack Leica. The IIIg was released in 1957, three years after the release of the innovative Leica M3. The IIIg appears to be an effort to rescue those Leica fans that could not keep up with the Barnack Leica and its bold improvements such as a change in the lens mount with the M3, and reflects ambitious improvements, such as the mounting of a parallax correction mechanism and a viewfinder with a bright frame compatible with two types of lenses. In addition, it is the IIIg that established the precedent of the shutter dial magnification increments used today. Looking at the IIIg, it is understood that Leitz continued to develop the Barnack Leica without cutting corners to the end.

3.11 Death of Barnack

Barnack seems to have been involved in the development of all models ranging from the first commercial Type I, of course, to the Type III series. Naturally, it is clear that Barnack was deeply involved in the development and design of various mechanisms that were pioneering for the time, such as lens interchange, rangefinder coupling and low shutter speed, because his name is listed as the inventor in patents.

With the Ur-Leica, at the beginning of the 20th century, having laid the foundation for compact precision cameras and since then having been at the forefront of the times for more than 20 years ... No, on the contrary ... With Barnack having continued to influence the design, internal layout and mechanisms leading up to the current camera, Barnack's passion and gifted talent should be considered immeasurable.

Barnack, the father of the modern compact precision camera, died of pneumonia in 1936 at the age of 56. Even in his later years, when he was in good health, he would suddenly appear at work and present new ideas. Leitz completed the trial production of the Type IV in 1935 after the Type III, and this prototype was partially equipped with the innovative specifications and mechanisms of the M3 to be released after the war. Meanwhile, in the early 1930s, the Nazis led by Hitler took the stage, and war clouds loomed on the horizon. In this disturbing atmosphere, the Type IV lost the opportunity to hit the market, and the release of the M3 was delayed until 1954. How would the camera have evolved if Barnack enjoyed a long life and there was no war?

A photograph of Barnack taken at work in 1934 remains to this day. He exhibits a firm gaze that makes it difficult to imagine that he would pass away just two years later, but the photo being tinged with melancholy is impressive.

Photograph 3-12　Barnack in the Lab
(Provided by Leica Camera Japan Co., Ltd.)

References and citations

1) Kondō, Hideki. *Daremo Kakanakatta Raika Monogatari* [The Untold Leica Story], (Shashin Kōgyō Shuppansha, 2001), p.66.
2) Keller, Emil G. *Raika Monogatari: Daremo Shiranakatta Raika no Himitsu* [Leica im Spiegel der Erinnerungen], (Kojinsha, 2008), pp.44-45.
3) JCII Camera Museum, *THE LEICA - Raika no Hyakunen* [THE LEICA – One Hundred Years of The Leica], Pictorial Record (JC11 Camera Museum, 2013), p.4.
4) Laney, Dennis. *Raika Korekutāzu Gaido* [The Leica Collector's Guide], (Alpha Beta Publishing, 2000), p.16.
5) *75 Jahre Photo und Kino Technik* [75 Years of Photo and Cinema Technology] (Zeiss Ikon), p.42.
6) Shōichirō, Takeda. *Twuaisu Ikon Monogatari* [The Zeiss Ikon Story], (Kojinsha, 2010), pp.36-37.
7) Shōichirō, Takeda. *Twuaisu Ikon Monogatari* [The Zeiss Ikon Story], p.105.
8) Laney, Dennis. *Raika Korekutāzu Gaido* [The Leica Collector's Guide], p.12.

Why 36 Exposures?

Currently, for 35 mm cartridge film, 36 exposures is the standard, but this also originates with Barnack. Still image cameras that used 35 mm film existed, but all of them were capable of a significantly higher number of exposures. The reason for this is probably because of the prejudice that, if the camera is to use long movie film, it would be a loss to not have a high number of exposures.

Barnack, without thinking much about stinginess, first determined the size of the camera based on portability and then packed the camera with an amount of film that would fit inside. The number of exposures was probably more than 40 and less than 50. The fact that the total number of Ur-Leica exposures is 50 at maximum confirms this.

However, with the commercialized Leica, it became necessary to put the film in a magazine and the size of the magazine was determined based on an eyepiece case of a microscope that was lying around, making the number of exposures not as high as that of the Ur-Leica. Furthermore, unlike the Ur-Leica which was premised on dark room loading, the camera required a blank feed, which further decreased the number of exposures.

An early pamphlet on how to use the camera included an honest note: "The film used is a 1.6 m negative film for cinematography offering 36 exposures.... We had initially planned to provide 40 exposures with 1.75 m of film, but this was found to be impossible, and thus settled on 36 exposures." The thickness of the film at the time sometimes caused problems when the film was rolled, which probably led to the writing of this explanation (Note 1).

In fact, in the 1980s, when I examined thicknesses of film for reference for camera design, there was information that some products of film manufacturers in the eastern Europe countries that used old equipment were thick, making it easy to suppose that the thickness variations in the 1920s were even larger.

In the end, the truth is most likely that when the approximate 138 cm available for photo shooting after subtracting the approximate 11 cm length of the leader part, the approximate 8 cm of the two exposures of blank feed, and the approximate 3 cm of the rear end from the 1.6 m was divided by the pitch 3.8 cm corresponding to one exposure, 36 exposures became the standard.

It seems from a picture taken with his wife that Barnack was of small stature and probably not even 165 cm tall. Since the arm span of a person is almost the same as his or her height, the theory is widely disseminated that Barnack pulled out an amount for the Ur-Leica from a long roll film equivalent to his arm span in the dark room and used it, making the number of exposures 36. In fact, I, being 165 cm tall, appreciated its easy-to-handle length when I developed 36-exposure film for the first time myself over 40 years ago, and have always believed this theory.

The circumstances of camera development just happened to result in 36 exposures, and the fact that the length was easy to handle in a dark room was also truly fortuitous.

The George Smith camera, which was prototyped in 1912, earlier than the Ur-Leica, using 35 mm film, was a very complete camera, with a maximum of 100 exposures. While it is said that this camera ended with only trial production due to insufficient funds, perhaps 36 exposures would not be the industry standard for the camera today if the George Smith had made it to the market.

(Note 1) Kondō, Hideki. *Daremo Kakanakatta Raika Monogatari* [The Untold Leica Story], (Shashin Kōgyō Shuppansha, 2001), pp.89-91.

4 Development of the 35 mm Compact Precision Camera

4.1 The Contax, Leica's Rival

Leica's strongest rival, the Contax, is a masterpiece produced by Zeiss Ikon. As mentioned earlier, Zeiss Ikon was created in 1926 through the merger of four leading companies, led by Carl Zeiss, in order to escape the post-World War I recession. Since the Leica I came out in 1925 and the merger occurred the following year, it is easy to conclude that Zeiss Ikon was founded to compete with the Leica, but that is not the case.

In fact, Zeiss did not even glance at the Leica for the first few years following the release of the Leica onto the world stage. It is also clear that the masterpiece of the spring camera, the Ikonta, was released in 1929 and gained much popularity, and the subsequent hit products of this series, such as the Baby Ikonta and the Semi Ikonta, were launched in rapid succession to survive the rough waves of the Great Depression. With new series being developed one after another while consolidating the pre-merger products of the four companies, the eccentric Leitz compact camera was of no particular concern.

However, at about the same time as the breakthrough of the Ikonta, the popularity of the Leica was increasing, and the "eccentric compact camera" gradually became a presence that could not be ignored. The creator of the Contax, Heinz Kueppenbender, was born in 1901 and joined Carl Zeiss in 1927 after graduating from RWTH Aachen University. In 1929, he received his PhD in research on rotating disc shutters for large cameras at Stuttgart University of Applied Sciences, and was sent from Carl Zeiss to Zeiss Ikon in the same year.

Photograph 4-1 Heinz Kueppenbender[1)]

Kueppenbender was chosen to head the company at the young age of 31 and, in 1941, was recalled to Carl Zeiss to serve on the Board of Directors and became the western leader of Zeiss, which was divided into East and West divisions after World War II, and thus had a reputation for excellence.

The first camera designed by Kueppenbender after moving to Zeiss Ikon was the Contax I (the Contax when first released, but for the sake of distinction, is now called the Type I after the release of the Type II).

Photograph 4-2 Contax I
(Provided by JCII Camera Museum)

There is a myth that the Contax I was developed as an antithesis to the Leica. Certainly, the Contax I has a strong technical and structural contrast with the Leica, such as its vertically traveling metal shutter curtains to Leica's horizontally traveling cloth shutter curtains, its removable back cover to Leica's non-existent back cover, its focus adjustment on the body side to Leica's focus adjustment on the lens side, and its bayonet mount to Leica's screw mount.

However, there seems to be a strong implication that these differences are the result of Kueppenbender pursuing an ideal compact camera, and that these features differ from those of the Leica by chance. Of course, the Contax I had to adopt a different structure to avoid patent infringement and certain changes were most likely consciously made based on the identity of the engineer, but if the Leica were nonexistent, would the compact Contax camera made by Kueppenbender be any different?

For example, when considering the shutter, the Leica has its shortcomings, such as malfunctions at low temperatures due to the stickiness of the rubberized cloth curtains in early products, risk of pinholes when accidentally facing the sun, and long exposure time from start to end due to travel in the longitudinal direction of the picture frame.

As a result of pondering the ideal shutter structure, Kueppenbender most likely concluded on vertical travel and the use of metal. Modern focal-plane shutters, while having different structures and shapes, are constituted by rigid metal blades that travel vertically, and so it is not impossible to say that Kueppenbender had foresight. Yet, the main reason behind the design of the modern shutter is unitization and synchronized speed when using a flash device.

The Contax I represented the culmination of

Kueppenbender pursuing the ideal camera while being cognizant of the Leica. As a result of the pursuit of the ideal, the design was more elaborate, but Zeiss Ikon had the production technology for mass production.

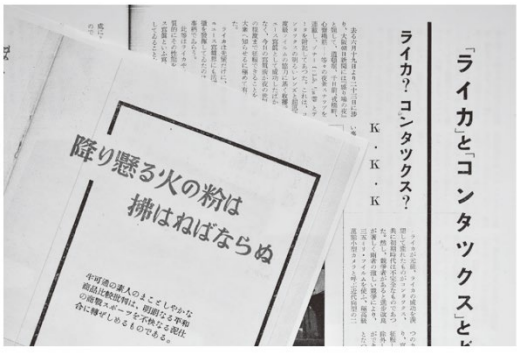
The metal curtain of the shutter is a "louver type" that combines thin plates of duralumin, which was the most advanced alloy at that time, and the body is constructed of die-cast aluminum alloy silumin all the way to the back cover, making a blockbuster with as many as 650 parts. The large number of parts can be contextualized from the fact that many SLR cameras of later years would be constituted by less than 1,000 parts even with full additions of a mirror drive mechanism and the like.

The Contax I was released in 1932, and the Leica II was released in the same year followed by the Leica III in the following year. The two great rivals of the 35 mm format compact precision focal-plane shutter camera stood their respective grounds and, without anyone capable of following their lead, enthusiastic camera fans watched the battle unfold between the two strongholds with deep interest. The Japanese, in particular, who may have a national character that enjoys lionizing confrontations between two powerful forces, such as Tochinishiki-Wakanohana (sumo-match), Waseda-Keio (university) and Giants-Tigers, were divided into the Leica camp and the Contax camp.

The confrontation came to the forefront in the famous 1935 Leica-Contax controversy. In the August issue of Asahi Camera of that year, the article "Which Is Better, the Leica or the Contax?" written under the pseudonym KKK, ignited the smoldering Leica-Contax controversy.

4.2 Contax I Technology in the Leica-Contax Controversy

The Asahi Camera article created a big stir. Although the author claimed to be fair, the fact that he was in the Contax camp is clear since all attached examples were indoor photographs advantageous to the Contax, and the total score given when the cameras were rated by specification and function was higher for the Contax. This no doubt incensed the Leica camp.



Photograph 4-3 Leica-Contax Controversy[2)]

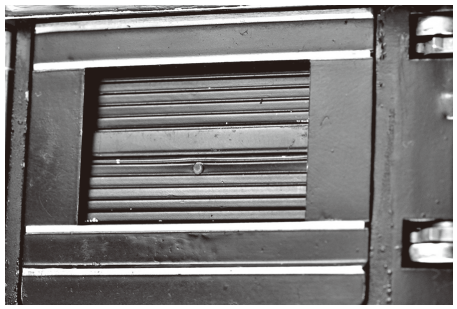
The Leica import shop, Schmidt Shōten, responded immediately. In March of the following year, Schmidt Shōten published a brochure entitled "*Furikakaru hinoko wa harawaneba naranu*" [Brushing Off the Falling Sparks] and offered a counterargument.

The superiority or inferiority of a camera depends on the values of the user and the subject to be photographed, and the quality of being "beautiful in appearance" mentioned in the article should not be easily scored in view of the diversity of aesthetic consciousness. However, since the scheme of the article itself reflects an extremely interesting point of view, in this paper, I would like to follow this article and touch on the characteristics of the Contax I while comparing the Contax I with the Leica IIIa.

The article rates twelve specifications and technologies. In the words of the author KKK, "Criticizing superiority or inferiority vaguely lacks clarity. Performance and other main points were therefore separated out into twelve items, and superiority and inferiority were compared by a scoring method based on a scale of 100 points, giving 100 points to the superior camera ... " The following considers the technical features of, among the 12 items, the shutter, rangefinder, viewfinder and lens, as well as the operation system and lens mount which were not among the 12 items.

4.2.1 Shutter Mechanism of the Contax I

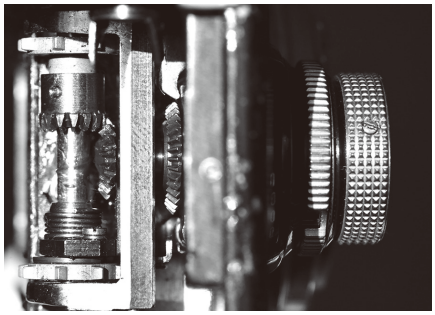
As mentioned above, the Contax I uses a vertically traveling focal-plane shutter made of metal. The shutter curtain is made in a louver style by combining strip-shaped duralumin to prevent light leakage, and is supported by cloth ribbons on both sides. The structure that drives the front curtain and the rear curtain independently in a retractable manner is similar to that of the Leica.



Photograph 4-4 Shutter of the Contax

Given the series of problems of stickiness at low temperatures with the rubberized cloth shutter curtains in the early days of the Leica, the use of metal made sense. However, Leica had claimed to have already solved the problem by replacing the shutter with a better one (but honestly admitted that the shutter had had some problems).

The reason for changing to vertical travel is probably the desire to shorten the travel distance more than to compete with the Leica as mentioned above. While certainly there is a justification in this regard, the axis of rotation of the shutter curtain became perpendicular to the axis of rotation of the winding knob on the front side of the camera. Therefore, in order to transmit the rotation operation of the winding knob to charge the shutter, right angle conversion by a bevel gear was required. The knob on the right in Photograph 4-5 is for winding, and there are two bevel gears on the back (left side), the right being for shutter charge and the left being for film winding.



Photograph 4-5 Structure of the Contax (1)

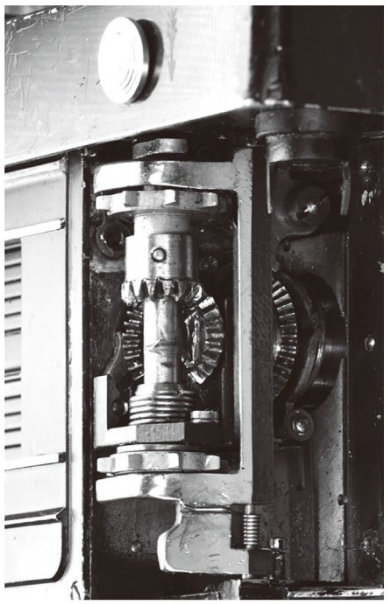
As understood by mechanical engineers, regardless of whether we are talking about a camera or not, a power source of a rotating system transmits power more efficiently with the axes parallel to the extent possible. This is because spur gears can generally be designed with higher transmission efficiency than bevel gears. While the bevel gear is also theoretically highly efficient, the axes intersect, making it difficult, as a practical matter, to arrange bearings efficiently. Further, the bevel gear is exceedingly sensitive to machining accuracy and assembly accuracy, causing a drop in efficiency even with the slightest error. In view of the production technology at that time, the rationality of the Leica, with the shutter, spool and winding knob all designed with parallel axes, is appreciated here again.

However, Zeiss Ikon designed such a shutter because the company was confident in the high production technology for mass production that supported it. Production technology and design level should always be considered together, and the point is that the shutters of the Leica and the Contax are fundamentally different in their position in terms of the company, product development concept, and design concept, and should not be easily labeled superior or inferior since the value judgment varies depending on the individual who uses it.

Perhaps the point that the Leica camp found most unforgivable was that KKK rated the Contax shutter 100 points and the Leica shutter 60 points. As for the superiority and inferiority of functions, there are advantages and disadvantages as mentioned above, but KKK's comment, "The Contax ..., as it stands today, appears to be without fault" is somewhat of an overreach. From the latter half of the 1930s to wartime, the German army adopted the Leica as a military camera, and it is a fact that the Leica IIIc was unavailable to the private sector because most were for military use. According to the book by Sanuki Matao, an aviation critic who lived in Germany around 1940 and has a deep knowledge of German cameras, Sanuki could not get the Leica IIIc in Germany and finally bought a second-hand one in Switzerland. When the shutter of the Contax II that he had purchased earlier broke down, he wrote, "The plates of the shutter are made of metal, but cloth strings are what binds them together. It was said that this string is destined to break, but undoubtedly it broke quickly due to harsh use. This is not very suitable for military use."[3)] So, it seems that the Contax shutter was more likely to break down than the Leica shutter and, at least for military use, the reliability of the Leica shutter was higher.

4.2.2 Operation System

As mentioned above, the rotation axis of the Contax I winding knob is parallel to the optical axis of the lens, but this also requires right-angle conversion for film winding. In other words, the axis of the winding knob, the winding axis of the shutter curtain and the winding axis of the film intersect three times, like each axis in an XYZ space, as shown in Photograph 4-6. For this reason, the power of the winding knob is transmitted to the film winding system and the shutter charge system via a complicated transmission system, causing the power to be extremely torqued. To begin with, the winding knob is on the front of the camera, which is not a position for easy operation.



Photograph 4-6 Structure of the Contax (2)

The reason that the winding knob is on the front is probably that it was difficult to install with a horizontally long rangefinder provided on the upper side of the camera. The winding knob was installed coaxially with the shutter dial. The shutter dial was placed on the front because Kueppenbender was contemplating installing an exposure meter in the future.

Of course, it is better to place the exposure meter on the subject side (that is, on the front side of the camera). At that time, it was easier to link the exposure meter and the shutter dial. Kueppenbender was convinced that the exposure meter would be an important specification in the future, which was correct in consideration of later camera transitions, but this winding knob was problematic with its operation surface and high torque, and he conceded a point to the Leica, which prioritized operability.

The Asahi Camera article makes no mention of operability. The only item related to operability is film loading, where Leica scores 90 points against the 100 points for Contax. The Contax is viewed as having an advantage because the back cover can be removed, which is understandable, but the Leica camp most likely found it hard to understand the omission of other aspects of operability.

4.2.3 Rangefinder and Viewfinder

The Leica IIIc rangefinder was designed with an external horizontal rangefinder built into the camera, but the baseline length was about 38 mm due to the arrangement of the operation system. On the other hand, the Contax I has a baseline length over 100 mm by fully using the width of the camera at the beginning of its release, and 93 mm with the new optical system installed midway through the series. The accuracy of the rangefinder is determined by the effective baseline length, which takes into account not only the baseline length but also the magnification and, although the Leica increased the magnification of the rangefinder midway through the series against the Contax, the Leica could not match the Contax.

The reason that the Contax I rangefinder changed midway through the series was that it changed from the initially mounted orthodox type, which has a movable mirror, to the drehkeil type, Zeiss's specialty. The drehkeil (meaning to twist a wedge) type is a combination of two wedge-shaped circular lenses as shown in Figure 4-1, and the deviation angle is changed by rotating each in the opposite direction. The stable structure has more redundancy than moving a mirror and is resistant to shock and aging. In addition, since the rear bar-shaped prism and the drehkeil can be separated, the drehkeil can also be used for spring cameras where the lens and body are mechanically separated, and is an excellent method utilized in many Zeiss cameras such as the Ikonta series. However, the adoption of a bar-shaped prism made it impossible to place a viewfinder between the left and right rangefinder windows.

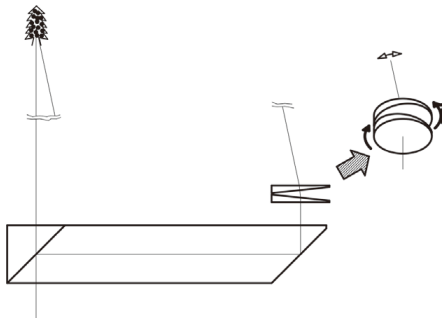


Figure 4-1 Drehkeil Rangefinder

There is a theory that the Contax I changed the position of the viewfinder from the middle of the series because it violated a Leica patent, but this is incorrect. Zeiss has the right to place the viewfinder between the left and right rangefinder windows in Germany. Nevertheless, the Leitz patent, which was filed about nine months behind Zeiss, was granted overseas, including Japan, prior to Zeiss. In other words, Zeiss had preferential rights in Germany and Leitz had preferential rights overseas. It is not public how the two companies resolved this twisted state of affairs, but presumably they exchanged license agreements with each other[4].

The Contax drehkeil rangefinder is an exceptionally good rangefinder in itself, and its performance as a rangefinder surpasses that of the Leica. Nevertheless, the viewfinder was pushed to one corner of the camera to avoid the long bar-shaped prism. In this regard, the Leica, making effective use of space, places the viewfinder close to the shooting lens, making it possible to reduce the distance between optical axes of the viewfinder and the shooting lens and reduce the parallax, which is a shortcoming of rangefinder cameras. The Contax had to compromise on this point. Nevertheless, with a telephoto lens for which a rangefinder with a long baseline length is effective, the parallax problem is alleviated, making this is a strong telephoto policy. In short, this is also a difference in product concept, and should not be labeled simply either superior or inferior.

4.2.4 Lenses and Lens Mount

In a sense, what made the Leica camp grit their teeth the most when the Contax I was released may have been the Contax lens lineup. When the Type I was released, six interchangeable lenses were prepared. Each one was a highly acclaimed lens for posterity and showcased Carl Zeiss's optical technology to its fullest. Among them, the Sonnar 50 mm F1.5 boasted epoch-making brightness at that time, and the 50 mm F2 boasted the highest F value in the focal length range, greatly surpassing the Leica. The brightness of a lens is an irreplaceable property and, with only low-sensitivity films at the time, such brightness was a great advantage especially when shooting indoors. It seems that there were many photographers and enthusiasts devoted to the Contax I because

of the existence of this lens.

The lens mount also was a big advantage for the Contax side, even though, for some reason, it was not addressed in the Leica-Contax controversy. Leica screw mounts had features such as ease of standardization, wear resistance and excellent workability, and later many third-party Leica mount (hereinafter "L mount") lenses and cameras appeared, forming the L mount family. On the other hand, the Contax bayonet mount was modern in terms of quick attachment/detachment and easy radial positioning. In fact, the fact that Leica also adopted a bayonet mount when transitioning to the Type M, and that most of the later SLR systems of each company ended up using the bayonet mount format is proof of this.

Photograph 4-7 Lens Mount of the Contax

In the Asahi Camera article, KKK gave Leica 75 points for the lens against Contax's 100 points, but regardless of the quantitative validity, the Leica camp had to admit that Contax was the winner in the lens department. However, photographers who do not need a bright lens may well feel that the score difference should not be so high. The lens also is an aspect that depends largely on subjective values.

On the whole, clearly it is quite unreasonable to judge everything as superior or inferior based on a quantitative score. KKK also understood this as he wrote, "When you score the cameras based on 12 items, the result is as described above. The scores, however, are not absolutely reflective, and the importance of each item varies from person to person," slinking away in the end.

4.3 Achievements of the Leica and the Contax

The Leica-Contax controversy in Japan was a mudslinging match and, although the article by the instigator KKK can certainly be described as somewhat unfair, the Leica camp already enjoyed a big difference in sales and perhaps should have tried to look undaunted and not have made such a battle cry.

Looking at the production volume of each from 1932 to 1945, to the Contax's (I-III) 134,200 units, there were 317,385 Leica (II-IIId) units, a figure more than double the Contax's[5], and the Leica had the marketing battle advantage in Japan as well. So, there was probably no need for the Leica camp to aggravate the face-off after all.

In any case, the development competition between the Leica and the Contax was fierce, and as a result, new technologies were introduced with each model change, honing the specifications and functions. Given that it is an undeniable fact that this rivalry contributed significantly to the development of the 35 mm focal-plane shutter market, I would like to once again pay tribute to the passion and talent of Barnack and Kueppenbender, the creators, and to Leitz and Zeiss Ikon, the companies that produced such wonderful products.

4.4 The Contax II

In contrast to the Leica, which evolved through a cumulative process of frequent minor changes, the Contax exhibited a full model change with the Type II released in 1936. This is probably because it was necessary to improve the elaborate parts seen in the Type I and to incorporate requests probably received from inside and outside the company.

Photograph 4-8 Contax II
(Provided by JCII Camera Museum)

First, improvements were made to the film winding knob. The position of the film winding knob provided on the front of the Type I was problematic in operability and, due to the internal structure, the torque was high and the feel was not good. The knob was moved to the upper surface of the camera, significantly enhancing the transmission efficiency and improving the winding feel.

The shutter dial, which was complicated to set, was also improved to a uniaxial type, that is, a type that allowed the shutter speed, even a low shutter speed, to be set with one dial, ahead of the Leica. While the war may partially account for it, the Leica did not adopt the uniaxial design until the M3 in 1954, so the Contax was a pioneer in this regard.

Furthermore, the viewfinder also improved to a single-lens type integrated with the rangefinder, and the rangefinder also changed to a schwenkkeil type, which is a further improvement of the drehkeil type. Schwenkkeil means a

swinging wedge and, as shown in Figure 4-2, is a combination of two cylindrical lenses, one of which is “swung” to change the wedge angle and alter the optical path.

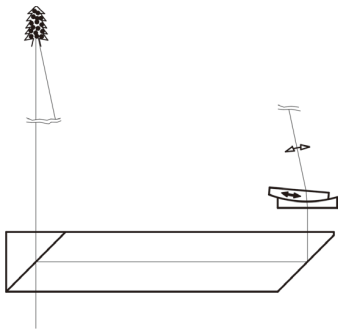


Figure 4-2 Schwenkkeil Type

The design was also updated and, as indicated by the nickname Chrome Contax that set it apart from the black-painted Type I, its appearance with beautiful chrome plating has that camera-like look when viewed from a modern perspective.

4.5 Compact Camera Under Wartime Regime

Occasionally I have mentioned that compact cameras played a military role. As Nikon (Nippon Kogaku Kogyo Co., Ltd. at the time of establishment), which celebrated its 100th anniversary in 2017, is well known as a Mitsubishi-affiliated optical weapons manufacturer that developed rangefinders for battleships, sights for bombers and fire control systems for ballistic calculation (mechanical calculators), optics and the military are closely linked. Various industries were deployed for military purposes, and the optics field is no exception. Here, I will describe the trends of compact cameras under the wartime regime, which triggered the development of cameras after World War II.

4.5.1 Military Use of Compact Precision Cameras

I think 1936 (Showa 11) was a milestone year in the long history of the camera. Shortly before Schmidt Shōten published the brochure entitled “Brushing Off...” during the Leica-Contax controversy in March of 1936, the February 26 Incident occurred and a disturbing air was beginning to drift in Japan.

Overseas, Hitler became the chancellor of Germany in 1933, and the largest piece of propaganda, the Berlin Olympics, was held in 1936. In that corner of Germany, Oskar Barnack embarked on his eternal journey on January 16 of the same year. Then, as described later, the full-scale sale of the Hansa Canon, Japan's first 35 mm focal-plane shutter camera, began in 1936 and, in this same year, the photo magazine LIFE, which brought about a major turning point for later Japanese cameras, debuted in the United States.

In this dark era, at Zeiss Ikon, the president, Goldberg, retired because he was Jewish, and was replaced by Kueppenbender. On the other hand, Leitz also transferred many Jewish employees to Leitz New York in the United States as a humanitarian move. Despite this chaos, the compact 35 mm camera proved especially useful for military use. As a cold climate specification, a special Leica IIIc military model with ball bearings built into the shutter drive shaft was made and delivered to the German Air Force.

As mentioned above, most of the Leica IIIb and IIIc, except the post-war versions, were devoted to military or government agencies. This is because the 35 mm camera, which is lightweight, durable, provided with interchangeable lenses depending on the situation, and known to deliver surprisingly good images, was indispensable for reconnaissance and intelligence activities.

While, due to the nature of the matter, the 35 mm camera was not showcased in this role, an example that supports the above is that, in the Sorge incident in 1941, which is considered to be Japan's largest espionage incident, the Leica and the Contax were found among seized goods. Richard Sorge, the main criminal, favored the Leica, and Branko Vukelić, who was in charge of photography, favored the

Contax I and II. The Type II reportedly had the Sonnar 50 mm F1.5 mounted thereon[6]. These 35 mm cameras were purchased as general commercial products and did not undergo any special modifications for espionage, providing a glimpse of their overall excellence.

4.5.2 Penetration of Compact Precision Camera into News Media

Although not intelligence activity per se, another example of the 35 mm camera playing an active role in a similar situation is the February 26 Incident. On the early dawn of February 26, 1936, an army infantry regiment, having left the Roppongi barracks, divided into several groups, attacked and assassinated leading officials, and subsequently occupied various locations. Japan was shaken from the attempted coup d'etat that caused many injuries and nine deaths, including the deaths of two ministers, but surprisingly the event in various parts of Tokyo are recorded in a number of vivid photographs. The rebels attacked the Asahi Shimbun and Tokyo Nichi Nichi Shimbun, and were also strongly hostile to a number of media outlets, so why were the rebel soldiers so easily photographed? The answer lies in the compact precision camera.

The Asahi Shimbun, which detected signs of a major incident, kept all six Leica III models at the photo-related distribution trading company Konishiroku Honten that day, and started using them the next. Other companies perhaps also pulled out in-house compact cameras that had been rarely used until then. On the other hand, when looking at this from the rebel soldier side, there is the stereotype of the news photographers at that time having a big clap camera (folding cameras used for news at that time), and the crowd of people wearing coats and wandering around appeared only to be the general public. The rebels, first off, could not afford to make enemies of the general public, and so could not reproach them. They did not realize, it seems, that they were having their photos taken by photographers who were sticking out just the tip of a small lens from behind their coats, and the photographers were able to take advantage of the situation and get closer.


戒嚴令下に治安維持さる
戒嚴司令官告諭
財界平穩に推移
各銀行平常通り營業
株式取引所のみ引續き休業
治安維持上の權限
軍司令官に移

Photograph 4-9　Asahi Shimbun Relaying February 26 Incident[7)]

In this way, a number of powerful, compelling photographs coupled with scenes of unmelted snow that had fallen on the city a few day earlier made their debut, and represent a turning point for the news media as they realized the usefulness of the compact camera.

4.6 Leica Copy Genre

With the gradual recognition that the 35 mm compact camera is suitable for various activities under the wartime regime, the demand in the military and national institutions of each country increased. On the other hand, production restrictions also increased, making it difficult to increase the number of shipments. In Germany, although domestic sales were secured with priority, the hostile Allies put a halt to importing the excellent German camera.

Japan also entered a state of war starting with the Marco Polo Bridge Incident in 1937, and the Trade and Related Industry Coordination Law and the Temporary Measures Law on Imports and Exports were proclaimed in August and September, respectively. This made it difficult to import cameras from abroad for virtually non-military purposes. Even securing the required import quantities for military purposes was difficult due to geographical problems and, while there seemed to be a back route via Manchuria, the quantity was limited.

If importation proved difficult, domestic production was the only answer, and so each country sought to produce a 35 mm compact camera by respective methods. The result? The birth of a large number of Leica copies.

The term Leica copy is now common, but its definition is ambiguous. This is because, even given the definition that Leica copy is a rangefinder camera that uses 35 mm film, is equipped with a focal-plane shutter, and is similar in exterior design to the Leica, to what degree the design is similar or not is a subjective assessment.

I have two books, “LEICA COPIES” and “300 Leica copies.” If you look at the number of models, the former lists about 230, and the latter lists about 300 as the title suggests, so you can see that the number depends on the definition. For example, each model of Nikon manufacture, which is a typical rangefinder camera in Japan, is not listed in the former but is listed in the latter. This is because the former defined a Leica copy as having a “lens mount compatible with that of the Leica,” therefore removed a Nikon camera that had a Leica type shutter but a lens mount conforming to (but not completely compatible with) that of the Contax.

Photograph 4-10　Leica Copy Reference Books

In any case, it is surprising that so many Leica copies were produced in countries all over the world. Among these countries, Japan enthusiastically produced many copies. Some were made for military purposes in a manner close to national policy, while others were made out of personal passion. One thing that can be said is that the development of the compact precision camera, whatever the purpose, attracted the hearts of the Japanese people. The national character reflected in the quest, playfulness and hand dexterity in the creation of elaborate mechanical dolls may have constituted a perfect prerequisite for the embrace of a compact precision camera that requires minimal resources and materials and has reasonable hobby-like characteristics that satisfy the joy of personal ownership.

Above all, the Leica served as a great exemplar. When disassembling the Leica, the hobbyist is charmed by its direct simplicity and cannot help but feel that, even for him, it may be easy to make. The Contax, however, does not even begin to stir a feeling of wanting to make a dead copy to that complexity; it would actually be impossible. This is the reason why, compared to the abundant number of Leica copies,

Contax copies are virtually non-existent.

4.6.1 Leica Copies Made in the United States

In this section, I will take a momentary sidestep away from the topic of Japanese Leica copies and briefly touch on the situation of the 35 mm compact camera in the United States and, in the next section, in the Soviet Union.

When the importation of the Leica ceased, there was a movement to develop a Leica type camera in the United States. New York Leitz, the US base of Leitz, actively cooperated with the US military and, unusual for its national character that emphasizes originality and dislikes imitation, developed the Kardon, a Leica copy. With a late start, the Kardon was actually delivered to the military in 1943, but this camera is very well made and showcases the industrial strength of the United States at the time. The Kardon also included, as a complete military model, a model called the Military Kardon which featured a larger winding knob and the like to improve operability when wearing gloves and is now a collector's item due to the limited number produced.

Photograph 4-11 Military Kardon
(Provided by JCII Camera Museum)

In connection with the development of the compact 35 mm camera in the United States, the Kodak Ektra deserves to be mentioned, although it is not a copy. Kodak, being a film manufacturer, had felt that the camera need only be a tool that consumes film, that is, a tool having the bare minimum for taking photographs, and hence produced products that were a far cry from a camera designed as a precision machine. Yet, in 1941, Kodak, out of the blue, released the Ektra. This camera was equipped with epoch-making specifications and functions, such as a rangefinder with a long baseline length, a zoom finder, and film back replacement, and partly outperformed the Leica and the Contax. The Ektra was the result of Kodak tapping into its technical capabilities while making reference to the German camera, but was a failure that sold only about 2,500 units in eight years. It was much larger and heavier than the Contax. The Ektra was a concrete example of the fact that the philosophy that performance matters most, regardless of heaviness and length - as was the case with American cars in the past - did not apply at all to the camera.

Photograph 4-12 Ektra
(Provided by JCII Camera Museum)

4.6.2 Leica Copies Made in the Soviet Union

The Soviet Union was a country that produced Leica copies much earlier than Japan. Since there was no partner company such as New York Leitz in the United States and the country was completely hostile to Germany, the Soviet Union ignored patent rights and proceeded to produce dead copies.
The FED has many variations as Leica copies, but reportedly its first trial was completed in 1932. Then, in 1934, mass production of the FED, almost a perfect copy of the Leica II, began. FED is an acronym for Felix Edmundovich Dzerzhinsky, the founder of the KGB. These cameras were apparently used for both civilian and military purposes. The FED brand copies were conscientious replicas, some even with the Leica stamp, resulting in the speculation that they were made on a national scale to earn foreign currency. Many Soviet Leica copies, such as the FED and the subsequent Zorki, were manufactured for a long time after the collapse of the Soviet Union, and many remain in the used camera market to this day.

Photograph 4-13 Zorki
(Provided by JCII Camera Museum)

Leica copies are thought to have been produced in almost all countries that had even the slightest experience in camera manufacture, and yet, upon closer observation, reveal the particular national character and national strengths of each country, making them very interesting as a research theme on technological cultures.

4.7 Leica Copies and Development of Compact Precision Cameras in Japan

Many Leica copies emerged in Japan as well. The definition of a Leica copy is ambiguous, but herein a Leica copy is defined as a 35 mm film-compatible camera equipped with a focal-plane shutter, provided with a Leica-like internal layout

and exterior design, and capable of lens interchange. In this section, we will consider the background, technical features and subsequent developments of each manufacturer.

4.7.1 Precision Optical Instruments Laboratory (Currently Canon)

While I have emphasized that the main purpose of a Leica copy was military use, the first Leica copy in Japan, the Hansa Canon, was not for military use, and there is some resistance to lumping it together with the other copies.

Yoshida Gorō, who had a career in repairing motion picture cameras, came up with the idea of developing a camera when his business partner in Shanghai told him that if Japan can produce such excellent battleships, there is no reason why Japan cannot make its own cameras. An experienced camera repairman, looking at a disassembled Leica, would most likely believe that he could do it himself. Yoshida immediately brought in his brother-in-law, Uchida Saburō, who worked for a securities company, and established Precision Optical Instruments Laboratory (later Japan Precision Optical Instruments Laboratory, Precision Optical Industry, Co., Ltd., Canon Camera Co., Ltd., and now Canon Inc., hereinafter referred to as Precision Optical), and starting producing mockups and various prototypes. An advertisement using a mockup appeared in an issue of Asahi Camera at that time.

Yoshida's enthusiasm inspired in Shanghai is evident in the advertisement, “The best submarine is the I-go. The best airplane is the Army Type 92. The best camera is the Kwanon. They are all the best in the world.” Yoshida made detailed advances with the Kwanon in the Takekawaya Building near the Roppongi Intersection, but development did not progress as expected. A camera such as the Leica looks easy to make, but in fact is not.

Photograph 4-14 Kwanon Camera Advertisement[8)]

There is an interesting story. On the west side of the Roppongi Intersection, near what is now Tokyo Midtown, there was a barracks for the Army Infantry Regiment. Captain Yamaguchi Ichitarō, who was there, was ideologically close to Captain Andō Teruzō, the mastermind of the February 26 Incident, and allowed the removal of firearms and bullets from the warehouse on the day of the incident. Yamaguchi was a bright light in the field of optical equipment and, in Matsumoto Seichō’s exploration into Showa history, it is stated, “Yamaguchi was quite an engineer in measurement instruments that measure the impact distance of guns, and he contributed to a number of developments in coincidence-type rangefinders. That is why he had contact with Nippon Kogaku, Nippon Kokan, Kayaba Manufacturing, etc., and ... seems to have earned a bit of pocket money.”[9)]

In addition, it seems that he was also in and out of Precision Optical, which was a few minutes' walk away, and his autographed resume states, “In 1935, ... I personally provided guidance for Canon, which established a research institute in Roppongi.” Further, it seems that he also pursued a rubberized cloth curtain for Konishiroku’s aerial cameras[10)].

While the details are unknown, there are signs that show that military personnel proficient in technology moved behind the scenes between companies, eventually complementing each other's technical and material shortfalls, which lead to the development of the Japanese optical industry. There is a similar story about the mounting of the Nikkor lens in early Precision Optical cameras.

Kwanon, the brand in the advertisement, is named after Yoshida's Kannon faith. In addition, the advertisement states “Kasyapa” as the lens name, which is also a religious name derived from Buddha's disciple Mahākassapa. Reportedly, because either the eccentricity of Yoshida was not in line with that of Uchida or Yamaguchi or he was suspected (yet falsely accused) of unaccounted-for expenditures, Yoshida left the research institute less than a year after the institute was established. Looking at overseas documents, one document describes Yoshida as the catalyst of Canon. Since the term catalyst means inspirator, it is indeed strange to say that the role of Yoshida was to encourage others and trigger development.

Although Yoshida's camera was modeled after the Leica, it seems to be the result of pursuing his idealized form rather than simply making a Leica copy. Adopting a brand name reflecting one’s faith perhaps implies that he held some sort of belief in the technical aspects as well. However, he had a tendency to pursue the ideal to an excessive degree.

Looking at the advertisement in Asahi Camera and the sketches of the prototype that Yoshida drew based on his memory in his later years, there is one in which the winding knob is placed on the front of the camera following the Contax I. However, in Japan at that time, it was not possible to achieve precision part machining at the level of Zeiss, and success remained elusive. It seems that Uchida completely corrected the trajectory after Yoshida’s departure, and although the camera gradually came to resemble the Leica, the fact that a film counter was placed in front was novel. Uchida also wanted to bring out originality.

Speaking of originality of Precision Optical, there is the shape of the camera when viewed from above. The Leica has an oval shape and the Contax has a rectangular shape, but

Precision Optical used an octagon to differentiate the camera from others. This octagonal design has long been used in later Canon cameras and is a distinctive exterior feature.

What Uchida had trouble with were the rangefinder and viewfinder. Even if he could manage to achieve the mechanical design, the more specialized optical design was out of reach. The solution to the dilemma came in the form of a partnership with Nippon Kogaku. Uchida consulted with his second oldest brother, who was a supervisor there, about optical design. At that time, Nippon Kogaku was a manufacturer of optical weapons for suppliers to the Navy, and although it seemed strange to lend a hand to consumer cameras, the company was interested in and enthusiastic about consumer products that would enjoy a stable demand.

In any case, a good prospect for optical design was found. The scope of intellectual property rights of Leitz for its utility model of "placing the viewfinder between the two windows of the rangefinder" was very wide, and designers had a hard time avoiding it, but Uchida came up with a tricky "jack-in-the-box" solution in which the viewfinder pops up at the time of use. Compared to the subsequent Leotax which avoided the patent rights by shortening the baseline length, resulting in a significant loss in ranging performance, the camera was much smarter. A utility model for this "jack-in-the-box" is registered with Uchida named as the inventor.

The mechanism of the coupled rangefinder, similar to that of the Contax, rotates the distance ring of the lens from the camera side, and seems to have been designed by Yamanaka Eiichi at Nippon Kogaku, as the utility model (Registration No. 229211) was registered under his name[11]. Due to the adoption of this coupled rangefinder, the mount was unique, differing from the Leica, but was changed to the L mount in successor models after the war. Perhaps it would have been more advantageous to make a universal Leica-compatible camera.

The decision was made that Nippon Kogaku would also supply standard lenses and that Omiya Shashin Yohin (currently Hansa Co., Ltd.), which enjoyed huge sales channels for photographic supplies, would be the dealer. In the fall of 1935, more than a year after the camera was advertised in Asahi Camera, its release was finally officially announced. This camera was the Hansa Canon, Japan's first 35 mm compact precision camera with a focal-plane shutter. The Hansa is a brand name of Omiya Shashin Yohin and it was equipped with the Nikkor 50 mm F3.5 of Nippon Kogaku as a standard lens. The form crowned by each of the three major brands still in existence today - the Canon, the Nikkor and the Hansa - is spectacular even to this day and, as a camera that makes full use of each company's specialty, is fitting as Japan's first 35 mm camera with a focal-plane shutter.

The selling price was either 270 yen or 275 yen, depending on the literature, but the difference of five yen seems to be whether or not the sales staff received a commission.

Photograph 4-15 Hansa Canon
(Provided by Canon Camera Museum)

Although there is evidence that a small number were sold in 1935, full-scale sales began in early 1936. The beginning of 1936, as you recall, was the time of the February 26 Incident. In connection with this, there was an episode that showcases the scale of Precision Optical at that time. In the early days of the incident, a part of the infantry regiment that left the Army garrison made a left turn at the Roppongi Intersection where Precision Optical was located, and headed for Nagatacho where the Prime Minister's Office was located. Uchida and his colleagues, frightened by the unusual atmosphere, decided to evacuate, gathered together the work-in-progress and other parts of the camera, which amounted to only two wicker trunks, and were able to escape immediately. Even though this was just after the release of the first domestically produced 35 mm rangefinder camera, that was all they had.

The Hansa Canon was a product that brilliantly shined in the history of the Japanese camera industry and was highly praised at that time, but productivity became a problem as the Sino-Japanese War bogged down into a stalemate. The cameras relied on Nippon Kogaku for the coupled rangefinders, lenses and mounts, but Nippon Kogaku began to prioritize munitions products, leaving little room for the consumer camera. Among the cameras, in 1939, Canon's standard type (also called Type S), popular type (also called Type J), new standard type and popular type with a slow shutter were commercialized in small numbers, and this small-scale production of consumer cameras led to success after the end of the war.

When Japan entered the Pacific War, the country had no choice but to focus on the production of munitions products. According to company history, the company produced binoculars, range meters and the like[12], and most likely these were requested by Nippon Kogaku. The range meter was the Army's term for the Navy's rangefinder, and is mounted on a tank or the like to measure the distance to the target.

In March 1944, Nippon Kogaku formed the Japan Optical Industry Corporate, an organization of 108 partner companies[13], and there is information indicating that the director general was Precision Optical[14].

Precision Optical temporarily dissolved in the burnt fields immediately after the end of the war, but revived with 156 employees on October 1 and, even in the midst of scarce supplies immediately after the end of the war, collected parts from before and during the war, and launched production quickly, bringing a total of about 500 postwar popular type (Type JII) cameras to the market[15]. Then, in the fall of 1946, the newly designed SII was released, which became the blockbuster that led to the company's rebirth.

Precision Optical got this far with the cooperation of

Nippon Kogaku in personnel transfers, equipment transfers and the like, but in the years after the war, developed their own lens, Serenar, ridding themselves of dependence. Even after being hit by the "M3 Shock" later, the company continued to develop and improve the rangefinder camera and, having released various models through the latter half of the 1960s, is the authority with regard to the rangefinder camera equipped with a 35 mm focal-plane shutter in Japan.

The Hansa Canon, which is not an L-mount, is, at the very least, not a Leica dead copy, and its originality is largely evident. This originality is what draws the line between the Hansa Canon and dead copies such as the Leotax, the Nicca and the Melcon described later, and it seems that the early independent spirit of this camera is what led to later development. In a sense, it is truly moving to think that the maker, in a small room with two wicker trunks of work-in-progress at the time of the camera's launch, is now a corporate giant with annual sales of about 4 trillion yen.

4.7.2 Kyōei-sha (later Showa Kōgaku, Showa Optical Works Ltd., Leotax Camera)

With the ambition to make a 35 mm film camera after learning about the Leica, several engineers left Rokuosha, the camera manufacturing division of the long-established photographic supplies company Konishi Honten, and created Kyōei-sha in 1938. Minagawa Shōten, which was a manufacturer of First brand cameras, and San-ei-sha, a sales company, invested in it, and a sales channel was established through Misuzu Shōkai (later Misuzu Sangyō), a major photographic supplies sales company. Well aware of the difficulty of obtaining German products and the success of the Hansa Canon, the manufacturing and sales departments, seeing the future of the 35 mm camera, had an intense, passionate bond.

The company name was changed to Showa Kogaku immediately, and the Leotax original was released the following year. The Leotax was the second domestically produced 35 mm compact precision camera with a focal-plane shutter following the Hansa Canon. With the brand name being a compound word combining Leica and Contax and the exterior design being virtually identical to that of the Leica II, the camera lacks the originality of the Hansa Canon. The internal structure is almost a dead copy of the Leica, but the rangefinder and the viewfinder periphery are different from the Leica. In order to avoid the utility model intellectual property rights of Leitz, the viewfinder had to be placed outside the left and right rangefinder windows instead of between them. For this reason, the baseline length was inevitably extremely short. Even the Leica's 38 mm was short, so 27 mm, which is about 30% shorter, was problematic in terms of performance.

Photograph 4-16 Leotax (Original)
(Provided by JCII Camera Museum)

In addition, the rangefinder was a stand-alone type that did not couple with the lens distance ring, and so was not as useful as that of the Leica. Thinking about it now, perhaps a little more ingenuity was required in the utility model workaround. Priority was given to achieving an exterior appearance like the Leica, but in doing so essential performance was sacrificed.

Still, Leotax products were relatively good in other respects and sold reasonably well, so the company was able to release improved models one after another. In 1942, when the rangefinder-coupled Special A and the Leica utility model became available after the war, Showa Optical made a good showing with the release of the Special DII and Special DIII, which boast a performance close to that of the Leica. The fact that the cameras were equipped with Simlar and Topcor lenses made by Tokyo Optical was also highly praised. Like Nippon Kogaku, Tokyo Optical was an optical weapons manufacturer with close ties to the military, and also worked extensively on camera lenses.

Leotax continued to make constant model changes and stood shoulder to shoulder with other rangefinder cameras, but after the 1954 "M3 Shock," was unable to switch to a SLR camera like other manufacturers, broke away from the Leica copies, and bet on the Leotax G, which featured a design closer to the M3. This model was well thought out and developed, and had the potential to be the first step in recovery. However, because the company had stopped production of products made to date and at the same time focused its efforts on this new product alone, it didn't manage to survive even as far as the date of release. At last, the subcontractors were able to hand over the parts and the assembled products were released, but it was too late and Leotax's good fortune completely ran out. The final product, the Leotax G, is ironically unbelievably valuable in the current collector's market, partly due to the low production volume.

4.7.3 Kōgaku Seikisha (Optical Precision Instrument Company)

Precision Optical, which set sail on the compact precision camera ocean with the Hansa Canon, left the cramped Roppongi quarters four months after the February 26 Incident and moved to a new factory in Meguro, where production continued and developed steadily. By 1938, the number of employees, which was less than 10 at the time of its founding,

had increased to nearly 100. From there, a few engineers with aspirations founded the spinoff Kōgaku Seikisha (later absorbed by Yashica via Nippon Camera, Nicca, and Taiho Optical) in 1940. From the company name (meaning “Optical Precision Instrument Company” in English), one gets a sense of the motivation and ambition of the founders, believing that they too could make a similar camera.

Initially, the company worked on remodeling the Leica and domestic cameras, but then decided to make a Leica copy based on an offer from the military, which was suffering from difficulty in obtaining compact cameras. As mentioned above, the United States started developing the Leica dead copy called the Kardon for the same reason, so Japan and the United States faced the same situation, craving the Leica in the face of the Pacific War. In that sense, in contrast to the Kardon whose commercialization was delayed in 1943 despite its high quality, the technology of Kōgaku Seikisha, which was easily commercialized in 1942 (although an imitation), is quite skillful. It was also a big deal that the company was allowed to ignore the Leica utility model with the approval of the military. The result of this effort was the Nippon. In the UK, there is a remarkably high quality Leica dead copy called the Reid. The Reid was produced in the UK based on drawings of the Leica that the British army requisitioned after the war due to the difficulty in obtaining the Leica, but took more than three years to complete and, when compared to the Reid, the ease of handling of Kōgaku Seikisha’s product stands out.

Photograph 4-17 Nippon
(Provided by JCII Camera Museum)

The Nippon was immediately delivered to the military. The number delivered is said to be about 300, and apparently some were installed in the night fighter, the Gekkō (Moonlight)[16]. Considering that there was no leakage of information related to complaints from the military, most likely the Nippon was used as a substitute for the Leica without much problem.

After the war, the Nippon was launched as a consumer camera under the Nicca (abbreviation for Nippon Camera) brand. The company name was changed to Nicca Camera in 1950, and the Nikkor lens supplied by Nippon Kogaku was made their standard, causing the company to be relatively well received. Focusing on exports, the company expanded its sales channels and made cameras for Sears Roebuck under the Tower brand, Peerless under the Peerless brand, and Australia under the Snider brand, but could not escape the Leica dead copy impression and gradually business deteriorated.

In 1959, the company changed its name to Taiho Optical and became a subsidiary of Yashica as a mid-sized camera manufacturer, and soon was completely absorbed and merged. Yashica was founded as Yashima Seiki in 1949 and, in 1953, changed its name to Yashima Kōgaku Seiki. and started mainly producing the 6 x 6 format camera. Almost at the same time as the merger of Nicca, Yashica also incorporated Zunow Opt., which developed an advanced single-lens reflex camera, and strengthened its technological capabilities for the compact precision camera. As a 35 mm focal-plane camera, the last Leica copy of the Nicca brand (copy of the Leica M3), the Nicca IIIL, was released in 1958, and the same model was released as the Yashica YF the following year. This camera is a rare model that features both the Yashica and Nicca logos.

Yashica's specialty was mainly compact cameras with lens shutters, and the company subsequently achieved a blockbuster hit with the Yashica Electro 35 series and also entered into production of popular price range SLR cameras. In the 1970s, the Contax RTS, an ultra-luxury SLR camera that revived the Contax brand in partnership with Carl Zeiss, suddenly appeared on the market, astonishing the world. However, due to the failure of new business and the oil crisis, business deteriorated, and the company was absorbed by and merged with Kyocera at a humiliating share ratio of 1:13. After the Nippon camera, which started from a Leica dead copy, finally reached, through twists and turns, Leica’s rival, the Contax brand, what was it that caused the company to ultimately withdraw from the camera market? An explanation of SLR cameras, such as the Contax RTS, will be given in a later chapter.

4.7.4 Nippon Kogaku Kogyo Co., Ltd. (currently Nikon Corporation)

There is considerable resistance to classifying Nippon Kogaku as a Leica copy manufacturer. This is because the lens interchange is almost compatible with the Contax, not the Leica, and the exterior design is similar to that of the Contax II. However, features such as the shutter structure and layout are similar to those of the Leica, so it can be said that it is a “best of both worlds” camera.

Nippon Kogaku was founded in 1917 by Mitsubishi Zaibatsu who, sensing the need for an optical weapons manufacturer, merged a part of Iwaki Glass and a part of Tokyo Keiki Company, and immediately after that, Fujii Lens Manufacturing. In line with its stated reason for being, the company was engaged in the production of military optical weapons such as periscopes and rangefinders until the end of the war, but after the end of the war, the number of employees, which had been as many as about 25,000 until then, was reduced to 1,724 and the company made a fresh start[17]. A camera was one of the candidates for advancement into consumer products. Initially, priority was given to the twin-lens reflex camera, but development of the lens shutter did not go well and so resources were concentrated on the 35 mm

focal-plane camera. Thus, in 1948, the Nikon I (the original name was the Nikon Camera, but later was changed to the Nikon I to distinguish it from its successor) was released. Even Nippon Kogaku, which boasted some of the most advanced technologies in military optical weapons, struggled with consumer products, and the camera was released after a difficult delivery due to schedule delays and quality problems.

Photograph 4-18 Nikon I
(Provided by JCII Camera Museum)

The Nikon I is equipped with a horizontal focal-plane shutter similar to the Leica, but the lens mount used is the Contax bayonet type. The reason for this is that, from before the war when the lens was delivered to Precision Optical to after the war when the lens was delivered to Nicca, there was some reluctance to make a camera that used the same L-mount lens.

Although the company had experience in camera lens production, the Nikon I, the first compact consumer camera from Nippon Kogaku, exhibited originality in its internal mechanism that makes the camera not just a copy, adopted a ball bearing for the shutter bearing, and incorporated ingenuity such as coaxially arranging the shutter speed setting dials for high speed and low speed, which are separately arranged on the top and front of the camera on the Leica, on the top of the camera. In addition, the picture size is 24 x 32 mm, the so-called Japanese format. The Nikon I was not the first to adopt the Japanese format. The format was adopted earlier in cameras such as the Minolta 35I, the lens shutter camera the Olympus 35, and the Mignon of Tokyo Optical, and was seen in overseas cameras as well. However, there is no evidence of use of the Japanese format being planned together among the companies. The Nikon I is the result of selection of an aspect ratio that felt well-balanced, and it seems that the company considered this 3:4 ratio as more suitable for human sensibilities than the Leica's 2:3 and prioritized the economic efficiency of taking 40 pictures.

However, because this Japanese format did not match the automatic cutter for slides, complaints were made by the US military stationed in Japan, and thus, in the next Nikon M, the company was compelled to correct the pitch between picture frames to 38 mm, which is the same as the Leica, while changing the picture size to 24 x 34 mm.

The Nikon M was internally treated as a corrected drawing version of the Type I, and came to be called the Type M later by adding the letter M to the serial number for distinction. Furthermore, the same camera with a synchro terminal added was released in late 1950 and was called the Type S.

Photograph 4-19 Nikon S
(Provided by JCII Camera Museum)

In the same year, photojournalist David Douglas Duncan, who was sent to Japan to shoot antique art by LIFE magazine, was surprised at the sharpness of a photo taken of him by his colleague, Miki Jun, at his office in Tokyo and learned about the excellence of the Nikkor lens. The Korean War broke out on June 25, and Duncan flew to the Korean Peninsula with two Leica IIICs and a Nikkor 50 mm F1.5 and a Nikkor 135 mm F4 converted to L mounts. Also, a few days later, LIFE magazine photojournalist Carl Mydans headed to the Korean Peninsula with the Contax and a Nikkor in hand.

Hank Walker, who took the place of Duncan, headed for the frigid Korean Peninsula with the Nikon M. While other cameras stopped working, the Nikon M seemed to work without fault. The excellence of these Nikon cameras and Nikkor lenses became a hot topic in a New York Times article published on December 10 of the same year. The number of Nikon cameras sold increased about five-fold from 2,533 in 1950 to 12,873 in 1953[18].

The Nikon S got on track and gained confidence as well as development investment, and full improvements were realized in its successor, the S2. The S2 camera was to be the first Nikon to have a picture size of 24 x 36 mm, and a system was set up to pursue the Leica in earnest, but the innovative Leica M3 was released in April 1954, just before the release of the S2, causing confusion in urgent improvement work and delaying the release until the end of the year. The improvements made were reportedly to the winding lever, the rewinding knob and the viewfinder magnification, but were not made public.

The features of the S2 include the 24 x 36 mm size, a one-time winding lever (the Leica M3 is a two-time winding lever),

a crank-type rewinding knob, an equal-magnification albada-type viewfinder with a bright frame, a high speed shutter time of 1/1000 second and an aluminum die-cast body (until then it was a sand molding). The S2 is a camera having extremely good balance in terms of performance, quality and price, and became a best-selling rangefinder camera of Nikon.

Nippon Kogaku subsequently released the S3, the S4 and the SP. The SP released in 1957 boasted the highest performance among the Nikon rangefinder cameras, and is comparable to the Leica M3 with its universal viewfinder that supports lenses with six focal lengths and an evenly spaced uniaxial non-rotating shutter dial. Nevertheless, at this time, the Contax S, a SLR camera with a pentaprism, and the Asahiflex, Japan's first 35 mm SLR camera, were already available, and the design and development team of Nippon Kogaku was strongly aware of the SLR camera.

4.7.5 Chiyoda Kogaku Seiko Co., Ltd.

Chiyoda Kogaku Seiko was founded in 1928 as Nichi-Doku Shashinki Shoten (Japan-Germany Camera Company), was later renamed through Mechanismus Optik und Linsen von Tashima (MOLTA) and, in 1947, shortly after the war, released the Minolta 35I, a 35 mm focal-plane camera. This camera is considered to be the fourth Leica copy in Japan and is listed in the previous two Leica copy books, but has originality and personality that set it apart from a simple Leica copy. The designer was the company's Miyabe Hajimu, who used the Leica before the war, identified its strengths and weaknesses, and developed the camera based on the design concept of “More is luxury, less is out of the question.”

Photograph 4-20 Minolta 35I
(Provided by JCII Camera Museum)

As you can see in the picture, the Minolta 35I is different from the Leica in terms of appearance. As for the mechanisms as well, the specifications are a bit different from the Leica, including adoption of the Japanese format, installation of a self-timer, adoption of a single-lens finder (the rangefinder and the viewfinder for composition share the same window), a unique design called “Umebachi (a plum blossom crest) type” of the lens distance ring, a 4-axis focal shutter, a 45 mm F2.8 as the standard lens and a synchro contact on the accessory shoe. The 4-axis shutter replaced the thick shaft on the feeding side, which is the basic form of the Leica, with two thin shafts, and is an excellent mechanism that has been adopted in many SLR cameras since then. The concept appears to be one of reducing the horizontal width of the camera and prioritizing the miniaturization in the horizontal direction as well as adoption of the Japanese format.

The company also showcased its ingenuity in the way the film is loaded, and adopted a hinged back cover that is neither the Leica bottom lid type nor the Contax back cover removable type. This method was also advanced as evident from the fact that it was subsequently adopted in most cameras.

Chiyoda Kogaku Seiko manufactured 6 x 4.5 format cameras before the war and released products in a wide range of fields such as twin-lens reflex cameras and lens shutters after the war, expanded into single-lens reflex cameras in 1958, was renamed Minolta Camera in 1962, and grew into one of Japan's leading SLR manufacturers. Yet, it seems that its ingenious development capabilities originated with the Minolta 35I.

It should be noted that Miyabe subsequently transferred to Mamiya Optical and demonstrated his talents in, for example, making a prototype Prismflex equipped with a pentaprism, and later worked as a professor at Chiba Institute of Technology and developed camera-related standards.

4.7.6 Other Manufacturers

After World War II ended, many Leica copies came to the market. This was because after Germany’s defeat all German patents related to cameras and the like became available based on the Berlin Declaration. As a result, the 35 mm cartridge film became widespread, expanding the user base, and, above all, cameras offered a large margin of added value to resources and many found it incredibly attractive that, with little skill and knowledge, it was possible to make a reasonably profitable product with small-scale equipment and minimal materials.

The Leica copy brands in Japan, in a broad sense, are listed below, each with a brief explanation. The phrase “in a broad sense” encompasses cameras that use 35 mm film, are lens interchangeable, equipped with a focal-plane shutter and provided with a rangefinder, and have an overall design similar to that of the Leica. These descriptions hopefully convey the enthusiasm and vibrancy of the camera engineers who longed for the Leica and desperately pursued it in the short period immediately after the war, even though the manufacturers were not up to the standard of those described in the previous section.

(1) The Melcon

The Melcon is a Leica copy released by Meguro Kōgaku Kōgyō in 1955. It is almost a dead copy of the Leica, but is characterized by a back cover that opens and closes. The Nikkor was mounted on the Melcon, making the Melcon quite popular. While it seems that the mounting of the Nikkor stemmed from the sales company of the Melcon being the same "Hinomaruya" as the Nicca, the camera apparently caused a complaint from Nippon Kogaku. From the successor, the Melcon II, the Leica copy was eliminated and the camera became a Nikon S2 copy, but the mount remained the L mount instead of the Nikon S mount. Meguro Kōgaku Kōgyō continued production until 1958, but went bankrupt due to a shortage of capital and its lack of prowess from a technical point of view.

Photograph 4-21 Melcon
(Provided by JCII Camera Museum)

(2) The Tanack

The Tanack is a Leica copy sold by Tanaka Optical since 1953, a company that made motion picture lenses, Leica accessories and the like. Although the camera is almost a dead copy, the back cover opens and closes like the Melcon. The Tanack featured its own lens brand, the Tanar, and continued to release successor models to 1959. The company showed its ambition, particularly in the later period, with its release of the Tanack 35 V3, featuring a change from the L mount to an original bayonet mount, but apparently ran into a lack of capital as lenses for that mount were never released, causing the camera to require attachment of an L mount lens via an adapter. Subsequently, the VP, which reverted back to the L mount, was the last model.

Photograph 4-22 Tanack IIC
(Provided by JCII Camera Museum)

(3) The Chiyoca/Chiyotax

The Chiyoca 35 was released in 1951, which is relatively early compared to other Leica copies, and is the only Leica Standard (a popular version of the Leica II with the rangefinder removed) copy in Japan. This camera was made by Reise Kōgaku (later Reise Camera) and sold by the trading company Chiyoda Shōkai. Note that Chiyoda Shōkai has nothing to do with Chiyoda Kogaku Seiko Co., Ltd., mentioned above. After releasing several successors, including Leica II copies, for its Leica III copies the company changed the brand name to Chiyotax IIF. This is because Chiyoda Kogaku Seiko registered the name of Chiyoca as a trademark, so the name could no longer be used. The Chiyotax IIIF included a model with the Hexar 50 mm F1.9 lens from Konishi Honten.

Unable to increase production scale and with the withdrawal of Chiyoda Shōkai midway through development, Reise Camera released the product leaving the brand name as is. Subsequently, in 1957, the Alta was released that was remarkably similar to the Chiyotax IIIF, but it is said that the major trading company Misuzu Shōkai acquired Reise Camera, renamed it Misuzu Kōgaku Kōgyō, and released the cameras under a new brand[19]. The attached lens, the Altanon 50 mm F2, is similar to the Tanar 50 mm F2 made by Tanaka Optical mentioned above, so it seems that this lens was also made by simply changing the brand name.

Photograph 4-23 Chiyoca IIF
(Provided by JCII Camera Museum)

(4) The Ichicon, Honor and Jeicy

Only a small number of cameras with the Ichicon, Honor and Jeicy brand names remain in the current used camera market, and the details of these cameras are not well understood. The singularly famous book "Maboroshi no Kamera wo Otte [Chasing the Phantom Camera]" left by Shirai Tatsuo has an interesting description of an interview with Kumagai Genji, the founder of Kōgaku Seikisha, and is referenced herein.

Kumagai, the designer of the Nippon Camera, resigned from Nicca in 1948 and made a new prototype of a Leica copy called Jeicy, featuring a back cover that opens and closes. This was the Ichicon 35 which was brought to Dai-ichi Kogaku and mass-produced, and continued production with Zenobia Optical, which was rebuilt after Dai-ichi Kogaku collapsed,

but later collapsed as well. The Honor was made and released by Mejiro Kōgaku based on the Ichicon 35 without notifying Kumagai[20].

Subsequently, the Honor brand seems to have changed hands from Mejiro Kōgaku to Zuiho Optical. The SL, the final model of the Honor, was not a Barnack Leica copy but rather a design that imitated the Canon. The camera had no major features in terms of specifications and was eventually withdrawn.

Photograph 4-24 Ichicon 35
(Provided by JCII Camera Museum)

(5) The Simor, Murey and Motoca

Other Leica copies such as the Simor, Murey and Motoca are known to have existed, but little is known about them. The only thing that can be said is that these cameras were decent Leica copies, perhaps not at all junk, even if the origins are unknown. At this distance in time, we can only sense that unknown engineers, passionate about the camera, were absorbed in imitating the Leica without any funds or sales channels, as if possessed by something, and so there existed professionals working in the light of recognition as well as laymen and enthusiasts making their energetic contributions in the shadows in the Japanese tradition of craftsmanship.

4.7.7 Analysis of the Rise of Leica Copies in Japan

Allow me to repeat myself a bit. While the Leotax as well as the Nippon are dead copies, the technology for making reasonably high quality products in a short period of time can be said to be unique to Japan, and I think that is significant. In the United States and the United Kingdom, even to make a copy, the manufacturer seems to have gone through a series of formal processes, including disassembling the Leica, starting from an investigation of each mechanism and a detailed investigation of each part, subsequently creating the drawings, building a prototype to check the quality, and then entering mass production. In, Japan, however, there were factories that, if one just brought to them original parts and asked them to duplicate them, they would do it without a lot of fuss, and that was that. There is a technique called “matching” in progressive press working, which leaves recesses unrelated to function on the outer circumference of a part, and there are amusing stories relating that even these recesses were blindly copied by Japanese factories.

However, even if such parts were blindly copied, it is a definite fact that the production technology and processing technology of the unknown subcontractors in Japan at that time, who made parts virtually identical to the parts shown to them in a short period of time, satisfied the minimum requirements.

An interesting phenomenon is that, despite excellent copies being made in the United States and Europe, there was almost no subsequent development taking advantage of the copies, yet the camera industry in Japan, after the war, developed dramatically based on the technology gained from making the Leica copies. In Europe and the United States, where originality is more valued, manufacturers had no choice but to get involved in producing copies as an emergency measure in the war effort, whereas Japanese people, who were always encouraged to “steal art” from their masters, did not feel much resistance to imitation. In addition, rather than being business-like, it was probably fun to disregard profitability and make something for its own sake.

By nature, Japanese people are flexible in thinking and technical ability, and are able to handle everything dexterously, so following an original was not so difficult. Nevertheless, it is also a fact that further development could not be achieved without some strengths such as novelty and originality being involved during the pursuit. As described later, the moment Japan felt it had caught up, the innovative Leica M3 was released, which proved to be a turning point in the Japanese camera industry. After this, many Leica type and Leica copy manufacturers were forced to drop out, and only three companies, Canon, Minolta and Nippon Kogaku, survived. The technology of Nicca, narrowly incorporated by Yashica, remained, but was not much different from Leotax, which went bankrupt due to the absorption-type merger.

The three companies had originality and financial strength. It can be seen that, for the Leotax, the Nicca and the Tanack, the companies tried to plan a product with originality and changed their minds after seeing the M3. A full model change required huge development costs, however, and the companies got bogged down due to cash flow issues. Perhaps the companies could have been saved if they had proceeded down their own individual paths as early as possible, but they recognized the change in the situation too late.

Darwin said, “It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change,” and when we look at the dawn of development of the compact precision camera in Japan, we recall those words.

4.8 Growing Reputation of the Japan-Made Camera and Background

After the war, Precision Optical, which was the first to launch a consumer camera, completed the J developed before the war as the JII, and released the SII in the fall of 1946. From the SII, the original mount of the Hansa Canon was changed to the L mount, offering the practical advantage of usability with the many Leica lenses available on the market.

Photograph 4-25 Canon SII
(Provided by Canon Camera Museum)

Cameras of the Canon brand, which got off to a flying start after the war and boasted stable camera quality, were extremely popular among the US military stationed in Japan. Precision Optical changed its name to Canon Camera (hereinafter referred to as Canon) in September 1947, and the reason for this changes is that, for the Americans who came in their jeeps directly to the factory to purchase the camera, the Canon name proved much easier to remember than Precision Optical[21].

Following Canon, which skyrocketed to the top of the 35 mm focal-plane cameras after the war, was Chiyoda Kogaku Seiko Co., Ltd., who entered the 35 mm focal-plane market with the Minolta 35I in 1957. Then, Nicca and Leotax followed, who had been working on Leica copies since the war. I have already mentioned that Nippon Kogaku underwent a large-scale restructuring immediately after the war ended, but one of the reasons that the camera industry started up faster than any other industry immediately after the war ended was, I believe, that many camera engineers and workers flowed from Nippon Kogaku to other camera companies. Then, Nippon Kogaku, with a slight delay, continued with the Nikon I in 1948, and quickly released the improved M version. I think such a movement after the war is due to the structure peculiar to the camera industry, which somehow can manage with technology even if resources and materials are scarce.

The Japanese government spared no effort to back up the production of these compact precision cameras in Japan. This is because sales to the US military stationed in Japan were regarded as exports, even though they were domestic, and could contribute to the acquisition of foreign currency as collateral for imported food products.

Canon launched the IIB as a successor to the SII in 1949, and won first prize at a national camera exhibition held in San Francisco in the fall of the same year. The following year, the camera was exhibited at the first international trade fair in Chicago and was well received. As mentioned above, Nikon lenses and cameras were also highly praised by the publications in LIFE magazine and the New York Times, and helped raise the level of the Japanese camera industry as a whole. The Japanese-made camera that was thought to be in the realm of imitation was now in the spotlight.

The domestic economy was also boosted by the special demand brought on by the Korean War from 1950. This is because, when people have leisure time to enjoy things, they tend to be attracted to hobby-like diversions, such as photographs. Figure 4-3 shows the sales performance of Canon and Nikon cameras during this period. The figure shows that the number of sales increased significantly every year.

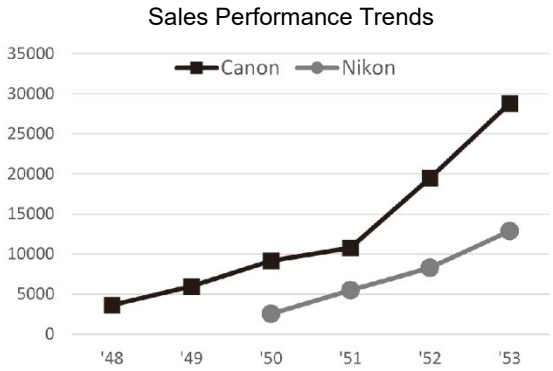


Figure 4-3 Trends in Post-War Sales Performance of Canon and Nikon Cameras[22]

On the other hand, domestic cameras with quality problems began to emerge and, from January 1949, the Japanese government decided to apply the Act Concerning Control of Export Commodities to cameras as well, and inspection of cameras for export became obligatory. New JES (Japanese Engineering Standard) 7101 and 7102 were used as inspection criteria. These new JES standards were based on the inspection rules for exported cameras, which were drafted by the Office of Control Association for Precision Tools in 1943 during the war and prepared by the Camera Subcommittee of the Optical and Precision Instruments Manufacturers' Association after the war. JES is the predecessor of the current JIS (Japanese Industrial Standards).

This exported product inspection was taken over by the Japan Camera Inspection Institute (later, Japan Camera & Optical Instruments Inspection and Testing Institute (JCII)) established in 1954 with Moriyama Kinji, a member of the Diet, as the chairman, and became a method for professional inspection by a third party. Until then, self-inspections and subcommittee inspections were the main types of inspections. This exportation inspection by JCII was carried out over a long period until December 1989, and greatly contributed to the maintenance and improvement of the quality of exported cameras. Note that the current JCII has shifted the focus of its business to cultural projects and, while the abbreviation remains JCII, the institute, as the Japan Camera Industry Institute, manages the JCII Camera Museum, the JCII Photo Salon and the JCII Library under the supervision of the wife of Moriyama Kinji and the former Chief Cabinet Secretary, Moriyama Mayumi.

References and citations

1) Hans-Jürgen Kuc. Kontakkusu no Subete [On the Trail of the Contax], (Katsumido Shashinkiten, 1993), p.24.
2) Schmidt Shōten. “Furikakaru hinoko wa harawaneba naranu” [Brushing Off the Falling Sparks] and Asahi Camera, August, 1935.
3) Sanuki, Matao. Doitsu Kamera no Hon [Book on the German Camera], (Shogakukan, 1998), pp.9-13.
4) Kurashikku Kamera Senka No. 76 [All about Historical Cameras No. 76], (Asahi Sonorama, 2005), pp.72-76.
5) Sakai, Shūichi. Raika to Sono Jidai [The Leica and its Era], (Asahi Shimbun Publications, 2000), pp.188-189.
6) Ogura, Iwao. Kamera to Sensō [The Camera and War], (The Asahi Shimbun, 1994), pp.61-62.
7) Asahi Shimbun, February 28, 1936, Tokyo evening edition, first page.
8) Asahi Camera, August 1934, (The Asahi Shimbun), A22.
9) Matsumoto, Seichō. Shōwashi Hakkutsu 6 [Unearthing Showa History 6], (Bungeishunju, 2005), p.356.
10) Ogura, Iwao. Kamera to Sensō [The Camera and War], pp.52-55.
11) Arakawa, Tatsuhiko. Sōgyō [The Foundation], (Asahi Sonorama, 1986), pp.27-29.
12) Canon Inc., Kiyanonshi: Gijutsu to Seihin [Canon History - 50 Years of Technology and Products], (Canon Inc.), pp.21-22.
13) Nikon Corporation, Hikari to Mikuro to Tomoni – Nikon 75-nen-shi [Light and Micro Together: A 75-year History of Nikon], (Nikon Corp., 1993), p.90.
14) Arakawa, Tatsuhiko. Fukkoku Akarui Anbako [(Reprint) The Bright Dark Box], (Asahi Sonorama, 2000), p.50.
15) Katsumido Shashinkiten, Kiyanon Renji Faindā Kamera [Canon Rangefinder Camera] (Katsumido Shashinkiten / Asahi Sonorama, 1996), pp.54-55.
16) Shirai, Tatsuo. Maboroshi no Kamera wo Otte [Chasing the Phantom Camera], (Asahi Sonorama, 1982), p.19, 25.
17) Nikon Corporation, Hikari to Mikuro to Tomoni – Nikon 75-nen-shi [Light and Micro Together: A 75-year History of Nikon], p.100.
18) Nikon Corporation, Hikari to Mikuro to Tomoni – Nikon 75-nen-shi [Light and Micro Together: A 75-year History of Nikon], p.139.
19) Leica Copies by HPR (CCP).
20) Shirai, Tatsuo. Maboroshi no Kamera wo Otte [Chasing the Phantom Camera], pp.25-26.
21) Katsumido Shashinkiten, Kiyanon Renji Faindā Kamera [Canon Rangefinder Camera], p.61.
22) Katsumido Shashinkiten / Asahi Sonorama, Kiyanon Renji Faindā Kamera [Canon Rangefinder Camera], p.72; Hikari to Mikuro to Tomoni – Nikon 75-nen-shi [Light and Micro Together: A 75-year History of Nikon], p.139. (Graphics by author)

5 From Leica Copies to SLRs

5.1 The Impact of the Leica M3

Recently, it was announced that Photokina, the world's largest photo trade fair in Cologne, Germany, that has been held in the fall of even-numbered years will now be held every spring, starting from 2019. Photokina in 1954, which dates back 65 years from 2019, was also held in the spring, and on April 3, the first day of the event, the Leica M3 took the stage, which was a major turning point in the history of the camera. Leitz removed itself from the 35 mm focal-plane camera trail it had blazed with the Leica IIIf and introduced a completely new system.

Photograph 5-1 Leica M3
(Provided by JCII Camera Museum)

However, Japanese camera manufacturers had a notable penchant for finding out information in advance, and the number of persons making the trip to Photokina were more than usual, including some who, without visiting other exhibits, purchased the M3 released upon its announcement, and immediately returned to Japan. The fact that such persons prepared enough foreign currency to immediately buy an expensive camera indicates that they had acquired information in advance.

While the round shape on the left and right gives tribute to the Barnack Leica, the camera has a modern and sophisticated design, beautiful chrome plating and a large viewfinder, causing the viewer to catch his breath just by looking at it, and yet, when disassembled, reveals a series of even more astonishing things. Many of the functions and capabilities of the Leica M3 are introduced below.

5.1.1 Finder

In the Barnack Leica, the rangefinder and the viewfinder, used for composition confirmation, were separated. While a method of incorporating the rangefinder within the viewfinder, referred to as single-lens type already debuted in the Contax II and the Minolta 35I, Leica also realized this in the M3. However, the Leica M3 took it even further.

First, the bright frame-type field frame indicating the shooting range is automatically switched in accordance with the focal length of the lens. A bright frame is a white field frame that emerges clearly by skillfully combining multiple thin plates so that only the field frame portion of light can pass through a dedicated lighting window, and overlaps the subject image. The conventional field frame is simply vapor-deposited directly onto the viewfinder lens, and was sometimes difficult to see, depending on the viewing angle.

As shown in Figure 5-1, the bright frame-type field frame is a beautifully translucent white frame automatically selected in accordance with the focal length when any of the three types of 50 mm, 90 mm and 135 mm lenses released at the same time was attached (the outermost frame for 50 mm was always visible).

Figure 5-1 Finder of the Leica M3

The finder optical system itself is a sight to see, and because it is 0.91x, which is close to equal magnification, the subject can be captured in an image close to the naked eye. Further, the finder image can be seen directly with the right eye and the subject can be seen directly with the left eye, which is ideal for snapshots that often involve quick shooting.

However, the Leica is not the founder of the bright frame finder itself. In 1947, the Duflex, the world's first SLR camera equipped with a Porro prism-type eye-level finder, had a window-type bright frame finder. The Leica development team may not have known about the Duflex, as it was produced in only a small number in Hungary, but the Casca II, launched in 1948 in the same country of Germany, had a manually selectable bright frame finder.

In fact, the window-type bright frame itself had been used in the Kontur finder for a long time. The Kontur finder is a somewhat primitive finder that allows you to look at a bright frame with one eye and look directly at the subject with the other eye, combining both images in the brain to obtain a “subject image with a frame.” The Leica development team aimed to integrate the principle of this Kontur finder into the finder with a built-in rangefinder, and that was exactly what it

was.

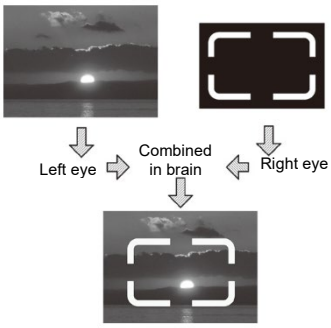


Figure 5-2 Principle behind Kontur Finder

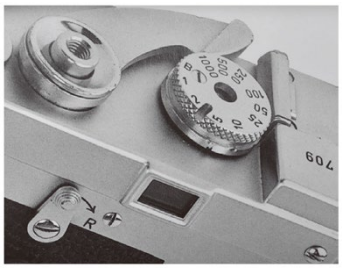
Even though the finder was already by far the best, the team added the parallax automatic correction function. One of the weaknesses of the rangefinder camera was the increase in parallax at short distances. Because the optical axis of the shooting lens and the viewfinder are far apart, when the distance to the subject is short, the shooting range and the viewfinder frame do not match. However, the Leica M3 reads the distance information at the rear end of the lens and corrects the parallax frame position and, by doing so, eliminates the parallax. This is Leica's striking move to create a superior product through the skillful combination of conventional technologies.

5.1.2 Uniaxial Non-Rotating Shutter Dial

One of the drawbacks of the Barnack Leica shutter was that the shutter dial rotated while the shutter was operating. This is because, as described above, the pin that unlocks the rear curtain works with the shutter dial. Another drawback is that the high-speed shutter and the low-speed shutter setting dials are separated, in a so-called biaxial format. This was because the Leica was developed by adding a low-speed shutter mechanism to the early models that had only high-speed shutters.

In order to solve these two drawbacks simultaneously, the M3 was redesigned from scratch so that there was no rotation during operation (non-rotating) and the camera could be set from high speed to low speed with a single shutter dial (uniaxial), thereby achieving a shutter-setting mechanism called a uniaxial non-rotating dial.

Considering the design of the entire camera, the short but simple and easy-to-operate shutter dial featured the shutter speed scale on the shutter dial arranged at equal angles, and allowed the shutter speed to be set in the middle of scale markers. Furthermore, notches are provided on the upper surface of the dial so that when a removable selenium type exposure meter is attached, an appropriate exposure value can be found in conjunction with the shutter dial. All of these features established the standard for later models.



Photograph 5-2 M3 Shutter Dial[1)]

5.1.3 Bayonet Mount

The 26-thread/inch fine-threaded L-mount used in the Barnack Leica was used in many rangefinders and interchangeable lenses. The combination of pitch and diameter is not in the ISO standard for unified fine threads, but it is easy to make because it is a standard thread with an apex angle of 60 degrees. There was even a third party who changed the pitch of 0.979 mm to an easy-to-make 1 mm metric screw system.

Nevertheless, since it is a screw type, it takes time to mount and is difficult to position in the radial direction during mounting. Further, as the number of bright lenses increased, vignetting was a concern. In order to solve these problems in one stroke, M3 adopted a bayonet mount called the M mount.

Changing the mount is risky considering compatibility with conventional interchangeable lenses, but Leitz decided that continued development of the screw type was not desirable. It is in the spirit of the conscientiousness of the Leica that the flange back is slightly shortened so that the L mount lens could be used with a conversion adapter.

With this, the difficulty when changing the lens, which was a drawback of the Barnack Leica, was eliminated, making it now possible to compete against the Contax mount and Nikon S mount. With the leap of the M-type Leica, the M mount subsequently became the standard mount, and many third-party interchangeable lenses have been produced to date.

Photograph 5-3 M3 Bayonet[2)]

5.1.4 Operability

The film winding was changed from the knob type used to date to the winding lever type. The winding lever was found in earlier cameras, but the M3's was easy to operate and complete in design. Initially, when the camera was released, it required two operations, but was improved to one operation midway through the series. The shutter release button was installed coaxially with the winding lever. This is Barnack's favorite layout, even a Leica tradition, one could say. Looking at the M3 from above, the design, which incorporates modernization while retaining remnants of the Barnack Leica, is not at all obsolete even after more than 60 years.

The first thing you notice upon touching this camera is the extreme smooth feel of the winding lever and shutter dial, and your sensibility is tickled every time you operate them. In subsequent film cameras, the major goal was to bring the winding feel closer to that of the M3.

The film loading, which was a disadvantage of the Barnack Leica, involved the same loading method from the bottom cover side, but now was much easier than before with a portion of the back cover that opened and closed.

5.1.5 Leica M3 Marketing Strategy

The exterior finish of the M3 is also wonderful, and the beauty of the chrome plating is reminiscent of traditional craft. The camera was available with a black body as well, although produced in smaller numbers. The philosophy of offering both chrome and black options became a marketing strategy that influenced subsequent cameras.

Even after the product was released, the company remained vigilant and continued to make small modifications, effectively driving up market demand. Leitz added manual switching of the field frame, changed the winding lever to single operation, and changed the sequence of the shutter speeds from the international series of 1,2,5,10 ... to the multiple series of 1,2,4,8,15 ... and so on. These minor improvements were favorably accepted as Leitz' intention to strive ever closer to perfection and, at the same time, created collectible value. The Leica was strictly managed in terms of product numbers, bolstering its value. Even today, the Leica's mystique still generates topics of interest to camera enthusiasts, such as the quiet fad of searching for the Leica of one's birth year, which is a great achievement of the Leica.

On the other hand, there were certainly some conservatives who could not keep up with the innovations of the M3, and some disliked the M3 becoming somewhat bigger and heavier than the Barnack Leica. This, however, was already factored into Leitz' strategy, and countermeasures were considered in advance. In the same year that the M3 was released, the self-timer was built into the IIIf, and subsequently the improved IIIg and the low-priced version Ig were simultaneously released.

Photograph 5-4 Leica IIIg
(Provided by JCII Camera Museum)

The IIIg is equipped with the bright frame finder and parallax automatic correction that were successful in the M3. The clever marketing strategy that sold the M series and the Barnack Leica together for a long time until 1970 and held the hearts of old and new fans serves as a great reference even today.

5.1.6 Postwar Zeiss Ikon Trends

I would like to touch on the post-war trends of Zeiss Ikon, who gave birth to Leica's strong rival, the Contax. When the US military occupied the city of Wetzlar, home to Leitz, the city amicably welcomed the occupation. For this reason, the Leica remained substantially intact, could start production shortly after the war and, although there were some problems with the quality of the arranged parts, sales of the post-war version of the Leica IIIc resumed in the fall of 1945.

On the other hand, Carl Zeiss and Zeiss Ikon awaited harsh fates. The first to invade Dresden was the US military, but since the region was to be governed by the Soviet Union, the US military, wanting the best optical technology in the world, secured executives and senior engineers and transferred them to Heidenheim and Oberkochen under US military jurisdiction, which was the limit amidst the pressure of the time.

The facilities and personnel of Carl Zeiss left behind in East Germany were requisitioned by the Soviet Army who turned up later. Zeiss Ikon, in charge of camera manufacture, was even more disastrous. The company was integrated with other manufacturers in Dresden and turned into a Volkseigener Betrieb (VEB) (Publicly Owned Enterprise). Naturally, motivation did not rise and, in the afterglow of prewar technology, the company finally released the world's first pentaprism-equipped SLR camera, the Contax S. While later the camera division only was separated and released a Pentacon brand SLR, the sales routes to wealthy Western countries were limited.

In addition, the Soviet Union, intending to manufacture cameras in the country, sent Zeiss Group engineers along with equipment and some jigs and tools necessary for production to Kiev, Ukraine, and resumed production of the Contax II and III. The components of the cameras were Contax, but the brand changed to Kiev and the cameras were named the Kiev II and III. This series of the Kiev brand continued with the IIa, IIIa,

IV and V, but was produced by inertia until the late 1970s in a closed socialist regime behind the Iron Curtain, with only a few minor improvements. Yet, because the basic design was good, many of these “Kiev Contax” are of decent quality, which is rare for the Soviet Union.

Photograph 5-5　Kiev II
(Provided by JCII Camera Museum)

Of the Zeiss Group transferred to the West by the US military, Zeiss Ikon secured a camera production site at the former Contessa factory in Stuttgart, but had to leave its excellent workers in East Germany and so the production launch was delayed. While the Leica IIIc resumed production in the fall of the year the war ended, Zeiss Ikon did not resume full-scale production until 1948, and this production also focused on the spring camera.

In 1950, Zeiss Ikon finally released the 35 mm camera with a focal-plane shutter as the Contax IIa and the Contax IIIa, which were improved versions of the II and III, respectively. This is the year that the Leica masterpiece, the IIIf, hit the market.

Although late, these improved Contax versions were cameras that made up for the weaknesses of the previous Contax cameras to date. First, the camera was smaller and lighter. The width is 135 mm, which is almost the same as that of the Leica IIIf, and the weight is 690 g, which is 30 g lighter than before the improvements, making it not the same but the closer to weight of the Leica IIIf, 530 g. Further, the layout of the rangefinder window and the focus adjustment dial was changed at the expense of a baseline length of 95 mm to 75 mm, but avoided the drawback of the II, where the finger covered the rangefinder window when adjusting the focus.

Photograph 5-6　Contax IIa
(Provided by JCII Camera Museum)

However, the Contax was a good rival of the Leica really only with these two models. This is because Zeiss Ikon shifted its focus to the development of the SLR camera. The result of this shift was the Contaflex, which was released in 1953. This camera, however, as described later, was equipped with a lens shutter and lacked potential. Further, in 1960, the Contarex series equipped with a focal-plane shutter was fully released, but the price was abnormally high. Zeiss Ikon could not win the battle with the SLR camera made in Japan and, after a while, withdrew from camera manufacture. The fact that that final decision was made by the former Contax I project leader, Kueppenbender, who was now the president, is a quirk of history.

The Contax brand would later be revived with the cooperation of Yashica, the details of which will be described later. In addition, the Zeiss Ikon name was revived in 2005 as a rangefinder camera in partnership with Cosina of Japan, but there was no successor and ended with only one sister camera in the popular price range.

5.2 Swell to the SLR Camera

1954, when the M3 was announced, marked nine years since the end of the war and, for the Japanese camera manufacturer who had gotten an early start, brought an opportunity to solidify its position with the special demand of the Korean War and the support of the government. Canon relocated to the current Shimomaruko, Ota-ku, and was about to release the IV Sb2, a brush-up version of the famous IV Sb, which was said to be on par with the Leica IIIf, while Nippon Kogaku was to release the newly developed Nikon S2. The Nicca and the Leotax also secured certain positions as Leica alternatives as the quality stabilized.

During this period, the photography culture spread through the general public due to the economic upturn, and the number of cameras in the popular price range other than the 35 mm focal-plane camera was rapidly increasing in Japan. As mentioned above, since the legendary “Ginza San-ai Building Queue Affair” by Ricohflex III in 1950, TLR cameras boomed, and many camera manufacturers jumped into the race. The spring camera was also still actively used.

It was under such circumstances that the Leica M3 was unleashed. At first glance, it was clear that the sophisticated design and advanced features surpassed even the Barnack Leica, which had reigned at the top of rangefinder cameras. And, to everyone’s surprise, Leitz not only announced the M3, but released it at that very same time. This is amazing considering that taking several months to release a product after its announcement is only natural, and in some cases, in consideration of the recent digital camera situation, a camera

may never even get released after being announced.

However, it was those involved with camera manufacturers who were shocked by the appearance of the M3, and its debut may have seemed fantasy-like to the general public. Originally, the Leica and the imitation 35 mm focal-plane cameras were luxuries and out of reach unless you were a professional or a photo enthusiast-of-means. Looking at the prices of the cameras at that time, the domestic Leica types (Nikon S, Canon IV Sb, etc.) were 60,000 to 80,000 yen, but the TLR camera was around 20,000 yen, depending on the attached lens, and the Ricohflex III, which caught the hearts of the general public, was less than one-third of that, which was a significant difference.

However, even if existent in another dimension, it is natural that camera enthusiasts of the Leica (at least its copy) would one day become interested in a camera that uses 35 mm film and, looking at this time period from a holistic view, 35 mm cameras became the mainstream in place of the medium-format cameras and were divided into SLR cameras and popular compact cameras.

Figure 5-3 illustrates changes in the number of domestic cameras produced by model. In the 1950s, the spring cameras and TLR cameras were the mainstream, but subsequently SLR and compact cameras using a lens shutter rapidly became widespread as 35 mm cameras. Below, I will delve into the upsurge of the era of the 35 mm SLR camera from various aspects.

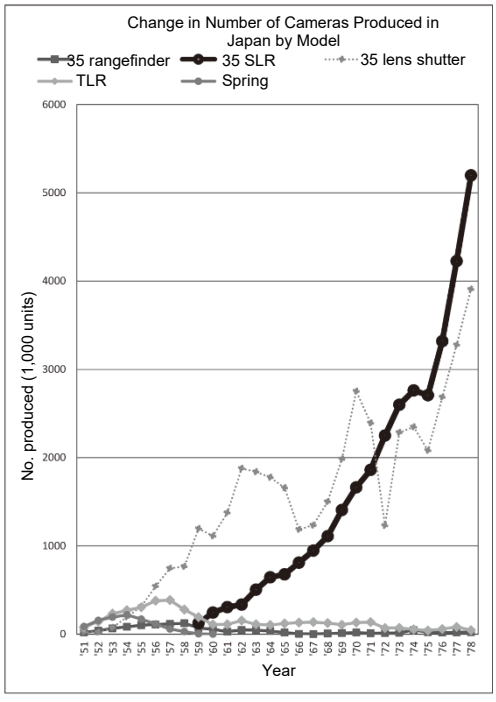


Figure 5-3 Change in Number of Cameras Produced in Japan by Model[3)]

5.2.1 Features of SLR for Rangefinder Camera

One of the advantages of the SLR camera over the rangefinder camera is that the SLR is strong in telephotography and close-up photography, as mentioned above. The SLR camera allows you to observe the image of the shooting lens as is on the finder, making it possible to easily take pictures even if attached to a microscope or an astronomical telescope, to put it to extremes.

While this is not impossible with a rangefinder camera, it is exceedingly difficult. For example, Leica accessories include a mirror housing with the brand name Visoflex, and Nikon also has something similar. This housing, like an SLR, reflects the image of a telephoto lens by a mirror placed in the middle, allowing the user to check the focus by observing the image, but its weakness is its lack of mobility.

Photograph 5-7 Visoflex
(Provided by JCII Camera Museum)

It is very difficult to take a close-up shot at an extremely close distance to a subject using a rangefinder, but an SLR camera allows you to easily take such photos as long as you have a close-up lens, or even just by placing an ordinary loupe in front of the lens.

In other words, the SLR camera offered an extremely versatile systematic design, and the catch phrase, “From eyes to the moon,” of the first domestically produced 35 mm SLR camera, the Asahiflex, and the catch phrase, “From outer space to bacteria” used when Olympus announced the M-1 later clearly reflect this. The SLR camera was, so to speak, a child of the times who was able to successfully ride on the current trend of seeking expansion of the imaging range.

Yet, on the other hand, there are many drawbacks unique to the SLR camera. First, when the finder image is observed and the shooting operation is started, it is necessary to retract the mirror at the observation position and transfer the optical path of the shooting lens to the film. Hence, a phenomenon in which the finder becomes pitch black and the image cannot be observed (a so-called blackout) occurs. This is a problem that is difficult to avoid, in principle, and the mirror must be raised prior to the shutter operation and returned to the original position after the exposure is completed. In particular, in order to shorten the blackout time, a quick return mirror mechanism that automatically and instantly returns the mirror immediately

after the end of exposure is required.

In order to forcibly avoid this problem, there were some cameras that secured the semi-transparent pellicle mirror in place and left some light on the viewfinder side even during shooting, but the amount of light for shooting was insufficient, and thus such cameras were not widely used for general photography, but mainly used as special cameras for high-speed photography.

Next, there is the problem of open aperture. When shooting, the aperture of the lens is set to the desired value according to the desired shooting parameters, but in order to confirm the viewfinder image, the aperture should be set to the maximum until just before the shutter is activated. This is because a bright image is required to correctly observe the finder image. Accordingly, normally it is ideal that the open aperture value is set to a predetermined aperture value only during shooting. In the case of a rangefinder camera, the viewfinder for observation and the lens for photography are completely different optical systems, so problems are not likely to occur.

In addition, the necessity of this open aperture causes a problem when measuring the brightness of the subject. Since the aperture value is different during observation and shooting, it is necessary to transmit the difference between the open aperture value of the shooting lens and the aperture value at the time of shooting to the camera side in advance when measuring the light in advance. This full aperture metering method has aspects that make it quite difficult for an SLR camera that is premised on interchangeable lenses. There is also an aperture metering method that actually stops down the aperture of the lens to perform metering, but a detailed explanation will be given in a later chapter, and here we will only introduce the terms “full aperture metering” and “stop-down metering.”

There is also the problem of supporting wide-angle lenses. In a rangefinder camera, in principle, there is only a thin focal-plane shutter between the shooting lens and the film surface, but with an SLR camera, the rear end of the lens cannot be physically brought close to the film surface because a mirror is inserted between them. For this reason, it is not possible to adopt a symmetrical wide-angle optical system in which lens groups are arranged substantially symmetrically about the principal point of the lens, such as, for example, the Topogon type optical system shown in Figure 5-4.

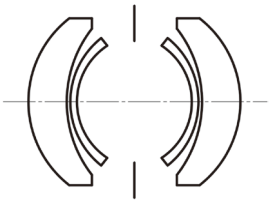


Figure 5-4 Optical System of Topogon Type Wide Angle Lens

In the 1930s, an optical system called retrofocus (meaning to shift the focus backwards, also called inverted telephoto) was invented, and it was indeed fortunate timing for the SLR camera that in 1951 Angénieux (France) put retrofocus into practical use in a 28 mm F3.5 lens for Exakta mounts. This optical system is suitable for an SLR camera with a mirror because the back focus can be lengthened even with a wide-angle lens. An example is illustrated in Figure 5-5. A concave lens is placed in the front for divergence, making it possible to move the convex lens group in the rear forward and gain the back focus. Compared to a normal single lens indicated by the two-dot chain line, the distance from the rear end of the lens to the film surface is lengthened from L’ to L, and a single-lens reflex mirror can be placed in this space.

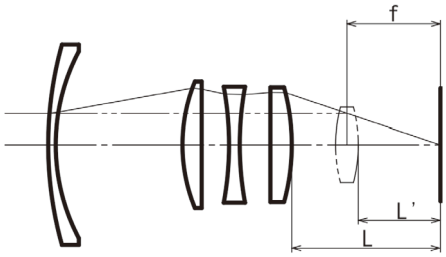


Figure 5-5 Optical System of Retrofocus Type

However, even today when we can take advantage of the developments of optical design technology with computer-based ray tracing, this optical system is still large compared to that of the rangefinder camera. While this point posed extreme difficulty, just to find a way to eliminate the shortcomings of the SLR camera had significant value.

Although the SLR camera had several shortcomings as described above, the great promise the camera held in expanding the imaging range to various fields was irreplaceable. For the companies in Japan, the Leica, which had been considered a fellow competitor in the race, was now clearly way out in front with its debut of the M3, making companies decide, as a practical matter, to head in a different direction from the Leica and continue to expand the advantages of the SLR and overcome its shortcomings.

5.2.2 Roads to the SLR

Naturally, it is easy to imagine that those in the industry who traveled from Japan to Photokina and purchased the M3 in Germany conducted a disassembly survey within each department upon their return to Japan. At the very least, there are records indicating that the newly established Japan Camera Industry Association obtained the camera and allocated to each company part of the task of analyzing its mechanisms and performance.

The general theory is that the companies marveled at the innovative spirit of the M3 and changed their direction from the rangefinder camera to the SLR camera at once, but there are differences with regard to the circumstances and methods between the companies. First, let's classify the roads taken after the M3, focusing on each company that bloomed as an SLR camera manufacturer later. The company names written here are those from around 1954, the year that the M3 was announced.

(1) From Leica type to SLR

Manufacturers that switched from a Leica type, that is, a 35 mm focal-plane camera, to an SLR camera include Nippon Kogaku, Canon and Chiyoda Kogaku Seiko. Nicca Camera (later absorbed by Yashica via Taiho Optical) is also considered to have taken this route, although the circumstances are somewhat complicated. This transition was not possible for Showa Optical Works (later Leotax Camera), Tanaka Optical, Meguro Kōgaku and many other small-capital Leica copy manufacturers.

Leica type cameras are basically equipped with a focal-plane shutter, and the shift to an SLR camera, which is more compatible with a focal-plane shutter than a lens shutter, was easy to some extent, at least from the viewpoint of the shutter. However, the development of the mirror drive mechanism and finder optical system, which are the core of SLR camera, demands enormous development costs and technical capabilities, so it was not possible to survive without adequate financial resources and technical capabilities evincing some originality.

(2) From Non-Leica type to SLR

There are many camera manufacturers that switched from a non-Leica type, such as a 35 mm lens shutter camera and a TLR camera, to the SLR camera. Olympus Optical Co., Ltd., Konishiroku, Tokyo Optical, Mamiya Optical, Fuji Photo Film, Kuribayashi Camera, Riken Optical, Sanshin Kōgaku Kōgyō, etc., to name a few.

While it was easy for each company to unitize the mechanical parts of the 35 mm lens shutter camera, the TLR camera and the spring camera and primarily introduce lens shutters made by shutter manufacturers such as Seikosha and Copal to produce their cameras, these manufacturers decided to enter the market in anticipation of the future of the SLR camera. As a result, these manufacturers, although entering the market at different times, succeeded in developing the focal-plane shutter SLR camera. Among them, the respective speeds of the technological development of Tokyo Optical, which released Topcon R in 1957 ahead of Nippon Kogaku and Canon, and Kuribayashi Camera, which announced Petri Penta in 1959, are noteworthy.

The relatively large manufacturers listed above were able to offset development costs for the SLR camera through sales from other areas of business and types of camera, but on the other hand, many of those in the camera “cottage makers” did not have the resources to meet the prohibitive development costs, were unable to transit to the SLR camera, and thus were destined to withdraw or disappear.

(3) First-time market entry with SLR camera

A few manufacturers aimed at the SLR camera from the start without paying attention to the development of Leica copies and cameras of other genres. A representative example is Asahi Optical Co., Ltd. (founded as Asahi Optical Joint Stock Co., later Asahi Optical Co., Ltd., Pentax, HOYA, etc. and now Ricoh Imaging; hereinafter Asahi Optical) and, even though digital is now the mainstream, the Pentax brand continues to shine.

In addition, Orion Seiki Sangyō Y.K. (later Orion camera, Miranda Camera) known for mass production of Japan's first pentaprism-equipped SLR camera, and Teikoku Kōgaku Kōgyō (later Zunow Opt.), which developed Japan's first SLR camera equipped with an open aperture mechanism, were also oriented toward SLR cameras from the start, but have disappeared.

These two manufacturers should be praised for their foresight and high aspirations in ascertaining the future of the SLR camera, but are examples that demonstrate the difficulty of tapping into the SLR market, which requires a high degree of systematic design and quality.

5.2.3 Pioneers of 35 mm SLR Cameras

In Japan, all 35 mm SLRs except the Asahiflex in 1952 were released after the introduction of the Leica M3 in 1954. Looking back from a global perspective, however, its appearance was seen even before the war. Here, I will describe the emergence and initial trends of these 35 mm SLR cameras.

(1) The Sport and the Kine Exakta, earliest ancestors of the 35 mm SLR camera

Conventionally, the world's first 35 mm SLR camera was generally said to be the Kine Exakta delivered by the German company Ihagee in 1936, but later research revealed that the honor goes to the Sport, a camera announced by GOMZ (Gosularstvennyi Optiko-Mekhanicheskii Zavod (State Optical-Mechanical Factory)) of the Soviet Union in 1935 and sold in small numbers.

Photograph 5-8 Sport
(Provided by JCII Camera Museum)

As evident in Photograph 5-8, the Sport has a strange appearance that does not look like any other camera. The second story of the “two-story structure” has reasons for being, one of which is the role of the waist-level finder. The typical waist-level finder is foldable to improve portability, but the Sport cannot be folded because the second story also serves as

a shelter for the shutter plate (front curtain), which is its second purpose.

An astute reader may wonder where the other shutter plate (rear curtain) sits waiting, but the answer lies in the “sliding” incorporated at the bottom of the camera. It is completely unique. The structure is illustrated in Figure 5-6. After the mirror rises in the direction of arrow A, the front curtain retracts in the direction of arrow B and exposure of the film begins. After the predetermined shutter time elapses, the rear curtain waiting at the bottom of the camera rises along the guide groove, swinging in the direction of arrow C, to close the opening, and the exposure ends.

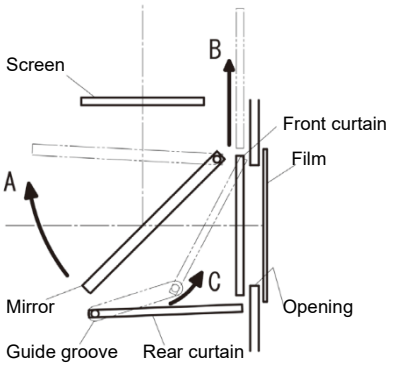


Figure 5-6 Structure of Sport Shutter

The Sport is an enigma in every respect, but it is a fine SLR camera because it reflects the image of the shooting lens upward with a mirror, allowing the user to observe the image. However, only a small number were manufactured, and knowledge of its existence was hard to come by due to the closed nature peculiar to the Soviet Union. Yet, even if the camera had been known, it was too unique in form and function to serve as a model for subsequent SLR cameras, and in a general sense it is correct to assume that the actual earliest ancestor of the 35 mm SLR camera is the Kine Exakta.

About the Kine Exakta, Ihagee had already released the best format (4 x 6.5 cm) SLR camera, the Exakta, in 1933, and developed the 35 mm format based on the Exakta. The term “Kine” means cine (motion picture) and was so named because the camera uses the 35 mm film for motion picture cameras. The best format film has a backing paper like the 120 type film and, in comparison, the 35 mm camera that fed the film by perforations required more precision manufacture, making advancements in 35 mm SLR camera precision machining inevitable.

Photograph 5-9 Kine Exakta
(Provided by JCII Camera Museum)

The Kine Exakta is a high-quality camera that incorporates Germany’s proud tradition of precision metal machining and is comparable to the Leica and the Contax. Its mechanical appearance overflowing with precision shines to this day. In addition, features such as the lever mechanism that winds one frame per pull, the interchangeable finder screen (focusing screen, hereinafter referred to as the screen) and the sync contact installed prior to the Leica reveal a high degree of foresight. The finder is a waist-level fixed type, but a built-in loupe is available for more accurate focusing. However, the mirror is not a quick return type, resulting in a blackout after shooting, and must be returned back into place by winding.

There are many mysterious specifications incorporated in this camera. For example, the lever and shutter release button for film winding are operated by the left hand. In addition, a film cutter is built into the camera, allowing the shot frames of the film to be removed. The intent behind these mechanisms is not quite understood, but the concept of this camera seems to be one focused on close-up photography and copying. An SLR camera that allows observation of the image of the shooting lens, as is, is clearly more advantageous for close-up photography and copying than a rangefinder camera with parallax and, when this camera is mounted on a copy stand, the waist-level finder is in the ideal position and the winding lever, normally operated by the left hand, is positioned on the right-hand side. At first glance, it seems inconvenient that the shutter release button is on the lower side, but this poses no problem at all since it is natural to use the cable release for copying. With a close-up ring also available as an accessory, so I think this concept discussed above is most likely quite close to the truth.

(2) The Duflex, boasting incredible innovation

As was the case with the Kine Exakta and the Sport, early SLRs employed a waist-level finder. The waist-level finder was widely employed with TLR cameras because of its extremely simple structure, but has a major drawback with

SLR cameras. That is the difficulty of vertical shooting. With the TLR camera, the original Rolleiflex had a square frame, so there was no need for vertical shooting in the first place, but this is not the case with the 35 mm SLR camera. With the Sport, designers ducked the issue by separate installation of a reverse Galilean eye-level finder. However, it is only natural that the user would want to view a realistic finder image formed by the shooting lens, which is the greatest feature of the SLR camera, at eye level. Such an eye-level finder also facilitates vertical shooting and increases maneuverability. The Duflex was the first to achieve this eye-level finder for the 35 mm SLR camera.

The Duflex was developed by Gamma in Hungary, and only a small number were manufactured and sold in 1947. Being a model born in Hungary during a period of rapid communization under the occupation of the Soviet Union after the war, its existence remained unknown in Japan, but in 1969 it happened to catch the eye of a representative of Asahi Optical in Europe, and was obtained and sent to the Pentax Gallery in Japan, where it became known for the first time. Details such as its background were introduced in the September 1970 issue of Camera Mainichi.

Photograph 5-10 Duflex
(Provided by JCII Camera Museum)

The features and specifications of the Duflex reveal incredible foresight. It was an innovative camera equipped with a number of functions ahead of the Japanese-made SLR camera that later swept the world, including a Porro mirror type eye-level finder and a bright frame viewfinder installed side by side, a quick return mirror, an automatic aperture (close to the idea), a lens mount bayonet structure, a uniaxial non-rotating shutter dial, a metal curtain (a thin curtain that is not a Contax louver-type) and a focal-plane shutter.

Provision of a viewfinder along with an eye-level finder is strange at first glance, so a little explanation is needed. The Duflex eye-level finder allows direct observation of the shooting lens image, but the image is only near the center and the full frame is not visible. Therefore, a viewfinder is needed to check the composition. Why the full frame was not made observable is unknown, but presumably the designers were against the idea of making the dimensions, particularly the overall height, of the camera too large. In order to see the full frame with the Porro mirror type, a large space is required for three mirrors, each of a size close to the picture size, instead of the pentaprism, which inevitably increases the size in the height direction. If a compromise is made only in the center area, each mirror can be made smaller and an increase in the size of the camera can be avoided. The decision was made to install a separate viewfinder for a full-frame view, but the company did not cut corners at all and made it possible to switch between three types of bright frames.

The designer of the Duflex, Jeno Dulovits, is a Hungarian. It is very interesting to think that if Hungary remained on the Western side and the Duflex had been widely known to the world from the beginning, how its innovation would have influenced the later development of the Japanese SLR camera, especially with regard to the quick return mirror dispute between Asahi Optical and Nippon Kogaku, which will be described later. Furthermore, Dulovits could have become a great figure in the camera world alongside Barnack, but when total production reached about 580, an order to discontinue production was issued early only because the defect rate was high[4]. In the midst of the post-war turmoil, the Soviet Union invaded Budapest, and Gamma was swallowed by the wave of the socialist regime.

(3) Contax S, the world's first camera equipped with a pentaprism

Currently, the eye-level finder of the SLR camera uses a pentaprism (to be exact, a pentagonal roof prism) or a pentamirror having a similar optical path. While this principle has been known since the 19th century and a specific patent was granted, the pentaprism was not realized because its machining is so advanced.

In 1949, the world's first pentaprism-equipped SLR camera, the Contax S, was released. Manufacture was achieved by the former Zeiss Ikon, which had been separated, left on the Eastern side, and turned into a publicly owned enterprise, and for the first time the precision pentaprism was mass-produced by an optical manufacturer that, though separated, still had a high level of technical capabilities. Plans for the pentaprism type SLR camera had been made before the war, and a patent application was also submitted in 1941[5]. Naturally, the pentaprism seems to have been incorporated in Kueppenbender's concept as well. It has also been pointed out that the basic design of the Contax S was influenced by the Duflex. That is, the Duflex System Reflex S equipped with a pentaprism was announced in 1948 as a successor to the Duflex, and the appearances of the unfortunate model that ended only in this prototype and the Contax S are similar[6]. Perhaps there was some form of technology transfer (outflow)

from Gamma, which dissolved shortly after the announcement.

Photograph 5-11 Contax S
(Provided by JCII Camera Museum)

By adopting a pentaprism, the Contax S realized a modern design that would serve as a model for future SLR cameras and had a great influence on the subsequent development of Japan-made SLR cameras, including the internal layout. An optical path diagram of the Contax S is illustrated in Figure 5-7.

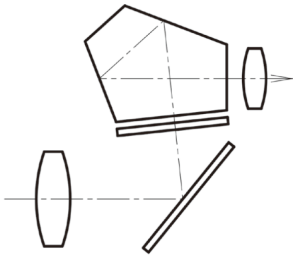


Figure 5-7 Optical Path Diagram of the Contax S

The optical path is almost the same as that of a modern SLR except that the pentaprism is made to "bow" a little, but this seems to be a sign of efforts to make the triangular roof caused by the pentaprism appear as low as possible. The triangular roof, which is not so strange to our modern eye, was not considered pleasing in appearance at that time. However, this "bowing" is surprisingly effective in making the camera look smaller, and the Minolta αSweet II, which was released about 56 years after the Contax S, was also miniaturized by this same "bowing" method. While it can be said that this "bowing" was a result of "visiting the old to learn something new," the use of a pentamirror instead of a pentaprism in the Minolta was a modern design. By the way, most SLR cameras have the pentaprism upright, but there also exists the Contarex I (see Photograph 5-14) in which the pentaprism is leaned backwards (the mirror's reflection angle exceeds 90 degrees), which is the opposite of "bowing." This may have been to secure space for the exposure meter in front of the pentaprism.

The Volkseigener Betrieb (VEB) (Publicly Owned Enterprise) on the Eastern side, which designed and developed the Contax S, released models with minor changes, such as the Contax D, after this camera, but soon the Contax brand could no longer be used for export due to a trademark issue that broke out with the Western side. The company had no choice but to switch to the brand Pentacon, and in 1964 the company name was changed to VEB Pentacon. Furthermore, because there was also a former KW brand, Praktica, among those incorporated into the same publicly owned enterprise after the war, the SLR brand was ultimately unified to Praktica. New models of the Praktica SLR camera continued to be released while making some technological improvements on the Eastern side until at least 2000. Nevertheless, because the brand change coincided with the era when Japanese SLRs swept the market, and because the SLR required a hobby-like quality that satisfies both practicality and the desire for ownership, the brand change cut the camera's appeal in half and its reputation in the market never really took off.

(4) The Exakta Varex, a finder-interchangeable SLR

In 1950, the Exakta Varex, an improved version of the Kine Exakta, was released. The special feature of this camera lies in its waist-level finder that can be replaced with an eye-level finder employing a pentaprism. That is, the camera is designed with an interchangeable finder, making it possible to make good use of the characteristics of the SLR camera, which reflects the subject image via a mirror to form an image on the screen, and allow adjustment to the shooting style of the user, whether at eye level or waist level.

Photograph 5-12 Exakta Varex
(Provided by JCII Camera Museum)

The Exakta Varex had only two types of finders, but served as the foundation for the birth of finders with various functions in later Japan-made SLR cameras, such as a finder that magnified the finder image (high-magnification finder), a finder with a longer eyepoint to improve maneuverability (action finder, speed finder) and a finder with a built-in exposure meter and automatic exposure function. This model seems to have been quite popular in Europe and the United States, and appeared in the Hitchcock thriller movie "Rear Window."

5.2.4 SLR with Lens Shutter

All of the models that have been described thus far as an "SLR camera" have been equipped with a focal-plane shutter.

From the end of the 1950s to the beginning of the 1960s, Japan-made SLR cameras appeared one after the other, and the flow of camera development changed drastically. But, prior to this discussion, I would like to break away and touch on the form of the SLR camera with a lens shutter. This is because, to write about Zeiss Ikon on the Western side, such a form cannot be avoided.

(1) The Contaflex and stumble of Zeiss Ikon

After the war, in contrast to the former Zeiss Group on the Eastern side which experienced a slowdown, Zeiss Ikon on the Western side was recovering its business under the command of Kueppenbender. While introducing spring cameras such as the Ikonta series, which had been popular since before the war, and the IIa and the IIIa, which are improved versions of the Contax II and III, Zeiss Ikon on the Western side also extended their tentacles to the development of the 35 mm SLR camera. In 1953, the long-awaited camera, the Contaflex, made its debut. The name Contaflex was also given to a prewar TLR camera, but this was a newly developed model that has nothing to do with the earlier camera.

Photograph 5-13 Contaflex II
(Provided by JCII Camera Museum)

The Contaflex is a camera with a Leitz-like beauty in appearance and sense of precision. The SLR, while having a large and rugged image compared to the rangefinder camera, has a width of 127 mm, which is nearly 10 mm smaller than that of the Leica IIIf. Equipped with a pentaprism, the camera is tall, but features a Fresnel lens mounted on its finder which gives a brilliant aerial image, making image viewing extremely easy. The back cover is removable and integrated with the bottom side of the traditional Contax, and the winding knob, film counter and shutter release button are coaxial, echoing the simplicity of the Contax II.

However, the lens of this camera is not interchangeable. The reason is that the company despised the complicated and delicate focal-plane shutter and installed a lens shutter instead. Lens shutters are widely used in spring cameras and TLR cameras and, because there were specialized manufacturers such as Deckel and Gauthier, when delivered as a unit, savings in the labor required for development were achieved and, at the same time, reductions in development and product costs could be expected. In addition, use of a lens shutter offers the advantage that the entire camera can be made smaller because the internal space for the focal-plane shutter is not required.

Furthermore, in flash photography with a flash or the like, even at the high speeds at which the focal-plane shutter ends up providing slit-like exposure, the lens shutter always exposes the entire image, which has the great advantage of enabling high-speed synchronization. Perhaps the Contaflex planners viewed these advantages as more than compensating for the disadvantages, but it turned out that that view was through rosy sunglasses.

With a lens-shutter type SLR camera, it is usually necessary to keep the shutter open for image observation. To prevent light leakage with a mirror only is difficult, so a light-shielding plate is required immediately in front of the film. In other words, the series of operation sequences at the time of shooting becomes extremely complicated, such as press shutter release button → close shutter, stop down aperture → raise mirror, move light-shielding plate away → open shutter → close shutter → return aperture, return light-shielding plate, lower mirror. If this were a focal-plane shutter camera, the focal-plane shutter also serves as a light-shielding plate, making the operation relatively simple: press shutter release button → stop down aperture, raise mirror → open shutter → close shutter → return aperture, lower mirror. In fact, the mirror of the Contaflex is not a quick return.

In addition, since the lens shutter is naturally located within the lens optical system, the difficulty in coupling the action of the mirror and the action of the shutter is problematic, resulting in poor compatibility with an interchangeable lens function. With the Contaflex, the designers gave up on the interchangeable lens and provided, as fixed types, an attachment type conversion lens capable of obtaining a telephoto effect of 1.7 magnification and several close-up auxiliary lenses called Proxars for close-up photography. However, the greatest feature of an SLR camera –the ability to directly observe the image of any shooting lens as long as the lens is attachable – was narrowed by these lenses being fixed. Some of the lenses of later models were interchangeable to wide-angle, telephoto and close-up lenses by interchanging the front lens group, but Zeiss's high-quality large-diameter interchangeable lens group could not be used.

The Contaflex made frequent model changes, and as a result, continued to sell for almost 20 years until the early 1970s. However, at least in terms of sales, and apart from in the early days, the camera ranked far below Japan-made SLR cameras. Then, compared to Japanese models equipped with a quick return mirror as a matter of course, the Contaflex with its "pitch black view after shooting" until the final model in 1970 was technically completely behind the times.

Furthermore, as a result of allocating development

capabilities to the Contaflex, it was no longer possible to release a successor to the Contax IIa and IIIa, which also dropped out of the competition with the Leica.

Zeiss Ikon positioned the Contaflex as an intermediate model and may have been intended to leverage the Contarex I, which was equipped with a focal-plane shutter and released in 1960, in the high-end model field, but the Contarex I was very expensive, big and heavy, and with its strange styling shown in Photograph 5-14, there was no way to beat Japan's full-scale SLRs, including the Pentax AP, the Minolta SR-2, the Nikon F and the Canonflex, that appeared one after the other in the latter half of the 1950s, and thus Zeiss Ikon withdrew from the camera market in 1971 and became a lens specialist.

Photograph 5-14 Contarex I
(Provided by JCII Camera Museum)

Why did Zeiss Ikon employ a lens shutter in the Contaflex? As mentioned above, it may be because of miniaturization and cost advantages, but presumably Zeiss had a close relationship with Deckel, a long-established, highly skilled lens shutter manufacturer. Deckel's flagship product, the Compur shutter, was praised for its high quality since that time, adopted by various models including the Zeiss, and highly regarded. Most likely use of a shutter produced by Deckel, with which Zeiss Ikon was so familiar, seemed attractive when advancing into the SLR, and as a result, was given a higher priority. Another thing, in the development of the SLR, perhaps Zeiss Ikon found it difficult to install a Contax-type vertically traveling shutter due to the camera layout. Because the SLR has an observation screen just above the shooting frame, with vertical travel, there is no place to install the windup shaft with a Contax-type shutter. With a modern (non-windup) vertically traveling metal focal-plane shutter, installation is possible, but such a design had not been developed yet in this era. This made it necessary to develop a new horizontally traveling, that is, a Leica-type, focal-plane shutter, but perhaps the hurdle seemed too high.

(2) Domestically produced lens shutter type SLRs

That Zeiss camera, the Contaflex, described in the previous section, though not of “good pedigree” due to the installation of the new light-shielding plate and the complexity of the shutter operation sequence, which are peculiar to lens shutter type SLRs, could be bought at a relatively reasonable price, and therefore certainly was a hit such as it was. Witnessing this, many manufacturers entered this field. In Germany, Kodak's Retina Reflex and the well-established Voigtlander Bessamatic are famous.

While this document describes a model equipped with a focal-plane shutter as representative of the mainstream, there is also the fact that lens-shutter-type SLRs, such as the Contaflex mentioned above, prospered for a while and so, even though the topic deviates from the main subject of this document, I will describe the unique technology of the domestically produced 35 mm lens shutter type SLR for reference.

This type, which can reduce manufacturing costs including development costs by using ready-made lens shutters, was also incredibly attractive to domestic manufacturers, and a considerable number of products were released from the 1960s to the 1970s mainly in the field of popular cameras. Although Tokyo Optical and Kowa aggressively commercialized such cameras, it is remarkably interesting that Nippon Kogaku and Canon, whose main products were focal-plane shutters, also temporarily introduced lens shutter type SLRs in the popular model price range.

Here, the technology will be explained using, as an example, the Topcon Wink Mirror S of Tokyo Optical, which pursued functionality, as a representative work of a domestic lens shutter type SLR.

Tokyo Optical was established along with Katsuma Kōgaku Kikai in 1932 as a manufacturer of optical weapons mainly for the Army, with the surveying instrument factory of Seikosha serving as the base. With its background similar to that of Nippon Kogaku, which had a close relationship with the Navy, the two companies were called “Toko of the Land, Nikko of the Sea” with the name Toko certainly standing for Tokyo Optical in Japanese (Tokyo Kogaku) and Nikko certainly standing for Nippon Kogaku. While Nippon Kogaku would advance to camera manufacture after the war, Tokyo Optical entered the camera business in 1936 before the war, producing lens shutter cameras such as the Lord and the Minion, and supplying lenses such as the Topcon and the Simlar to other manufacturers. After the war, Tokyo Optical released TLRs and the like, followed by the focal-plane shutter type SLR, the Topcon R, in 1957, and the lens shutter type SLR, the Topcon PR, in 1959. The Topcon strategy was to equip high-end 35 mm SLRs with focal-plane shutters and popular models with lens shutters. The Topcon PR was not equipped with a quick return mirror yet, and the lens was fixed, but 1963 ushered in the release of the Wink Mirror S equipped with a quick return mirror and an interchangeable lens with a dedicated bayonet mount.

Photograph 5-15 Topcon Wink Mirror S
(Provided by JCII Camera Museum)

The epoch-making feature of this model is that, instead of being an interchangeable type only in terms of the lens front group like the Contaflex, the entire lens was interchangeable like a focal-plane shutter type SLR. To achieve this, the Seikosha SLV300 G shutter, specifically designed by Seikosha for SLR cameras, was used. Figure 5-8 shows the principles behind the camera mechanisms and the coupling of the shutter.

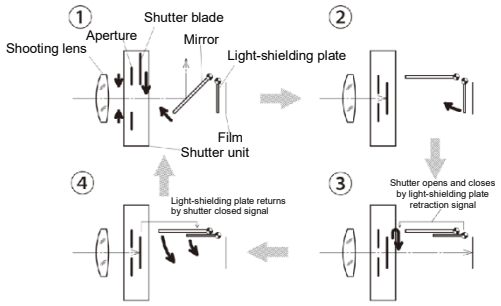


Figure 5-8 Operation of the Topcon Wink Mirror S

① is the state before shooting. The mirror is lowered and the light-shielding plate is closed, but the aperture and the shutter are open, allowing observation of the subject image with the finder. Now, when the shutter release button is pressed, the mirror rises in the direction of the arrow. The mirror, the aperture of the unit shutter and the shutter blade are coupled, and so as the mirror rises, the aperture stops down to a predetermined value, the shutter blade closes, and the state shifts to ②.

② Once the mirror has completed retracting, the light-shielding plate starts to rise in the direction of the arrow. At this point, the shutter blade is closed, so there is no exposure.

③ A signal is output when the light-shielding plate is completely retracted, causing the shutter blade to open and close, and the film to be subject to a predetermined exposure.

④ The lock that held the mirror and the light-shielding plate is released by the closing action of the shutter blade, and each component starts its return. The light-shielding plate returns first, and light leakage is prevented by the opening action of the shutter coupled with the mirror. The aperture is also coupled to the mirror and so, when the mirror returns, the shutter opens, the aperture opens, and the state returns to ①.

In this way, it was possible to realize a quick return mirror almost in the same way as a focal-plane shutter type SLR while intricately coupling the shutter on the lens side and the mirror and the light-shielding plate on the camera side.

Subsequently, the Topcon Wink Mirror S developed into the Topcon Uni and the Unirex and, while the field of the lens shutter type SLR established a certain position in the popular SLR genre until the 1970s with the Kowa models and the like, subsequently the advantages were gradually reduced with the practical application and development of the unitized metal focal-plane shutter, and the lens shutter type SLR faded away.

5.3 The Infancy of Domestic Cameras and Overcoming their Technical Issues

The “M3 shock” of 1954 brought about a big turning point to domestic camera manufacturers, but to what extent depended greatly on the position of each company at that time, as described in Section 5.2.2. Among the manufacturers of Leica-type focal-plane shutter cameras, those lacking the wherewithal and resources to shift to SLR development went bankrupt or were absorbed by other companies in the early 1960s. On the other hand, before the appearance of the M3, Asahi Optical, which released the Asahiflex, the first domestically produced 35 mm SLR in 1952, and other manufacturers were well aware of the merits of the SLR over the rangefinder camera, so most likely hardly felt the M3 shock.

What is interesting is that while most of the “cottage makers” among the group of manufacturers of lens shutter cameras, such as TLRs, that are not focal-plane shutter cameras ran out of steam, all manufacturers within this group that had a certain amount of capital participated in the SLR camera battle. These manufacturers should not have been very affected by the M3 shock. So, from a different point of view, perhaps the M3 just happened to be announced when the 35 mm SLR, which began in Europe from around 1936, had been gradually blooming over a period of just less than 20 years before and after the war.

At the very least, the trend of the times demanding a variety of photographic expressions undoubtedly boosted the breakthrough of the SLR suitable for use with super-telephoto lenses and close-up lenses. The appearance of the M3 was just the beginning, and it seems that the flow from the rangefinder camera to the SLR was extremely natural in the field of cameras equipped with focal-plane shutters. Whatever the reason, there is no doubt that the interests of Japanese camera manufacturers gradually or instantly shifted to the SLR since the Photokina in 1954, though some differences exist for each manufacturer.

In the early 1960s, Japanese camera manufacturers suddenly turned to the SLR, but as for Germany, which was a leader in the camera industry, Leitz focused on the rangefinder camera, Zeiss on the Western side strayed from the royal road with the lens shutter mounting, Ihagee, manufacturer of the Kine Exakta, took time to overcome the shortcomings of the SLR, and Zeiss on the Eastern side failed to show any remarkable development after the Contax S due to the isolation

and rigidity peculiar to the socialist system.

During this period, Japan turned the tables on Germany in terms of both sales and quantity in the camera industry, and to this date Japan's position remains unchanged. The situation is illustrated in Figure 5-9.

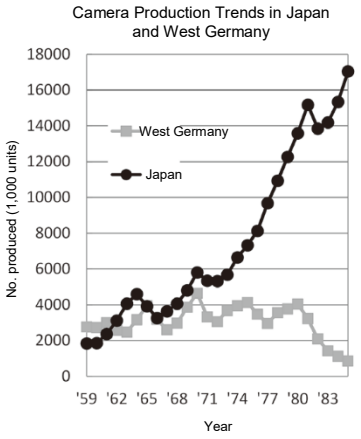


Figure 5-9 Change in Number of Cameras Produced in Japan and Germany[7)]

In this section, I will describe in detail the process of transition to the SLR by each camera manufacturer, the technology that overcame various issues and became the cornerstone of development, and the models that were epoch-making.

5.3.1 Entry of Domestic Camera Manufacturers into 35 mm SLR Market (until 1950s)

The following explains the background of the entry of each Japanese camera manufacturer into the development of a 35 mm focal-plane shutter type SLR, and the technical features and product concept of each representative model, in this order, while including anecdotes and the like. Since there were many manufacturers, separate descriptions will be given for the period through the 1950s and then the period from the 1960s.

(1) Asahi Optical, producer of first domestically produced 35 mm SLR

Japanese cameras, which were developed one after the other after the war behind the Leica, were influenced by Barnack Leica to a greater or lesser extent and competed for victory in the field of rangefinder cameras similar to the Leica. Only Asahi Optical was different. Asahi Optical started its business in 1919, and gained its ability as an optical manufacturer through lens production as a subcontractor of Konishiroku and Chiyoda Kogaku Seiko. In 1936, when times were becoming more military-charged, the founder, Kajiwara Kumao, became suddenly ill and his nephew, Matsumoto Saburō, who was still in his early twenties, became the successor, and the company was inevitably incorporated into the munitions industry and suffered from the destruction of factories due to air raids. Nevertheless, despite such difficulties, business resumed after the war, starting with the production of binoculars, and the company gradually got on track as an optical lens manufacturer as before the war, aiming to enter the camera market.

Matsumoto had the foresight and ambition to bet on the future of the SLR while other manufacturers were looking at easy-to-enter market genres such as the TLR. Asahi Optical is the only domestic manufacturer that released an SLR before the appearance of the Leica M3. Matsumoto's extraordinary sense and ability to execute can be seen here as well.

The Kine Exakta had already been on the market as a 35 mm SLR camera for more than 15 years, and although it was far behind, Asahi Optical's first camera and Japan's first 35 mm SLR camera, the Asahiflex I ("I" was later added for distinction), emerged in May 1952. According to one theory, the plan was to combine the 6 x 6 format SLR, which was popular at the time, with the Leica compact precision camera, and this is worth considering. Alternatively, around 1950, both Canon and Nippon Kogaku had already released highly complete rangefinder cameras, and perhaps Asahi Optical thought that it was not a good idea to counter them head-on.

Photograph 5-16 Asahiflex I
(Provided by JCII Camera Museum)

The finder of the Asahiflex I was a waist-level type, but the camera was also equipped with a reverse Galileo-type perspective finder for vertical shooting. Adding a perspective finder to the waist-level finder, which is completely unsuitable for vertical shooting, is a method readily evident in early SLR cameras overseas. Since the pentaprism-type Contax S was already released in 1948, the adoption of a pentaprism should have been considered, but probably because it was the first camera by Asahi Optical, it seems the company did not want to overdo it.

In addition, the camera was equipped with a groundbreaking semi-quick return mechanism. It is designed so that when you press the shutter release button, the mirror retracts, and when you release your finger from the shutter release button after shooting, the mirror returns. Releasing the finger after shooting is substantially a natural movement, and thus well addresses the drawbacks of SLR and the blackout problem, though not completely. Two years later, the IIB equipped with a quick return mechanism that quickly returns the mirror in conjunction with the travel of the rear curtain of the shutter after shooting came to fruition, which will be described later.

Of course, Matsumoto planned this camera, but Suzuki Ryōhei and Yoshida Nobuyuki were actually in charge of the design. These two were transferred from Konishiroku, which resulted in Asahi Optical making the lens of Konishiroku's popular camera, the Pearlette[8].

The Asahiflex I, the earliest ancestor of the domestic 35 mm SLR, was improved to the IA, IIB and IIA over the next few years, and steadily developed into the Asahi Pentax, the first SLR equipped with a pentaprism (later called Pentax AP for distinction) in 1957. Asahi Pentax, as the name implies, was equipped with a pentaprism. In addition, the 37 mm dedicated screw mount was changed to a larger diameter M42 screw, that is, a so-called Praktica screw mount (hereinafter referred to as M42 mount). This screw mount was adopted by the Praktica released in East Germany in 1949, and was widely used due to its easy-to-manufacture, standardized 1 mm pitch metric fine threads.

While subsequent cameras such as the Miranda were finder-interchangeable types, the aim was to separate from the pentaprism type and reduce the size and weight of the body, and the clear concept and reasonable price were widely accepted, making the model popular. From here, the Pentax brand began to make a leap forward as a representative of domestic SLRs.

(2) The Miranda T, the first domestically produced camera equipped with a pentaprism

As for the pentaprism method, which is the most suitable finder optical system for SLRs, the Prismflex Mamiya was announced in 1952 by Mamiya Optical as a prototype. In addition, Orion Seiki Sangyō (later Orion Camera and then Miranda Camera) also announced the prototype of the Phoenix in 1954, and at the beginning of 1955, the existence of a prototype equipped with a pentaprism called the Altair was known.

The year after the announcement, the Phoenix became the first pentaprism-equipped SLR camera released in Japan under the name of the Miranda T. The Miranda T was epoch-making in that the finder was interchangeable, but included many old-fashioned parts such as an old shutter dial that rotates while the shutter is operating, a biaxial high-speed/low-speed format, and a mirror that was not a quick return type.

Photograph 5-17 Miranda T
(Provided by JCII Camera Museum)

Subsequently, the company continued improvements and released various SLRs, with a particular emphasis on exports, including models bearing the Soligor brand for overseas. The Miranda held a certain position in the SLR market, but had less individuality than other SLRs. In addition, the following was also pointed out, indicating poor quality:

Ogura Iwao, who was a doctor at Asahi Camera magazine's famous corner, “Camera Diagnostic Room,” tells the story that, when he worked for a US company in the early 1960s, six Miranda SLRs were brought into the company, but one month later all broke down due to the exact same phenomenon[9]. At the time, the Japan Camera Inspection Institute had been checking export cameras, but had difficulty completing durability tests, so the defect must have been missed.

Miranda Camera was acquired by an overseas company in 1969, and unfortunately the company ended production of SLRs in 1976, but the brand name Miranda remains in history as the first domestically produced SLR camera equipped with a pentaprism.

Among the other prototypes that sought to be equipped with a pentaprism, the Prismflex Mamiya was never mass produced since Mamiya Optical was busy producing the flagship 6 x 6 format camera. Nevertheless, from my point of view, it seems that the difficulty of machining the pentaprism is the main reason why the pentaprism-equipped cameras of each

company other than Phoenix ended as prototypes. As a practical matter, the angle of the surfaces (the roof-shaped portion), which is a characteristic of the pentaprism, is required to be exactly 90 degrees and a rounded ridgeline, if existent, affected visibility, requiring machining to a sharp edge. However, at the technical level of the time, the yield must have been extremely poor due to problems such as inadequate machining accuracy and ridgeline chipping.

(3) Asahiflex IIB equipped with quick return mirror

Asahi Optical released the Asahiflex I improved version, the IIB, in 1953. This camera is the first model in Japan to use a quick return mechanism for the mirror. Some old commentary books indicate it was “the world's first,” but as mentioned above, that spot was ceded to the Duflex of Hungary, which would become known to Japan in later years. However, without knowledge of this predecessor, the camera was highly praised for its originality in conception. The designer of this epoch-making mechanism is Yoshida Nobuyuki mentioned above. Yoshida was that type of individual who made mockups of things before sketching drawings and would have his subordinates make the drawings of his handmade products[10]. It is an anecdote reminiscent of Barnack.

As mentioned above, the Asahiflex I had already adopted a semi-quick return mechanism. That is, with the Asahiflex I, the necessity to return the mirror immediately after shooting was understood, but a perfect quick return could not yet be achieved, and the company would only realize the ideal for the first time with the Asahiflex IIB.

Photograph 5-18 Asahiflex IIB
(Provided by JCII Camera Museum)

It is speculated that the reason why Asahi Optical, at first just a mere subcontractor, became one of the leading SLR manufacturers was not just its clear concept of the camera itself, but also its culture of valuing production technology. Asahi Optical exhibited cautiousness from its onset with the repair and maintenance of machine tools damaged by air raids followed by preparation of jigs and tools and then the transition to mass production, and courage in its decision to, upon seeing that SLR production would expand, scrape together an amount of money equivalent to three times its capital in order to purchase an automatic lathe made in France[11].

This sincere attitude toward “the making of things” stands out starting with the Zunow, described later, and presumably has been the driving force for its long-held leadership role in domestic SLRs.

(4) The Topcon R with a complete lens lineup

About two years after the Miranda T, Tokyo Optical released the Topcon R in November 1957, making it the third manufacturer of domestically produced 35 mm focal-plane shutter SLRs. While the Asahiflex and the Miranda T prototype, the Phoenix, launched development before the Leica M3, the Topcon R was the earliest released after the M3. This shows the high level of development and technical capabilities of Tokyo Optical. Though much heavier than the Asahiflex and the Miranda T, the camera was steadily put together by the designer, Zenyōji Kenichi. As mentioned above, Tokyo Optical had also been working on the development of a lens shutter type SLR from early on. For the company origin and its lens shutter type SLR camera, refer to Section 5.2.4.

Photograph 5-19 Topcon R
(Provided by JCII Camera Museum)

The Topcon R was greatly influenced by the Exakta line. First, the Topcon R emphasizes a systematic design, has an interchangeable finder, and adopts a highly versatile Exakta lens mount. Then, the semi-automatic aperture uses an external coupling mechanism that imitates that of the Exakta.

With its release, eight interchangeable lenses, from a 35 mm wide-angle to a 300 mm telephoto, were simultaneously announced. The 35 mm F2.8 lens probably represents Japan's first retrofocus optical system of domestic manufacture. The 300 mm was a so-called “Sannippa (328)” with a large diameter of F2.8. These also are a testament to the high level of optical design technology achieved by Tokyo Optical.

A semi-automatic aperture mechanism was adopted for three of these interchangeable lenses. First, the aperture is charged to open via a release lever provided on the lens barrel, and an aperture button that works coaxially with the shutter release button on the camera side is provided on the tip of the arm on the lens. Pressing this aperture button when shooting an image stops down the aperture, and pressing it further

presses the shutter release button on the camera side, causing the mirror to rise and the shutter to operate.

With this method, the aperture is in a stopped-down state after shooting, making it necessary to manually recharge to open the aperture. Even though the mirror used a quick return method, the fact that the subject image remained dark after shooting remained as a point needing improvement. In addition, in order to realize this externally coupled semi-automatic aperture, the shutter release button on the camera side was arranged on the front side instead of the upper side. It looks strange at first glance, but this is not bad for operability.

The shutter was the first focal-plane type for Tokyo Optical, and the shutter dial, being a high-speed/low-speed two-stage type and not non-rotating, was a little outdated, but these were steadily improved with a fully automatic aperture adopted in the RII (common name; released in July 1960) and a non-rotating uniaxial type adopted in the RIII (released in September 1961).

(5) Chiyoda Kogaku Seiko's Transition to SLR cameras

The Minolta brand Chiyoda Kogaku Seiko was also greatly influenced by the appearance of the Leica M3. The company had already established a certain position as a 35 mm focal-plane shutter camera in the Minolta 35 series, but after seeing the M3, planned a full model change of the existing rangefinder camera. From the President, Tajima Kazuo, down, all worked together to prepare for the M3 pursuit, kicked off the endeavor at the end of 1955, reviewed everything including the shutter, rangefinder and design, and made the decision to design and develop a model named the Minolta Sky.

The prototype was completed in 1957 and was shown to a distributor in the United States, home to the largest market. But, surprisingly, the rangefinder camera received a lukewarm response and, conversely, development of an SLR was strongly proposed.

Normally, there would be hesitation here, but Tajima's decision was quick and, as soon as he returned to Japan, he shelved the Minolta Sky and made a major shift to development of the SLR[12]. It is the corporate culture of Minolta to take such an opportunity to boldly change its course, and the company continued to subsequently do the same time and time again.

The company's first SLR camera, the Minolta SR-2, was released in October 1958. It is an orthodox camera lacking distinctive features. The camera suppressed key points such as a quick return mirror, a uniaxial non-rotating shutter dial and a self-timer, and was a semi-automatic type in which the aperture was returned by the next film winding.

Photograph 5-20 Minolta SR-2
(Provided by JCII Camera Museum)

The design, however, is something to behold. The flowing elegance created by Shiramatsu Shō became a major feature of subsequent Minolta SLRs[13]. Shiramatsu is a designer who had contributed ideas about cameras to the monthly magazine Shashin Kōgyō since he was a student, and Chiyoda Kogaku Seiko noticed his extraordinariness and recruited him.

Consideration was given to systematic design and, while the finder was fixed, an angle finder (which can be attached to the eyepiece and viewed from above) and a magnifier (which magnifies the viewfinder image) were available. Six interchangeable lenses were also available, from a 35 mm wide-angle to a 600 mm super-telephoto.

Despite the major policy change, the technical capabilities of Chiyoda Kogaku Seiko, which entered the 35 mm SLR camera in just one and a half years, are remarkable. The company incorporated the camera brand into the company name in 1962 and became Minolta Camera.

(6) The Zunow, a phantom SLR

When you unravel the history of domestic SLRs, you will definitely come across the Zunow. The camera was called the Zunow Pentaflex when announced in the April 1958 issue of the monthly magazine Shashin Kōgyō, and thus Zunow Pentaflex is its official name. But, since this camera is the one-and-only Zunow SLR, the Zunow or the Zunow Camera suffices. Looking at the features and specifications incorporated, the camera is so advanced that it is hard to believe that it was released in 1958. The camera is equipped with a quick return mirror, a fully automatic aperture mechanism and a pentaprism, and thus completely overcame the shortcomings of the SLR. Moreover, because the finder and the screen were interchangeable, and the equidistant, uniaxial non-rotating shutter dials were used, they were far ahead of other companies' cameras at that time in terms of functionality.

Furthermore, the design entrusted to the GK Industrial Design Incorporated was truly advanced as it was based on straight lines. "The embodiment of the Noh spirit" was reportedly the design concept. The overall height of the camera is even shorter than that of the Pentax AP, which is a typical compact SLR of this period, and it is a daring camera design even now. The GK Industrial Design Incorporated was

founded by Ekuan Kenji, a well-known industrial designer, is famous for the design of Kikkoman tabletop soy sauce bottles, and later participated in the design of the World Expo 1970 in Osaka.

Photograph 5-21 Zunow
(Provided by JCII Camera Museum)

The greatness of the Zunow does not end there. Zunow Opt., which made the Zunow, made F1.1 night photography lenses at the request of the Navy during the war, when it called itself Teikoku Kōgaku Kenkyūjo. Taking advantage of that experience, the company also prepared a 58 mm F1.2 large diameter lens for the Zunow.

The lens mount adopted the spigot type. In contrast to the bayonet or screw mount in which the lens is mounted by being rotated, in this type the lens itself is fixed with a tightening ring at the base without being rotated. The positions of the camera and lens in the rotational direction could therefore be determined accurately, making use of a fully automatic aperture advantageous. The FD mount that Canon later adopted in the professional F-1 model and the best-seller AE-1 was also of this type, and the focal point was good.

The designer was Arao Kiyoshi, who had transferred from Chiyoda Kogaku Seiko Co., Ltd. Arao's skill in designing such functions ahead of the industry leaders Nippon Kogaku and Canon is immeasurable. Nevertheless, as fate would have it, Arao left the company due to conflicts with the company around the release of this camera, and the camera itself was extremely short-lived.

From the spring of 1958, the company placed a large number of advertisements in camera magazines, but the reality was that the camera was still in the trial stage where troubles frequently occurred. Subsequently, problems did not go away and the company held a presentation for the general public at Nihombashi Mitsukoshi department store in August. Although it seems that the release of the camera was a snap decision by the company, there are no records indicating whether this was so or not. This might simply be because just a few prototype-level models were sold to important customers only.

In general, for cameras with new functions (although not limited to cameras), the various functions are checked in trial production, then a mass production trial is performed to identify problems in mass production, and transition to the mass production process cannot be made until all problems have been solved, but there is no evidence that this process was properly followed with the Zunow. Reportedly, hundreds of units were painstakingly released to the world, but there was a problem with quality and they were returned one after another. The fact that the finder was an interchangeable type but no finders were released other than the camera-equipped standard model hints at insufficient preparation.

Zunow Opt. went to the trouble to set up a company called Shinkō Seiki to produce this camera. In today's terms, the strategy was “fabless” production, but it seems there were considerable problems with the level of production technology and design studies.

There were also functional problems that likely stemmed from mistakes in the initial concept design, and the long-awaited fully automatic aperture was slow in operation, resulting in incidents of the aperture lagging behind in time to the shutter travel. This was probably due to a poor balance between the moment of inertia and the stopping down force.

The height of ambition as an SLR was comparable to that of the Nikon F released the following year, but while the Nikon F became a long-selling camera for about 15 years, Zunow, both the company Zunow and the camera Zunow, disappeared into the darkness with a slight glow like a meteor. While the Zunow models that still exist today are few in number with virtually none working perfectly, categorizing the camera as a phantom camera today, the Zunow will forever be legendary as a rare camera that solved (or attempted to solve) almost all of the problems related to the SLR at once.

After leaving the company, Arao joined Mamiya Optical and was in charge of designing TLRs and 6 x 7 size SLRs.

(7) Differentiation by Canon of rangefinder and SLR cameras

At this time, Canon, which had already established itself as a major camera manufacturer, chose a slightly different way when entering the SLR market. The company decided to continue pitching the rangefinder camera. Perhaps it was aiming for profits by being the rangefinder camera’s sole remaining manufacturer, with other Japanese manufacturers moving away from it.

First, Canon put their efforts into developing the VT and the VL. For film winding, the L was a lever type and the T had a trigger lever at the bottom, improving richness in variation. In addition, the cameras countered the M3 finder with a variable magnification finder. Furthermore, in 1959, Canon released the P. P is an abbreviation for *Populaire* (French for “common people”), and the strategy was to price the camera in the popular price range and differentiate it from the expensive M3. With the advent of the P, Leica-type rangefinder camera manufacturers who could not enter the SLR camera market were completely finished.

Photograph 5-22 Canon P
(Provided by Canon Camera Museum)

Canon's rangefinder cameras subsequently remained alive and well, securing a certain position as a low-priced version of the Leica and maintaining its standing as a domestic rangefinder camera with models such as the 7 and the 7S. What is unforgettable about the 7 and the 7S is the Canon 50 mm F0.95 ultra-large diameter lens. There was a time when Nippon Kogaku released the Nikkor 50 mm F1.1 for rangefinder cameras and Zunow also released the Leica 50 mm F1.1, competing for the title with a large-diameter lens, but Canon was one step ahead at least in terms of brightness.

Photograph 5-23 Canon 7S
(Provided by Canon Camera Museum)

In the end, the only company in Japan that did not simply abandon the rangefinder line even with the debut of the M3 and demonstrated the tenacity to continue selling the rangefinder camera until nearly 1970 was Canon.

On the other hand, Canon also, of course, anticipated the future of the SLR, and released the Canonflex in May 1959, one month ahead of Nippon Kogaku. It seems that the company's underlying strength was to achieve entry into the SLR market while continuing to develop the rangefinder camera.

Photograph 5-24 Canonflex
(Provided by Canon Camera Museum)

The Canonflex is the first domestically produced SLR that can be coupled with an exposure meter. When a dedicated exposure meter is attached to the right shoulder of the camera, the meter is coupled with the shutter dial and the appropriate aperture value can be derived and displayed from the subject brightness and shutter speed. However, this dedicated exposure meter was sold separately. The viewfinder is interchangeable, the mirror is a quick return type, and a portion of the dedicated lenses have automatic aperture capabilities.

A wide variety of interchangeable lenses were prepared, but were biased toward the telephoto side, suggesting that the company intended to segregate the telephoto system to the SLR and the wide-angle system to the rangefinder.

The Canonflex has a well-crafted exterior, a beautiful design with the pentaprism cover painted black, and a lens mount that uses a spigot R mount of the same type as the Zunow. The R mount is compatible with the later FD mount except for the aperture coupling system and has a large diameter, and thus the future was well thought out. However, this camera was extremely short-lived. Production was discontinued about three months after its release. The reasons are not clear, but it may be because the size was larger than the Nikon F released soon after, and the bottom trigger lever type winding was not suitable for general use.

Subsequently, from the 35 mm SLR to the digital SLR today, Canon and Nikon have been ranked the top two manufacturers in the SLR category by the press. While the Nikon F became a big hit selling about 860,000 units, Canonflex finished with just under 20,000 units in just three months. The fact that there was such a big difference in the debut of the first SLR debuts by the top two is unbelievable today.

(8) The Petri, entering the SLR market via the low-priced route

So far, description has been made of the entries into the domestic 35 mm focal-plane SLR market for each manufacturer in chronological order. In summary, the order is 1952: Asahi Optical, 1955: Miranda Camera, 1957: Tokyo Optical, 1958: Chiyoda Kogaku Seiko, Zunow Opt., 1959: Canon, and then 1959: Nippon Kogaku, Kuribayashi Camera, 1960: Yashica, Konishiroku Photo Industry, but the first SLR from Nippon Kogaku, the Nikon F, is a prominent figure in the history of the 35 mm SLR in Japan and will be revisited in a later section.

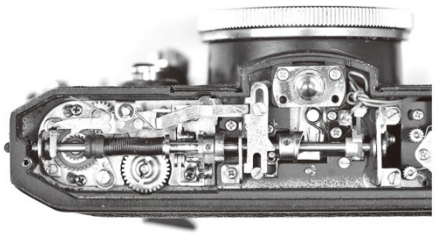
Kuribayashi Seisakusho (later Kuribayashi Camera, Petri Camera and now Petri Kōgyō) was founded in 1907 and is the second oldest domestic camera company in the industry after Konishiroku. Before the war, the company made lens shutter cameras, such as spring cameras and TLRs, under the brand named First, but in October 1959 it entered the SLR market with the first Petri brand SLR, the Petri Penta. Petri's SLR strategy was characterized by its low-priced route. The price of the first product, 28,000 yen for the Petri Penta, compared to the SLR camera released in the same year, is less than half

the 69,500 yen for the Nikon F and even 20% cheaper than the Asahi Pentax S2, which was strategically set at a popular price of 35,000 yen by Asahi Optical (both are prices with an F2 lens).

Photograph 5-25 Petri Penta
(Provided by JCII Camera Museum)

This low-price strategy was somewhat effective and secured the company a certain position in the SLR genre. The camera also had technical strengths, employing original mechanisms such as a film counter coupled to shutter operation (usually coupled to film winding), and a structure with a long camshaft installed at the bottom for controlling the mirror, shutter and the like by its charge and rotational operation.

To further explain this camshaft system, which is Petri's original mechanism, as shown in Photograph 5-26, the camshaft installed on the bottom of the camera is charged by the winding operation and starts rotating via the release operation. A cam for driving the mirror, a cam for shutter release, and the like are arranged in various places, and each operation is initiated at an appropriate timing. With the camshaft centrally controlling each part, stable operation can be achieved.



Photograph 5-26 Petri Camshaft System (Camera: V6II)

Appearance-wise, the camera features a shutter release button installed diagonally on the front side. Exemplary of this design is the Contax S, but according to the designer Yanagisawa Akira, the arrangement is to make space for the layout of the upper surface.

While Petri has had an image of being cheap or bad, in my high school days, around 1970, there were quite a few students using the Petri V6 or V6II. In short, Petri cameras were the only SLRs affordable in terms of price, yet there was not much mention of quality problems such as breakdowns.

The company, which was renamed Petri Camera in 1962, continued to take the low-priced route in its release of SLRs, and although the company managed to keep up with other manufacturers in terms of automation of exposure, it was late in competing in SLR miniaturization in the early 1970s, and, moreover, a significant labor dispute broke out, resulting in the resignation of the entire management team. Subsequently, the union continued to develop and produce cameras independently, but withdrew from camera production in 1976. To the general public, more than the camera, the Petri name became identified with labor disputes that became such hopeless messes that they were taken up in the Diet.

5.3.2 Nippon Kogaku: From Entry into the Camera Market to the Nikon S2 and SP

Going back a little, though there may be some overlap, let's take a look at the flow from postwar camera market entry to the SLR at Nippon Kogaku. My boss, Satō Akihiko, interviewed several alumni who were in the design department in earlier years about early camera development at Nippon Kogaku, which was to be left as records, and I had the opportunity to inspect these documents. Based on that information, I will describe the flow while adding my thoughts.

After the war, Nippon Kogaku, which was cut off from the production of optical weapons, decided to shoot for consumer camera development. The leader was Fuketa Masahiko, a mechanical designer who joined the company in 1937 and, during the war, designed mechanical computers called fire control systems that used about 35,000 gears to calculate the trajectory of anti-aircraft guns and torpedoes.

After the war, Fuketa was in charge of designing consumer cameras, initially prioritized the development of the TLR and completed trial production, and even decided on the product name “Nikoflex;” but problems with the reliability of the outsourced shutter could not be solved. Since it would cost an enormous amount of money to introduce jigs, tools and machinery to develop a lens shutter in-house, the company abandoned the TLR and decided to develop a 35 mm focal-plane camera. According to Fuketa, if it was the focal-plane shutter, he was confident in in-house development. Perhaps, Fuketa thought that, compared to the lens shutter, which requires development costs and development time for press dies and the like, development of the focal-plane shutter, which had many lathe-turned parts, could reduce such costs and time, and thus would be easier to develop.

Shortly after the war, in October 1945, instructions to start development were given, and disassembly and analysis of the Leica and the Contax began, but there is an anecdote that Fuketa made an employee angry upon discovery that Fuketa had disassembled the camera he had lent to him. The drawings were completed in half a year, and the prototype a year later, but there were many problems such as poor material quality, which led to a change from the machining of aluminum die casting –which had a lot of cavities – to sand casting, film scratches due to foreign matter on the film pressure plate and the useless piano wire, not Swedish-made, for springs[14]. Even

so, the I, the M and the S sold well to the US military, launching the camera business of Nippon Kogaku.

(1) Leica M3 countermeasures by Nippon Kogaku

At the time of the announcement of the M3 in 1954, Nippon Kogaku was just about to release the Nikon S2, which was a full model change of the S. The company quickly postponed the announcement for about half a year to counter the M3, and took measures to urgently carry out improvements to the winding lever, finder magnification and the like. As time was running out, some of the countermeasures were insufficient, but had some effect, and the S2 boasted the largest quantity sold among the Nikon rangefinder cameras.

Photograph 5-27 Nikon S2
(Provided by JCII Camera Museum)

At the same time, in order to approach the epoch-making finder of the M3, Nippon Kogaku started development of the SP, a high-end rangefinder camera with a novel finder optical system that supports as many as six types of interchangeable lenses. This camera was released in September 1957, became the flagship model of the Nikon brand, and is still often referred to as a famous model, but due to the high retail price, the sales volume did not reach that of the S2.

Photograph 5-28 Nikon SP
(Provided by JCII Camera Museum)

Subsequently, Nippon Kogaku released the S3, a low-priced version of the SP, and the S4, a popular model, but the feelings of the development team had already shifted to SLR development.

(2) Birth of the Nikon F

Fuketa was aware of the future of the SLR from an early stage, and started SLR development with a slight delay by diverting the mechanisms of the SP. Based on the stories of Fuketa and Matsunaga Gorō, who was in charge of the design, the full-scale start of development was around the fall of 1956.

The reason why the camera was developed in the format of diverting the high-end rangefinder camera and the shutter mechanism of the SLR was to omit the time required to design each of the two while keeping in mind the division of roles, with the former being strong in the wide-angle realm and the latter being strong in the telephoto realm. The sales team firmly requested a rangefinder camera, that is, a camera that could counter the M3, and the development of the SLR, which did not interest them so much, was carried out in a free atmosphere led by the design and development team. This anecdote illustrates the contrast in philosophies between the sales side, which seeks immediate action, and the development side, which has a more long-term perspective.

The F, the first Nikon brand SLR camera, was released in June 1959. The SLRs of Asahi Optical, Tokyo Optical, Minolta, Canon and other companies were already on the market, and although the F was just about the last SLR to emerge from among the major companies, it was extremely complete. Above all, the systematic nature, which is the greatest feature of SLRs, was well thought out. By the end of the year of release, the lens lineup ranged from a 21 mm ultra-wide-angle lens to a 500 mm ultra-telephoto lens. The viewfinder and the screen were also interchangeable, making it possible to support various shooting genres according to application. Subsequently, when the built-in camera exposure meter became mainstream, the company took action by replacing it with the Photomic finder. Furthermore, the fact that a motor drive could be installed to allow continuous shooting was epoch-making, which greatly expanded the market share in the press.

Photograph 5-29 Nikon F
(Provided by JCII Camera Museum)

The camera specifications and functions were also extremely innovative. The camera was equipped with a fully automatic aperture that stopped down to the set aperture value only during shooting and instantly returned to the open

aperture after shooting, as well as a quick return mirror that retracted during shooting and instantly returned. The Nikon F was quite early to realize these two functions, except for the Zunow, which had virtually disappeared overnight. Various mechanisms will be described later, including the quick return mirror mechanism, which became a hot topic in the fierce patent dispute with Asahi Optical after its release.

In addition, a mirror lock-up mechanism was also provided to support fisheye lenses and ultra-wide-angle lenses. With these lenses, when a retrofocus optical system is not adopted in pursuit of miniaturization, the lens back end comes close to the film surface side, requiring a mirror lock-up mechanism for getting the mirror out of the way in advance. Even more, the camera had a preview button that made it possible to check the depth of field in advance, the viewfinder frame coverage was the ideal 100% and the bright screen was also well received.

The adopted lens mount was a large-diameter bayonet mount for that time, and this F mount was the standard for Nikon SLRs for nearly 60 years and still is so today. For example, the Nikon Df, a digital SLR released in 2013, can be equipped with a lens released at the same time as the Nikon F, that is, a lens that is more than half a century old, even if its functions are limited, and used to take pictures.

The Nikon F is a masterpiece in the history of the SLR and was well received by the press, professional photographers, and advanced amateurs for a long time until discontinuation in 1974.

(3) Mirror and aperture drive mechanism of the Nikon F

In the development of the Nikon F, Fuketa instructed Matsunaga to set two priorities: to have a viewfinder frame coverage of 100% and, to the extent possible, to utilize the various mechanisms of the Nikon SP for the winding system and shutter system. Considering that an entire mirror box would have to be added to adopt the mechanisms of the rangefinder camera in an SLR, the task certainly proved more difficult than was expected. Therefore, from a modern perspective, there was something slightly but undeniably redundant about the Nikon F's combination of a shutter release mechanism and mirror/aperture drive mechanism. Nevertheless, due to the clever design of Matsunaga et al., the camera turned out to be a model boasting excellent durability and reliability. Here, the mirror and the aperture drive mechanism will be described with reference to Figure 5-10.

<<Shutter release to mirror-up>>

(1) When the shutter release button (not shown) is pressed, the mirror release hook 2 is pressed in the direction of arrow A, mirror 1 is unlocked, and the mirror-up action of mirror 1 is triggered.

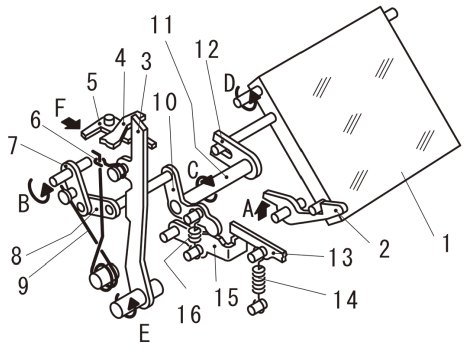


Figure 5-10 Mirror Mechanism of the Nikon F

(2) This rotational torque is obtained by the mirror drive spring 9 rotating the link 7 in the B direction with its left arm and rotating the mirror drive lever 10 in the direction of the arrow C via the link 8.

(3) Since the mirror drive lever 10 and the fork-like mirror drive arm 12 rotate integrally, the mirror 1 rotates in the direction of arrow D and rises.

<<Mirror-up to shutter travel>>

(4) When the mirror-up action is completed, the shutter front curtain travels by a mechanism (not shown) to start exposure, and then the shutter rear curtain travels.

(5) The travel motion of the rear curtain of the shutter is transmitted as shown by the arrow F, and the holding lever 5 rotates counterclockwise to disengage from the mirror vertical lever 3.

(6) The mirror vertical lever 3 is pulled to the left in the figure via the connecting rod 6 by the force of the right arm of the mirror drive spring 9, and the convex part near the center of the mirror vertical lever 3 pushes the link 8 and rotates the mirror drive arm integrated with the mirror drive lever 10 in the direction opposite to the arrow C in a movement reverse to the mirror-up action to lower the mirror.

<<Charge of drive mechanism>>

(7) When the winding lever is wound after a series of shooting operations, the charge lever 4 pushes the upper end of the mirror vertical lever 3 to the right, and the mirror vertical lever 3 is hooked onto the holding lever 5 and held to complete charging.

The remarkable point of this mechanism is that both the mirror-up and the mirror-down are performed by a single mirror drive spring 9. This is possible because the torque from the right arm of the mirror drive spring 9 is higher than the torque from the left arm by an amount equivalent to that through the mirror vertical lever.

Normally, when a quick return mirror is designed, it is common to prepare two springs, a spring for mirror-up and a spring for mirror-down, and the Asahiflex and the Duflex have such a design. The Nikon F was also similarly designed in the beginning, but there is a reason why the design was changed

to the above mechanism midway through development; there was a conflict with Asahi Optical's utility model right.

Asahi Optical submitted a patent application for the quick return mirror mechanism of the Asahiflex IIB, but since Tokyo Optical had already submitted an application for the principle, rights were granted only after downgrading the application to a utility model. On the other hand, in the design of the Nikon F, Nippon Kogaku was most likely not too concerned about the utility model right of Asahi Optical since Tokyo Optical was first to file. However, a lawsuit was filed by Asahi Optical, and while the dispute was ostensibly continued, Fuketa hurriedly changed the design in case the company lost, resulting in the mechanism described above. In the end, camera critic Kitano Kunio and the Ministry of International Trade and Industry at that time set out to settle the muddied dispute. In an era when the camera was a prize product in the export industry, such an internal conflict was not desired. The conditions of the settlement were not announced, but it is said that Asahi Optical approved the use of the utility model right and Nippon Kogaku paid some unrelated amount[15].

Even so, despite the sudden design change, Fuketa's talent as a mechanical engineer who created a quick return mirror mechanism that is so simple and avoided contention is amazing. I was shown this mechanism shortly after joining the company, and for a while I could not understand how the mirror-up and mirror-down worked. I then moved the components around, and finally understood. It is quite impressive. I will never forget when I was taking the company employment test and had an interview with Fuketa who was the Vice President at the time.

(4) Anecdotes in the development of the Nikon F

The Design Division Manager, Fuketa, assigned Matsunaga Gorō to the development of the F. Matsunaga joined the company during the war and was in charge of the fire control systems for torpedoes. It seems to be a quirk of fate that, like Fuketa, Matsunaga moved from being in change of fire control systems to the consumer camera, completely different areas. After the war, Matsunaga demonstrated his abilities not only in the mechanical design of the Nikon S, but also in various fields such as various testing machines and lens barrels. At that time, Nikon lenses included the Nikon S mount and the L mount for the Leica, and by being widely responsible for these, Matsunaga was able to clearly solidify the concept of the Nikon F mount when designing the SLR. The design strategy reportedly was to design the F mount first, attach the mirror box to it, and then build up the other mechanisms.

Anecdotes about Matsunaga indirectly reached my ears as well. His nickname within the company was "The Edison of Nikon," and it said that he also liked it. Matsunaga left the company less than two years after the launch of the Nikon F and moved to a high-speed camera manufacturer, later revealing that he made the transition because he wanted to work on measurement-related equipment and devices. Certainly, looking at the Nikon F, the camera has durability and reliability, allowing use not only as a consumer camera but in academic fields as well. Based on the results of a durability tester designed by Matsunaga himself, these qualities were achieved by involving the in-house metal material laboratory and devising materials and heat treatments of worn parts.

Although the Nikon F is often hailed as a famous camera nowadays, its reputation at the time of its release was not so great. What reveals this is the evaluation in the New Face Diagnostic Room in the June 1959 issue of Asahi Camera. Although there are problems in representation, more than half of the article is negative. To give an example, the front side of that characteristic pentaprism of the Nikon F is ridiculed as "the triangular headband worn by ghosts," a reference to the appearance of ghosts in Japanese folklore. The design of the Nikon F was the work of an outside designer, Kamekura Yūsaku. To the extent that Kamekura was given a dedicated room inside Nippon Kogaku to design the camera, much energy was put into the endeavor, but to be humiliated in this way was unbearable for the Nippon Kogaku design team.

Hori Kunihiko, a designer, and a public relations officer went to the Asahi Camera editorial department to protest, but nothing came of it. This event became a hot topic in the industry because Shirai Tatsuo, who was in the editorial department at that time, compared the event to the February 26 Incident and called it a "raid by young officers," but when I joined the company and asked Hori, who was a production technology related director, to act as an intermediary for some work, I found that he was a very gentle person who kindly taught me various things, and I understood that the characterization "raid" was a bit of hyperbole.

The fact that one of the best magazines in the industry dismissed the hot new model makes one think, though the expression is old, of the good old days when there were no such shackles. Despite the headwinds created by the article, the Nikon F eventually became popular and became the leading SLR in Japan. This article is legendary even now, more than half a century after its appearance, partly because of the interesting comparison.

Kamekura Yūsaku was in charge of not only the exterior design of the F, but also the artistic design of promotional posters, packaging, catalogs, instruction manuals and the like, and the originality in his work became a hot topic. Subsequently, Kamekura was active in designing emblems and posters for the 1964 Tokyo Olympics, and became one of Japan's leading graphic designers.

5.3.3 Entry of Domestic Camera Manufacturers into 35 mm SLR Market (From 1960s)

With the dawn of the 1960s, the domestic SLR market saw dramatic development. It was a time when camera overall sales surpassed those of West Germany in terms of both amount and quantity.

In 1960, the first Japan Camera Show was held. The show was sponsored by the Japan Camera Industry Association (currently the Camera & Imaging Products Association), and while the name changed to Photo Festa Japan, Photo Expo and Photo Imaging Expo with subsequent changes in the composition of the co-sponsoring organization, the show is now established as CP+ and is held every spring at Pacifico Yokohama. During the Japan Camera Show era, the show was held in major cities all over the country, and served as a great opportunity for PR with camera fans living in rural areas.

The 35 mm SLRs of each brand, such as Pentax, Canon, Nikon, Minolta and Topcon, which already entered the SLR market, released a number of successors and variations and enhanced the interchangeable lens group. Then, there was an increase in the number of cases of entry into the SLR market by manufacturers that produced cameras of other genres. Precisely at this time, the camera market and the SLR market were booming like never before, as Japan as a whole was enjoying a favorable business climate with the 1964 Tokyo Olympics just around the corner. The entry of major manufacturers into the SLR market through the 1950s was described in the previous section, and those who subsequently entered are summarized below.

(1) SLR market entry by the long-established Konishiroku

Konishiroku is one of the longest-established shops in Japan in the photography industry, based on the Konishiya Rokubeiten, which began selling photographic materials in 1873. In 1903, the company launched the first domestically produced Cherry Hand Camera for amateurs, and since then took domestic leadership in all fields related to photography, contributing to the market expansion of cameras mainly in the popular price range. By the way, Japan's oldest photography-related trading company, Asanuma & Co., Ltd., was founded in 1871, about two years earlier.

The company enjoyed its spring camera Pearl series as a best seller before the war, developed and produced military aerial cameras and the like during the war, and released small lens shutter cameras and TLRs under the Konica brand after the war, but never touched the Leica-type 35 mm focal-plane shutter camera. This is because they focused more on popular cameras than on high-end cameras.

Of course, the company was aware of the movement of the times toward the SLR, and around 1955 to 1957 made prototypes of an orthodox horizontal-travel cloth curtain focal-plane shutter and a vertical-travel split-type metal blade focal-plane shutter. The former is known as a prototype with the KONIFLEX-35 engraving, and the latter is known as the Konica Flex. The latter was finally selected as a camera for mass-production, and was released overseas as the Konica F in March 1960, about a year after its announcement in 1959. While the shutter of the Konica F was not yet unitized, by the time it was released, the Copal Square unitized by joint development with the shutter manufacturer Copal was mass-produced and installed in the low-priced Konica FS released in Japan in the same year as the Konica F. Since then, the number of SLRs equipped with a vertical-travel split metal blade focal-plane shutter, which became the standard for subsequent SLRs, gradually increased, and their origin can be seen in the Konica F.

Photograph 5-30 Konica F
(Provided by JCII Camera Museum)

The Konica F was equipped with this highly advanced shutter and achieved a high shutter speed of 1/2000, as well as a flash synchronization speed of 1/125 that took advantage of shutter travel in the short-side direction of the frame. Furthermore, the camera was equipped with unique mechanisms such as a built-in external exposure meter coupled with the aperture, an interchangeable viewfinder, a swing-back type quick return mirror and a pressure plate retreat mechanism that prevents frictional resistance and film scratches when winding the film. Surprisingly, however, the camera was short-lived. The release was delayed for more than a year from the Nikon F and, being expensive, big and heavy, and lacking consideration in terms of operability with a less-than-ideal shutter release button position and poor holding feel, proved no match for its competition.

However, by fusing the SLR development technology cultivated with this camera and the unique technology of Konishiroku, the Konica brand SLR has gained a certain position mainly in the genres of intermediate and popular models since then.

(2) Yashica entry into SLR market with Nicca technology

I have already written about how Yashica introduced focal-plane shutter technology by absorbing and merging Nicca Camera, manufacturer of Leica copies, and Zunow Opt., manufacturer of SLRs. The result was the release of the Yashica Pentamatic in the spring of 1960. This camera features a large-diameter lens mount, which gives it a luxurious feel. Furthermore, the camera also introduced unique technologies such as a combined accessory shoe and rewind knob, but the semi-automatic aperture and lack of features such as a self-timer, preview mechanism, automatic number counter restoration and mirror-up function left a slightly half-finished

impression, and sales-wise it could not be called a success.

Yashica changed its strategy from a high-end model with its own mount to the popular J series, which had changed to a versatile M42 mount. Although the Yashica Penta J-3 had a built-in external CdS exposure meter, it was set at a lower price than the cameras of other companies to secure a certain market position.

Photograph 5-31 Yashica Penta J-3
(Provided by JCII Camera Museum)

Subsequently, through collaboration with Tomioka Optical Co., Ltd. (later Kyocera Optec Corporation), a long-established optical manufacturer, Yashica aimed to improve SLR technology and continued to make medium-sized SLRs mainly in the popular camera price range. This would later blossom as the Contax brand.

(3) Mamiya Optical, a company willing to change the mount

Mamiya Optical, which had strong ability as a medium-format camera manufacturer, also entered the 35 mm SLR market with the Mamiya Prismat CLP in January 1960. However, this was an export-only model, and its first domestic release was the 1961 Mamiya Prismat NP.

Photograph 5-32 Mamiya Prismat NP[16)]

Mamiya Optical had already prototyped the Prismflex Mamiya equipped with a pentaprism in 1952, and had subsequently announced a number of 35 mm SLR prototypes, but because the main medium-format camera was doing well, lowered its priority, considerably delaying its release to the market from the first trial production.

This model employed a highly versatile Exakta mount, but used a unique external coupling semi-automatic aperture mechanism for the aperture. In 1962, the Prismat WP, which realized a fully automatic aperture with a dedicated bayonet mount, was released, but only two years later the Prismat CP with a M42 mount was released, resulting in inconsistency in the lens mount to say the very least. While perhaps this occurred because the company introduced the optimum technology at the time of each release, it also caused confusion on the user side. This trend continued until the 1980s with the lens mount changing six times in about 20 years. Although the last ZE mount was the first to be equipped with a full-fledged electrical contact to show off its advancedness, in the end the product did not become mainstream in the 35 mm SLR world.

With Mamiya Optical often called "*Karakuri no Mamiya*" [Mamiya, the company of mechanical gadgetry] and having continuously come up with one original idea after the other, it is a pity that the company could not come up with a clear strategy for the 35 mm SLR.

(4) Olympus, taking the world by storm with its half-size

Olympus Optical Co., Ltd. (currently Olympus), founded in 1919 as a microscope manufacturer under the name Takachiho Seisakusho, made a foray into cameras with the Semi-Olympus I in 1936, and worked on a wide range of spring cameras, TLRs, and 35 mm lens shutter cameras. Maitani Yoshihisa, who later became known as Oskar Barnack in Japan, joined the company, and the camera that he planned himself as part of training was the Olympus Pen. The picture size of 17 x 24 mm, which is half that of the Leica, and the double number of shots were well received by the family demographic at that time, and the subsequent Pen series lineup was a big hit.

The Pen F was planned as the half-size flagship SLR, also known as the "Pen size," and was released in 1963, making it the first Olympus 35 mm focal-plane shutter SLR. Being half-size, the Pen F cannot be compared to a Leica-format camera, but was a really unique camera.

Photograph 5-33 Olympus Pen F
(Provided by JCII Camera Museum)

As you can see from the outside, this camera does not have the triangular roof or pentaprism that a normal SLR should have. Instead, it uses a finder optical system that replaces a part of the Porro mirror system used in some early SLRs, such as the Duflex, for example, with a prism. The optical system is illustrated in Figure 5-11.

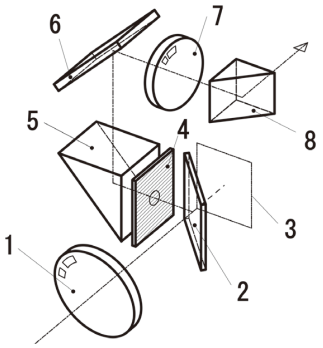
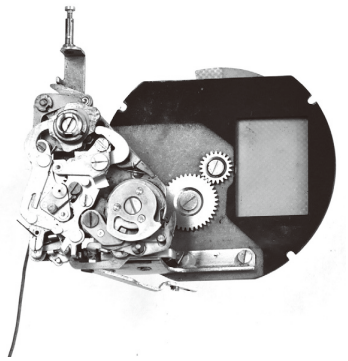


Figure 5-11 Optical System of Olympus Pen F

Utilizing the vertically long frame 3, the image from the photographing optical system 1 is reflected once laterally by the movable mirror 2 and guided to the eyepiece by the prism 8 via the prism 5, the mirror 6, and the lens 7. With this optical system, the top surface of the camera is as sleek as a rangefinder camera. In exchange, the left side is longer when viewed from the front, but this makes it convenient to hold with the right hand, so the configuration kills two birds with one stone.

The vertically long half-size resulted in another original mechanism. That is the rotary focal-plane shutter shown in Photograph 5-34.

The rotary shutter has the advantage of requiring only one fan-shaped curtain and, in accordance with the operation of the shutter curtain, is circular as a whole. Unlike a normal focal-plane shutter, the structure is relatively simple because the momentary exposure is performed by rotating the curtain. When viewed from the front of the camera, the mechanism that drives and controls the shutter curtain is located at the bottom left, avoiding interference with the triangular first prism that guides the captured image, and is shaped to secure space.



Photograph 5-34 Shutter of The Olympus Pen F

The coupling for shutter charging is performed via a gear located near the bottom of the camera, and thus couples naturally when the unitized shutter is attached to the chassis of the camera body. It is a skillful design considering assembly workability.

Most of the shutter curtain is made of titanium having a thickness of 0.03 mm, other than the ribs having a thickness of 0.04 mm in a radial pattern. According to Maitani's book, he had a hard time with this shutter curtain, optimizing it through a process of repeated trial and error on matters such as thickness and the machining of uneven surfaces, and purposefully eschewed any increase in mass to the extent that he did not even paint it. Therefore, when the back cover is opened, a dull silver shutter curtain can be seen, but the camera is free of problems such as light leakage. Thanks to his hard work, it became possible to increase the curtain speed, and the camera achieves 1/500 second high-speed synchronization with flash use, which was thought to be difficult for focal-plane shutters. Among the SLRs at that time, the Konica F was capable of a high shutter speed of 1/2000 seconds, but considering that the synchronization time was only 1/125, Maitani's camera had amazing specifications.

The Pen F achieved a high degree of miniaturization due to its original and rational layout. There is no wasted space inside and the appearance is slick. Such features exude not only Maitani's imaginative power and technical sense, but also his aesthetic sense, and that spirit would be passed on to later products, the M-1 and the XA.

Olympus entered the 35 mm SLR market with a very unique and bold model, earning itself a solid reputation, and, like other companies, kept pursuing the challenge posed by the Leica-format SLR. This was because, with the price of film decreasing and the value of a half-size "capable of taking twice as many shots" diminishing, the odds were against the camera, with its hard-to-overcome disadvantages of a vertically long frame when held and its inferior enlarged photos due to such a small frame.

The first Olympus SLR in the Leica format was the Olympus FTL, the first release of which was in the United States, in 1971. It was a so-called "makeshift" model that the development team reluctantly made at the insistent request of a major US dealer. This was because, although development of the full-scale system SLR M-1 had started, it would take another three years to bring the products to the market, and so a separate development team was assigned to the task. This uncoordinated operation made the FTL an extremely short-lived camera.

Photograph 5-35 Olympus FTL[17)]

The M-1 (renamed OM-1 immediately after its release) was released in 1972. Certainly, the camera, taking only three years to develop and featuring ingenuity in not only the product concept of miniaturization, but also its various specifications and functions, is an epoch-making model that makes a name in the history of the 35 mm SLR. Details of the camera will be described in the next chapter in the discussion on miniaturization.

(5) Ricoh

When considering the entry of various manufacturers into the 35 mm focal-plane shutter SLR market, Riken Optical (currently Ricoh) was an unfortunate manufacturer greatly affected by World War II. Before the war, Riken Optical produced cameras that used 127 type film, such as the Gokoku and the Ricohl I and IIB, from early on with focal-plane shutters, but after serving as a wartime munitions factory during the war, technology succession going into the postwar period did not go well.

Even so, the company gained strength with the legendary blockbuster, the Ricohflex III, in 1950, considered ways to enter the SLR market while taking a side glance at the SLR breakthrough, and finally around 1960 received a supply of Copal unit shutters. In this way, the Ricoh Singlex TLS released in July 1962 made its debut in the SLR market. This model does not have any major features, but the successor Ricohflex TLS401 released in 1970 adopted, instead of a pentaprism, a pentamirror system that achieves the same optical system by combining multiple mirrors. Since the pentamirror is standard in modern SLRs in the popular price range, the company certainly exhibited extreme foresight. Moreover, with its advantageous hollow structure, the camera adopted an epoch-making mechanism that allows the user to switch between eye-level and waist-level views with a dial. This technology will be described later.

Photograph 5-36 Ricohflex TLS401
(Provided by JCII Camera Museum)

(6) Other domestic SLR manufacturers

Other Japanese manufacturers that entered the SLR market include the Fujica, Cosina and Chinon brands, but the years of entry were after 1969, which was considerably behind the aforementioned manufacturers, and the cameras offered few functions that surpassed those of previous models.

Nevertheless, as the companies gained experience, later models had some distinctive specifications. For example, the Fujica ST701 introduced an LED display in the viewfinder, and the ST901 made it possible to digitally display the shutter speed. These unique models and their specifications will be touched upon in the next chapter to the extent possible as part of the progress and development of various functions.

References and citations

1) Satō, Takatoshi. *Raika no Shikumi* [How the Leica Works], (Green Arrow, 2000), p.32.
2) Satō, Takatoshi. *Raika no Shikumi* [How the Leica Works], p.28.
3) Japan Camera Industry Association, *Nippon Kamera Kōgyōshi* [The History of the Camera in Japan], (Japan Camera Industry Association, 1987), p.376. (Graphics by author)
4) *Kurashikku Kamera Senka No. 61* [All about Historical Cameras No. 61], *Kine Ekizakuta kara Hajimaru Kurashikku 35mm Ichigan-refu* [35mm SLR, from the Kine Exakta onwards], (Asahi Sonorama, 2001), p.91.
5) Sakai, Shūichi. *Raika to Sono Jidai* [The Leica and its Era], (Asahi Shimbun Publications, 2000), p.285.
6) *Kurashikku Kamera Senka No. 9* [All about Historical Cameras No. 9], *35mm Ichigan-refu Kamera* [35mm SLR Cameras], (Asahi Sonorama, 1987), p.8.
7) *Nippon Kamera Kōgyōshi* [The History of the Camera in Japan], p.384. (Graphics by author)
8) Ogura, Iwao. *Kokusan Kamera Kaihatsu Monogatari* [The Story of Camera Development in Japan], (Asahi Shimbun Publications, 2001), pp.134-138.
9) Ogura, Iwao. *Kamera to Sensō* [The Camera and War], (The Asahi Shimbun, 1994), pp.92-93.
10) Ogura, Iwao. *Kokusan Kamera Kaihatsu Monogatari* [The Story of Camera Development in Japan], p.150.
11) Ogura, Iwao. *Kamera to Sensō* [The Camera and War], pp.146-148.
12) Kamio, Kenzō. *Raika ni Oitsuke!* [Catch up with the Leica!], (Asahi Sonorama, 1995), pp.136-141.
13) Kamio, Kenzō. *Mezasu wa Raika!* [The Aim is the Leica!], (Soshisha Publishing Co., Ltd., 2015), p.260.

14) Asahi Camera. *Nyūfēsu Shindanshitsu Nikon no Ougon Jidai 1* [New Face Diagnostic Room – Nikon's Golden Age], (The Asahi Shimbun, 2000), pp.205-206.
15) Arakawa, Tatsuhiko. *Fukkoku Akarui Anbako* [(Reprint) The Bright Dark Box], p.174.
16) *Kurashikku Kamera Senka No. 9* [All about Historical Cameras No. 9], *35mm Ichigan-refu Kamera* [35mm SLR Cameras], p.91.
17) *Kurashikku Kamera Senka No. 9* [All about Historical Cameras No. 9], *35mm Ichigan-refu Kamera* [35mm SLR Cameras], p.102.

Thinking about picture size

There are various picture sizes for silver halide cameras, but this paper focuses on cameras that use 35 mm film and have a picture size of 24 x 36 mm.

Picture sizes are standardized by the international standard ISO 1754, and there are various sizes including medium-format in addition to 24 x 36 format. The Japanese Industrial Standard JIS B7115, which corresponds to this ISO standard, specifies a wider variety of sizes, including the 10 x 16 size that was once used in the Minolta 16 as well as other devices that use 16 mm film.

Looking at these standards, the upper and lower tolerances of 24 mm in length and 36 mm in width are +0.8/0. It seems that the large tolerance in width is due to the fact that, depending on the type of lens, the diffraction of light affects the picture size. The standards are conditional in that they "apply to frames taken with a standard lens," but it is difficult to define a "standard lens" in the first place. Nowadays, lenses with a focal length of around 50 mm are often called standard lenses, but this is based on the fact that the Leica Anastigmat, which was the lens when the Leica was released, happened to be a 5 cm F3.5.

Subsequently, attempts were made to define a standard lens, but none of them were persuasive, and now there is only a philosophical definition that "the standard lens is the one having the focal length that the user or manufacturer considers to be the standard," isn't there?

There is a reason why the tolerance is on the positive side. That is, although securing 24 x 36 mm is preferred, there are circumstances where a larger picture size is problematic. In the case of the SLR, there are models that claim 100% viewfinder frame coverage, but since the finder's field frame is fixed, the field of view decreases relatively as the picture size increases. Therefore, the idea of "securing 24 x 36 mm, but making any increase as close to 0 as possible" is expressed in the one-sided tolerance +0.8/0.

In that respect, the panoramic size born in the United States has a width of 36.4 mm ± 0.4 mm, which is the same as the actual 24x36 size, but is expressed by the median and distribution tolerance. This is probably because the first product of this size was a "one-time-use camera" whose performance was not mentioned.

Although I am straying off the subject, there is a tendency to set the drawing dimensions to the median + distribution tolerance due to the influence of 3D-CAD in mechanical design. While such dimensions are easy to understand, the design concept might be ignored, so I believe the one-sided tolerance method should be prioritized.

By the way, the Leica was not the first camera of this most popular 24 x 36 format size, but this size became popular due to the popularity of the Leica, and so even today is understood as the "Leica format." Nevertheless, most likely because they do not want to use the brand names from other countries or other companies, manufacturers in Japan often call this format the 35 mm format or full-size instead of the Leica format. Aside from the 35 mm format, "full-size" seems a little strange. Some digital cameras these days are less than 24 mm long and/or less than 36 mm wide, and yet use the term "full-size." The reason I think specifications should adhere to "+0.8/0" vertically and horizontally when "full-size" is declared is perhaps because I am partial to silver halide. However, it may be argued that full-size is not the size including the tolerance, but rather the nominal value of 24 x 36.

Whether standard lens or full-size, I feel once again that the definition of words ought to be clarified from time to time to prevent problems from occurring later.

Note that this paper uses the term "the Leica format" in honor of Barnack, rather than the "24 x 36 format" name specified by ISO. Besides, "the Leica format" is simple as a term whereas "the 24 x 36 format" is redundant.

6 Development of SLR Camera and Evolution of Technology

Up to the previous chapter, I have described how major Japanese camera manufacturers entered the SLR camera market. Since the beginning of the 1960s, the 35 mm SLR market, spurred by these manufacturers, has grown dramatically and Japan has dominated the market ever since.

In this chapter, we will look at the history of this breakthrough from the aspect of the technological evolution and development of each function.

6.1 Development of Focal-Plane Shutter

The small focal-plane shutter for 35 mm film, born from the inspiration of Oskar Barnack, became the foundation of subsequent shutters. While this shutter had almost the ultimate configuration from the beginning, fundamentals aside, minor improvements such as increases in speed, productivity improvements, miniaturization, unitization and overcoming other shortcomings were progressively made.

In the 1960s, from the Leica-style horizontal-travel winding, a new type of shutter that allows multiple metal blades to travel in the vertical direction of the frame emerged based on a concept unique to Japan. To this day, this type of shutter has become the mainstream, including in digital SLR cameras. This section describes the development process for these various types of focal-plane shutters.

6.1.1 Form of Horizontal-Travel Focal-Plane Shutter

The horizontal-travel focal-plane shutter is based on the Barnack design, with the feeding side of the shutter curtains being a thick, drum-shaped shaft. In order to distinguish this type from the thin two-shaft type subsequently developed, I will call this type the three-shaft type, combining the single shaft with the two shafts on the winding-side of the curtains. In contrast, the type subsequently adopted in many domestically produced SLR cameras is a four-shaft type in which the feeding side of the curtains is separated with two shafts in the front and rear, respectively.

A transverse cross-sectional view of each shutter is illustrated in Figure 6-1. In the three-shaft type, the shaft on the side that feeds out the shutter curtains is a thick shaft and, as mentioned in the Leica section, rotates independently for the front curtain and the rear curtain in the thrust direction (direction perpendicular to the paper surface).

In the three-shaft type configuration, the thick shaft only rotates a little less than one turn and is thus compatible with the brake system, the winding system and the like, and the rear curtain in the standby state is thickly wound, resulting in the advantage of being less susceptible to stress and curling compared to the four-shaft type. However, due to the “thick shaft,” the three-shaft type occupies space inside the camera, causing the width of the camera in particular to become large.

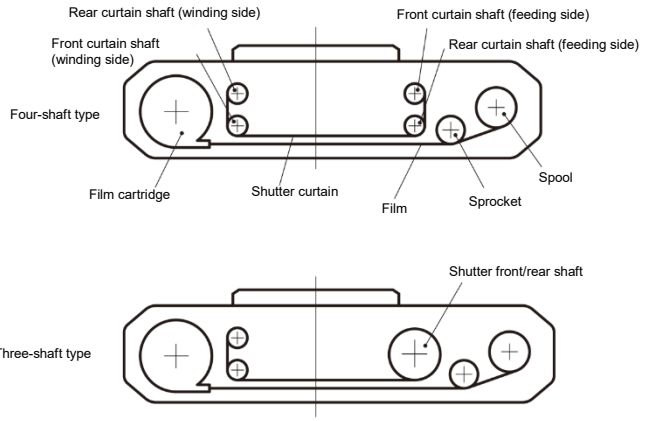
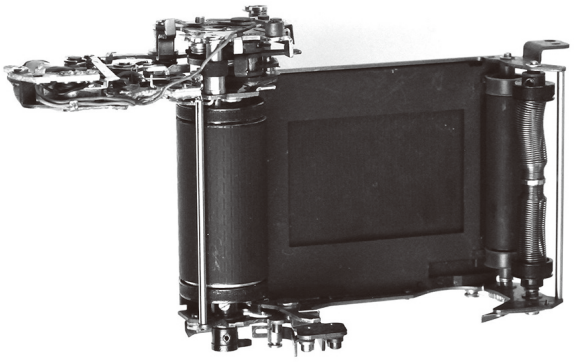


Figure 6-1 Shutter Transverse Cross-Sectional View

The design conceived to narrow the horizontal width of the camera was the four-shaft arrangement. Minolta paid attention to this arrangement from early on, and already adopted the design in the company's first 35 mm focal-plane shutter camera, the Minolta 35I, which was released in 1947. Subsequently, this design was adopted by many SLR cameras, including Canon, because of its space efficiency. In terms of flagship models from the early days of the SLR camera, Nikon and Topcon used the three-shaft type, while Pentax, Canon and Minolta used the four-shaft type. Canon adopted three shafts in its rangefinder cameras and four shafts in its SLR cameras, taking advantage of their respective characteristics.

In the 1970s, the withdrawal of Topcon from the camera market and the acceleration of miniaturization led to an increase in the proportion of four-shaft cameras, and leading SLR camera manufacturers, such as Olympus and Yashica, also adopted the four-shaft type. The Nikon F3, which was sold for more than 20 years starting from 1980, was substantially the final runner as a three-shaft type following the Leica tradition. The shutter of the F3 is shown in Photograph 6-1.

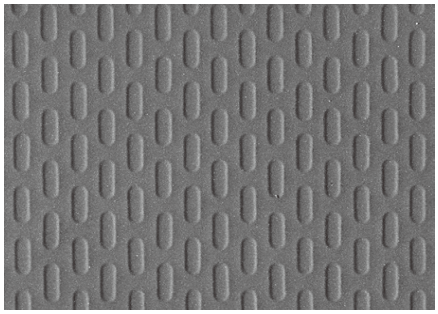


Photograph 6-1 Unit Shutter of the Nikon F3

This focal-plane shutter incorporated the trends of the time, such as unitization and electronic control, but the basic configuration itself, such as the thick shaft structure on the feeding side of the curtains, does not deviate from that of the initial Leica.

This shutter curtain is made of thin titanium. Although early

focal-plane shutters that started with the Leica used rubberized cloth curtains, there was a movement to make the curtains out of metal as a measure to protect against temperature change and pinholes caused by condensing sunlight. Nippon Kogaku focused on titanium from the start and adopted metal curtains in the Nikon F, with the exception of the very early models. It turns out that titanium is an excellent material as a curtain for a horizontally traveling shutter, and was actively used for about 40 years until production of the Nikon F3 was discontinued. As Nikon's proprietary technology, the titanium curtain is embossed, which has the effect of preventing scratches and, when wound, preventing adhesion and stabilizing shutter travel due to the thin air layer created by the embossing.



Photograph 6-2 Embossing of Titanium Shutter Curtain

As for other metal materials, stainless steel curtains were used in Canon's early SLR cameras. These curtains, however, did not become mainstream due to stainless steel having a high inertia compared to titanium, and Canon eventually adopted the titanium curtain as well.

6.1.2 Debut of Split Metal Blade Type Shutter

The idea of using a thin metal plate for the shutter existed from the early stages. For example, the Sport, the originator of the 35 mm SLR camera mentioned above, reflects this idea. Unlike an SLR camera, a rangefinder camera does not have a mirror, and thus the shutter curtains may be exposed to a bright light source such as sunlight, and pinholes due to the heat are likely to occur. Therefore, metal became the focus and, as explained with the Contax I, a method of processing metal plates into a louver shape and then having the shutters travel vertically during winding was adopted.

Around 1960, a completely new type of focal-plane shutter emerged. This new shutter was a split-type metal blade shutter adopted in the Konica F (each blade is formed of elastic thin metal plates). With both the front and rear blades being formed of a plurality of thin metal plates, the distinctive feature of these blades is that that they do not take up much space even in the retracted position, making miniaturization possible.

The shutter of the Konica F, not yet unitized and still with guided linear blade travel, was considered to be still in its infancy, and thus the Copal Square adopted in the Konica FS released at substantially the same time is essentially said to be the first mass produced. Figure 6-2 illustrates the configuration of each blade of the Copal Square. The shafts depicted by checkered patterns in the figure are rotating shafts fixed to the shutter base plate, and form a parallel link with the respective blades of the front and rear groups.

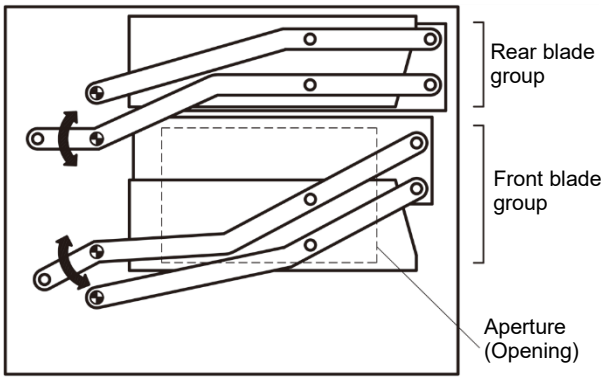


Figure 6-2 Blade Configuration of the Copal Square

The aperture is indicated by the dashed line. The figure illustrates the state before shutter release, with the front blade group covering the aperture and the rear blade group in a standby state in the upper area. As illustrated in the figure, by utilizing the parallel link, the two blades overlap in the retracted position, realizing a space-saving effect.

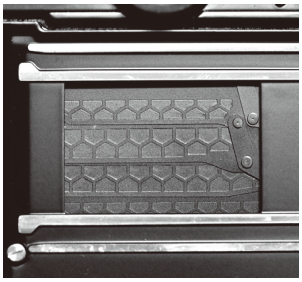
The principle of this mechanism was conceived by the inventor Chatani Kunju of the Kansai region and, according to anecdotes, he was inspired by the crossing barrier at a railroad crossing. Chatani was also one who could not draw and so embodied the idea in a rough sketch and an enlarged model and had an expert draw the drawing later[1]. Based on Chatani's invention, Copal developed the Copal Square, a unitized shutter, selected Konica FS as the first installation, and then started supplying the new product to each camera manufacturer. This shutter structure was awarded the 1961 Akashi Memorial Award of the Japan Society of Precision Engineering (currently the Japan Society for Precision Engineering) under the joint names of Chatani and five Copal engineers.

Many camera manufacturers, confused by the elevated level of production technology and quality control required for in-house focal-plane shutter production, turned to external procurement, and thus this focal-plane shutter was adopted not only in the Konica but also in Ricoh's SLR cameras, the Canon EF, and Nikon's intermediate camera brand, the Nikomat, and the like.

This type of vertically traveling unit shutter rapidly became widespread due to the advantage of a lower shutter price by mass production. Initially the new shutter was mainly adopted in popular cameras, but with the advantages, in principle, of a shorter travel distance in the vertical direction of the frame, allowing an increase in flash synchronization speed, subsequent miniaturization through blade configuration ingenuity, improvements in the blade material, resulting in higher durability and higher speed, and the intensification of competition due to the entry of Seikosha, a company strengthened by its lens shutter, the horizontally traveling shutter started to be driven out in the 1980s and this new shutter was adopted in many models. The technological evolution is described below for each element.

(1) Higher speed

For a shutter, it is especially important to reduce the inertia of the blades (curtains) that travel at high speed. For this reason, various new materials were used in place of the original thin steel plates. The Nikon FM2 extended the speed limit to 1/4000 by incorporating blades into the Copal shutter that were developed by its own company and formed of a titanium material thinned into a honeycomb shape by etching to reduce the weight.

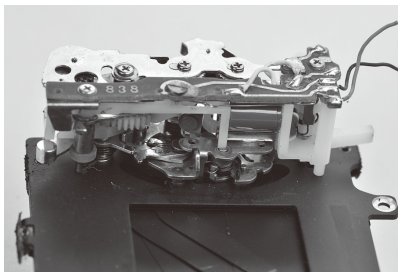


Photograph 6-3 Titanium Honeycomb Shutter Blades

Later, lighter aluminum alloys and plastics were adopted, and currently some blades now use carbon fiber composites. The blades are split into four or more in each group as standard, with some shutters having six. It became common to select the material for each blade in accordance with the amount of movement and role of the blade, using the right material in the right place. These tireless improvements led to the ultra-high shutter speeds of 1/8000 in the Nikon F-801 released in 1988, and 1/12000 in the Minolta α-9Xi released in 1992.

(2) Element improvement and miniaturization

While Copal focused on increased speed, Seikosha prioritized miniaturization. The Pentax ME released in 1976 was declared the world's smallest and lightest Leica focal-plane shutter SLR camera (at that time), thanks to the small size of Seikosha's shutter, the Seiko MFC-E. This shutter is thoroughly miniaturized and simplified. For example, the coil winding frame of the shutter control magnet is integrally molded with the board frame to which other parts are attached[2]. This is shown in Photograph 6-4. This is surely a skillful design by Seikosha's Nakagawa Tadashi, taking advantage of the degree of freedom provided by plastic parts.



Photograph 6-4 Mechanical Portion of the Seiko MFC-E

The Copal Square became Copal's blockbuster product, but there was still room for improvement. The reason is that the link structure that supports the blades was not yet optimized, making it impossible to split the blades into a greater number. Increasing the number of split blades makes the size more compact, which makes it possible to reduce the size of the slit-forming blades that move at high speed over a long distance and thus reduce the inertia and increase the speed.

Inoue Nobuyoshi of Copal devised an epoch-making parallel link structure that supports three or more split blades. As illustrated in Figure 6-3, multiple blades are sequentially imparted with a parallel link structure in positions near the rotating shafts. This format became the basic configuration of subsequent Copal shutters, proving to be the company's moneymaker. At one point, this type was said to have a shutter market share of over 50% and over 80% when including the shutters made by other licensed companies. This configuration created by Inoue received the 1985 Prime Minister's Invention Award.

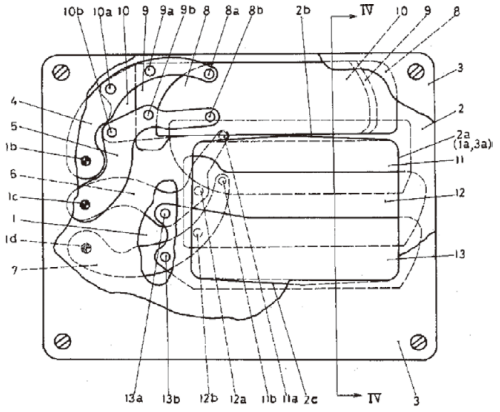
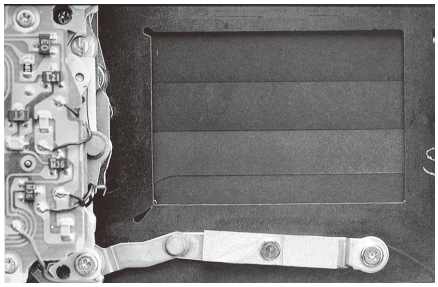


Figure 6-3 Copal's Shutter Blade Support Structure
(Japanese Examined Patent Publication No. 54-019175)

(3) Other additional functions

An attempt was also made to improve performance by adding functions to the existing shutter.

The shutter balancer is a function built into Nikon's own unit shutter, which was installed in the Nikon F4 released in 1989. This balancer is synchronized with the movement of the shutter front blade group so that its momentum works in opposition to that of the blade group, thereby mitigating the impact of the jump of the shutter blade group. With the momentum of the shutter blade group being unexpectedly large, tungsten alloy, which has an extremely high specific gravity, was used for this shutter balancer.



Photograph 6-5 Shutter Balancer[3]

The shutter became electrically controlled as the automatic exposure system of the camera advanced. At first, the front curtain was mechanically released and only the rear curtain was electromagnetically controlled, but this method evolved to use magnets to control the respective operation start timings of the groups of blades in the front and rear. Often this was done by changing the current to the magnets to release the attraction force and free the iron core, but Canon developed a technology of controlling the operation timings of the front and rear blade groups by using a rotary magnet that does not have a magnetic attraction surface, thereby preventing malfunctions caused by dust. The principle of the electrically controlled focal-plane shutter will be explained in the next section on shutter control.

Shutters having split-type blades need to have a larger overlap because of the risk of light leaking through the gaps between the blades. This increases the inertial mass of the blades and hinders their ability to reach higher speeds, which led to the development of the double-light-shielding technology. In a normal state, the aperture is doubly blocked by the front blade group and the rear blade group, and the rear blade group is retracted at the start of release and then the front and rear are moved to expose the image. Although the operation is more complicated, the amount of overlap between the blades is reduced because there is no longer any concern about light leakage, which means that the inertial mass can be smaller, allowing for higher speed.

The accuracy and precision of the shutter speed may deteriorate over time, but a shutter monitor function was developed as a countermeasure to this problem. This was first mounted in the Nikon F5 released in 1996. An optical sensor is placed to constantly monitor the shutter speed, and automatically corrects for any deviation in shutter speed. The sensor also serves as a safety device to warn the user in the event of shutter blade damage.

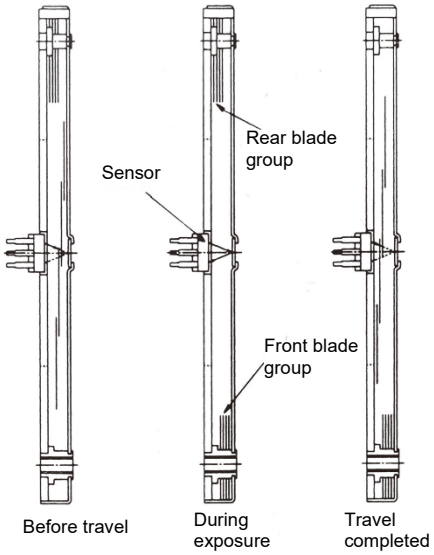


Figure 6-4 Shutter Monitor[4)]

6.2 Automatic Exposure

The disadvantages unique to SLR cameras were overcome with technologies such as the quick-return mirror and the fully automatic aperture, and so the focus of development turned to automation. In this section, we will discuss automatic exposure, starting with the evolution of the light metering system, a prerequisite.

6.2.1 Light Metering

One SLR camera with a built-in exposure meter is the Konica F, which uses selenium as the light-receiving elememt, although it is an external light type. Production of this model was short-lived, however, due to technical problems. Selenium has the advantage of not requiring a battery because it generates electricity based on the brightness of light received, but has low sensitivity and requires a large area that spoils the camera design and thus has only been used in a few SLRs, such as the Canon RM.

Later, technological advances in light-receiving elements led to the emergence of cameras that employ CdS photoresistors that utilize a thin film of cadmium sulfide. CdS has a resistance value that changes depending on the brightness of the light received and therefore requires a battery, but its metering performance was excellent compared to selenium.

The Minolta SR-7, released in 1962, had a built-in CdS on the left shoulder, although it was an external light type. Compared to selenium, CdS has a much wider dynamic range, making it possible to measure light in dimly lit rooms. Other CdS external-light cameras include the Canon FX and the Petriflex 7, but because the external-light system measures an amount of light that does not pass through the shooting lens, it does not take advantage of the key feature of the SLR, which is the ability to observe the captured image as it is.

Photograph 6-6 Minolta SR-7
(Provided by JCII Camera Museum)

The method of measuring the light of a subject through the shooting lens is called TTL (Through The Lens) metering. TTL metering was naturally being considered by many companies, but installation of the light-receiving element in the imaging optical path interfered with the photographed image or finder image and thus required ingenuity in terms of the position of installation. Figure 6-5 illustrates the main candidates for the installation position of the light-receiving element in an SLR camera.

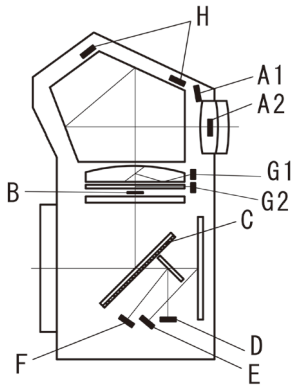


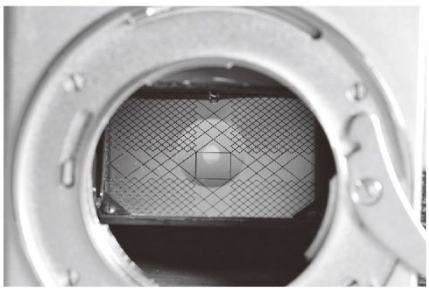
Figure 6-5 Main Arrangement of Metering Elements

At Photokina in 1960, Asahi Optical exhibited a prototype called the Pentax Spotmatic, which attracted much attention. In this camera, the CdS sensor can be moved onto and away from the screen (position B in Figure 6-5), and thus can be moved out of the way during observation. Although this arrangement is almost ideal for light metering due to the proximity of the element to the imaging plane, it is limited in principle to spot light metering, which measures only the part of the image where the light-receiving element exists, requires a complicated mechanism for insertion and removal of the light-receiving element and, most importantly, even though retractable, causes black shadows to be visible in the field of view during observation, resulting in disfavor and an end with just a prototype.

The first mass-produced SLR camera to offer TTL metering was the Topcon RE Super released in 1963. This model was the masterpiece of the SLR cameras of Tokyo Optical, boasting many features in addition to metering due to the company's uncompromising application of its technologies. The term “TTL metering” was first coined with this model.

Photograph 6-7 Topcon RE Super
(Provided by JCII Camera Museum)

The head of the Design Department was Zenyōji Kenichi, and the designers were Utsumi Kōzō and Kawase Suminosuke. The light-receiving element was installed on the back side of the mirror (position C in Figure 6-5) according to Kawase's idea. There are other SLR cameras that use a “mirror meter” with the light-receiving element placed here, such as the Ricohflex TLS401, but they are extremely rare. As shown in Photograph 6-8, there are groups of slits in a checked pattern on the surface of the mirror, and light is transmitted through these slits only and metered by the CdS on the back of the mirror. To take advantage of the large area, two types of CdSs are vapor-deposited, one for low brightness and the other for high brightness. This is the result of Toshiba's technology, which is apparently related to the fact that Tokyo Optical became a subsidiary of Toshiba in 1960. The mirror retracts during shooting so that it is not in the way, and the metering accuracy is good because the subject light does not pass through the screen, making this arrangement close to ideal for an SLR metering system. The technical hurdles of installing a special light-receiving element pattern and a light-receiving element in a moving section were high, and Tokyo Optical's technological prowess in overcoming these difficulties and commercializing the product is held in high regard.



Photograph 6-8 Mirror Meter of the Topcon RE Super

The Topcon RE Super was a modern SLR camera designed by an American industrial designer at the request of a US agency, but in terms of sales could not compete with the Nikon F, which was already the reigning king of the high-end SLR camera industry. Although Tokyo Optical decided to withdraw from the camera business in the 1970s, its many outstanding ideas and mechanisms as well as distinctive designs still shine brilliantly in the history of 35 mm SLR camera.

The Pentax SP, the second best TTL metering camera, was released in 1964. The metering method used in the prototype for the Photokina exhibition was abandoned in favor of metering the screen projected image from both sides of the eyepiece (position A2 in Figure 6-5). Since the screen is viewed from a distance, spot metering has errors due to the effect of the microprism in the center. For this reason, average metering, which averages the metered light across the entire frame, was adopted.

Some models utilize a condenser lens near the screen for placement of the light-receiving element. In the Canon F-1, a semi-transparent part is set diagonally near the center of the condenser lens, and the reflected light is metered by a light-receiving element next to the condenser lens (position G1 in Figure 6-5). Although the accuracy is good because metering takes place immediately after screen imaging, the periphery of the frame cannot be metered in principle, resulting in partial metering. Canon further developed this method and, in the New F-1 released in 1981, a beam splitter was placed near the screen to perform metering at position G2 in Figure 6-5.

The Minolta SRT101, released in 1966, adopted a split metering system called CLC metering. This is achieved by placing two light-emitting elements at position H in Figure 6-5, with one primarily metering the lower part of the frame and the other primarily metering the upper part of the frame, preventing measurement from being swayed by extremely

high-brightness information, such as that of sunlight.

Photograph 6-9 Minolta SRT101
(Provided by JCII Camera Museum)

Types that place the light-receiving element around the eyepiece, such as the Pentax SP, have some disadvantages such as being readily affected by the aperture value and focal length of the lens since transmission is through the light-diffusing screen, and the possibility of exposure compensation during screen replacement. However, with the light-receiving element becoming increasingly smaller in size, such as CdS to SPD (silicon photodiode) and GPD (gallium arsenide phosphide diode), more and more cameras had the element installed in position A1 or A2 in Figure 6-5, where there are fewer parts placed together, and this has become the mainstream. In addition, the Pentax SP used average metering, but subsequently turned to center weighted metering, which emphasizes the brightness near the center. This is because the main subject generally has a high probability of being near the center, and it is easier to follow the user's intention if the emphasis is placed there.

On the other hand, there are several variations of in-body metering, which is a method of metering in front of the screen, like the Topcon RE Super.

Leitz, which had been defending its position as the lone stronghold of rangefinder cameras, released its first TTL SLR to keep up with the times. This camera was the 1967 Leica Flex SL. The camera is provided with a sub-mirror on the backside of the original mirror (hereinafter referred to as “main mirror”) to guide some of the light to position D in Figure 6-5. The optical path through the semi-transparent section in the center of the main mirror is reflected downward and metered by the SPD element at the bottom. When shooting, the sub-mirror moves about 135° and retracts together with the main mirror. The Nikon F3 released in 1980 also adopted the sub-mirror system (position F in Figure 6-5). In this model, a large number of pinholes are placed in a portion of the main mirror instead of the half mirror, which is prone to aging. In addition, with the light-receiving element oriented slightly toward the film surface, it can be used as a TTL light control element during flash use.

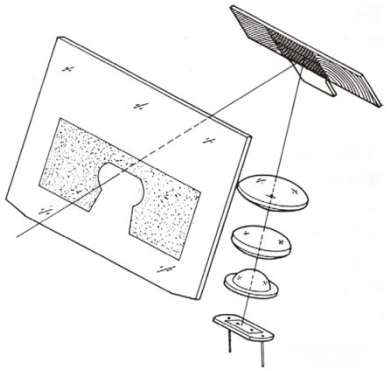


Figure 6-6 Pinhole Mirror of the Nikon F3[5)]

However, these sub-mirror systems had constraints in terms of the sub-mirror size, forcing the metering distribution to be partial metering or close to partial metering, and took up more space on the bottom of the camera with the AF (Autofocus) elements as AF development progressed, and thus are no longer seen today.

There are also methods of performing metering immediately in front of the film surface. Although not an SLR camera, the Leica M5, released in 1971, was the first in the Leica M series to offer TTL metering. This camera features a retractable light-receiving element installed immediately in front of the focal-plane shutter. The light-receiving element emerges to enable metering when the film winding lever is wound, and retracts just before exposure after the shutter release button is pressed. This is a straightforward metering method typical of Leica, but the M5 had an unfavorable reputation because of its uncomfortable size compared to the previous M series cameras. Yet, this metering system was carried over to the Leica CL. The Leica CL, released in 1973, was sold under the product name Leitz Minolta CL only in Japan, and was a collaborative product designed by Leitz and manufactured by Minolta. It was a monumental model created through the technical collaboration between Leitz and Minolta, but it was a bit of a departure from the orthodox Leica, with unique features such as a focal-plane shutter that used a vertical-travel winding system like the Contax.

Photograph 6-10 Leitz Minolta CL
(Provided by JCII Camera Museum)

Since the topic of the Leica CL has come up, I should mention the metering system of its successor, the Minolta CLE. In this model released in 1981, a large number of white dots are printed on the front of the front curtain of the focal-plane

shutter, and the light of the photographed subject reflected by these dots is metered by a light-receiving element placed at the bottom of the camera. The shutter front curtain retracts during the shooting operation, eliminating the need to provide a mechanism for moving the light-receiving element in and out as in the Leica CL. This is a very smart method, but there is a precedent for it.

The Olympus OM-2, released in 1975, was the originator of this form of metering in which groups of white dots are printed on the focal-plane shutter front curtain and metering is performed by the reflected light (position E in Figure 6-5). The disadvantage to the rangefinder camera is that, as an SLR camera, metering is not possible when the mirror is in the observation position (mirror down position). For this reason, normal metering must be performed with a separate light-receiving element installed near the eyepiece to display the information. When the shooting operation is started, the camera instantly meters the light after the mirror travels up and determines the shutter speed. The beauty of this method, called direct metering, is that it truly measures the amount of light in the image being captured in real time. When there is insufficient reflected light from the shutter front curtain, the camera accumulates the reflected light on the film surface after the shutter opens, which in principle enables automatic exposure even for long exposures of up to several tens of seconds. Photograph 6-11 shows the shutter curtain of the OM10, a popular model in the OM series. The printing pattern is changed for each model to optimize the photometric sensitivity distribution.

Photograph 6-11 Printing Pattern for Curtain Surface Metering of Olympus

Further, the ancestor of the TTL light control of the flash light previously described is the OM-2, and when the amount of reflection of the flash light from the film surface becomes appropriate, a signal is sent from the camera side to turn off the light. In conventional flash photography, even though referred to as automatic flash control, the flash is controlled by the sensor on the flash side, and thus TTL light control controlled through the actual shooting lens is remarkably effective in close-up photography and greatly expands the shooting area.

The direct metering of the OM-2 was also developed by Maitani Yoshihisa, the designer of the Olympus Pen F.

6.2.2 Multi-Pattern Metering

The Nikon FA, which was introduced in 1983, was equipped with multi-pattern metering. The Nikon FA can independently meter each of the five split areas of the frame. Although the Nikon FA was sometimes labeled “the world's first,” the origin of pattern metering was the Minolta SRT101 described in the previous section. However, at that time, it was already commonplace to install a CPU in a camera, and the Nikon FA was able to calculate the various pattern metering information with a complicated algorithm to derive a more optimal exposure value.

Pattern metering is performed by splitting the light-receiving portion of the light-receiving element into areas, arranging a lens in front of the light-receiving portion, and forming the screen image on the light-receiving element. In the Nikon FA, as illustrated in Figure 6-7, two three-pattern elements were used, but in principle one multi-pattern element may be used.

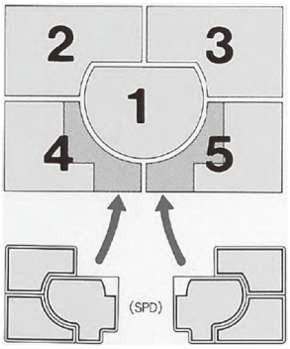


Figure 6-7 Multi-Pattern Metering of the Nikon FA[6)]

The idea is that, if there is a high-intensity light source in the vicinity of the frame, for example, the light source is regarded as the sun and predetermined exposure compensation is applied. Nippon Kogaku initially analyzed the imaging data of approximately 20,000 images to create an algorithm to find the optimal solution. However, it is important to note that, when considering the question, “What is the proper exposure?,” there is no perfect answer as individuals often have different preferences for high key (overexposed) or low key (underexposed) photography.

Multi-pattern metering subsequently evolved to increase the number of areas, with the Nikon F5 boasting an element with 1,005 areas in 1996. With the increase in the number of areas, the light-receiving element, which was an SPD in the FA, became a CCD in the F5, and in modern digital mirrorless cameras, the imaging element itself can be utilized as the light-metering element, making even an order of magnitude increase in the number of areas possible, in principle.

6.2.3 Full-Aperture Metering and Stop-Down Metering

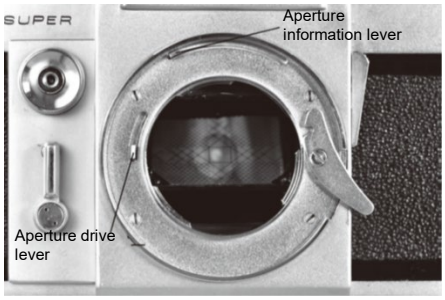
Although TTL metering with a metering element built into the camera became possible, it created quite a troublesome issue. With an SLR camera that realizes a fully automatic aperture, viewfinder observation is basically performed with the aperture open and so metering is also performed in that state. However, in actual shooting, the aperture is stopped down to the set aperture value, and compensation must be

made for the difference.

One possible countermeasure is to stop down to the set aperture value only during metering. This is called stop-down metering. Although it is true that high accuracy is achieved because metering is performed in the shooting state, it is annoying to have to stop down the aperture only during metering after having achieved a fully automatic aperture that makes it possible to obtain a bright observation image. So, naturally, a method of metering with the aperture value fully open and then later correcting for the number of stops (the difference between the open aperture value and the set aperture value) was considered. This is called full-aperture metering.

Full-aperture metering is a perfect match for a fully automatic aperture and TTL metering, but requires knowing the number of stops of the lens in advance, which is not easy with an interchangeable lens SLR. This is because the number of stops is information on the lens side, which must be communicated to the camera side. Until this point, designers had their hands full with other things and had not given much thought to the transmission of information between the camera and the lens, so they had to think about adding a new system to transmit information on the number of stops while taking into consideration compatibility with lenses that had already been sold.

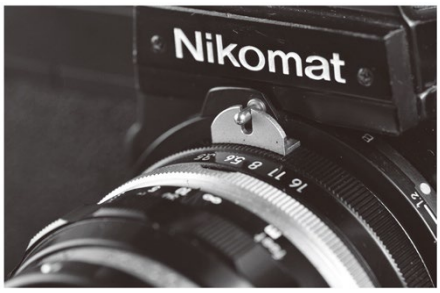
The first to adopt full-aperture metering was, again, the Topcon RE Super. In this camera, the aperture value is mechanically converted into information indicating the number of stops in the lens, and the camera receives this information to realize full-aperture metering. Tokyo Optical had obtained the rights to a powerful patent on this method, and thus the manufacturers that followed had to obtain the license rights for use of this patent from Tokyo Optical. This full-aperture metering method is also based on Kawase's idea. Photograph 6-12 shows the area around the mount. The aperture information lever receives the number of stops of the lens, and the aperture drive lever drives the aperture of the lens during shooting.



Photograph 6-12 Mount Periphery of the Topcon RE Super

Nikon's SLR cameras, which had a fairly accurate outlook on the future in terms of system performance, struggled with this point. From the earliest lenses, each lens was equipped with an interlocking “crab claw” to provide aperture information. These claws worked well with external metering, but when TTL metering became the norm, the lack of open aperture information became a problem. In other words, even if the aperture value is the same, say F5.6, the correct exposure value at the time of shooting is not known without knowing whether the metering value (full-aperture metering value) at the time of shooting is F1.4 or F2.8.

As a painstaking measure, Nippon Kogaku made it possible to manually set the open aperture value when the lens is mounted. The Nikomat FT, an intermediate model, had a film sensitivity setting dial where the open aperture value of the attached lens could be set manually, but the Nikomat FTn, released in 1967, adopted a semi-automatic open aperture indexing mechanism commonly known as “click-clank.” With this mechanism, when the lens is mounted on the camera, the aperture ring is first moved back and forth to engage the pin on the camera side with the “crab claw,” which is the lens aperture information, and then rotated to the abutment on the full-aperture side, automatically setting the open aperture, making use of the fact that the “crab claw” is always in the F5.6 position of the aperture ring. Though the mechanism was semi-automatic, this elaborate method enabled Nikon SLR cameras to use full-aperture metering with conventional lenses as well, and also successfully avoided the Tokyo Optical patent.



Photograph 6-13 “Crab Claw” of the Nikon F

Other companies were also hobbled by mount restraints, and Canon finally made full-aperture metering possible with the Canon F-1, released in 1971, by revamping its signal system and developing a new FD mount. The Canon F-1 was a system SLR camera that took five years and a huge amount of development money to prepare as a competitor to the Nikon F. With a wide range of accessories and lenses, the camera caught up with Nippon Kogaku in the professional market and took the official camera title from Nippon Kogaku for the first time at the 1976 Montreal Olympics. The camera in Photograph 6-14 is the Montreal Olympics commemorative model.

Photograph 6-14 Canon F-1
(Provided by Canon Camera Museum)

In Pentax SLR cameras, the M42 mount was a screw-in type, making positioning difficult, and the mechanical linkage was still challenging, but full-aperture metering was achieved in the Pentax ES, also released in 1971.

Nippon Kogaku as well, not wanting to take second place to competitors by staying with the "click-clank" mechanism, bought the patent license for use from Tokyo Optical in 1977 and introduced an Ai system, which directly transmitted information on the number of stops, and reformed the signal transmission system between the camera and the lens. Typical of Nippon Kogaku, they left the "crab claw" on the new Ai lenses for compatibility and the conversion of old lenses to the Ai system was accepted for over 30 years.

6.2.4 Evolution to Automatic Exposure

The general formula expressing the exposure value Ev of a camera is as follows:

$$Av + Tv = Ev = Sv + Bv$$

(Ev: Exposure value, Av: Aperture value, Tv: Shutter speed, Sv: Film sensitivity, Bv: Subject brightness)

As easily understood from this equation, as long as film sensitivity and subject brightness cannot be changed, the exposure value is determined by two factors: aperture value and shutter speed. In other words, automatic exposure is a technique that controls either or both the aperture value Av and the shutter speed Tv for a certain desired exposure value Ev.

(1) Aperture-priority AE and shutter-priority AE

To obtain a certain correct exposure value Ev, there are two main methods: (1) setting the aperture value Av and controlling the shutter speed Tv, or (2) setting the shutter speed Tv and controlling the aperture value Av. This means that when the camera performs automatic exposure, a decision is made as to whether to prioritize aperture value or shutter speed, and the camera controls the remaining one. (1) is referred to aperture-priority AE, and (2) is referred to as shutter (speed)-priority AE (AE stands for Auto Exposure). In a typical camera, for aperture-priority AE, the exposure value Ev is obtained from the subject brightness (metering value) Bv and the film sensitivity Sv, the aperture value Av is determined by the photographer, and thus the shutter speed Tv to be controlled is determined by Ev - Av. Similarly, with shutter-priority AE, the aperture value Av to be controlled is determined by Ev - Tv.

When promoting the use of automatic exposure in SLR cameras, it was up to each company to decide which AE method they wanted to use. A relatively substantial number of manufacturers started with aperture-priority AE, including Nikon, Olympus, Minolta and Pentax. On the other hand, Canon and Konica worked on shutter-priority AE. The reason why aperture priority is of the majority is because the shutter control required for aperture-priority AE is completed in the interior of the camera, whereas aperture control must be applied to the entire interchangeable lens group, which is larger in scale. Canon was able to do this because it grasped the necessity for aperture control in the future when the company switched to the FD mount in 1971.

(2) Shutter speed control

For aperture-priority AE, the shutter speed need only be controlled to a speed corresponding to the set aperture value. This can be achieved by starting the front curtain of the shutter and then starting the rear curtain at a predetermined timing. Figure 6-8 illustrates this principle.

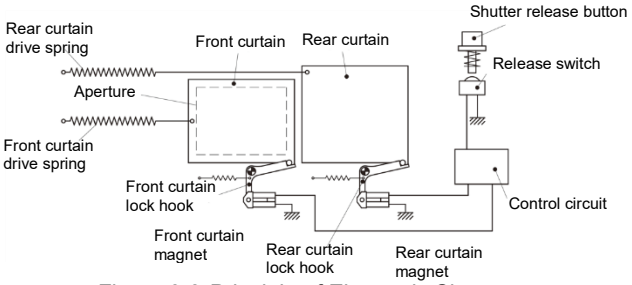


Figure 6-8 Principle of Electronic Shutter

The predetermined shutter speed is obtained by starting the front curtain by unhooking it with the release of an iron piece from a magnet, and then disengaging the rear curtain based on instructions from the control circuit.

In early electronic shutters, the front curtain was started mechanically, but there were also designs that picked up a start signal and then started the rear curtain based on electrical information (such as the amount of charge stored in a capacitor) corresponding to a predetermined shutter speed converted from metering information.

The Pentax ES was the first 35 mm SLR camera to be equipped with an electronic shutter, enabling automatic exposure control using TTL metering (for the external metering type, the Konica Autorex, released in 1965, was the first AE-equipped 35 mm focal-plane shutter SLR camera). Also, as mentioned earlier, this camera is Pentax's first full-aperture metering type with an interlocking claw and pin for aperture information with the M42 mount left as is.

Photograph 6-15 Pentax ES
(Provided by JCII Camera Museum)

Shutter control for aperture-priority AE can be achieved relatively easily with just an electrically controllable shutter and a circuit for storing metering information, and thus a number of manufacturers adopted this method.

With the Nikomat EL in 1972, Nippon Kogaku achieved its first aperture-priority AE as a 35 mm focal-plane shutter SLR camera.

Photograph 6-16 Nikomat EL
(Provided by JCII Camera Museum)

Minolta similarly entered the automatic exposure SLR camera market with the Minolta X-1 in 1973. This model was a high-end professional model with an interchangeable viewfinder, and adopted aperture-priority AE. At the time, there was still a deep-rooted belief that using automatic exposure was somehow unprofessional, making this a revolutionary camera in that sense.

Photograph 6-17 Minolta X-1
(Provided by JCII Camera Museum)

Asahi Optical, which was the first company to convert to AE with the Pentax ES, had managed to survive to this point with the M42 mount, but sensed its limitations with the small mount bore, the hassle of mounting and the like, and abandoned the M42 mount in 1975 and shifted to the newly designed K mount, simultaneously releasing the Pentax KX, K2 and KM to promote the new mount. In particular, the K2 was an ambitious camera equipped with the newly designed electronically controlled unit shutter, the Seiko MF, jointly developed with Seikosha. Normally, a major mount change is a risky move for a manufacturer, but Asahi Optical managed to release not only three models, but also a large number of interchangeable lenses at the same time and included automatic exposure advancements as well, successfully breaking through the shackles of the M42 mount.

Photograph 6-18 Pentax K2
(Provided by JCII Camera Museum)

(3) Aperture Control

The aperture is located on the lens side, making controlling the aperture in the same way for all interchangeable lenses from the camera side more difficult than shutter control. In contrast to shutter control, which is achieved substantially by no other strategy than electrical control, aperture control can be classified into several forms. The following is an explanation according to classification.

(1) Meter needle holding method

To achieve a fully automatic aperture, stopping down the lens from the camera side via an interlocking mechanism was already being done by the SLR cameras of various companies. For example, when Canon changed to the FD mount, the aperture value was transmitted by the aperture information lever on the inside of the mount on the camera side, and the aperture on the lens side was stopped down by operating the separately installed aperture drive lever. In other words, the desired aperture value can be obtained by controlling the amount of movement of the aperture information lever (on the camera side) by some means.

Therefore, the method used in lens-shutter compact cameras, which utilizes the movement of the meter needle to indicate the exposure value, was adopted in SLR cameras as well. Because the amount of movement of the lever to be stopped down corresponds to the exposure value obtained as a result of light metering, this can be directly read as position information and reflected in the aperture value. This is the principle behind the meter needle holding method. The Canon EF, released in 1973, was Canon's first shutter-priority AE SLR camera that

used this method.

The principle is illustrated in Figure 6-9.

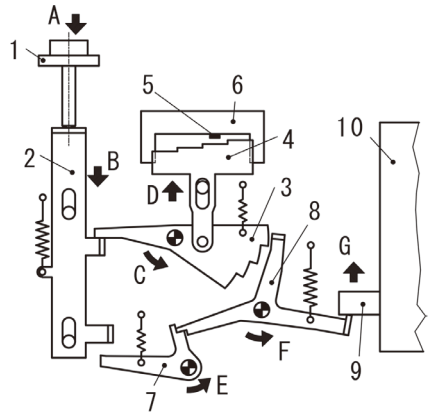


Figure 6-9 Meter Needle Holding Method

The operation is performed in order from arrows A to G. The following is a step-by-step explanation.

(1) When the shutter release button 1 is pressed in direction A, the slide lever 2 moves in direction B.
(2) The stepped lever 3, which was restricted by the sliding lever 2, starts to rotate in direction C.
(3) This causes the meter needle holding plate 4, which is linked to the stepped lever 3, to move in direction D.
(4) The needle 5 of the exposure meter is positioned in any position in the guide plate 6 according to the brightness of the subject.
(5) The meter needle holding plate 4 holds the needle 5 and stops at a height corresponding to its position.
(6) Meanwhile, the slide lever 2 is pressed further downward, and the locking hook 7 starts to rotate in direction E.
(7) Engagement with the locking hook 7 is released and the aperture drive lever 8 starts to rotate in direction F.
(8) At this time, the aperture drive lever 8 is limited by the position of the step of the stepped lever 3.
(9) In other words, the position of the needle 5 of the exposure meter determines the position of the aperture lever 8.
(10) As a result, the position of the aperture lever 9 of the lens 10, which is pressed in direction G by the aperture lever 8 is determined, and the aperture is controlled at the aperture corresponding to the exposure meter (exposure value).

The meter needle holding method was used in early SLR cameras because of its relatively simple configuration, but the force required in pinching the delicate meter needle and the long shutter release button stroke were disliked, and the system was gradually replaced by other methods.

(2) Instant stop-down method

There was a debate about which was best, aperture-priority AE or shutter-priority AE, but with even a little knowledge of photography, it is obvious each has its advantages and disadvantages, the former being better for emphasizing depth of field and the latter being better for expressing the movement of the subject. However, in the early days, SLR cameras were equipped with only one or the other, and naturally, there were expectations that a model with both would eventually appear.

Having both capabilities is referred to as “dual-priority AE,” and the first SLR camera with dual-priority AE was the Minolta XD in 1977 (called Dual AE by Minolta). Because Minolta started with aperture-priority AE, the company adopted a unique method to incorporate the aperture control necessary for shutter-priority AE. This is the instant stop-down method.

Photograph 6-19 Minolta XD
(Provided by JCII Camera Museum)

When the shutter release button is pressed, the aperture lever starts to operate and the lens is gradually stopped down. In association, the amount of light traveling to the light-receiving element on the camera side also changes from bright to dark. The light intensity value is measured in real time, and the aperture lever is stopped when the desired value is reached. Because of this principle, the instant stop-down method is also referred to as the light intensity feedback method.

For manufacturers like Minolta and Nippon Kogaku, who had to start with aperture-priority AE, the amount of movement of the lens aperture drive lever and the actual amount of aperture reduction differ from lens to lens. For example, with lens A, moving the aperture lever by 3 mm results in a 3-stop reduction, but with lens B, the same 3-mm movement only results in a 2-stop reduction. This is because the time when the system was created was so long ago that designers did not take aperture control into consideration at all, and companies postponed changing the system out of consideration for users with conventional lenses. In this regard, the instant stop-down method feeds back the light intensity as it is, not the amount of movement of the aperture lever. This was Minolta's painstaking strategy to avoid this problem. The XD was a hit because of its dual-priority AE feature and compact, lightweight body that was easy to operate, but the instant stop-down method had a fundamental disadvantage.

Metering needs to be done at all times during the lens aperture operation, and the mirror needs to remain in position during this time. This is because raising the mirror cuts off the light to the light-receiving element. In other words, the mirror was raised simultaneously with stop-down, but now had to be raised after stop-down. Because both mirror lock-up and the

aperture drive require about 20 to 40 ms, the shutter time lag, which is the time between pressing the shutter release button and actual exposure, becomes longer, which may result in missed shutter opportunities with moving subjects.

Nippon Kogaku, which was in the same position as Minolta, adopted the instant stop-down method for its Nikon FA, FG and others, but later, as automatic winding was developed and high-speed continuous shooting became more important, this time lag problem gradually emerged, and both Minolta and Nippon Kogaku were forced to switch to new lens systems.

(3) Stop-down amount feedback method

Aperture control refers to controlling the aperture lever on the lens side in an appropriate position from the camera side, and thus the aperture lever can be controlled at any position by converting the position information into electrical information and reading the electrical information. Canon, which started automatic exposure with shutter-priority AE, worked diligently to develop this method and introduced it in the Canon AE-1 released in 1976.

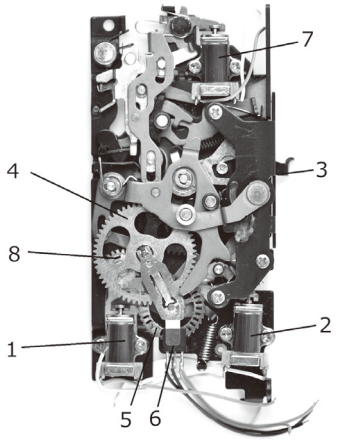
This model was an unprecedented hit due to the introduction of a full-fledged CPU (microprocessor) into the SLR and the low price achieved by advancements in automated production. The aperture control also adopted a resistance value feedback method in which the stop-down amount, that is, the amount of movement of the aperture lever, is converted into a resistance value for control. The introduction of the CPU maximized the advantages of being able to control each mechanism in the camera in parallel and instantaneously.

Photograph 6-20 Canon AE-1
(Provided by Canon Camera Museum)

Two years later, in 1978, Canon introduced the A-1, which used digital processing to control everything in the camera. The aperture control is also more advanced than the AE-1, adopting a digital value feedback method that converts the aperture value into a digital value for control. Although the A-1 fell behind the Minolta XD as a dual-priority AE SLR, the A-1 was an extremely complete and innovative camera.

Photograph 6-21 Canon A-1
(Provided by Canon Camera Museum)

The digital value feedback aperture control method would later become the standard for SLR cameras, and would be used by Nikon as well, especially in professional cameras where time lag was critical. As an example of this type of aperture control mechanism, the mirror/aperture control mechanism of the Nikon F5 released in 1996 is shown in Photograph 6-22.



Photograph 6-22 Mirror/Aperture Control Mechanism of the Nikon F5

This mirror/aperture drive system mechanism performs all of the functions of shutter release, mirror drive and aperture control. The aperture control mechanism alone can be described as follows.

(1) The aperture start solenoid 1 is activated, rotating the aperture lever 3 clockwise to initiate stopping down. Although not shown in the photograph, 3 is linked to the aperture lever on the lens side.
(2) The movement of the aperture lever 3 is increased in speed by the acceleration gear 4, rotating the ratchet wheel 5 provided with many holes.
(3) The photocoupler 6 counts the number of holes in the passing ratchet wheel 5.
(4) When the count (which corresponds to the aperture value) reaches a predetermined value, the aperture stop solenoid 2 is activated and the aperture stops at the predetermined value.

Such a process as described above is used to control the aperture to a predetermined value. Note that 8 is the gear system for eliminating gear system backlash, and 7 is the solenoid for shutter release. Along with the aperture control mechanism, I think you will easily understand the modern

drive system that uses solenoids and other dedicated electromagnetic actuators for various movements.

6.3 Automatic Feeding

Once advancements in exposure automation were made and accepted by the market, the next step was to develop automatic feeding technology that automates film winding. This so-called accessory is called a motor drive or a winder. Generally speaking, the accessory is called a motor drive if the continuous shooting speed is fast, and a winder if the continuous shooting speed is slow, but the boundary between the two is not clear. My sense is that it is the former if the speed exceeds 2 fps (frames per second), and the latter if the speed is less than that or if the shooting is single-frame shooting only.

6.3.1 Motor Drive

Automatic film feeding itself has been around for a long time, and Nippon Kogaku, which had been used by the press for its high reliability, had offered a mountable motor drive device since the advent of its rangefinder cameras as a special specification. Even the Nikon F, although requiring some adjustment, could be retrofitted with a motor drive. For professional applications, most of the high-end SLRs of each company established motor drive specifications, such as the Canon F-1 released in 1971. Minolta also released the X-1 Motor in 1976, which combined a motor drive with the X-1 professional model. Nippon Kogaku also released the successor to the F, the F2, in 1971, with enhanced motor drive functions and a faster continuous shooting speed of 5 fps. High-speed continuous shooting became a great advantage, especially in the field of sports photography.

In order for a motor drive and a camera to work organically, the interlocking system needs to be optimized. Early models, such as the Nikon F2, used a coupling for winding and a "prod" for the shutter release as a mechanism. At that time, mechanical shutter releases were used, so the only way to release the shutter from the motor drive side was by mechanical means such as a prod. Because there is no signal from the camera side to end exposure, the camera is forced to start winding in expectation of the end of exposure, resulting in a risk that winding will start during exposure at low shutter speeds. Therefore, a setting dial is provided on the motor drive side to determine the timing of the start of winding in accordance with the shutter speed of the camera. The motor drive system of the Nikon F2, although prehistoric now, was advanced at the time, including automatic film rewinding, and was used by many news photographers at the Olympics and other events.

The need for high-speed continuous shooting by the news media was understood from early on and, in 1971, the F High Speed, which was based on the Nikon F and could shoot at 7 fps with the mirror locked up, was released as a model tailored toward the press. This model was for the Sapporo Winter Olympics, and a special external viewfinder was provided for use with the mirror raised.

Photograph 6-23 Nikon F High Speed[7)]

Canon, which was planning to penetrate into the professional market, was also keen to improve the continuous shooting speed and launched the F-1 High Speed Motor Drive Camera in 1972 for the Munich Olympics. In order to increase the speed, Canon abandoned the mirror drive that requires a long operation time, and adopted a fixed semi-transparent pellicle mirror and made the aperture manual. In addition, the metering function and low shutter speed were omitted to achieve a maximum speed of 9 fps. The camera, shown in Photograph 6-24, receives power from an external battery pack of 20 AA batteries via a cord.

Photograph 6-24 Canon F-1
High Speed Motor Drive Camera
(Provided by Canon Camera Museum)

In 1978, Nippon Kogaku also released the F2H with a fixed semi-transparent mirror, surpassing Canon with 10 fps. However, the race to increase speed in this era had limitations in terms of general photographic performance, such as metering, the prices were extremely high, and many products were sold only to the press, resulting in models that had little to do with general photography enthusiasts.

Photograph 6-25 Nikon F2H
(Provided by JCII Camera Museum)

In the 1980s, the electric shutter release became more common, making it possible to release the shutter by an electric signal rather than mechanical means such as a prod. At the same time, necessary signals such as the shutter rear curtain signal (for timing the completion of exposure) could now be exchanged by simply installing electric contacts. Finally, the era was now one in which ordinary amateurs could benefit from high-speed photography with almost no restrictions.

The race for faster motor drives between the top two manufacturers, Nikon and Canon, in the high-end professional camera market continued with the Nikon F3 and Canon New F-1. In the Nikon F3 released in 1980, the camera's winding mechanism and shutter mechanism were redesigned, and ball bearings and other components were used in abundance to reduce the winding torque. This was partly to improve the feel of the original winding lever, but according to Satō Akihiko and others in charge of the design at the time, motor drive acceleration and energy saving were also in mind.[8] Indeed, the MD-4 motor drive for the F3 can achieve 5.5 fps with a dedicated NiCd battery, or 6 fps with the mirror lock-up, without requiring any special modification. Additionally, the MD-4 consumes relatively little battery power.

Photograph 6-26 Canon F3 + MD-4 Motor Drive[9]

Canon came out with the New F-1, the successor to the F-1, in 1981. The position of the motor drive for this camera is unique. The aperture control mechanism is on the motor drive side and shutter-priority AE is enabled with the mounting of the motor drive. The design was based on the idea that, with the shooting prioritizing shutter speed, continuous shooting is required, but was intriguing as a new motor drive concept.

Photograph 6-27 Canon New F-1 +
AE Motor Drive FN[10]

The fastest continuous shooting speed for a 35 mm SLR is 14 fps, which was achieved by the Canon New F-1 High Speed Motor Drive Camera released in the 1984 Olympic year, combining the special technology of the fixed pellicle mirror and a special horizontally traveling, electromagnetically driven metal blade shutter. This camera was extremely large due to the use of a special 24 V battery and was sold in limited quantities for 1.3 million yen, but there was a certain demand for the camera for sports photography.

Since then, SLR cameras, including those for professional use, have been equipped with built-in motor drives rather than external ones, and the use of AF has advanced. Even though the playing field changed, the rivalry between the two leaders in the professional line, such as the EOS-1 series and the Nikon F5, continued for a long time.

Photograph 6-28　Canon New F-1 High Speed Motor Drive Camera
(Provided by Canon Camera Museum)

6.3.2　The Winder

In addition to the motor drive for high-speed automatic feeding for professionals described above, there is a type of automatic feeding called a winder. The winder evolved because, even in general amateur photography, automatic winding reduces the probability of missing the moment to take a photo and, first and foremost, increases convenience. If we go back in time, Leica had offered a spring-loaded automatic winding accessory and, in Japan as well, the Ricoh Auto Half and the Canon Dial 35, which were not SLR cameras, automated most of the functions of the camera, including film winding with a spring, making the models huge hits. Although it would be difficult to use springs in SLRs requiring a lot of energy to charge, the availability of compact, high-performance motors brought the wave to the SLR.

If you trace the origin of the winder for the SLR, you will find that it is once again a Topcon product. The aforementioned Kawase, after realizing TTL metering and full-aperture metering with the Topcon RE Super, thought that the next step in automation would be easy film feeding and decided to incorporate it in the successor. Tokyo Optical, with its track record of delivering motor drive devices, albeit in large scale, used that know-how to launch the Topcon Super DM for the general amateur market in 1973.

It was probably with this camera that the term “winder” became commonplace. The special winder that comes standard with the camera has a grip, the winding motor is placed inside the grip, and four AA batteries are positioned side by side at the bottom, a very reasonable layout indeed.

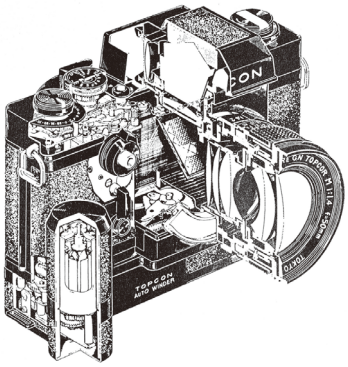


Figure 6-10　Topcon Super DM + Winder Structural Drawing[11)]

The rapid spread of winders began with Canon's blockbuster, the AE-1. The AE-1, also known for its full-fledged built-in CPU, was well received for its high functionality and reasonable price. In fact, Nippon Kogaku released the ELW and the AW-1 winder based on the Nikomat EL a few months earlier than the AE-1. However, the AE-1 was priced at 81,000 yen with a 50/1.4 lens, while the Nikomat ELW was priced at the same for the camera only, so it was far behind the AE-1 in terms of sales (the price in Photograph 6-29 is 85,000 yen, but that includes the case). In addition, most of the advertising was done with the Power Winder A attached, and even the sound of continuous shooting was played in the TV commercials. The Japanese catch phrase “*Rensha-ichigan* (continuous shooting SLR)” shown in Photograph 6-29 had a strong impact on the market, and the term “*Rensha* (continuous shooting)” was popularized by this camera.

Photograph 6-29　Canon AE-1 Advertisement
(Provided by Canon Camera Museum)

Since 1976, when the AE-1 was released, the most popular SLR cameras have been equipped with winders as optional accessories.

6.3.3 Emergence of SLRs with Built-in Automatic Winding Function

As motor drives and winders became more common, it was natural for companies to consider integrating motors into cameras for film winding. In the following, I will describe the history of this technology, but first, I would like to note that, in a broad sense, the Minolta X-1 MOTOR, SR-M and the like also have motor drives that cannot be removed, so one could argue that these cameras have built-in motors. However, from a technical point of view, the cameras are considered to be "integral" models with a fixed external motor drive, not a "built-in" motor drive. The following, therefore, describes cameras with an internal motor drive, such as the Konica FS-1.

(1) The Konica FS-1

At Photokina in the fall of 1978, a prototype of an SLR with an eccentric design was exhibited. The following year, in the spring of 1979, Konishiroku Photo Industry released this as the Konica FS-1, a 35 mm SLR with a built-in motor and automatic winding system.

Photograph 6-30 Konica FS-1
(Provided by JCII Camera Museum)

Konishiroku Photo Industry released a practical lens-shutter camera with a built-in flash, the Konica C35EF (nicknamed the Pikkari Konica in Japan) in 1975 and the world's first automatic focus (AF) camera, the Konica C35AF (nicknamed the Juspin Konica in Japan), in 1977, both of which became major hits, but Konishiroku Photo Industry took a backseat as an SLR manufacturer. This FS-1 model was to be their quick comeback, with a built-in film winding function and an attempt to automate the film loading process. The name "FS," which stands for Future System, also conveys their enthusiasm.

Technically, the motor was placed inside the film winding spool to increase space efficiency, and a differential mechanism was cleverly incorporated to wind the film and stop the winding. In conventional cameras, the sprocket feeds the film for a predetermined length (8 perforations = 38 mm) and then the spool rewinds it, but in this camera, the spool winds the film and the sprocket just counts the perforations. The adoption of the "spool drive" mechanism, as opposed to the conventional so-called "sprocket drive" mechanism, was a visionary move, considering the fact that cameras with built-in motors have since moved in that direction.

Power supply is a major issue for a camera with a built-in motor, but in the FS-1, four AA batteries were placed in the grip, improving the grip feel as well. Furthermore, to take advantage of the automatic winding system, accessories such as a wireless release device for shooting from a distance, an interval timer for cyclic shooting and a left-hand release button were also provided.

CPU control, which became mainstream with the Canon AE-1, was also incorporated to enable the well-timed control of three motors, including those for winding and drive system charging, and four solenoids for triggering each function.

The FS-1 was thus the ambitious work of Konishiroku Photo Industry, but it was not a success in terms of sales. There are various speculations about the cause of the unpopularity of the camera, such as malfunctions due to motor noise affecting the CPU, loading problems due to variations in film rigidity and difficulties in repairing the complicated winding mechanism. However, in my opinion, the reason was that the continuous shooting speed was too slow at about 1.5 fps (catalog data; the performance seemed much slower), even though the camera was deliberately equipped with four AA batteries. Even cameras with manual winding can shoot faster than that once the user becomes familiar with the mechanism. Also, despite the fact that automatic film loading was a very beginner-friendly specification, the price may have been ill-matched for the amateur. Konishiroku Photo Industry released a successor model, the FT-1 Motor, to break the slump of this model, but it too failed to make a splash and, at that point, the company gave up on the SLR market.

(2) The challenge of automatic winding for the Yashica Contax

When Konishiroku Photo Industry exhibited the FS-1 at Photokina in 1978, a slightly unusual model without a winding lever was also displayed at the Yashica booth. This was the Contax 137MD Quartz, the second automatic winding SLR with a built-in motor.

The name Contax abruptly appears here, and this requires an explanation. To digress a bit, as mentioned earlier, Zeiss Ikon misjudged the main battlefield of SLR cameras and missed the trend by launching the Contaflex with a lens shutter and the ultra-high-priced Contarex, and withdrew from camera production in 1971 to concentrate on the production of camera lenses. However, the company could not deny their SLR

ambitions, and was looking for a way to collaborate with a Japanese camera manufacturer that was gaining momentum. Asahi Optical, who was approached first, turned down the offer, but Yashica, who was next in line, gladly accepted. Yashica was languishing as a popular manufacturer of SLRs, and thought that it needed the prestigious Contax brand to expand into high-end models. Then, in 1975, the Contax RTS was sensationally released.

Photograph 6-31　Contax RTS
(Provided by JCII Camera Museum)

As an SLR compatible with Carl Zeiss lenses, this camera became a temporary threat to Nikon and Canon in the professional market. Then, the 137MD Quartz was exhibited at the same time as the Contax 139 Quartz at Photokina in 1978 as an intermediate model that could use these same lenses. As the name implies, the 139 Quartz was the world's first SLR camera to use quartz as the oscillator for timer control of the shutter speed and the like, and was released in April 1979.

A year and a half after its Photokina debut, the 137MD Quartz was released in May 1980, a year after the manually wound 139 Quartz. It is assumed that production difficulties were due to the complexities inherent in SLRs with built-in motors.

Photograph 6-32　Contax 137MD Quartz
(Provided by JCII Camera Museum)

Back to the topic at hand, the 137MD Quartz represented, in many ways, a stark contrast to the FS-1. First of all, the arranged position of the batteries was quite different. In contrast to the FS-1 with the batteries standing in the grip, four batteries were placed at the bottom. Most likely the company did not want to destroy the Porsche design image of the Contax RTS already put forth. Indeed, it is just a little bit taller, and can carry on the design without any discomfort.

The premier specification, automatic winding, was also equipped with interesting technology. In the Konica FS-1, independent motors were used to operate the mirror, shutter and aperture, feed the film and charge the mechanism system, but in the 137MD Quartz, only one motor was used to do all of these things. By making good use of a one-way clutch, the forward rotation of the motor after release causes the aperture to stop down, the mirror to rise and the shutter to travel, and the same motor is reversed after shooting to reset the drive system and wind up the film. The design saves space by requiring only one motor, and improves motor efficiency by avoiding the concentration of drive torque. In the case of cameras, quick operation is desired, so core-less motors with good responsiveness are the best choice, but they are expensive. This camera only requires one motor, resulting in a cost advantage.

Although the mechanism is complex with its clutches and interlocking systems, the 137MD Quartz was well organized as a camera, with a continuous shooting speed of up to 2 fps and a more comfortable feel than the FS-1. The camera was considered to be positioned as an aperture-priority AE model more for the amateur but, in 1982, was succeeded by the 137MA Quartz, which enabled manual exposure and increased the continuous shooting speed to 3 fps, surpassing the external winder models. This series continued until the 167MT in 1987, offering automatic rewinding capabilities and the world's first auto bracketing (automatic multi-step exposure) function that automatically captures three frames with different exposures, including a correct exposure, slight under exposure, and a slight over exposure. Yashica (merged with Kyocera in 1983) was to be commended for the reliability of its initial design of the automatic winding function and its technical ability to successfully evolve the function, but the only stumbling block was AF support.

The Contax automatic winding camera exhibited at Photokina in 1982 also had a built-in AF drive function. This prototype, based on the 137MD, is said to have already adopted the method that Minolta later used to astonish the world with the α-7000, in which the lens focusing is performed by an AF lens drive motor built into the camera side. However, this prototype never made it to the market. Then, in the subsequent AF SLR era, the company was not blessed with any hit products and completely withdrew from the camera business, but that story will be covered in a later section.

(3) Canon T series

Canon, which established an era of auto-exposure SLRs with the AE-1 and the A-1, was also keenly aware of the movement toward automatic winding and had been searching for a new concept since the early 1980s. This was realized with the T series. A new design concept was adopted for the exterior, and automation, including film winding, was accelerated. The first of these was the T50, released in 1983. Each camera of the T series has its own nickname, and the T50 was named “Automan” in Japan. This was probably due to the tremendous success of Sony's “Walkman” in the late 1970s.

Photograph 6-33　Canon T50
(Provided by Canon Camera Museum)

The T50 was a popular camera that only had program AE. Since automatic winding was still in its infancy, the intention was most likely thorough automation for beginners, i.e., an SLR version of a fully automatic compact camera.

This camera was followed by the release of the T70 in 1984. Its nickname was the Intelligent Shooter. In order to achieve thorough automation and multifunctionality and prevent that multifunctionality from leading to complicated operations, a new concept was applied to the user interface (hereafter UI), and information input using a large LCD panel and push buttons became a hot topic. This UI adopted by the T70 remains the standard method today, even in the digital camera era.

Photograph 6-34　Canon T70
(Provided by Canon Camera Museum)

In 1985, a year after the release of the T70, Canon's first AF SLR, the T80 (nicknamed the Art Robo) was released. This was a complete SLR camera with auto exposure, auto winding and autofocus (AF), but was not a hit because its AF performance, a crucial feature, was not yet up to the mark, falling short of the α-7000, a full-fledged AF SLR introduced by Minolta the same year.

Photograph 6-35　Canon T80
(Provided by Canon Camera Museum)

In 1987, the T90 appeared. Canon released the T-series cameras in quick succession, each with its own unique characteristics, but the T90 drew attention for its design. The ergonomic appearance, said to have been designed by Luigi Colani, an industrial designer famous for his curved and avant-garde works based on biological and natural motifs, had a strong impact both visually and in terms of operation feel.

Photograph 6-36　Canon T90
(Provided by Canon Camera Museum)

The UI, which was a further development of the T70 UI and used two control dials and a large LCD display, was also a precedent for later cameras. The internal mechanism was extremely advanced as well, using three motors to increase speed. The T series ended with this model because of the failure of the T80 to support AF, and so Canon changed the lens mount completely to transition to the EOS series, which prioritized AF support. However, the revolutionary specifications and design concept of the T90 were inherited for a long time by the next generation, and had a profound influence on other companies.

In this way, it can be said that Canon's characteristic policy during this period was to reconstruct the product concept, including the design, rather than simply aim for automatic winding specifications.

Incidentally, the nickname of the T90 was “the Tank.” The TV commercial was impressive. The head of a robot appeared on another planet and opened up, and the T90 inside it started continuous shooting.

(4) Relationship between other company motor built-in models and AF models

As understood from the fact that the Canon T80 is an AF camera, the tide toward AF was about to turn in the 1980s. The trend was for companies to try to achieve built-in motors along with AF. Minolta worked on the development, even including a major change in the lens mount, to make the trend toward AF blossom at once. The Minolta α-7000 was the first of its kind, and this model and the AF models that followed it will be discussed in detail in the later section on AF.

Olympus' first SLR with a built-in motor was also an AF model, the OM707. AF cameras almost inevitably came to include a built-in motor, making it natural to incorporate automatic winding as well.

Somewhat different from Minolta and Olympus, Nippon Kogaku seems to have intended to release an automatic winder model with a built-in motor before the AF model. It is well known that Nikon had been seeking a camera with a built-in motor from early on, as indicated by a special exhibition at the JCII Camera Museum[12] and a special exhibition at the Nikon Museum, “Prototype Cameras – Developers' Memories.” In 1985, Nikon's first SLR camera with a built-in motor, the F-301, was released based on a prototype model with a built-in motor, tentatively called the MDX, although it was not an AF camera. At that time, Minolta had already released the AF α-7000, so Nippon Kogaku could not deny that they were late to the party, but this camera was actually a milestone for the coming AF era.

Photograph 6-37 Nikon F-301
(Provided by JCII Camera Museum)

(5) Use of built-in motors in professional models

The shift to AF in SLR cameras, which began in the mid-1980s, accelerated almost in parallel with the introduction of built-in motors. AF will be discussed in a later section, but I'd like to note the subsequent evolution of models with built-in motors.

The performance of cameras with built-in motors improved dramatically since the latter half of the 1980s as motors became more efficient, smaller and less expensive, and as rechargeable batteries having better performance than NiCd, such as NiMH (nickel metal hydride) and lithium-ion batteries, were developed. This trend extended to professional SLRs as well, and models such as the Nikon F4 and the Canon EOS-1 were released in 1989 as models with built-in motors.

Photograph 6-38 Canon EOS-1
(Provided by Canon Camera Museum)

Photograph 6-39 Nikon F4
(Provided by JCII Camera Museum)

With multiple motors arranged in the right places, each mechanism became more efficient and unitized, making the camera smaller, lighter, faster and more energy-efficient than those with an external motor drive, which led to the rapid spread of this technology to various genres including that for the press.

In 1996, the Nikon F5 was released for the Atlanta Olympics, and was capable of high-speed continuous shooting at 8 fps. I was in charge of the development of this model, and felt that we were approaching the limit of what could be achieved without special modifications for high speed. Canon achieved 9 fps with AF tracking and 10 fps without AF tracking with the EOS-1V released in 2000, but in the prior year, 1999, Nikon released the D1, a full-fledged digital SLR for professional use, and the silver halide era was coming to an end, especially in the press.

Photograph 6-40　Nikon F5
(Provided by JCII Camera Museum)

Photograph 6-41　Canon EOS-1V
(Provided by Canon Camera Museum)

6.4 The Trend Toward Miniaturization

The following is a brief history of the trend toward smaller and lighter SLR cameras that began in the early 1970s.

6.4.1　Birth of the Olympus M-1

Belatedly, in 1972, after a long and vigilant development process to enter the Leica format SLR market, Olympus finally launched the M-1. Unlike the FTL, which succumbed to pressure from the sales department and went on sale first in the US market the previous year, the M-1 was a revolutionary model that caused a stir in camera history by advocating a system SLR from the start, and was the best of a group of masterpieces created by Maitani Yoshihisa, including the Pen, the Pen F and later the OM-2 and the XA.

Photograph 6-42　Olympus M-1
(Provided by JCII Camera Museum)

The concept was to banish the “three evils” of the SLR: size, weight and shock.

At 136 x 83 x 50 mm and 510 grams (body alone), the camera was only two-thirds the size (by volume) of an average conventional SLR. The width of 136 mm is the same as that of the Leica IIIf. Maitani said, “The size is not a simple copy of the Leica; it had to be that size.”[13] However, I believe that the Maitani was aiming for the size of the Leica IIIf from the start. Maitani used the Leica IIIf on a daily basis, and when Leitz, who had already released an M series, complained about the name M-1, Maitani immediately accepted Leitz's demands and changed the name to OM-1, which seems to show respect for the Leica.

Aside from that, taking into consideration compact and lightweight technology, Maitani started by revamping the entire layout. In conventional SLRs, the shutter dial was positioned on the left shoulder, but Maitani gave that prime location to the film sensitivity dial. This change was made in order to place the large exposure meter inside the film sensitivity dial, making efficient use of space. This position is right next to the pentaprism, making it convenient to bring the meter needle into the viewfinder. He then placed the shutter mechanism under the mirror box. Conventionally, a governor for low speeds or the like was placed in this position, but with the shutter mechanism now concentrated here, the need for linkage was eliminated. This led to the use of a ring provided at the base of the lens mount to set the shutter speed, but this is not a bad position as there is precedent for this in Nikomat and other cameras.

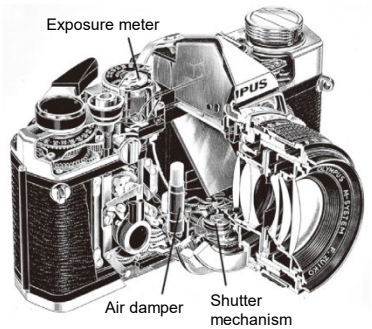


Figure 6-11　Internal Layout of the Olympus M-1[14]

Maitani also exercised ingenuity in making the shutter itself more compact. The format is a horizontal-travel shutter, but the ribbon that supported the front and rear curtains was replaced with string. The string made it possible to lower the height to the extent of the width of the ribbon. Finding a durable and temperature-insensitive string was difficult, but Maitani made arrangements for surgical suture thread. Photograph 6-43 shows the string wrapped around the shutter shaft. This string system was subsequently adopted by a succession of other companies, and was also used in the Pentax MX and the Contax RTS.

Photograph 6-43 Olympus Shutter Structure

To reduce the overall height, the condenser lens was omitted. The condenser lens is used to make the image on the screen uniformly bright all the way to the periphery, which is essential for high-end SLRs, but instead Maitani made the bottom of the pentaprism convex. However, there is a precedent for this idea: Zunow also made the bottom of the pentaprism convex in order to reduce size.

The condenser lens is made of glass and is relatively large in mass, so its omission also resulted in weight reduction. On the other hand, Maitani avoided miniaturizing the pentaprism, which would have had an immediate effect on weight reduction. The priority was to ensure a certain degree of frame coverage. With the same philosophy, the operation dials and other controls were never miniaturized, even though the aim was to make the overall size smaller. The development policy of Maitani, who enjoyed photography, is evident. The design team was instructed to thoroughly permeate the attitude of priority to miniaturization and weight reduction, and prioritize the miniaturization of each individual component while maintaining necessary functions.

I joined Nippon Kogaku and became involved in camera design at the end of the 1970s, and remember a senior colleague jokingly express his surprise when he disassembled the OM-1 and saw how small its parts were. “I wondered if the Olympus designers mixed up the 5x drawings and 10x drawings.”

To touch on the last of the “three evils,” shock, the OM-1 incorporates an air damper that acts when the mirror is driven. There is a limit to reducing the moment of inertia and initial speed of the mirror, and so to reduce the shock, an air damper was installed to avoid a sudden increase in speed, like a door closer. This is another technology that was later taken up by other companies.

Olympus succeeded in reducing the volume and weight of carried equipment by 30% to 40% for a typical photo expedition by reducing the size and weight of not only the camera but also the interchangeable lens group. This was widely well received by the general public, and the OM-1 became a huge hit, greatly redirecting the trend of SLR development toward smaller and lighter cameras.

Just to add a note, Fuji Photo Film's Fujica ST-701, released in 1970, was 8 mm taller than the OM-1 in terms of overall height, but 3 mm shorter in width at 133 mm, and could be said to have been a pioneer in the miniaturization of SLR cameras. Although the ST-701 was ambitious in some respects, such as the use of an SPD element for metering for the first time, it is unfortunate that other specifications such as the stop-down metering of the M42 mount were somewhat outdated, causing the camera to not be well received.

6.4.2 Pentax Persistence

Until then, it was Asahi Optical's Pentax series that had been small and light in the SLR market. The appearance of the OM-1 (M-1) seems like a bolt out of the blue, but the company at the time was in the midst of a major conversion from the M42 mount to the K mount and, with the time being one of pure pandemonium, had little choice but to just get it over with. In 1975, the company successfully switched to the K mount and released three models simultaneously, the K2, the KX and the KM, and from there turned its attention to the pursuit of miniaturization.

The Pentax development team must have worked desperately to develop a competing model, launching the MX the year after the release of the K series to take the title of the world's smallest and lightest Leica-format SLR. From the start of development to release of the product spanned only one and a half years; a heroic effort was made, indeed. This model is 0.5 mm smaller than the OM-1 in width, height and depth, showing blatant persistence, but there is no doubt that it was based on the OM-1, including the string structure of the shutter curtain support and the convex on the bottom of the pentaprism.

Photograph 6-44 Pentax MX
(Provided by JCII Camera Museum)

A month later, the ME was released. This was even smaller than the MX and also had automatic exposure. Since Olympus had already introduced an AE model, the OM-2, to the market a year earlier, it is thought that the company intended to line up both a small manual model and an AE model at once.

Although the MX and the ME look similar in appearance and size and seem to be siblings, they are not. The MX uses a horizontal-travel shutter while the ME uses the Seiko MFC-E jointly developed with Seikosha. The Seiko MFC-E is a revolutionary small shutter described in the shutter section.

The winders are also not common. Perhaps, although not efficient, a separate development team was hurriedly organized to launch the ME to compete with the OM-2 in contrast to the mainstream MX.

6.4.3 Pursuit of Miniaturization by Each Company

Stimulated by the OM-1, other manufacturers accelerated their move toward miniaturization. Nippon Kogaku developed the Nikomat line in the popular price range in the direction of downsizing, and introduced the Nikon FM in 1977. It was a manual camera with a Copal unit shutter and, although it did not have any major features in terms of specifications and was still one size larger than the OM series despite being small, was favorably received because of its quality and sturdiness, typical of Nikon. In 1978, Nippon Kogaku introduced the FE, an AE camera of about the same size and design as the FM. This camera was also well received because of its ease of use, matching the catchphrase “Simple Nikon.”

Photograph 6-45 Nikon FM
(Provided by JCII Camera Museum)

The FM and FE lines continued through the FM2, the FE2 and the like with almost the same appearance until the FM3A released in 2001, but production was unavoidably terminated due to difficulties in complying with the European RoHS (Restriction of Hazardous Substances) Directive that came into effect in 2006. If it had not been for that, the series would have continued quietly and become a long hit series.

Photograph 6-46 Nikon FM3A
(Provided by JCII Camera Museum)

Minolta's situation was a little different. Rather than focusing on miniaturization up front, the company chose to focus on new functions and make miniaturization a subordinate strategy. The aforementioned Minolta XD was the first dual-priority AE SLR camera, and was also considerably smaller than previous models, with a width of only 136 mm, the same as the OM-1. This is one aspect of Minolta's product strategy of not only downsizing but also incorporating the most advanced specifications at the time. The XG-E, released at the same time as the XD, was also downsized to approximately the same size, and was popular in the popular camera price range market. Note that the XG-E was the first model to be equipped with a unitized horizontal-travel shutter.

Photograph 6-47 Minolta XG-E
(Provided by JCII Camera Museum)

Minolta's SLRs in this family had numerous variations and many popular models. Among them, the X-700 was particularly popular as a highly complete model with a matching small size, light weight and high functionality, and remained on the market for nearly 20 years after its launch in 1981. In terms of buzz, the X-7, which featured in its commercials Miyazaki Yoshiko, a university student at the time who later became a renowned actress, drew much attention.

6.4.4 Miniaturization and Computerization

Canon's goal during this period was to reduce the size of the camera while at the same time increasing its electronic capabilities and productivity, and the AE-1, released in 1976, was the fruition of these efforts. The AE-1 has appeared herein at various times, but with the camera being so innovative, I hope you forgive me.

The AE-1 was intended to be fully electronic and unitized. Computerization, in particular, is closely related to miniaturization and weight reduction. For example, in conventional mechanical SLRs up until this time, the need for a series of operations such as shutter release, mirror drive, aperture drive and shutter drive to be linked mechanically required means to transmit the operation of each mechanical part. This reduces the degree of freedom of design and can lead to wasted space, and also requires levers and gears for transmission. On the other hand, if these are electrically transmitted signals, they can be designed substantially as independent units, eliminating the need for mechanical interlocking systems. In terms of the number of parts, the AE-1 reportedly achieved a reduction of about 300 parts due to computerization. As information transmission between units requires only the routing of lead wires, which were also

replaced by flexible printed circuit boards (FPCs), the freedom of electronic component placement was also revolutionarily improved. Simply put, electronic components could now be laid out as appropriate in the available space. Furthermore, electronic components also became smaller with the introduction of ICs and even higher density LSIs.

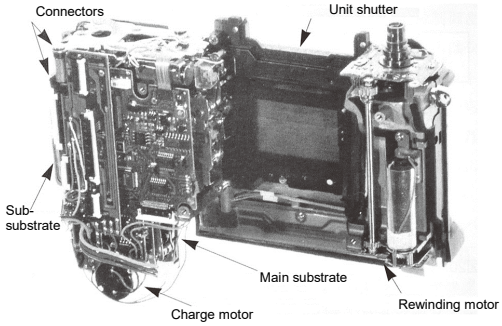
As mentioned above, the AE-1 became a big hit thanks to its low price and a marketing strategy that put the winder at the forefront, but it had no small influence on the subsequent trend of SLR cameras, not only by downsizing through advanced computerization and unitization, but also by reviewing the production line in order to improve productivity.

6.5 Sophisticated Electrical Mounting with Electronization

The Apple II was released in 1977 followed by the NEC PC-8001 in 1979 as almost complete personal computers, and the world was entering the "home computer" boom. As if in step with this trend, SLR cameras also entered an era in which the mounting of CPUs (microprocessors) was the norm.

These microprocessors evolved from 4 bits to 8 bits, reduced in package size and became less expensive, making it possible to install a plurality in cameras as well, depending on the model, to perform advanced calculations at high speed, which then became the demand. This is due to the need for high-speed and complex data processing with the inclusion of AF, the evolution of multi-pattern metering, complex sequence control and the like.

Initially, electronic components were placed by using larger FPCs and efficiently routing them in the open spaces between mechanical components in the camera, but eventually it became necessary to install rigid boards with multiple layers and higher density electronic components at key locations. For this purpose, the internal layout of the camera had to proceed from the beginning under the assumption of the presence of an electronic circuit board. However, mechanical parts also became unitized and could be placed independently, and miniaturization of motors, actuators, sensors and batteries advanced, resulting in the advantage of being able to reduce the size of each unit itself. Project leaders and electrical and mechanical leaders began to reach a consensus on the layout in the preliminary stages of model development. I remember that, when I participated in the planning of the Nikon F5 as a mechanical designer, the person in charge of electronics brought over a large multilayer circuit board from disassembled parts of a Sony Handycam TR-55 (a "passport size" hit) and demanded an equivalent amount of mounting space in the F5. After painstaking efforts to squeeze out such space, we were finally able to secure a location where the main substrate could be situated.



Photograph 6-48 Internal Mounting of the Nikon F5[15)]

The era was now one in which project leaders had to have knowledge not only of mechanical parts but also of electrical circuits and mounting.

6.6 Evolution of the Viewfinder

Needless to say, the most significant difference between an SLR and a rangefinder camera is the viewfinder. This section describes the technological evolution of the SLR viewfinder. To review terminology, Figure 6-12 illustrates a typical SLR viewfinder configuration. The main components are the screen, condenser lens, pentaprism and eyepiece.

In SLRs, the screen for checking the captured image in advance is placed at a position equivalent to the film surface. To obtain an image as close as possible to the captured image, including blurring, a transparent plastic having a matte finish on one side is used.

The condenser lens prevents the periphery of the image on the screen from becoming dark and is a convex lens, but a Fresnel lens is substituted or used along with the convex lens in some models.

In the pentaprism, an image reflected three times (two times by prism surfaces due to the 90-degree roof shape) is guided to the eyepiece. The eyepiece group can be thought of as a magnifying loupe focused on the screen.

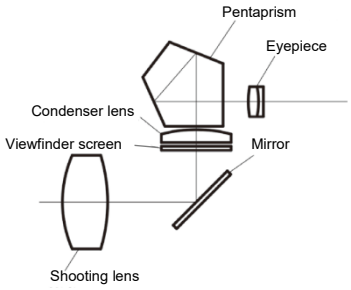


Figure 6-12 Optical Path Diagram of SLR

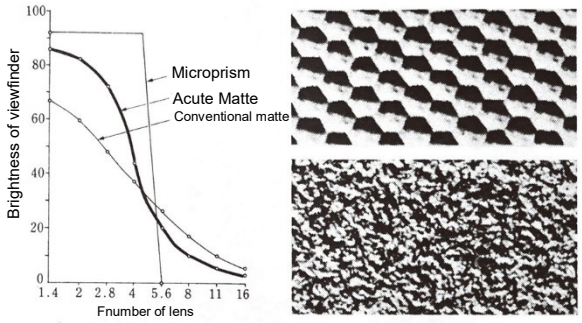
6.6.1 Screen

The screen is used not only to check the composition of the image, but also to check the focus of the captured image, check the blurriness and diffuse light to the metering system. Adequate brightness and diffusion are also contradictory elements, requiring each company's utmost attention. Early SLRs were molded in dies matted by a sand finish or a blasting

process. At the time, the screen for the Nikon F was highly regarded and was said to be the benchmark for many companies.

However, with the sand finish, a feeling of graininess remains and the image tends to look dark, so brightening attempts were made. In the Leicaflex, all areas except the center were made transparent so that an aerial image could be viewed as is. Leica, the leader in rangefinder cameras, may have wanted to present an image as clear as that of a rangefinder, but this camera was not well received due to the disadvantage of not allowing the user to fully check for blurriness.

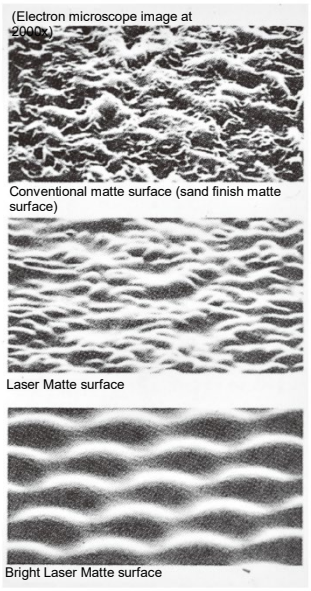
As a screen that is bright and allows the user to check for blurriness, the Acute Matte of the Minolta XD is a pioneer. The XD was the first camera with dual-priority AE and excelled in miniaturization as previously mentioned, but also did not neglect screen ingenuity. The Acute Matte is composed of cones having a diameter of about 20 μm in regular intervals, as shown in the upper right of Photograph 6-49. Although a viewfinder that is bright and allows the user to easily focus and check for blurriness was realized, the viewfinder had the drawback that the regularity of the unevenness interfered with patterns, such as a striped pattern, of the subject, causing moiré fringes.



Photograph 6-49 Minolta Acute Matte[16)]

To solve this problem, a technology was developed to create "randomly smooth unevenness" in dies by mobilizing photoresist and other chemical effects, and this technology was put to practical use in the Laser Matte and the Bright Laser Matte of Canon. Other companies followed suit, and Nikon, for example, developed the Clear Matte.

Although focusing is possible with a matte surface, for more accurate and faster focusing, some cameras use a split-image system with two wedge-shaped prisms placed in the center of the screen, aiming for an effect similar to the dual-image alignment of the rangefinder camera. In an out-of-focus state, the images of the two prisms are positioned in directions opposite to each other, making it possible to determine the state of focus with greater precision. A large wedge angle improves accuracy, but shade occurs with a lens having a large aperture value (slow lens). For this reason, cameras with interchangeable screens often offer several different screen types so that the user can select the one with the best angle for the lens used.



Photograph 6-50 Matte Surfaces of Canon[17)]

Based on the same principle as the split prism, there are also some matte surfaces with numerous fine pyramid-shaped microprisms aligned side by side. The image appears glary when out of focus and clear at the focal point, making focusing easier. The Acute Matte mentioned above is, if anything, an extremely fine version of a microprism. Figure 6-13 illustrates an example of a screen that has a split prism in the center and microprisms around it.

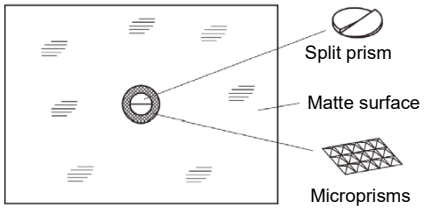


Figure 6-13 Microprisms and Split Prism

To prevent shading in the split area, techniques of providing a split prism surface with fine irregularities or surfaces at different angles were developed. These prisms are called the Canon New Split and the Nikon Dual Split.

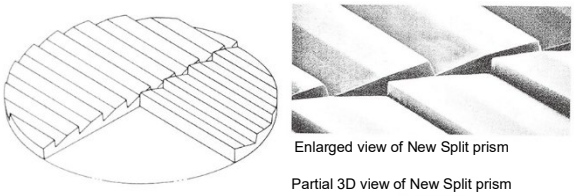


Figure 6-14 New Split Prism[18)]

There were many variations of the split area since the early SLRs. For example, the Canonflex released in 1959 adopted a technology called echelette grating, and one may say that the above New Split, introduced about 40 years later, is a developed form of this technology, echoing the spirit of discovering new things by studying the past, and is a reminder of the bygone era when engineers pooled their wisdom together in an effort to make the SLR viewfinders competitive with the double-image alignment of the rangefinder camera.

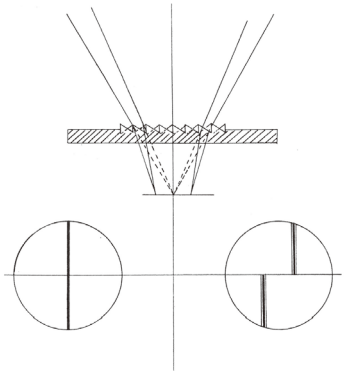


Figure 6-15 Echelette Grating[19)]

Cameras with interchangeable screens combine these technologies with further innovations to offer a large lineup of appropriate screens for a variety of applications, with some models offering more than 30 variations.

6.6.2 Pentamirror Debut and Special Viewfinder

The basic structure of the pentaprism, which is the symbol of SLRs, has not changed since the original Contax S, although there have been partial modifications due to improvements in glass materials and additions of display and metering systems. The outstanding idea of using the roof prism surfaces to return an image left-right reversed on the screen to the correct image led to the breakthrough of the SLR, and the same optical principle is still used in today's digital SLRs.

One of the most significant technological advances in the pentaprism portion of the camera is the debut of the penta-mirror. Pentaprisms are almost ideal for SLR viewfinder optics, but are heavy and result in poor productivity due to the mass of glass. If the optical path of the pentaprism could be made of mirrors, the conventional glass portion would be hollow and drastic weight reduction could be achieved, but ensuring the flatness and accuracy of the roof portion was difficult. Early 35 mm SLRs, such as the Ricohflex TLS 401, achieved this.

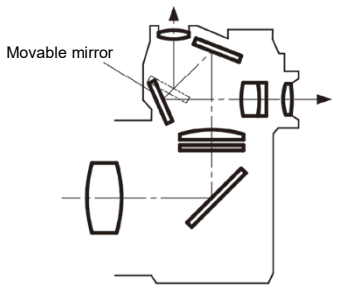


Figure 6-16 Optical Path Diagram of Ricohflex TLS 401

Ricoh had succeeded in adopting a plastic mirror for the roof prism surface with the 126C Flex, an SLR that, although not designed for 35 mm film, uses Instamatic (126 type film), and reutilized this technology. Thus, the first 35 mm SLR with a viewfinder that could be switched to eye level or waist level by moving the movable mirror up and down due to the advantages of its hollow design, as shown in Figure 6-16, was completed. Although this model was ambitious, including features such as the mirror meter used in the Topcon RE Super as a metering system, it was not a sales success and no successor was ever produced, perhaps because of the old-fashioned M42 mount and the camera size.

It should be noted that, as 35 mm SLRs that could be switched to eye level or waist level, the Rolleiflex SL2000F and its successors, which were released by Franke & Heidecke of West Germany in 1981, are extremely unique camera and, as one form of the 35 mm SLR camera, the Rolleiflex SL2000F is shown in Photograph 6-51.

Photograph 6-51 Rolleiflex SL2000F
(Provided by JCII Camera Museum)

With recent advances in molding and die machining technologies, the pentamirror system has gradually been adopted, and today the majority of SLRs in the popular price range use this system. Although the lightweight and low cost are attractive, the flatness of each surface is somewhat inferior to that of glass reflective surfaces, making pentaprisms still prevalent in high-end models.

6.6.3 Specifications of Viewfinder System

The eyepiece group, together with the pentaprism (or pentamirror), is used to magnify the image on the screen for observation and directly affects the visibility of the viewfinder, making the specifications of frame coverage, magnification, eyepoint and diopter important.

The frame coverage is the ratio of the shooting frame to the edge of the viewfinder frame (not the area ratio). Naturally, 100% is the demand, but various restrictions make that achievement surprisingly difficult. Even for high-end SLRs for professional use, the Canon F-1 and Contax RTS come in insufficient at about 97% and 92%, respectively, but the Nikon F achieved about 100% from the beginning because Fuketa, the design leader, made it a top priority. This specification has been carried over from the F2, the successor to the F, to the F6, and other companies have also achieved approximately 100% frame coverage in the field of professional high-end models.

There is a trade-off between viewfinder magnification and eyepoint. Eyepoint is the distance from the eyepiece to the furthest eye position from which the frame can be viewed without vignetting. Increasing the magnification makes the image itself easier to see, but the eyepoint becomes shorter, resulting in vignetting in the periphery of the frame, especially for people wearing glasses. An optical design that provides a long eyepoint while maintaining magnification is required, and the optimum choice is made according to the positioning and concept of the model.

The diopter depends on the distance to the imaginary image magnified by the eyepiece and is usually measured in diopters (Dp or D), the reciprocal of distance (m). If the position of the imaginary image is 1 m in front of the eye, the diopter is -1 Dp. With normal eyesight, viewing is easy at this distance. However, in consideration of people with nearsightedness or farsightedness, cameras that can be fitted with a diopter-adjustable lens in the eyepiece or that allow diopter adjustment by moving a part of the eyepiece group are now commonly available. As an example of diopter adjustment, the diopter adjustment knob of the Nikon F4 is shown in Photograph 6-52.

Photograph 6-52 Diopter Adjustment Knob of the Nikon F4

6.6.4 Development of Viewfinder Internal Display

When checking the composition of an image in the viewfinder, it is better to be able to simultaneously check shooting-related information as well. Therefore, the display in the viewfinder was gradually enhanced. In the early days of the built-in metering system, the needle of the meter indicating the measured light value was shown in the viewfinder frame as is, and a desired exposure value could be obtained by aligning the needle to a fixed point by changing the aperture or shutter speed while looking at the needle. Subsequently, it was better to be able to see the aperture value and the shutter speed value, and so some cameras were developed with an ingenious optical system that guides an optical path through the pentaprism, allowing the lens aperture value display and the shutter speed value to be seen directly or indirectly. In the case of a manual exposure setting, the display need only show the set value, but in the case of automatic exposure, the display must show the control value, not the set value. In this case, a configuration was adopted in which a display panel listing the shutter speed values was arranged, and the control value was indicated by a meter needle or dot LED. An example is illustrated in Figure 6-17.

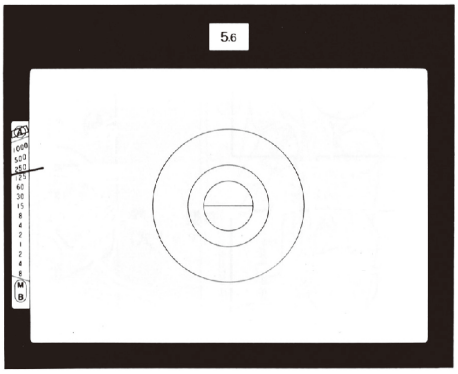


Figure 6-17 Display in Viewfinder of the Nikon FE[20)]

Later, with the spread of digital watches and calculators, seven-segment digital displays became widely accepted, and there was a movement to adopt such displays in cameras as well. The first camera to use seven-segment LEDs for the display in the viewfinder was the Fujica ST901 in 1974.

This camera could digitally display shutter speeds from 1/1000 to 20 seconds, but had many limitations and could not display 1/250 or 1/2000. With the ST801, a lower-end model, being capable of high shutter speeds of up to 1/2000, the ST901 specifications being limited to 1/1000 is a serious display limitation.

For reasons such as power saving, liquid crystal displays (LCDs) were introduced in camera viewfinders just as LCDs were introduced in calculators. Figure 6-18 shows an example of the LCD of the Nikon F3 released in 1980. The upper left side of the frame is the LCD, and the center is a direct-reading display for optically viewing the aperture value characters of the lens. Since calculators and watches with LCD had their market debut in 1973 and the technology was still new, there were concerns that the displays would become difficult to read over time, so the early F3 catalogs included a sentence stating that parts would be replaced free of charge in the event of aging.

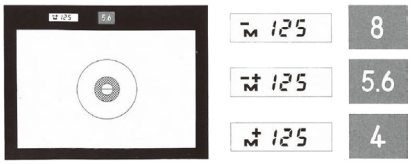


Figure 6-18 Display in Viewfinder of the Nikon F3[21)]

The LCD was subsequently widely adopted because of its high degree of freedom in display design and content. In addition to the aperture value, shutter release time and the like, the LCD can display the number of shots, a bar display in place of a meter, and the like, all at once. Although the liquid crystal is not a light-emitting device, with the mounting of a backlight, there are no hindrances to nighttime photography or the like. In recent years, some models have emerged with light-emitting displays such as organic electroluminescence.

6.7 Autofocus

With the development of auto-exposure and auto-feeding technologies, the big remaining automation technology was autofocus (AF). The principles of AF have been studied for a long time, and mainly include the rangefinder method, the contrast method and the phase difference detection method. These methods are described below, with specific products introduced.

6.7.1 AF Lenses for SLRs Using Rangefinder Method

The rangefinder method, as the name suggests, is based on the principle of triangulation used in rangefinder cameras to date, and electrically performs the dual image alignment of a traditional rangefinder. In this method, the pair of images from two windows spaced apart are detected by a line sensor, and one optical path need only be swung in conjunction with distance adjustment of the lens. Once the relationship between the focal point position and the two images is determined, the focus state can be detected.

Although not an SLR, the first commercially available camera with AF was the Konica C35AF, which used this rangefinder method. The AF sensor was the American Honeywell Visitronic. This method is not suitable for SLRs because the optics for AF are separate from the shooting lens, but Ricoh's AF Rikenon 50/F2 lens, released in February 1981 as an interchangeable lens for SLRs, uses this method.

Photograph 6-53 Ricoh XR-S + AF Rikenon 50/F2
(Provided by JCII Camera Museum)

Any camera could have earned the title of the world's first commercially available 35 mm AF SLR system as long as equipped with a motor in the lens, a battery and an AF sensor, and this one can be said to meet the criteria, but the camera struck out swinging due to its ruggedness and its principle drawback of poor AF accuracy at long distances. Another AF lens of this type that used an optical path other than the shooting lens was the Canon New FD35-70/F4 AF lens released in May 1981.

6.7.2 The TTL AF method used in SLRs

The rangefinder method used in SLRs did not fit the SLR principle of viewing the image from the shooting lens as is, and a TTL AF method was still desired. TTL AF methods can be broadly classified into two categories: a contrast detection method and a phase difference detection method. These methods are described below.

Figure 6-19 illustrates the contrast detection method.

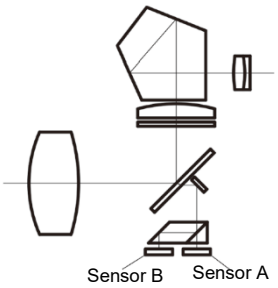


Figure 6-19 Principle of Contrast AF Method

A line sensor or image sensor is placed at a position equivalent to the film surface, and the contrast of the image is determined from the difference in output of each pixel, with the highest position being judged as in focus. As long as the sensor is installed correctly, the design has the advantage of high accuracy and simple structure. However, there are drawbacks, such as the fact that, in principle, whether in front or in back of the focal point position cannot be determined unless the lens is moved to change the contrast, and overshooting is required to find the highest point of contrast. Normally, the two sensors A and B are placed as shown in the

figure to determine the front and back of the focal point position based on the difference in output, but this is difficult to do when the image is extensively blurred, and sometimes the amount of light from each sensor is cut in half, resulting in limited effectiveness.

The phase difference detection method, in principle, is to identify the position of the primary image, that is, the focus position, by re-imaging the primary image of the shooting lens with a set of relay lenses placed at different rearward positions and checking the status of the re-imaging. Figure 6-20 illustrates the phase difference detection method.

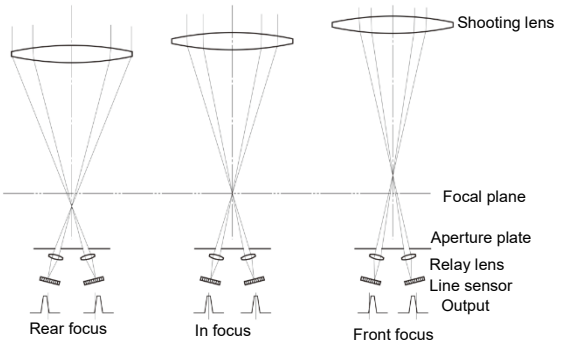


Figure 6-20 Principle of Phase Difference Detection AF Method

Sets of relay lenses and line sensors placed at the rear of the camera are each used to observe the primary image formed by the shooting lens. In the case of the front focus and in the case of the rear focus, the secondary image position shifts in different directions relative to the secondary image output state of each sensor when in focus, and thus the amount of shift indicates the amount of focus deviation, and the shift direction indicates the deviation direction. In other words, in contrast to the contrast detection method of conventional SLRs that is based on focusing an image on a matte surface, this method aligns two images that are split prism. Although this method requires more space because the relay lens and sensor must be installed rearward of the primary image with a certain optical path length maintained, the deviation amount and deviation direction are easily understood, which is a major advantage over the contrast detection method, making this method the mainstream with the exception of the early days of AF SLRs.

6.7.3 Transitional AF SLRs

The first commercially available AF SLR with an AF sensor in the camera interior was the Asahi Optical Pentax ME-F released in November 1981. This camera has a contrast AF sensor on the camera side, and sends a drive signal to the dedicated lens based on the distance measured. The lens side has a lens drive motor and battery, and the system drives the lens by signals from the camera side. With the AF sensor on the camera side, when a conventional lens is attached, the camera has a so-called focus-aid function in the viewfinder that can display front focus, rear focus and in-focus. Based on the Pentax ME Super, the camera was the first AF SLR with only an additional AF-related configuration and only one AF dedicated lens, but was not well received due to its poor AF performance, which is the most important factor.

Photograph 6-54 Pentax ME-F
(Provided by JCII Camera Museum)

The early 1980s was a time when companies were trying to figure out how to tackle AF. Existing lenses on the market could not be ignored, and resetting everything and transitioning to a new system meant high risk, making companies hesitant. There was also the question of whether to adopt the relatively simple contrast AF technology or to use the TCL module from Honeywell, which had been marketed as an AF sensor for phase difference detection. It was a time when experimental models were introduced to the market as each company approached the frontier of AF with trepidation.

First, manufacturers who adopted only focus-aid specifications, which also benefit conventional lenses, appeared. In March 1982, Canon introduced the AL-1 that used the contrast AF method, enabling focus-aids (called Quick Focus by Canon) with conventional lenses.

Photograph 6-55 Canon AL-1
(Provided by Canon Camera Museum)

Olympus and Minolta also followed the same trend, with Olympus launching the OM30 in November 1982 and Minolta launching the X-600 in April 1983, both with focus-aid specifications. Olympus, like Pentax, provided one AF-dedicated lens with the motor and battery on the lens side. These two models were equipped with the Honeywell TCL module, which used the phase difference detection method, in the AF sensor, instead of a contrast AF system.

In Nikon's case, the company entered the AF SLR market with a different approach than its competitors. The F3AF, released in April 1983, took advantage of the fact that the F3, a high-end professional-use model, had an interchangeable viewfinder, and kept the modifications to the minimum necessary, just adding contacts to the camera. The company enabled focus-aids by replacing the viewfinder with an AF viewfinder, and prepared two dedicated AF lenses and an AF teleconverter for attachment to the rear end of a conventional lens, enabling AF for older lenses by its attachment. The dedicated lenses have only a built-in motor and no battery, so are not much larger than an ordinary lens. On the other hand, the viewfinder has a built-in battery, AF sensor and optics, so it is huge. Claimed for professional applications and used with Nikon's own AF sensor instead of the TCL module, the camera boasted an AF performance and drive speed that were a step above those of other companies, but was naturally expensive and large, and did not become widely used like other AF SLRs of the period.

Figure 6-21 Perspective View of the Nikon F3AF[22)]

6.7.4 Debut of the Minolta α-7000

The first half of the 1980s was a period of trial and error for the major SLR manufacturers with regard to AF compatibility, as described in the previous section. All manufacturers were studying ways to solve the problem, but they were struggling to deal not only with the difficulty of the AF function itself, but also with the systemic nature unique to SLR cameras. The fact that so many interchangeable lenses were introduced to the market held manufacturers back and prevented them from taking the next step.

It was Minolta that boldly abandoned most of its conventional systems and tried to break through with a new system. With Minolta being one of the few manufacturers that prided itself on not having changed its basic lens mount since it introduced its first SLR in 1957, the public was surprised, but also awed by the excellence of the new system.

Photograph 6-56 Minolta α-7000
(Provided by JCII Camera Museum)

The α-7000, released in February 1985, incorporated an AF sensor, battery and lens drive motor on the camera side, and was configured to freely allow distance adjustment on the lens side using an AF coupling, similar to the tip of a flathead screwdriver, provided in the lens mount area. In this way, there is no need to place a drive motor inside the lens, making it possible to retain the size the same as a conventional lens. The AF sensor itself was made by Toshiba, and the optics related to AF were designed in-house, which would later become a problem, but the AF performance was outstanding compared to the TCL module used in the X-600.

The information necessary for focus and exposure adjustment specific to the new lens is held as ROM on the lens side, and this information is communicated to the camera side, achieving optimal control for any lens. This made it possible to achieve a faster AF drive, the long-cherished wish for AF SLRs. The camera was a big hit, not so much for its good performance as a camera and the fact that most of its functions, such as winding and rewinding, were automated, but because it maintained a price comparable to that of the conventional mid-range model. With this camera, Minolta, which had been third or fourth in the SLR market share, quickly rose toward the top.

Normally, a change of lens mount is a big risk for a manufacturer, but in Minolta's case, the trade-off was a great improvement in camera performance and, with careful preparation of interchangeable lenses and accessories, the camera was rather well received by the market. It was also significant that the company had developed its lineup by launching the high-end α-9000 six months after the α-7000, followed by the popular model, theα-5000, the following year.

Three years after the release of the α-7000, the α-7700i, its normal evolution version, was released and well received, leaving other manufacturers laps behind. Minolta seemed to be sailing smoothly, but at this time already had one foot mired in a muddy patent dispute with Honeywell.

6.7.5 Patent Dispute

Honeywell's TCL module, which was adopted in the SLRs of a number of manufacturers, utilizes the phase difference detection principle, but to reduce size, the optics and AF elements are actually contained in a single package. Although the module has the advantage of being space-efficient, making it easy to mount inside a camera, its AF performance was somewhat unsatisfactory. For this reason, Minolta, which once adopted the TCL in the X-600, switched to an AF system developed in-house when the company staked everything on the α system.

After witnessing the success of the α-7000, other companies began to develop their own AF sensors, resulting in a sharp decline in sales of the TCL module. Honeywell, however, was ready for its next move. The company sued Minolta in April 1987, claiming that it was in violation of its US patents. The patents in question were several, but the most important is USP 3,875,401, commonly known as Patent 401 or the Stauffer Patent after its inventor.

Normally, there are two main strategies to take when being sued for infringement of a patent: proving non-infringement or proving invalidity of the patent in question. Minolta took the latter. This is because there were actually publicly known examples that seemed influential.

Even in the SLR era, Leitz worked diligently to improve its rangefinder models. These efforts also extended to autofocus technology, and prior to Patent 401, the company had applied for an important AF-related patent, USP 3,860,935 (hereafter, Patent 935). It was the invention of Dr. Ludwig Leitz, the second son of Ernst Leitz II who once made the wise decision to introduce Leica to the world. Minolta argued that Patent 401 was invalid because of a known example, Patent 935. The fact that the Japanese application for Honeywell's invention was not published is evidence of this assertion.

However, Honeywell, which is well versed in patent disputes in the US and has been through many ordeals, noted that some lenses were not depicted in the illustrations of Patent 935, and argued that it was incomplete as an AF device and therefore did not constitute a known example.

It has been my experience that, in patent specifications and explanatory drawings, especially in the case of principle-based inventions, detailed parts that are obvious to an engineer may be omitted. Dr. Leitz, who wrote Patent 935, probably intended to omit them.

Even if some lenses are omitted, the validity of the invention is not impaired if the omission is easily recognized by a person of ordinary skill in the art, and therefore the issue is whether a person of ordinary skill in the art would recognize the omission of such lenses.

Honeywell's cleverness also lies in its choice of a jury trial (the plaintiff has a choice). In hindsight, since the jury, made up of average persons not familiar with the technology, was to decide whether “an engineer of ordinary skill would easily recognize such an omission,” the inevitable victorious outcome was as clear as day.

The case, which took five years to fight, ended in Minolta's defeat. The company paid approximately 16.5 billion yen in compensation to settle the case. Other camera manufacturers, who had been watching warily, lost their will to fight, concluding they would not win due to Honeywell’s homefield advantage, and all agreed to the settlement, paying large sums of money[23].

If we look at this case as part of a larger trend of the times, it seems that it was not unrelated to the fact that a pro-patent shift (strengthening patent protection) was gaining momentum in the US as the US manufacturing industry, led by the automobile industry, fell into a downturn and, personally, I feel some sympathy for the Minolta side.

6.7.6 Evolution of AF Technology

Did the defeat in the nightmarish Honeywell AF lawsuit leave Japanese camera manufacturers exhausted? No, at least not on the surface. The development race came to a standstill for a moment, but there was no manufacturer other than those in Japan that could take advantage of the situation and catch up. After paying a hefty settlement as pro-patent tuition, so to speak, the manufacturers returned to developing SLRs as if nothing had happened.

Below, the technological evolution of AF while be discussed while following the trends of each company.

(1) AF response by each company

In April 1985, two months after the release of the α-7000, Canon launched the T80, an AF SLR, but the camera failed to perform well due its pre-α shock specifications, including a contrast AF and only one AF lens. The amazing thing about Canon is that the company just knew that, in order to catch up with the α, they needed to rethink their system from the beginning, just like Minolta. After enduring several years of development, in 1987 the company converted to a completely new system, including the lens mount, and introduced the EOS 620 and 650 as its first new SLRs.

Photograph 6-57 EOS 650
(Provided by Canon Camera Museum)

The large mount, which has no vignetting even with large diameter lenses, has no mechanical linkage at all, and all signals are exchanged electrically. This was achieved by providing each lens with its own AF drive motor, but also on the strength of having Canon Precision as a motor manufacturer under the Canon umbrella and the ability to use ultrasonic motors, which are suitable for driving lenses, as one of the technologies in its possession.

Starting with the EOS 620 and 650, the company consistently expanded its lineup from mid- and high-end models to popular models from the following year, 1988, regaining the top position in the SLR market. Among them, the EOS Kiss series was a huge sales success, opening up new markets as SLR cameras for women and families.

At the top of the lineup, as a professional AF SLR camera, the EOS-1 was released in 1989 and evolved in function while continuing in spirit in the EOS-1N in 1994 and the EOS-1V in 2000, becoming the flagship series of Canon SLRs.

Like Minolta, this is an example of a company that succeeded in drastically revamping its lens mounts to support AF. Needless to say, this was made possible not only by a full lineup of cameras, but also by well-planned preparation of interchangeable lenses and accessories as well as the technical backup to support these lenses and accessories.

In the same year as the α-7000 shock, Nippon Kogaku launched the F-301 with a built-in motor, as mentioned above. Although the F-301 was not an AF model, the F-501, an AF model based on this, was released in April 1986, and this system was ready to follow on the back of the α. With the lens drive adopting an AF coupling method that utilizes a motor on the camera side, similar to the α method, and the AF sensor using Honeywell's TCL, the model was somewhat lacking for a latecomer, but Nikon's claim to fame was that it did not change the lens mount. Without changing the F mount, which had been in use since 1959, the company adopted measures such as adding the AF coupling and new electrical contacts for AF. Although the camera has a sense of building an extension on top of an extension, it appears to have received a certain level of recognition from long-time core Nikon fans.

Photograph 6-58 Nikon F-501
(Provided by JCII Camera Museum)

Subsequently as well, Nikon constantly released other models, such as the F-401, released in June 1987, as an AF SLR with a standard SLR design with a built-in flash and Nikon's proprietary AM200 AF sensor, and the F-801, which boasted a shutter speed of 1/8000 as well as other high basic performance standards.

The first AF camera for professional use, the F4, was released in 1988, but many pointed out that its AF performance was insufficient for professional equipment, so the F5, released in 1996, boasted a five-point AF area and a revolutionarily fast AF drive speed. Furthermore, what is unique to Nikon's strategy is that Nikon provided two different types of lens drives, one from the camera side and the other based on an in-lens motor, differentiating use according to lens type. For super-telephoto and other lenses with heavy driven optics, a dedicated motor was provided in the lens, while smaller lenses with less energy to be driven were coupling driven from the camera side. Although there is a disadvantage of wasting the drive mechanism on the camera side when using a lens with a drive motor, there is an advantage of being able to use a drive system appropriate to the lens type, so has advantages and disadvantages. This can also be said to be another measure to continue the traditional Nikon F mount.

Olympus launched its first AF SLR, the OM707, in October 1986. As a phase difference detection AF SLR, the camera took third, following Minolta and Nikon.

Photograph 6-59 Olympus OM707
(Provided by JCII Camera Museum)

The lens mount is similar to the Nikon counterpart, which added an AF coupling and electrical contacts to the conventional OM mount. After all, there was no time to review from scratch and create a new AF lens mount design, and risk was most likely to be avoided. In keeping with the Olympus corporate culture of unique specifications different from those of its competitors, this camera also incorporates various specifications, including a pop-up flash built into the grip, an AF auxiliary light that provides illumination for distance measurement in dark conditions, and a group of interchangeable lenses that are all controlled from the camera side, eliminating even the distance ring. However, it ended up being a failure, as evidenced by the fact that no successor to this camera was ever produced. There are some subjects that are just not good for AF, and to manually focus on them, you have to use a power focus switch on the camera because there is no distance ring, but this operation is not very comfortable. It seems that the fatal mistake was to cut corners in the basic camera operation of focusing.

In March 1987, about two years after the α-7000, Asahi Optical introduced the Pentax SFX, a phase difference detection AF SLR camera.

Photograph 6-60 Pentax SFX
(Provided by JCII Camera Museum)

The lens mount was, of course, similar to the Nikon counterpart, which added an AF coupling and electrical contacts to the conventional mount. While the earlier Nikon and Olympus models were TCL module cameras, this camera introduced Asahi Optical's own SAFOX AF system, including an AF sensor and a control system. Other unique designs, such as the LCD and flash above the pentaprism area, were also well received, but perhaps because what was wanted for Pentax was a compact and lightweight AF SLR rather than something unique, the company has since returned to a relatively orthodox design in the Z series and MZ series, with a few exceptions.

In 1985, when the α-7000 shock occurred, Yashica had already merged with Kyocera, but the design and development team of the former Yashica had the mettle to keep up with the competition. As mentioned above, even for an AF SLR, a prototype with AF built into the Contax 137 MD was exhibited at Photokina, a photography, video and imaging fair, in 1982. Like Minolta, the camera uses AF couplings to drive the lens from the camera side. A patent was filed for this in-camera AF drive motor, but Minolta was allowed to file first by a mere week or so[24]. Whether this was the reason or not is unclear, but this prototype never made it to the market.

Kyocera's first AF SLR was the 230AF, released in December 1986. Although the mount was not the Contax/Yashica mount that had been used since the Contax RTS debut and the Kyocera AF mount was newly adopted for AF, conventional lenses could still be used with some limitations with a 1.6x AF converter.

Photograph 6-61 Kyocera 230 AF
(Provided by JCII Camera Museum)

This model incorporated innovative ideas, such as the ability of use as an SLR with a built-in flash by combining a dedicated flash with the pentaprism area, and successor models were released, including a popular type, but these did not reach the point of being on par with other companies in terms of sales.

Kyocera continued to offer two series of mounts, this Kyocera AF mount and the non-AF Contax/Yashica mount, but in 1996, Kyocera suddenly released the Contax AX.

Photograph 6-62 Contax AX
(Provided by JCII Camera Museum)

The surprising thing about this camera is that the lens is not driven. Instead, an ultrasonic motor inside the camera moves the film support back and forth on the camera side to perform AF. It was the first ever AF SLR with automatic back-focusing, a unique feature that made AF possible even with conventional lenses. On the other hand, the camera body had to be larger and more expensive, and unfortunately, the model was not well

received in the market. From a camera engineer's point of view, however, the efforts of the Kyocera camera design/ development team in confronting and accomplishing this advanced technology should be highly commended.

Kyocera then made a complete change to its newly developed, fully electronically controlled N-mount system in 2000. Although it was a major shift in the direction of digitalization, it was already too late, and the company decided to withdraw from the camera business in 2005 without seeing any sales success. The reason for this was cited as, “We couldn't keep up with rapid changes in the market.”

(2) Development of multiple AF points

Early AF SLRs could only measure distances at the center of the shooting frame, which limited the composition of the image. Attempts were made to create a multi-point measurement system provided with AF points at the center as well as other locations. Minolta, a step ahead in AF technology, introduced four AF points with the α-7xi released in June 1991.

Another technique similar to multiple AF points is cross-type AF points. Phase difference detection AF in the early stages only looked at the correlation between the images of two line sensors placed horizontally across the frame, so in principle it was not possible to measure distance with a subject such as a horizontal line. Therefore, the line sensors are placed vertically to see the correlation in the vertical direction of the frame as well. As an example of a multipoint and cross-type system, the AF optical path diagram of the Nikon F5 released in 1996 is illustrated in Figure 6-22. In this model, three CCD sensor units are placed at the bottom of the mirror box to enable distance measurement at a total of five points: center, top, bottom, left and right. Three of these points, the center and left and right, can be understood as a cross.

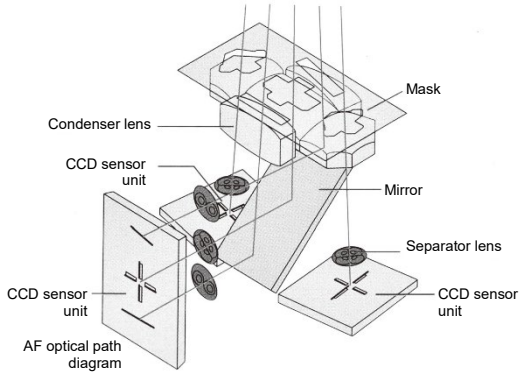


Figure 6-22 Five-Point AF Optical Path Diagram of the Nikon F5[25)]

The trend toward multiple AF points accelerated in other companies as well. For the 35 mm SLR camera, the EOS-3 released in November 1998 and the EOS-1V released in March 2000 boasted the highest number of AF points at 45 and, for the latest digital SLR camera, some cameras even have more than 100 AF points. These evolve with the technological development of CCD and CMOS sensors and the advancement of other AF-related technologies described below, and the field is expected to continue to develop greatly in the future, with the incorporation of AI technology, for example.

(3) AF on-screen display

As the number of AF points increased, it became necessary to indicate which AF point was selected. Such information is usually displayed on the screen, and thus the display is referred to as an on-screen display or superimposed display. There are several methods for achieving this, which are described below.

(1) LED illumination method

In this method, an LED light is illuminated to indicate the position on the screen corresponding to the AF point. Various optical paths are possible, but Figure 6-23 illustrates a general example. The light-emitting portion includes the same number of LEDs as AF points. These LEDs can emit light independently and emit light through individual light paths to predetermined positions on the screen. The screen has diffusibility, and thus a portion of the light is reflected toward the eyepiece lens, making the light visible to the photographer. This method is a luminescent type, making the display visible even in the dark, and the structure is relatively simple as long as a high-precision optical path system is provided. Although this method has the disadvantage that the light cannot be continuously left on from the standpoint of energy conservation, it is the most commonly used.

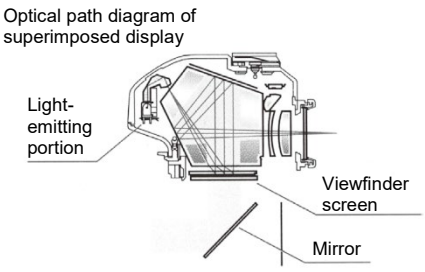


Figure 6-23 Optical Path Diagram of LED-Type Superimposed Display[26)]

(2) Liquid crystal display (LCD)

A method that utilizes an LCD also exists, which was used in the Minolta α-7700i. LCDs are commonly used in various types of devices and have the advantage of being stable in terms of quality and price. The format has a high degree of freedom, allowing indicators of information other than AF points, such as grid lines for checking the composition and light metering areas, to be displayed on the screen. On the other hand, the LCD has the disadvantage that, when used with a viewfinder, which requires a transmissive type, the entire viewfinder becomes dark due to the low transmittance of the LCD transparent portion. Further, because LCDs are not light-emitting elements, they have the disadvantage of being difficult to see with dark subjects.

Some cameras adopt PN LCDs to compensate for these shortcomings. PN is an abbreviation for polymer network. In a PN, when a liquid crystal material is encapsulated in a network made of UV curable resin or the like, the material is cloudy when not energized and aligned in the electrolytic direction and transparent when energized. Because of this property, this liquid crystal is also referred to as diffusion-type liquid crystal. Unlike conventional LCDs, the diffusion-type does not use a polarizing plate, resulting in high transmittance, and the cloudy diffusion display portion glows when irradiated by LED light, making it visible even with dark subjects without the use of separate LEDs for each AF point.

The first camera with a PN LCD was the Nikon F80, released in 2000. Figure 6-24 illustrates an exploded view of the viewfinder portion of this model. LEDs and light guides are placed on the left and right sides of the PN LCD plate and emit light from both sides at low luminance.

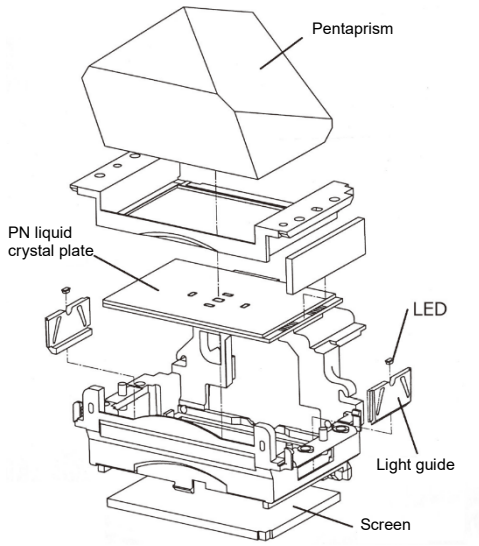


Figure 6-24 Exploded View of PN Liquid Crystal Display

(3) Electrochromic element

The Nikon F5, released in 1996, was the first to adopt an electrochromic (hereinafter EC) element as an on-screen display. EC elements combine thin films of iridium oxide and the like to electrically change the concentration. Unlike liquid crystals, EC elements are in an all-solid-state, so there is no need for sealing portions or the like, making it possible to ensure a wide frame. Furthermore, EC elements have a higher transmittance than LCD elements, resulting in the additional advantage of maintaining the brightness of the frame even when used with a viewfinder. Although not adopted in AF point displays in subsequent SLR cameras due to an inability to display luminescence and poor response at low temperatures, EC elements are capable of high-quality display and can be applied to grid line displays and the like that do not require responsiveness.

(4) Evolution of AF function

(1) Motion prediction

In sports photography and other fields where moving subjects are photographed, the time lag of the shutter release can be a problem. Even if the shutter is released at the right moment, a time lag occurs in the SLR camera due to mirror lock-up and the like, causing the image to be out of focus when the distance to the subject changes during that period. To prevent this, a motion prediction function was conceived that measures the speed at which the subject is moving and predicts the distance the subject will travel during the release time lag, ensuring that the image will not be out of focus at the time of shooting.

The Minolta α-7700i, released in 1988, was the first to adopt the motion prediction function, making it possible to improve the brand's in-focus rate with moving subjects. The principle of the motion prediction function is shown in Figure 6-25. The motion prediction function derives a regression line from multiple distance measurement data to calculate the speed of the subject at the time of shutter release, predicts the distance to be traveled over the camera's unique release time lag, and drives the lens to the corrected subject distance. Since it is exceedingly difficult to reduce the shutter time lag to 40 ms or less in SLR cameras due to the SLR principle, this technology became an indispensable feature of subsequent AF SLR cameras and was widely used in popular models.

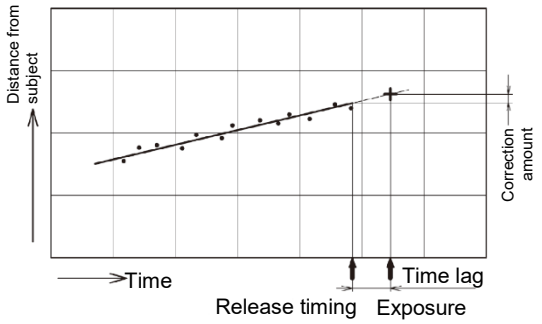
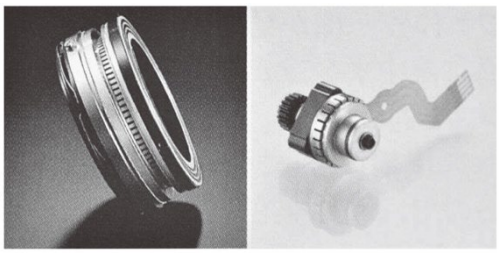


Figure 6-25 Explanatory View of Motion Prediction

(2) Higher speed

Advances in microcomputers greatly reduced the calculation time for distance measurement data and made it possible to handle more complex algorithms. At this same time, the performance of the motors used to drive the lenses improved, and the hardware significantly increased in speed. Especially in sports photography, where high speed is required, ultrasonic motors were commonly installed in the telephoto lenses used. Photo 6-63 shows examples of two types of ultrasonic motors: a ring type and a micro type.



Photograph 6-63 Examples of Ultrasonic Motor[27)]

The ultrasonic motor is based on the principle that a stator machined into a comb shape is crimped onto a rotor, and a traveling wave is generated by a piezoelectric element attached to the backside of the stator to rotate the rotor. Although not suitable for high-speed rotation, the high torque makes a speed reduction system unnecessary and the quietness makes it suitable for lens driving. The ultrasonic motor was adopted by Canon in their super-telephoto lenses and subsequently, with the micro type, in other lenses, and by Nikon in their super-telephoto lenses mainly used for sports coverage.

(3) Other AF-related technologies

Just before the beginning of the 21st century, cameras underwent a drastic shift from silver halide to digital, but technologies related to AF were still in the process of development and continued to steadily evolve. With the development of multiple AF points, a faster AF drive and increased computing power, functions for supporting the photographer in following a subject and functions for automatic tracking were developed, to name a few.

In addition, there have been proposed technologies that combine the selected AF point with information related to surrounding points to obtain an apparently large distance measurement area for a subject in motion and technologies that automatically select the AF point on the camera side. There are also technologies that capture not only an image of the subject, but also color and other unique information, and utilize this information to identify the main subject. These improvements were made possible by the development of CCD and CMOS sensor technology used for AF sensors as well as by improvements in microcomputer processing speed for calculating huge amounts of data at high speed to derive optimal distance measurement results.

References and citations

1) Ogura, Iwao. *Kokusan Kamera Kaihatsu Monogatari* [The Story of Camera Development in Japan], (Asahi Shinbun Publications, 2001), pp. 130-134.
2) Nakagawa, Tadashi. *Seikosha Shattā Monogatari* [The Seikosha Shutter Story], (Asahi Sonorama, 1998), p. 88.
3) *Nikon F4 Tekunikaru Gaido* [Nikon F4 Technical Guide], (Nikon, 1998), p. 10.
4) Shashin Kōgyō Bessatsu *Nikon F5 Tekunikaru Manyuaru* [Nikon F5 Technical Manual], (Shashin Kōgyō Shuppansha, 1997), p. 40.
5) Shashin Kōgyō Bessatsu *Nikon Tekunikaru Manyuaru (Zōhoban)* [Nikon Technical Manual (augmented edition)], (Shashin Kōgyō Shuppansha, 1982), p. 51.
6) Nikon FA Catalog, (Nikon, 1984), p. 5.
7) Uli Koch. Nikon 100 Anniversary, (OstLicht, 2016), p. 306.
8) Shashin Kōgyō Bessatsu *Nikon Tekunikaru Manyuaru (Zōhoban)* [Nikon Technical Manual (augmented edition)], p. 54.
9) Nikon F3 Catalog, (Nikon, 1981), p. 4.
10) Canon New F-1 Catalog, (Canon, 1985), p. 9.
11) *Kamera Kodawari Dokuhon* [In Pursuit of the Camera] 2001-2002 (Mainichi Shimbun, 2001), p. 194.
12) Nikon Exhibition Pictorial Record (JCII Camera Museum, 2003), p. 14.
13) *Orinpasu no Subete* [Everything Olympus], (Ei-Publishing, 2001), p. 16.
14) Olympus M-1 Catalog, (1972), p. 9.
15) Shashin Kōgyō Bessatsu *Nikon F5 Tekunikaru Manyuaru* [Nikon F5 Technical Manual], p. 46.
16) *35-miri AE Ichigan-refu Zenchōsa* [35 mm AE SLR Complete Survey], (Shashin Kōgyō Shuppansha, 1981), p.193.
17) *Manyuaru Kiyanon no Subete* [Full Canon Manual], (Ei-Publishing, 2001), p. 48.
18) *Manyuaru Kiyanon no Subete* [Full Canon Manual], p. 50.
19) Shashin Kōgyō, May 1959 (Shashin Kōgyō Shuppansha), p. 458.
20) Shashin Kōgyō Bessatsu *Nikon Tekunikaru Manyuaru (Zōhoban)* [Nikon Technical Manual (augmented edition)], (Shashin Kōgyō Shuppansha, 1982), p. 79.
21) Nikon F3 Catalog, p. 8.
22) Nikon F3 AF Catalog, (Nikon, 1984), p. 10.
23) Ogura, Iwao. *Kokusan Kamera Kaihatsu Monogatari* [The Story of Camera Development in Japan], pp. 199-207.
24) Ogura, Iwao. *Kokusan Kamera Kaihatsu Monogatari* [The Story of Camera Development in Japan], p. 181.
25) Nikon F5 Catalog, (Nikon, 1997), p. 6.
26) Nikon F100 Catalog, (Nikon, 1998), p. 5.
27) NIKKOR Lens General Catalog, (Nikon, 2009), p. 5.

7 In Lieu of an Afterword

It has been a long time since cameras transitioned from silver halide to digital. The Casio QV-10, which is said to be the first digital camera to become popular, was released in 1995. It was around that time that the rapid shift to digital cameras began, and even SLR cameras have now mostly been replaced by digital cameras.

However, a second look at the structure of the digital SLR camera reveals that the elements, other than the film feed mechanism, are an extension of the SLR cameras of the silver halide era. For example, the focal-plane shutter, the quick return mirror, the pentaprism ....

These are the result of improvements made by many camera designers, both famous and unknown, over half a century ago, and in some cases more than 100 years ago. This document is a systematic analysis of such technologies and the products that incorporate them.

The history of photography is nearly 200 years old, but it is safe to say that the first compact precision camera was the Leica, created by a genius in poor health, Oskar Barnack, about 100 years ago. The Leica was so groundbreaking that it seems few other industries have been able to create a product with such a high degree of perfection from the start.

At the end of 2016, the Center of the History of Japanese Industrial Technology of the National Museum of Nature and Science asked me to conduct a systematic analysis on the subject of "the mechanical camera." When I heard this theme, the first thing that came to mind was the Leica. I had been in charge of camera mechanism design for a long time, so I thought I could manage the topic. I also wanted to do some personal research on the Leica and Barnack, so I tentatively agreed to the project. Later, upon confirmation, I found out that the topic was the mechanical camera (that is, the silver halide camera) as opposed to the digital camera. The history of the silver halide camera can be traced back to the Edo period (1603-1868), and conducting a comprehensive systematic analysis on such a topic would be extremely daunting.

I was also told that two people had already declined the offer and that the museum had no more options. The fact that both of those who declined the offer had authored numerous books on camera-related topics and were senior members in the field with whom I was well acquainted also added to the pressure.

With my retreat cut off and the theme unexpectedly heavy, 2017 dawned dark and gloomy. With no other options, the decision was made to limit the theme to areas of familiarity and, as was my first thought, to limit the topic to the focal-plane shutter models starting from the Leica (though some exceptions were made in the end). The event that had the biggest impact in the history of the camera was the birth of the Leica, and it is an undeniable fact that the Japanese camera industry since then has been strongly influenced by the Leica.

The purpose of this systematic analysis is not only to investigate the history of technological development, but also to document the cultural background and the state of manufacturing in Japan. I would be grateful if you would agree that I have humbly served my purpose in touching on how the culture of the compact precision camera, starting with the Leica, developed in a way that shook and wove together the latent technical sense and manufacturing sensitivity of the Japanese people. In this respect, I was able to advantageously draw on my experience in camera mechanism design and production engineering since I joined the company.

In retrospect, the innovative Leica, with its streamlined layout and astonishing mechanisms that later changed the course of the photographic industry, might not have even been commercialized without the recession that accompanied World War I. The Contax I, made by Zeiss Ikon under the umbrella of the Carl Zeiss Foundation and based on the concept of an ideal camera achieved through thorough study and further enhancement of the Leica mechanism, of course would not have emerged, nor would the famous and unknown Leica copies have been born in an island country far to the East.

Compact precision cameras were deeply involved in World War II and related events, such as the February 26 Incident and the Sorge incident. The Leica-type cameras, which were highly portable, robust and reliable, had many military applications, including copying classified documents, reconnaissance and aerial photography. As the availability of Leica cameras became more difficult, countries began to develop their own Leica copies, which marked the dawn of the compact 35 mm format precision camera in Japan.

The Korean uprising also had a significant impact on Japanese cameras. The excellence of the Japanese lenses became known through the unassuming test shots taken by foreign news photographers who were in Tokyo to prepare for their coverage, and the reputation of the lenses grew dramatically.

However, the Leica M3, introduced in 1954, was a breakthrough that far surpassed even the old Leica at its pinnacle. Japanese manufacturers, realizing that they should have caught up, shifted their development focus to SLR cameras, which proved to be successful, and in the late 1950s, new products blossomed one after another, with dramatic development beginning in the 1960s.

Tossed about by the turbulence of these tumultuous times, compact precision cameras continued to evolve in Germany and Japan.

In delving into the theme, I considered various approaches, including product concept, internal mechanisms, specifications, manufacturers, various technologies and designers and, while I proceeded to write without yet having a clear idea of these, I tried to present the personalities of the designers as much as possible. This is due to the advice I received from my former boss: history is made by people – if you are going to write about history, include names. Indeed, the Leica is the "Barnack camera" born from the genius of Oskar Barnack, and the designs of cameras that made history are filled with the ideas and human touch of the people involved, such as Kueppenbender for the Contax and Yoshida Gorō for the Kwanon Camera, both cameras being designed with the Leica in mind.

Even in the SLR era, one notices a strong link between the product and its designer: Fuketa and Matsunaga for the Nikon F, Kawase for the Topcon RE Super, Yoshida for the Asahiflex and Maitani for the Olympus M-1.

Although I spent only a little less than 30 years as a designer in the 100-year history of the compact precision camera since the birth of Leica, I wanted to introduce the cameras by getting as close as I could to their design philosophy as someone who was involved in the camera design process.

I must apologize for not being able to make a comprehensive mention of even domestic SLR cameras, and for not being able to write about electronics and optical technology due to my limited knowledge of the subject. In addition, there are so many excellent literature and research books on the Leica and SLR cameras that it was impossible to read and digest them in a very limited time. As a result, it is with a degree of trepidation that I reread this document and found it incomplete and rambling, but I hope that it will be of some help as a systematic survey on the compact precision camera from the perspective of a camera designer.

Finally, I would like to note what happened to the Leica. After being late to the SLR competition and the original rangefinder models became more expensive due to rising fixed costs in Germany, Leitz was forced to move its production to Portugal and Canada. With the help of Minolta and Copal, the Leitz family entered the SLR camera market, but it was not enough to turn the business around, and the Leitz family sold its holdings to the Swiss company Wild and the company became its subsidiary. Camera production at the Wetzlar factory, which had been associated with Barnack, was halted, and the tradition was hanging by a thread. There was a time when I, as a camera enthusiast, spent many gloomy days wondering if the day would finally come when cameras of the Leica brand would no longer be produced. Nevertheless, the Leica brand kept its vitality by changing the company name from Ernst Leitz to Leica and later to Leica Camera, and products continued to be produced in small quantities in Solms and Portugal.

The camera industry then reached a turning point in the digital age. The Leica brand has been revived like a phoenix in high-end digital cameras through its partnership with Panasonic. The company returned to its traditional manufacturing base in Wetzlar and continues to produce the M series, which is more expensive but still carries the Leica blood.

Currently, its flagship product is a high-end mirrorless camera. Although the camera can no longer be called a rangefinder camera because an optical rangefinder is no longer needed, the mirrorless camera, which can measure distances using an imaging element and is without mirrors or a pentaprism, can in a sense be considered to be in the ultimate position of solving the shortcomings of both the rangefinder camera and the SLR camera.

I can only wonder how the thoughtful eyes of Barnack lying in Wetzlar would view the Leica, which at one time suffered from the launch of an offensive by the silver halide SLR camera, making a comeback with mirrorless cameras and now becoming a strong competitor to Japanese digital SLR cameras.

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would not have been possible.

Camera-related ISO standards

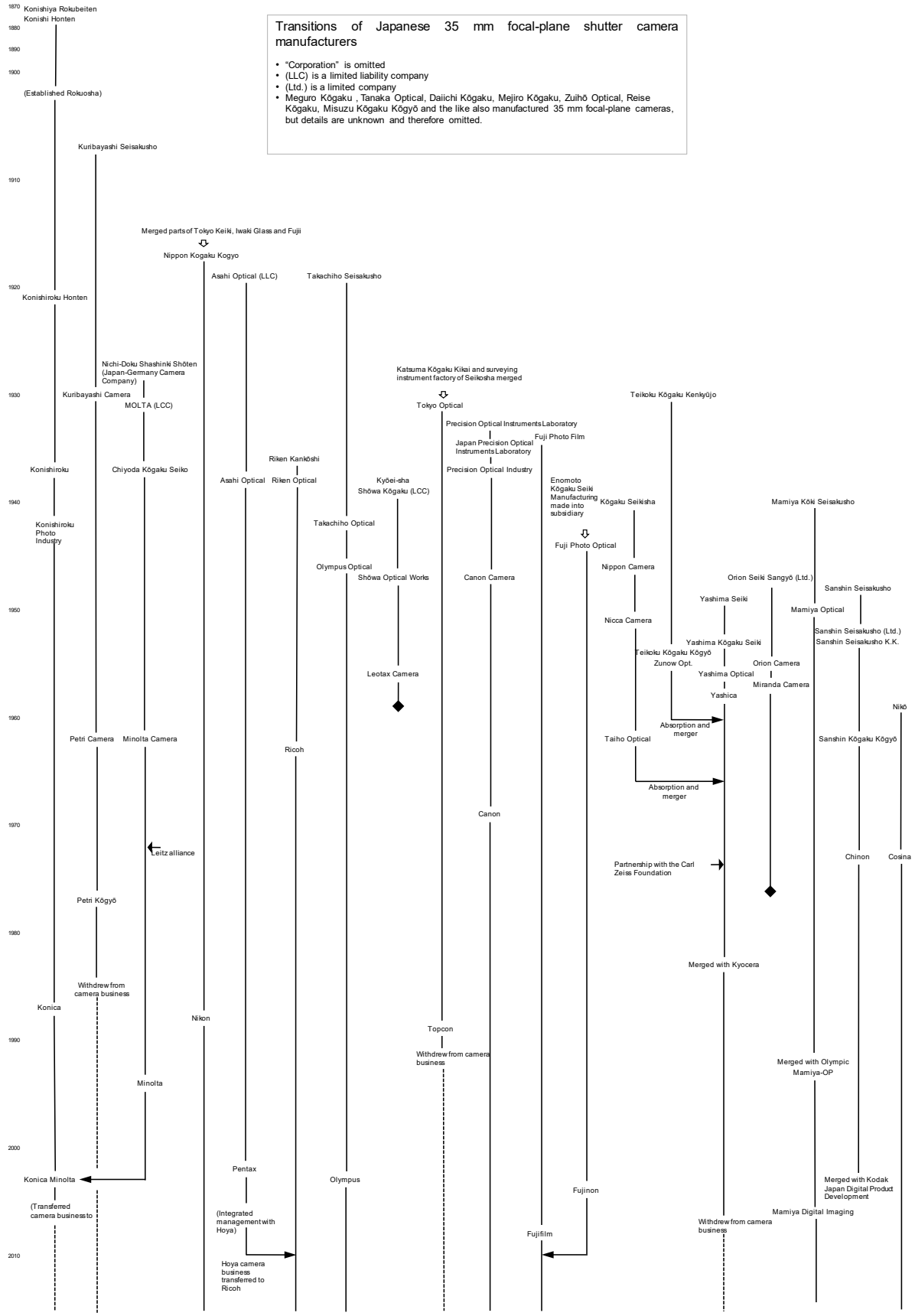
ISO	Name	Corresponding JIS
516	Camera shutters – Timing	B7091
517	Apertures and related properties pertaining to photographic lenses – Designations and measurements	B7094, B7095, B7106
518	Camera accessory shoes, with and without electrical contacts, for photoflash lamps and electronic photoflash units	B7101
519	Hand-held cameras – Flash-connector dimensions	B7102
1007	135-size film and magazine – Specifications	
1203	Roll film cameras – Back window location	
1222	Tripod connections	B7103
1229	Expendable photoflash lamps – Determination of light output	
1230	Determination of flash guide numbers	
1754	Cameras using 35 mm film and roll film – Picture sizes	B7115
1948	Front lens barrels up to 127 mm – Dimensions important to the connection of auxiliaries	B7111
2720	General purpose photographic exposure meters (photoelectric type) – Guide to product specification	
2721	Cameras – Automatic controls of exposure	
2800	Expendable photoflash lamps – Definition and evaluation of flashability	
2827	Electronic flash equipment – Determination of light output and performance	
3028	Camera flash Illuminants – Determination of ISO spectral distribution Index (ISO/SDI)	B7098
5763	Electronic flash equipment – Automatic control of exposure	
6053	Shutter cable release tip and socket – Dimensions	B7104
6516	Photographic lenses – Distance scale marking	
6728	Camera lenses – Determination of ISO colour contribution index (ISO/CCI)	B7097
8478	Camera lenses – Measurement of ISO spectral transmittance	B7107
8581	Electronic flash equipment – Connectors to synchro-cord	
10157	Flash exposure meter – Requirements	
10330	Synchronizers, ignition circuits and connectors for cameras and photoflash units – Electrical characteristics and test methods	

Camera-related Japanese Industrial Standards (JIS)

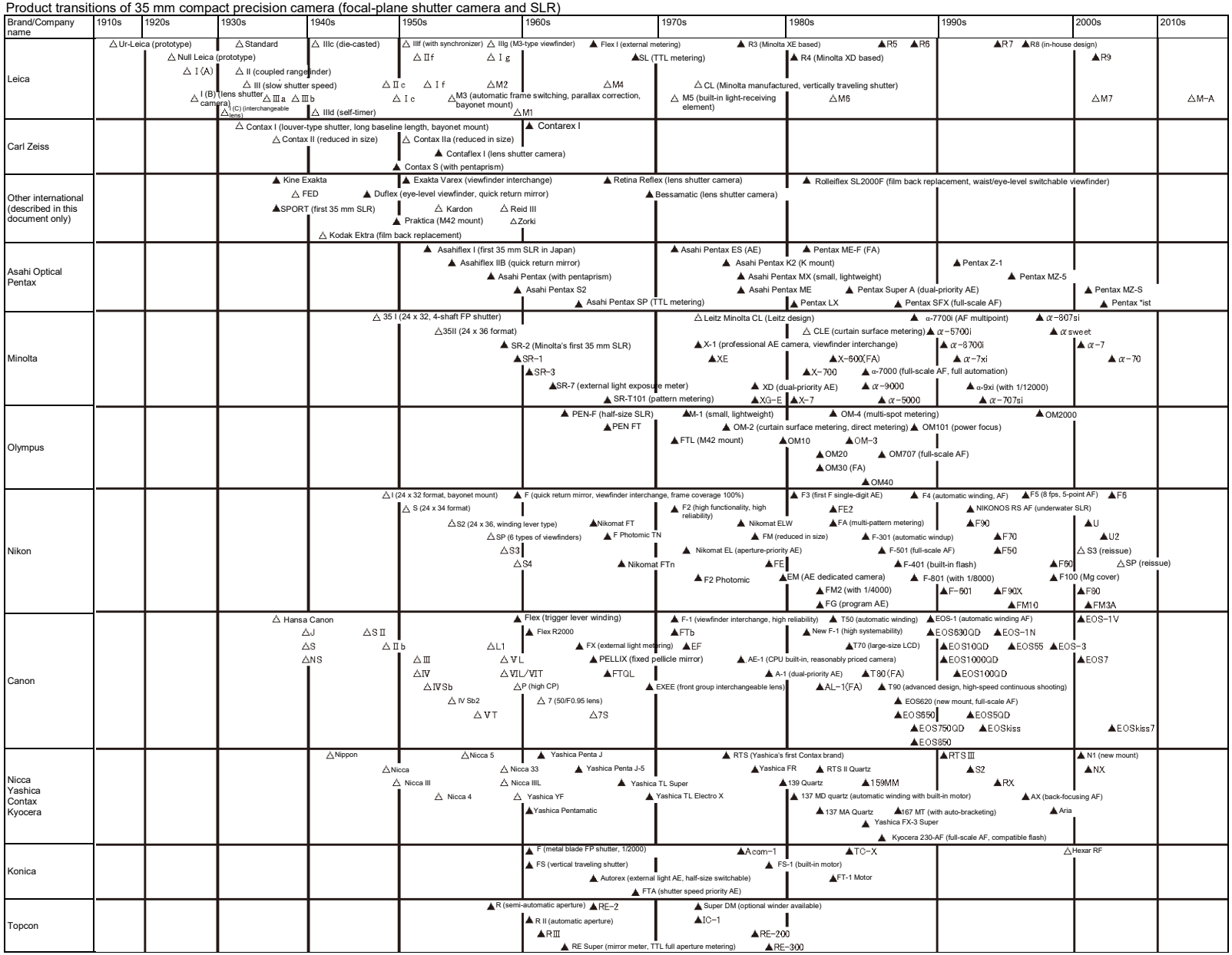
JIS B	Name	Year of publication	Most recent revision	Corresponding ISO
7091	Shutters for still cameras	1971	1992	516
7092	Photoelectric methods for measuring light exposure in focal planes of cameras	1973	–	2721
7094	Photographic lenses – Measurement of the focal length	1978	1997	517
7095	Photographic lenses – Methods for the measurement of the effective aperture, F-number and relative aperture	1978	1997	517
7097	Determination of ISO Colour Contribution Index (ISO/CCI) of Camera Lenses	1986	–	6728
7098	Photography – Camera Flash Illuminants – Determination of ISO Spectral Distribution Index (ISO/SDI)	1988	–	3028
7101	Camera Accessory Shoes and Feet	1952	1975	518
7102	Socket and plug for camera flash synchronization	1952	1995	519
7103	Tripod Connections for Cameras	1952	1975	1222
7104	Shutter cable release tips and sockets for cameras	1952	1992	6053
7106	Photographic lenses – F-number marking	1952	1997	517
7107	Photography – Camera lenses – Measurement of ISO spectral transmittance	1969	1997	8478
7111	Photographic lens – Front lens barrels up to 127 mm – Dimensions important to the connection of auxiliaries	1954	1997	1948
7115	Picture Sizes for Still Cameras	1955	1975	1754

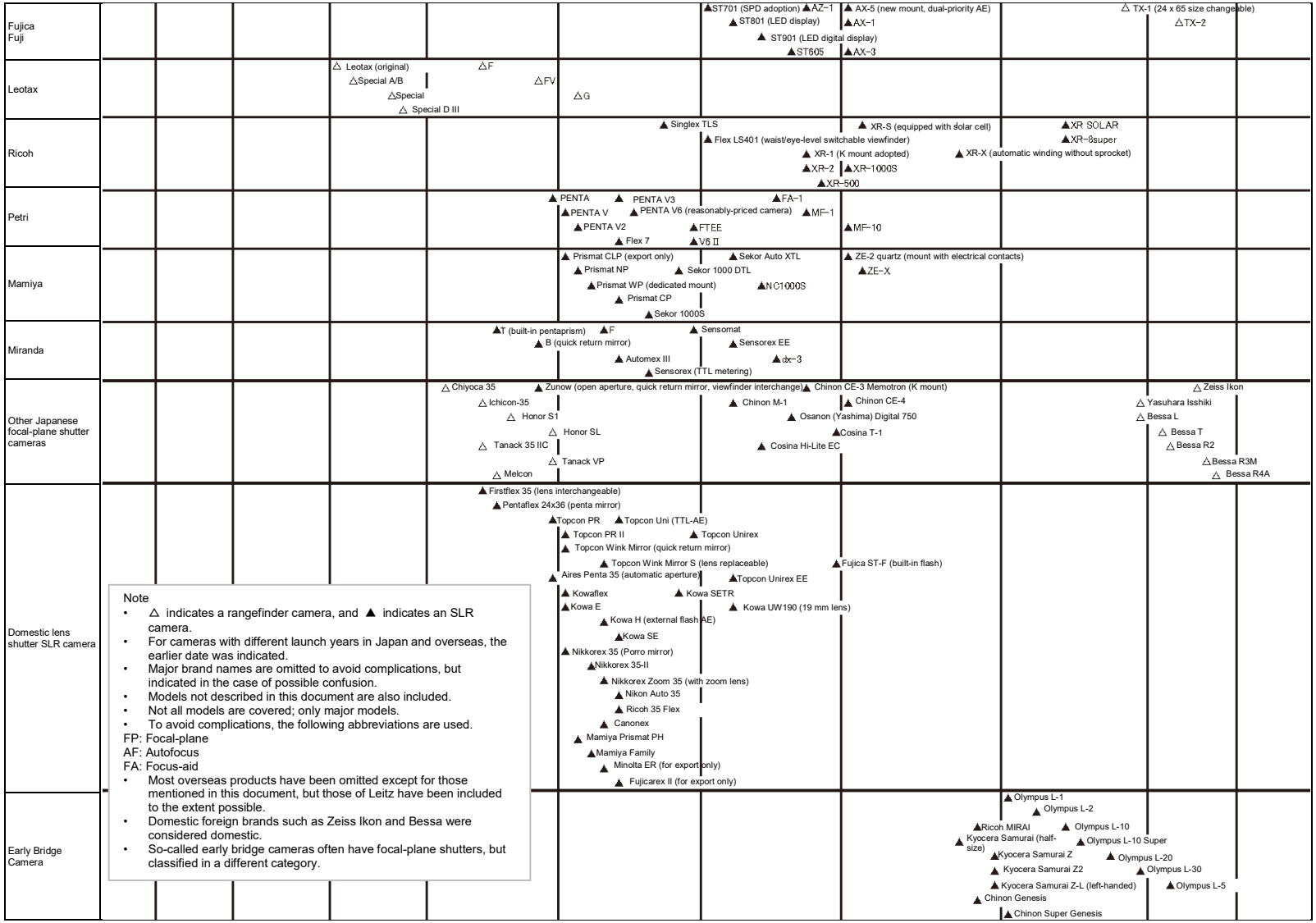
Japanese Camera Industrial Standards (JCIS)

JCIS	Name	Year of publication	Most recent revision	Note
2	*Kamera no dōchō hakkō kikō soketto oyobi puragu-yō genkai gēji* [Limit Gauges for Camera Synchronized Flash Mechanism Sockets and Plugs]	1963	–	Corresponds to JIS B 7102
3	*Kamera no sankyaku toritsukebu-yō gēji* [Gauges for Tripod Connections for Cameras]	1963	–	Corresponds to JIS B 7103
4	*Kamera no rerīzu-yō gēji* [Gauges for shutter cable release]	1963	–	Corresponds to JIS B 7104
8	*Seimitsu kiki-yō neji jūji ana* (0-ban) [Cross-Recess for Machine Screws for Precision Instruments]	1970	–	JCIS 8-10 are combined volumes.
9	*Seimitsu kiki-yō jūji neji-mawashi bitto (0-ban bitto)* [Screwdrivers for Cross Recessed Head Screws for Precision Instruments]	1970	–	
10	*Seimitsu kiki-yō jūji ana-tsuki koneji (0-ban koneji)* [Cross-Recessed Head Machine Screws for Precision Instruments]	1970	–	
24	*Kamera no richiumu denchi kōkan hyōji hōhō* [Camera lithium battery replacement indication method]	1993	–	
25	*Kamera no kigō E ni yoru sōsa hyōji hōhō* [Camera operation display method by symbol E]	1995	–	
26	*Kamera no gurafikarushinboru* [Camera graphical symbols]	1997	–	
27	*Kamera no shitsuryō oyobi sunpō no hyōji hōhō* [Method of indicating the mass and dimensions of a camera]	1997	–	
28	*Bōsui kamera no shurui to hyōji* [Types and method of indicating waterproof cameras]	1997	–	
29	*Shashin-ki nado ni shiyō suru mētoru hosome-kei neji* [Metric fine threads for photographic equipment, etc.]	1997	–	


Transitions of Japanese 35 mm focal-plane shutter camera manufacturers
• "Corporation" is omitted
• (LLC) is a limited liability company
• (Ltd.) is a limited company
• Meguro Kōgaku , Tanaka Optical, Daiichi Kōgaku, Mejiro Kōgaku, Zuihō Optical, Reise Kōgaku, Misuzu Kōgaku Kōgyō and the like also manufactured 35 mm focal-plane cameras, but details are unknown and therefore omitted.
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Konishiya Rokubeiten
Konishi Honten
(Established Rokuosha)
Konishiroku Honten
Konishiroku
Konishiroku Photo Industry
Konica
Konica Minolta
(Transferred camera business to
Kuribayashi Seisakusho
Kuribayashi Camera
Nichi-Doku Shashinki Shōten (Japan-Germany Camera Company)
MOLTA (LLC)
Chiyoda Kōgaku Seiko
Petri Camera
Petri Kōgyō
Withdrew from camera business
Minolta Camera
Leitz alliance
Minolta
Merged parts of Tokyo Keiki, Iwaki Glass and Fujii
Nippon Kogaku Kogyo
Nikon
Asahi Optical (LLC)
Asahi Optical
Pentax
(Integrated management with Hoya)
Hoya camera business transferred to Ricoh
Riken Kankōshi
Riken Optical
Ricoh
Takachiho Seisakusho
Takachiho Optical
Olympus Optical
Olympus
Kyōei-sha
Shōwa Kōgaku (LCC)
Shōwa Optical Works
Leotax Camera
Katsuma Kōgaku Kikai and surveying instrument factory of Seikosha merged
Tokyo Optical
Topcon
Withdrew from camera business
Precision Optical Instruments Laboratory
Japan Precision Optical Instruments Laboratory
Precision Optical Industry
Canon Camera
Canon
Fuji Photo Film
Fujifilm
Enomoto Kōgaku Seiki Manufacturing made into subsidiary
Fuji Photo Optical
Fujinon
Teikoku Kōgaku Kenkyūjo
Kōgaku Seikisha
Nippon Camera
Nicca Camera
Taiho Optical
Absorption and merger
Teikoku Kōgaku Kōgyō
Zunow Opt.
Yashima Seiki
Yashima Kōgaku Seiki
Yashima Optical
Yashica
Absorption and merger
Partnership with the Carl Zeiss Foundation
Merged with Kyocera
Withdrew from camera business
Mamiya Kōki Seisakusho
Mamiya Optical
Orion Seiki Sangyō (Ltd.)
Orion Camera
Miranda Camera
Sanshin Seisakusho
Sanshin Seisakusho (Ltd.)
Sanshin Seisakusho K.K.
Sanshin Kōgaku Kōgyō
Chinon
Nikō
Cosina
Merged with Olympic Mamiya-OP
Merged with Kodak Japan Digital Product Development
Mamiya Digital Imaging

Product transitions of 35 mm compact precision camera (focal-plane shutter camera and SLR)





Note

- △ indicates a rangefinder camera, and ▲ indicates an SLR camera.
- For cameras with different launch years in Japan and overseas, the earlier date was indicated.
- Major brand names are omitted to avoid complications, but indicated in the case of possible confusion.
- Models not described in this document are also included.
- Not all models are covered; only major models.
- To avoid complications, the following abbreviations are used.

FP: Focal-plane
AF: Autofocus
FA: Focus-aid

- Most overseas products have been omitted except for those mentioned in this document, but those of Leitz have been included to the extent possible.
- Domestic foreign brands such as Zeiss Ikon and Bessa were considered domestic.
- So-called early bridge cameras often have focal-plane shutters, but classified in a different category.

35 mm compact precision camera　Industrial technology history material　Location confirmed

No.	Name	Location	Material Type	Current State	Created by	Created Year	Reason for Selection	Note
1	Hansa Canon	Camera Industry Institute, JCII Camera Museum 25 Ichibanchō, Chiyoda-ku	Prototype	On display	Precision Optical Limits Laboratory (currently Canon)	1935	Japan's first 35 mm rangefinder camera with focal-plane shutter. This was a monumental product that was not merely an imitation of the Leica, but also marked the beginning of the compact precision camera made in Japan, with its unique lens mount, film counter on the front and unique pop-up viewfinder.	Product No. 1119 With Nikkor 50 mm F3.5 (No. 129)
2	Asahiflex	Camera Industry Institute, JCII Camera Museum 25 Ichibanchō, Chiyoda-ku, Tokyo	Mass produced product	On display	Asahi Optical Co., Ltd. (currently Ricoh)	1952 (Year of product release; year of manufacture not yet confirmed)	The first domestically produced 35 mm SLR camera. The unique screw mount permits interchangeable lenses, and the semi-quick return function eliminates the disadvantage of the SLR camera (loss of viewfinder image after shooting) by returning the mirror by release of the shutter release button.	Product No. 26274 With Takumar 50 mm F3.5 (No. 26207)
3	Nikon F	Nikon Museum 2-15-3 Konan, Minato-ku, Tokyo Shinagawa Intercity Building C	Mass produced product	On display	Nippon Kogaku Kogyo Co., Ltd. (currently Nikon)	1959	An SLR camera that quickly gained a reputation for functionality, quality and systemability. With its advanced lens mount, quick-return mirror, open aperture and interchangeable viewfinder, the camera has become the reigning professional and high-amateur camera for over 15 years.	Product No. 6400028
4	Topcon RE Super	Camera Industry Institute, JCII Camera Museum, 25 Ichibanchō, Chiyoda-ku, Tokyo	Mass produced product	On display	Tokyo Optical Co., Ltd. (currently Topcon)	1963	A 35 mm SLR camera with pioneering features such as TTL open-light metering and a mirror meter. In addition to its graceful design, the camera also deserves praise for its high systematics, including the commercialization of a 300mm F 2.8 large-aperture lens and a retro-focus wide-angle lens.	Product No. 4601021 With RE AUTO-TOPCOR 5.8 cm F1.8 (No. 99007265)
5	Olympus M-1	Hachioji Office, Olympus Corporation Olympus Technology History Museum, “Zuikodo” 2951 Ishikawa-machi, Hachioji, Tokyo	Mass produced product	On display	Olympus Optical Co., Ltd. (Currently Olympus)	1972	A 35 mm SLR camera with an astonishingly compact and lightweight design achieved by completely rethinking the internal mechanisms and layout. Despite its compact size and light weight, the camera maintains a high level of systematics and enhanced basic performance, such as the inclusion of an air damper, and established the ideal SLR camera for the future.	Product No. 100471
6	Canon AE-1	Canon Inc. 3-30-2 Shimomaruko, Ota-ku, Tokyo	Mass produced product	In storage	Canon	1976 (Year of product release; year of manufacture not disclosed)	A 35 mm SLR camera with advanced functions and specifications achieved through digitization while keeping the selling price low. Provided with a low-cost integrated dedicated winder, the product was an unprecedented hit with the catchphrase, “*Rensha-ichigan* (Continuous shooting SLR) camera.”	Product No. 357856
7	Minolta α-7000	1 Sakura-machi, Hino-shi, Tokyo Konica Minolta Tokyo Site Hino Konica Minolta With You, Inc.	Release commemoration	In storage	Minolta (currently Konica Minolta)	1985	The first interchangeable-lens SLR camera to realize a full-fledged automatic focusing function. This innovative product, which changed the trend of the 35 mm SLR camera in a single stroke, was the result of a complete rethinking of the conventional product form and the almost complete automation of functions, including the system itself.	Product no. 10000002 With AF70-210 mm F1.4 (No.10000002)