History of Rocketry and Astronautics

Proceedings of the Forty-Second History Symposium of the International Academy of Astronautics

Glasgow, United Kingdom, 2008

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AAS History Series, Volume 39

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 28

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 2013

ISSN 0730-3564

ISBN 978-0-87703-589-3 (Hard Cover)
ISBN 978-0-87703-590-9 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198
Web Site: http://www.univelt.com

Printed and Bound in the U.S.A.

Chapter 11

The Alfred Nobel Rocket Camera: An Early Aerial Photography Attempt*

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Abstract

Alfred B. Nobel (1833–1896), mainly known for his invention of dynamite and the creation of the Nobel Prizes, was an engineer and inventor active in many fields of science and engineering, for example, chemistry, medicine, mechanics, metallurgy, optics, armory, and rocketry. Among his inventions in rocketry was the smokeless solid propellant ballistite (that is, cordite) patented for the first time in 1887. As a very wealthy person, he actively supported many Swedish inventors in their work. One of them was Wilhelm T. Unge, who was devoted to the development of rockets and their applications. Nobel and Unge had several rocket patents together and also jointly worked on various rocket applications.

In mid-1896 Nobel applied for patents in England and France for "An Improved Mode of Obtaining Photographic Maps and Earth or Ground Measurements" using a photographic camera carried by a "... balloon, rocket or missile...". During the remainder of 1896, the mechanical design of the camera mechanism was pursued and cameras manufactured. In April 1897 (after the death of Nobel), the first aerial photos were taken by these cameras. These pho-

* Presented at the Forty-Second History Symposium of the International Academy of Astronautics, 29 September – 3 October 2008, Glasgow, United Kingdom. Paper IAC-08-E4.3.02.

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tos might be the first documented aerial photos taken by a rocket-borne camera. Cameras and photos from 1897 have been preserved. Nobel did not only develop the rocket-borne camera but also proposed methods on how to use the photographs for ground measurements and preparing maps.

Introduction

Very soon after the invention of photography in the late 1830s, the idea to use cameras attached to balloons for so-called aerial photography came about. The most likely first aerial photo (no longer existent) was taken in France by Gaspar Felix Tournachon in 1858, and he also filed for a patent using aerial photography for survey and mapping. The first preserved aerial photo was taken from a tethered balloon over Boston in 1860 by James Wallace Black. The first free-flight balloon photo-missions occurred in 1879 in France.[1]

In the 1880s the platform alternatives for aerial photography was broadened by using kites. The first proposal for a rocket-borne camera came in 1888 in an article published by Amédée Denisse, a French pyrotechnician, in the journal *La Nature* on 22 September 1888. This concept proposed taking a 360° panorama picture using 12 lenses in a horizontal plane. The first patent for a rocket-borne camera was received by Ludwig Rhormann in 1891 in Germany (Kaiserliches Patentamt No. 64209, 14 July 1891).[2]

Early in 1896, Alfred Nobel started his activities to design a useable rocket camera and the development of methods for using it in aerial mapping. The design work was followed by patents, but the camera manufacturing and the first photos taken by a rocket camera were only completed in 1897, after the death of Nobel.

Alfred B. Nobel

Alfred Bernhard Nobel (1833–1896) was born in Stockholm as the third of four sons of Immanuel Nobel, a self-made industrialist and inventor. After only one year of ordinary school, the family moved to St. Petersburg in 1842, and Nobel received, together with his older brothers, his education by means of private Russian and Swedish tutors until 1850. In the following two years he traveled to Germany, France, Italy, and the United States to study mainly chemistry at different laboratories. On his return to St. Petersburg, he worked in the company of his father until he followed the family and returned to Sweden in 1863.

Back in Sweden, Alfred Nobel, together with his father, started a factory for industrial manufacturing of nitroglycerine. Many accidents with the shock and temperature-sensitive nitroglycerine made Nobel aware of its extreme danger and difficult handling. In 1864 his younger brother was killed in an explosion in the production plant in Stockholm. Alfred Nobel managed to develop the shock-insensitive, easy-to-handle, and solid explosive dynamite, a mixture of nitroglycerine and kieselguhr, which was patented in Sweden, England, and the United States in 1867. This was to become the start of an expanding business and the source for the wealth of Alfred Nobel.

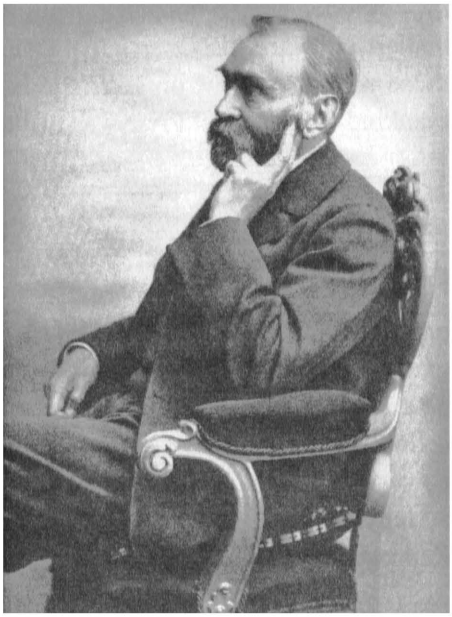

Figure 11–1: Alfred Bernhard Nobel, 1833–1896. Credit: Nobel Foundation.

In the next 20 years Alfred Nobel continued to improve dynamite and to develop ancillary equipment for its use. This also led to the build-up and control of an international group of production companies for dynamite, based on the Nobel patents. The original main use of dynamite was for civil mining and construction work, but inevitably the use of dynamite and its derivates was also to become a main element in explosive warheads and many inventions were to come to make it a reliable explosive for military use. Related to the improvement of warheads was the search for new propellants based on nitroglycerine as one component. This resulted in the first double-base, slow-burning, smokeless powder "ballistite," which was patented in France (No. 181 179, 1887), England (No. 1471, 1888), and Sweden (No. 2158, 1889; and No. 2752, 1890).

As a talented chemist and inventor Nobel also turned to develop other products, such as artificial rubber, leather and silk; new steel and aluminum manufacturing processes; various other chemical processes; and optical and medical equipment. He held in total at least 355 patents in many different countries. In the last 10 years of his life, he very actively also supported many talented inventors with funds and direct collaborations, for example, the work on rockets together with Wilhelm T. Unge.[3]

Nobel was to become a multimillionaire and, at his death in 1896, he (by his last will) left his fortune to a foundation to be that would award prizes "... to those who, during the preceding year, shall have conferred the greatest benefit on mankind." The Nobel Prize was instated.

Nobel Rocket Development

Alfred Nobel was permanently looking for possible applications for his products and inventions. As for ballistite, the initial use was as a propellant for gun shells, but Nobel soon was to consider the use in rockets, and, in 1891–1892, he applied for three provisional patents in England. Around this time the Swedish officer of the General Staff and military inventor Captain Wilhelm T. Unge got in contact with Nobel to get his support for the development of rockets, then called aerial torpedo. Unge was looking for means to increase the range and by all to improve the accuracy of rockets.

In the following years a close cooperation between Nobel and Unge took place, and Nobel became one of the shareholders of the Unge rocket development company, AB Mars. Their close cooperation resulted in two patents in Sweden (No. 10.036 and 10.257) both issued in 1897, the year after Nobel's death (Figure 11–2).

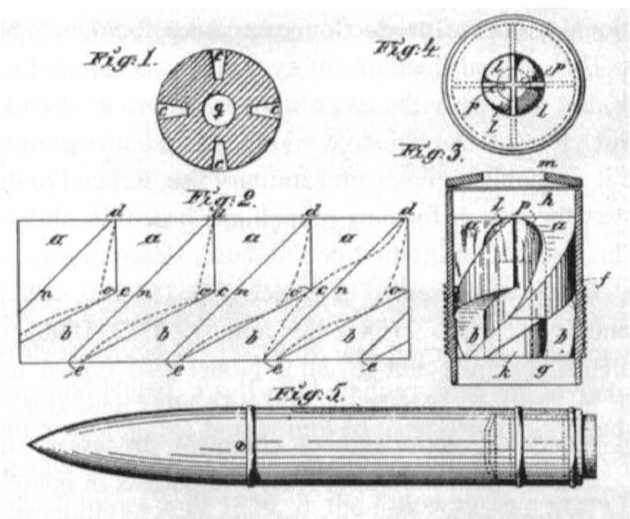

Figure 11–2: Nobel–Unge Swedish Patent No. 10.257, with the first application of the Laval-nozzle principle. Credit: Archive Skoog.

Unge was interested in the ballistite as a practical and powerful rocket propellant, and on 12 September 1896, the first ballistite rocket was fired in Stockholm (Figure 11–3).[4]

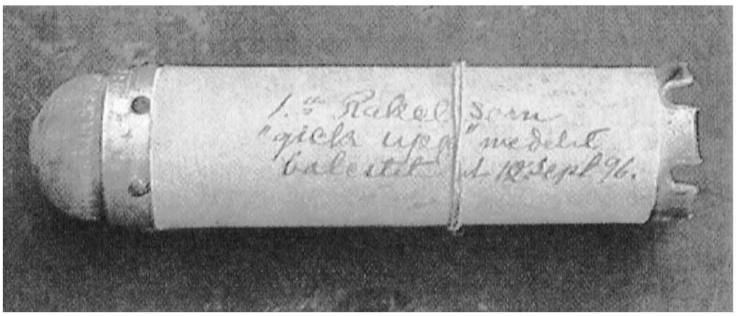

Figure 11–3: First ballistite rocket ever fired.
Credit: Nobel Museum Björkborn and Skoog.

The Rocket Camera Patents

Alfred Nobel wrote in a letter, dated 5 August 1896, to his assistant, Ragnar Sohlman, at Bofors addressing telemeters:[5]

> I have been thinking of a new way, which might be very useable. I deploy a small balloon equipped with a parachute and a camera including a small clockwork or explosive timer. At suitable altitude the balloon is automatically emptied or the parachute separated, which will then descend with the camera and picture. Peculiar that this did not occur to me earlier.

The English Rocket Camera Patent

Three months earlier, Nobel had filed a provisional patent in England on "An Improved Mode of Obtaining Photographic Maps and Earth or Ground Measurements" (English Patent No. 10.118, 12 May 1896).

The provisional patent letter is a mere two pages and contains no illustrations. The major claim is:

> I provide a balloon, a rocket, a projectile, or missile, of any suitable construction, with a photographic camera, which, except when carried by a captive balloon, is provided with a parachute, which at the right moment (as hereinafter explained) is disjoined from the vehicle which has carried it upwards, and gently descends, carrying said camera with it....
>
> A rocket or a projectile may be provided with a parachute and photographic camera, which, by means of a time fuse and proper mechanical arrangements, may be disconnected at the computed moment from said rocket or

projectile. A simple time fuse or suitable mechanical contrivance will then regulate, at the proper moment, the opening and shutting of the camera, and the parachute gently descends, carrying with it the camera and image which is then being developed.

The complete specification was submitted on 12 February 1897 and finally accepted on 12 May 1897. It contains three pages with a detailed description of the function of the rocket, parachute, release mechanism and camera, including two drawings. The claim is:

> An apparatus for making photographic maps, consisting of a suitable carrier, a small balloon, a rocket, a projectile, or the like, a photographic camera with or without a parachute, a time action suitable to disconnect, at a given moment, the camera and parachute from the carrier, and another time action suitable for operating, at the proper time, the shutter of the camera, substantially as and for purpose described.

The method for making the maps is also described:

> The negative image thus obtained is developed in the usual way, and positive transparent images taken from it. I then proceed to enlarge such positive image by projecting it, with suitable lenses or an enlarging camera, on a wall, or on a prepared surface. And in order to make such enlarged pictures serve as maps, and permit of telemetric measurements being readily made I project said enlarged images on sensitive surfaces, as films, plates or paper, which have been previously so ruled, or square ruled, as to represent, by distance between the lines, or by the size of the squares, equal distances or surfaces of real ground on the enlarged map....
>
> It is clear, that in order to get accurate measurements, or to enlarge the image to a certain scale, either the height, at which the exposure is made, or else the distance between two places showing in the map must be accurately known, the latter being by far the most practicable....
>
> This method can also be used to get accurate height measurements by taking successive images at different heights, when the difference in the angle of vision will furnish data for computing the heights of different objects shewing on the maps."

The rocket arrangement and the shutter mechanism are shown as drawings (Figure 11–4). It should be noted here that the shutter design is one of several documented in the period August 1896 until March 1897 (see also the French patent and the final camera design below), but in its basic principles is similar to the one in the French patent.

The complete specification for the English patent from February 1897 is as for all purposes the same as the original provisional application, but both these applications show obvious differences compared with the French one.

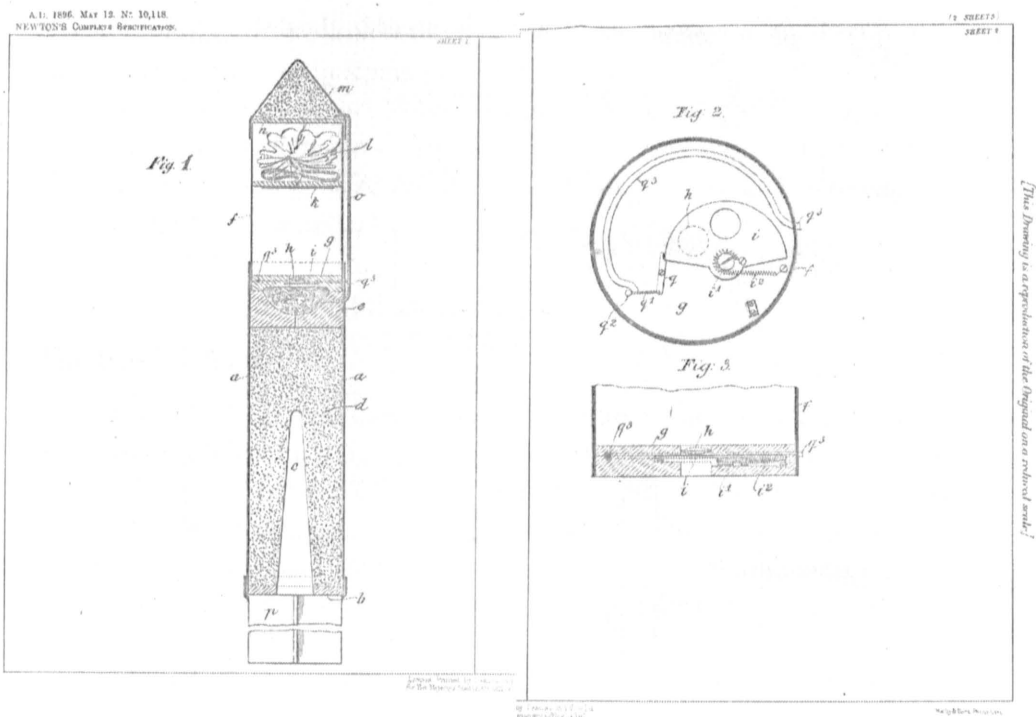

Figure 11–4: Rocket camera and shutter in English Patent No 10.118.
Credit: Archive Skoog.

The French Rocket Camera Patent

The French rocket camera patent "Télémètre photographique" (No. 258781, 10 August 1896) is very similar to the English one in its final form from 1897 concerning methods and technical solutions (Figure 11–5), but the drawings are more of a "manufacturing" type than the English ones, which are of a principle concept type.

A major difference is to be found in the application objectives. In the French patent a military application is in detail described in the very introduction of the patent as ". . . to give the distance to and the vision from outside of the position and direction of movements of enemy troops." A military application is only briefly mentioned at the end of the English patent as ". . . use for military reconnoitring, . . .".

One pronounced similarity between the applications is the preference for using a rocket as the carrier vehicle. Both patents discuss the possible use of a captive balloon and the disadvantages of this method.

> The simplest arrangement is a small captive balloon, as it allows an easy and accurate adjustment of the height, and because no parachute, and no ar-

rangement for detaching the camera, is needed. (English Patent No. 10.118).

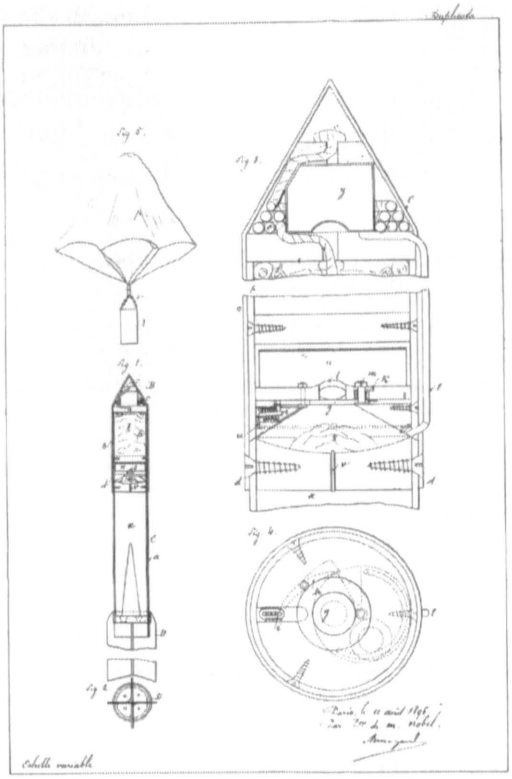

Figure 11–5: Rocket camera in French Patent No. 258781. Credit: Archive Skoog.

But the conclusion is that due to winds and other weather phenomena the captive balloon "... is apt to be unsteady...". The advantage of the rocket is given as:

> A rocket, if accurately charged and well balanced, can be made to ascend practically to a determined height, and in a regular trajectory.

Based on these conclusions the technical descriptions of the invention of a camera for aerial photography in both patents concentrate on the rocket application.

Other Planned Patent Applications

At the death of Alfred Nobel on 10 December 1896, manuscripts for patent applications in Sweden and Germany were available but never pursued. In the Swedish manuscript the idea of multistage rockets is introduced in order to

achieve altitudes of 4–5 kilometers to cover a ground area of some 8–10 kilometers in diameter for the mapping purposes.[6]

It should be noted that Nobel very often first applied for patents in England and France before doing so in his native country, Sweden. This is partly due to the fact that he lived most of the time in Paris, and that he had large commercial interests in England and the United States.

The Rocket Camera Design

The Rocket Design

The rocket camera design occurred at a time when Nobel and Unge were involved in solving the general guidance and stabilization problem of rockets. No specific design of a rocket to be used with the camera has been identified, but the two patent documents give some information of a possible concept. The rocket was of the conventional solid-propellant type with a central conical bore. Interesting is the concept to use axial vanes ("wings") in the exhaust outlet to improve the stabilization of the rocket.

The indication of using vanes at this time is even more interesting as far as that Unge and Nobel were already working on a concept of a series of inclined Laval-nozzles arranged in a ring around the central axis in order to create the spin and hereby stabilizing the rocket. This concept was then patented in 1897, the year when the English rocket camera patent was finalized (see also Swedish Patent No. 10.257, Figure 11–2, above).

The Payload

The payload consisted of a lower camera section and upper parachute compartment with a typical conical cap at the top end of the rocket. The system was equipped with two separation mechanisms, one to separate the payload from the rocket and a second one to separate the conical front end and deploy the parachute. Both mechanisms were of the pyrotechnical type (see also below).

The payload outer casing in form of a can was made of aluminum with the top attached to the parachute. In this can, the camera unit was mounted (Figure 11–6). The can was attached to the rocket casing, being pressed into an outer metal ring.

Camera

The camera consisted of a cylindrical chamber, at which at one end the photographic plate or film was mounted on the inside, and at the other end the lens, covered by the shutter mechanism, mounted on the outside (see Figure 11–7).

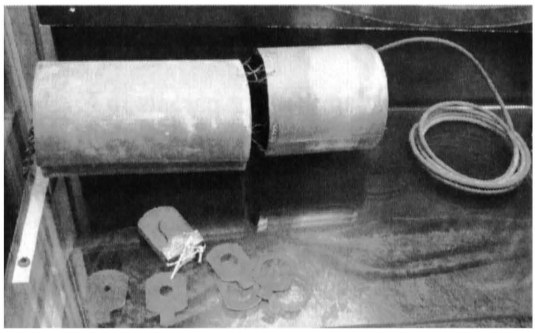

Figure 11–6: Rocket camera container (N 75; TM 23.797) and rocket camera N 274 (TM 23.799). Credit: Tekniska Museet, Nobel Museum Björkborn, Skoog.

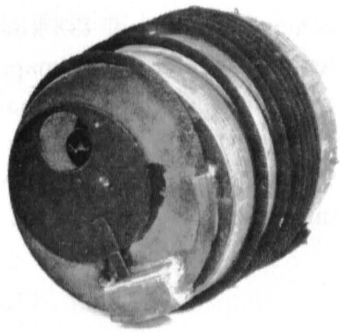

Figure 11–7: Rocket camera N 274 (TM 23.799). Credit: Tekniska Museet, Nobel Museum Björkborn, Skoog.

The shutter mechanism also served as a protection of the lens at the separation of the payload from the rocket by an explosive charge. On the shutter mechanism design from 28 December 1896 (Figure 11–8), the sealing problem has been solved by using two brass discs, one sliding on top of another fixed disc (lower left in Figure 11–8), which has ribs circumferential and radial to give a good sealing.

The camera focusing was performed by a fixed, but interchangeable, diaphragm. The setting for the desired distance and focus of the camera was done by selection of a diaphragm plate with a small or larger opening before flight (front Figure 11–6 and lower right Figure 11–8).

The shutter design from 9 March 1897 (Figure 11–9) was basically the one on the actual cameras (Figure 11–7) and also close to the design in the English final patent application of February 1897 (Figure 11–4).

It shall be noted that all concepts for the activation of the spring-loaded shutter were based on the use of a simple time fuse, not any expensive and complicated clock mechanism. The vast experience in use of time fuses from years of development and manufacturing of explosives provided the experience needed to exactly calculate the desired time delay.

Two rocket cameras are preserved, Figure 11-7 and Figure 11-10, at the Nobel Museum in Björkborn. The camera N 274 (TM 23.799)* is 124 mm in height and 115 mm in diameter. The outer shell is of metal. The second camera, N 275 (TM 23.800), is longer, 165 mm, and only 65 mm in diameter and has an outer shell of cardboard.

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* The hardware from the Nobel collection was numbered in a series N .... When transferred to the Tekniska Museet in Stockholm around 1945, the items also got a TM number from the museum. Most items are today at the Nobel Museum at Björkborn.

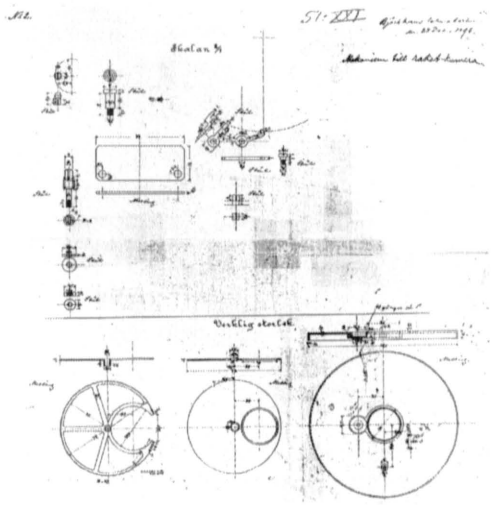

Figure 11–8: Shutter mechanism design, December 1896.
Credit: Nobel Archives at Riksarkivet.

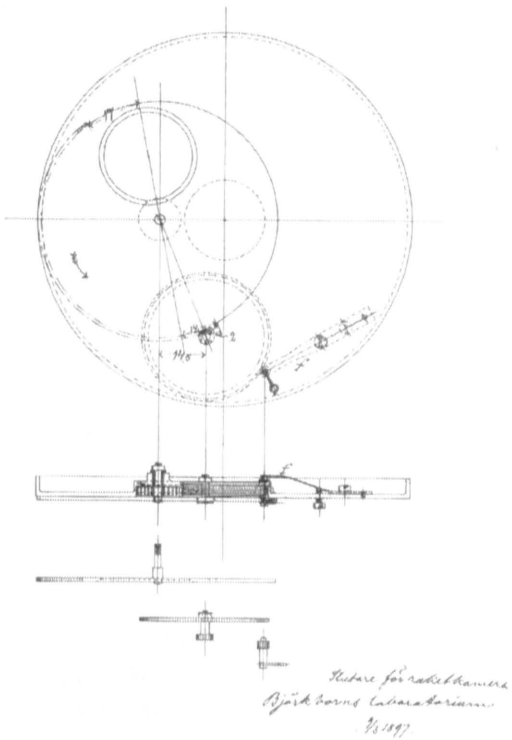

Figure 11–9: Shutter mechanism design, March 1897.
Credit: Nobel Archives at Riksarkivet.

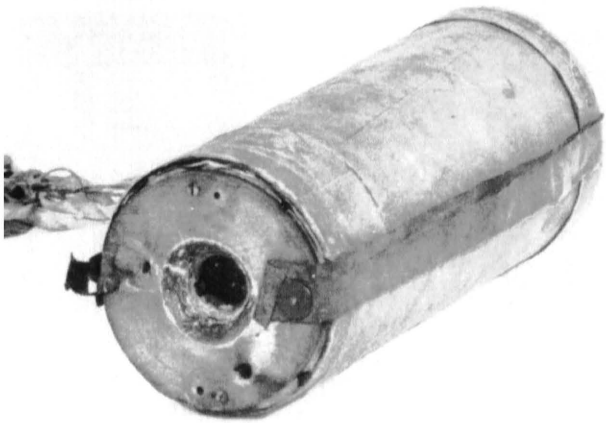

Figure 11–10: Rocket camera N 275 (TM 23.800).
Credit: Tekniska Museet, Nobel Museum Björkborn, Skoog.

Parachute

No parachute or any technical details of the same have been preserved.

The Operation

After launch of the rocket, at the end of the burning phase of the solid propellant, a short time fuse would ignite a charge of gun cotton, placed between the upper end plate of the rocket and the camera, which would drive out the payload tube and thus separate it from the rocket. At the time of the ignition of the separation mechanism, two time fuses were simultaneously ignited, one for the release of the top cap and deployment of the parachute, and another one with a longer burning time to activate the shutter mechanism.

The release time for the shutter was selected such that the parachute should have stabilized the camera module by the time of the exposure. Only one photo could be taken per rocket launch.

The design of the camera compartment was such that it should protect the camera itself during a gentle impact on ground.

The Inventor and the Designers

Alfred Nobel was for decades concentrating on the development and improvement of explosives, and at this time he also built up a worldwide system of companies for the manufacturing of the new safer explosives. Not until the last 10 years of his life, did he begin to pursue new ideas and to support proposed new inventions from outside.

Nobel was wealthy and also had the desire to help inventors to implement their ideas, and thus he got engaged as a financier and partner in many new projects. He supported the projects by financing, but also with concrete reviews of the work and ideas for how to solve problems. As for his own ideas, he tried to find skilled inventors and constructors to pick up and materialize his ideas in a partnership, unless he could resolve the invention with his own staff at San Remo and Björkborn research laboratories. In the literature and the Nobel Collection at the Riksarkivet in Stockholm, most of the activities are well documented and associated with names of inventors, designers, or industrialists. But as for the rocket camera, no name is given in the literature, and this is one of very few activities not clearly associated with a person or member of the Nobel staff.

The rocket camera and aerial mapping concept is, from what can be found in the Nobel Collection, an idea of Nobel himself.[7] After the two patents in England and France, Nobel initiated the design work of the actual hardware. However reviews of associated documents in the Nobel Collection (for example, Figure 11–8 and Figure 11–9) are without any indication of the designer or manufacturer.

A detailed description of the activities at Björkborn for the period of summer 1896 until summer 1897 has been given by Ragnar Sohlman, the assistant to Alfred Nobel and one of the testimony executors, in his book describing the time just before, at, and after the death of Alfred Nobel in December 1896.[8] This is the period when the rocket camera turned from an idea and initial patent into hardware. Sohlman provides detailed information on activities and the staff at Björkborn, and also the location of the employees during this period.

Employed at Björkborn were R. Sohlman (chemist and chief), G. von Feilitzen (chemist), O. Löfqvist, F. Langlet, E. Sederholm (chemist), and O. Ljungström (mechanical engineer and trained in land surveying). Löfqvist had most likely left Björkborn by year's end 1896. Thus the only non-chemists were Langlet and Ljungström, but Langlet spent his time from December 1896 until about April 1897 in San Remo to help Sohlman transfer the research activities and associated equipment to Björkborn and then close down the laboratory in San Remo.

Thus Oscar Ljungström is very likely the person responsible for the design, development, and testing of the rocket camera. He was one of three brothers, of which the other two, Fredrik and Birger, were involved in a company to develop bicycles, substantially supported by Nobel. All three brothers had their engineering training from working in the factory of their father manufacturing telemeters. Thus Oscar Ljungström had a good knowledge of optical instruments, land surveying, and fine mechanics. This makes him a very likely candidate for being the

person who pursued the work on the rocket camera from inside the Björkborn laboratory.

But it is also good to remember that Wilhelm T. Unge, the military inventor, officer of the general staff, and director of AB Mars, had a similar background. He invented a foldable camera, in 1867, and later the telemeter for military use. AB Mars was a company, where Nobel was a shareholder from 1893, which first produced Unge's telemeters and later on also his rockets. From 1892 on, Unge worked closely together with Nobel on improving the rocket performance and guidance. And later they shared patents (for example, Figure 11–2) on rocket inventions. During the 1890s, Unge was the person handling all rocket-development projects for Nobel. Furthermore Unge was, due to his experience in optical devices, also engaged by Nobel in a less-successful effort to develop a new optical technique for moving pictures in 1895–1896. What speaks against Unge as the main designer is the fact that he was, after the death of Nobel, seldom at Björkborn. But in his company, AB Mars, Unge had the capabilities to design and manufacture the elements of the camera.

Thus it cannot be finally concluded who the real designer was, but it is not unlikely that Ljungström and Unge might have cooperated in the development of a rocket camera, and most knowledge on the rocket itself and how to operate it ought to have come from Unge as the specialist.

The Rocket Camera Photos

Two Rocket Camera Photos

On 26 April 1897, two photos were taken with the rocket camera (Figure 11–11 and Figure 11–12). Both photos are preserved in the Nobel Collection at Riksarkivet. The two photos show the same area, but they deviate in the horizontal angle by ~25°. Figure 11–11 shows a view of the town of Karlskoga, where Björkborn is located, in a view more to the right than the other photo, Figure 11–12. There is also a small difference in the vertical angle, in that photo Figure 11–11 is slightly more vertical with less sky. The vertical angle to the houses in the foreground might be some 25°–30°. The horizontal field of view of 45°–50° is the same in both photos.

The two photos are different, not only in the slight shift of direction, but also in the setting of focus. The photo Figure 11–11 is focused on the front part (the houses in the front) with a larger opening. The other photo, Figure 11–12, is focused on the mid and far distance of the selected area and taken with a smaller diaphragm opening.

It is very likely that the two photos were taken on the same day, due to details around the houses in the front and the light setting and direction.

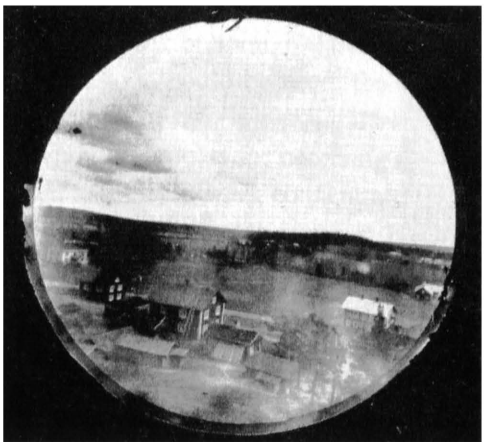

Figure 11–11: Rocket camera photo "right" from April 1897.
Credit: Nobel Archives at Riksarkivet.

Figure 11–12: Rocket camera photo "left" from April 1897.
Credit: Nobel Archives at Riksarkivet.

The Location of the Motif

Details of the motif on the two photos could possibly give some information on the actual location from where these photos were taken. All buildings have been identified by Rolf Lindelöf and Karlskoga Hembygdsförening (Karlskoga Historical Society).[9] The area is today fully built-up by the center of modern Karlskoga, and most of the buildings on the two rocket camera photos are long gone.

However, three of the buildings from 1897 (no. 2–4 on Figure 11–13) and the street in the foreground (no. 6 on Figure 11–13) are still existent. The exact location of two other buildings (no. 1 and 5 on Figure 11–13), pulled down in the mid-late 20th century, are also well-known. This makes it possible to plot them on a modern map of Karlskoga (Figure 11–14).

Taking the horizontal viewing angles on the two photos into consideration, the possible place for taking these photos is on the Rävåskullen, southern part, (Figure 11–14). No buildings did exist on this hill, which has an elevation of some 25 meters over the street (no. 6) in the front of the photos. The horizontal distance to the street from the top of the hill is in the order of 80–90 meters and to the houses some 70–80 meters. This would coincide with the angles in the photos. The actual hill in the forefront is still undeveloped today.

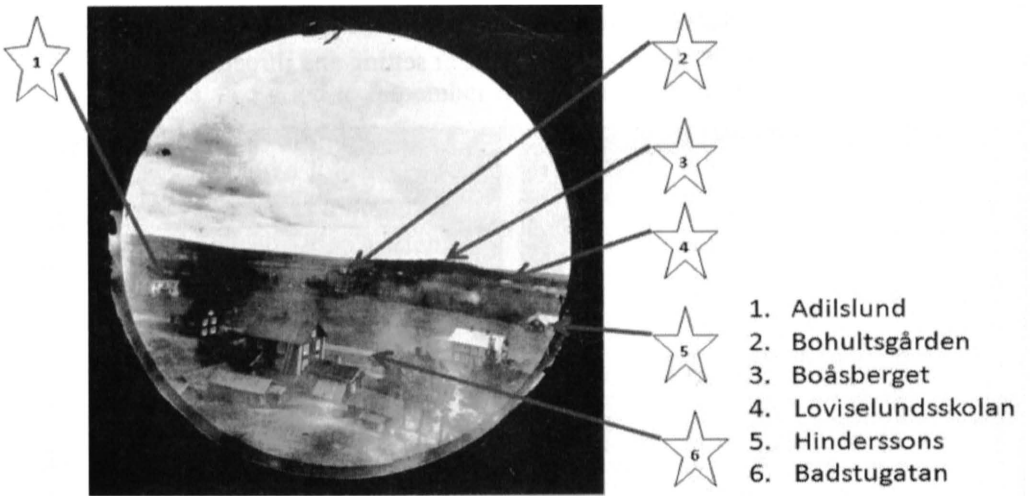

Figure 11–13: Identification of buildings in Karlskoga in 1897.
Credit: Lindelöf, Karlskoga Historical Society, Skoog.

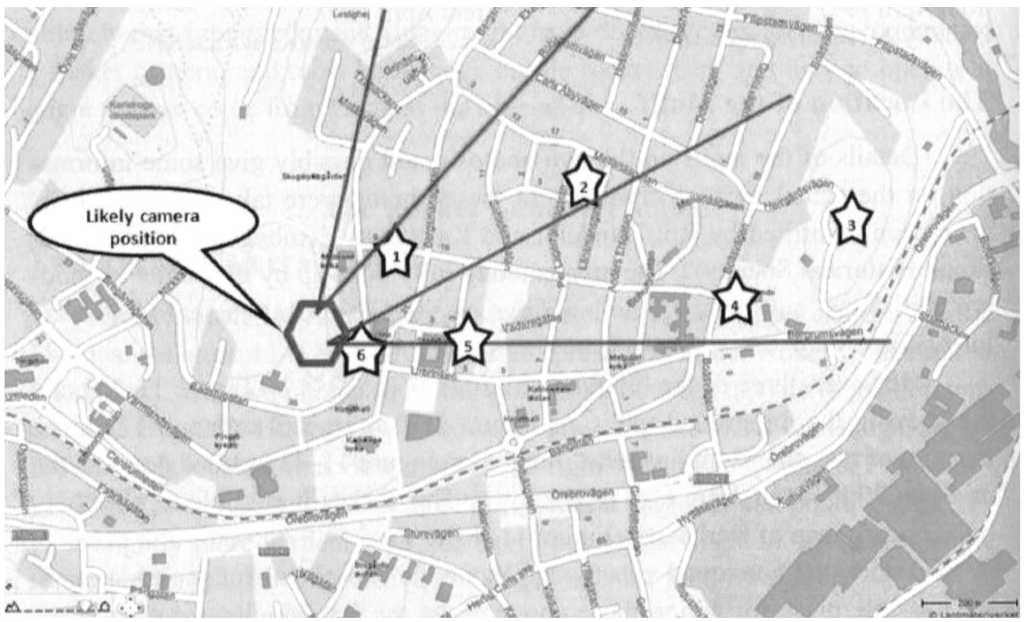

Figure 11–14: Location of identified buildings in today's Karlskoga
Credit: Lindelöf, Skoog.

Rocket or No Rocket?
How Were These Photos Taken?

Alfred Nobel envisaged a number of means to ascend the camera for aerial photography: balloon, projectile/rocket, missile, or kite. Unless a manned or captive balloon could be used, the camera would descend with a parachute and the activation of the shutter would have to be by automatic means. Nobel also gives several arguments for not using a balloon, but rather a rocket, and the patents and later associated work concentrate on this concept.

In the past, the question has been raised as to how these two photos were taken on 26 April 1897.[10] The main reason for this is the relatively low viewing angle on the photos. The method to be used according to the patents would be with the camera hanging under a descending parachute, which means that the photos would be vertical (90° to ground) or close to this (if windy weather).

Three means to determine how the photos were taken have been used in this investigation:

- Analysis of the details on the photos.
- Review of important literature on the work of Alfred Nobel.
- The documentation in the Nobel Collection at Riksarkivet.

Analysis of the Photos

The character of the two photos, with the selection of an area with houses in the front and also further away, a very horizontal pointing, and the difference in focusing, leads to the conclusion that these photos might have been made to test the camera itself. Thus a more horizontal pointing was deliberately selected, viewing a desired area for later analysis of known objects. And this could only be done from a fixed position at an elevation above the terrain in the photos, without the launch and descent of the camera.

If the photos were taken from a descending parachute, this means that very strong winds must have prevailed at the time of the launches (resulting in a swing of up to some 60° from the vertical). And it is not very likely that a test of such expensive equipment would be done under such uncontrollable conditions. It is also to be noted that Nobel ruled out the use of balloons due to the strong wind sensitivity, thus the wind-gust problem was well taken into consideration during the design.

Furthermore, if such strong winds would swing the camera, it is extremely unlikely that, noting that an automatic shutter system was used, two different rocket launches would result in two "almost identical" pictures, both in angle and direction.

If the camera was rocket launched, it must also be assumed that another place would have been selected for safety reasons. That is an area without houses in the vicinity of where the rocket would impact and not the one pictured in the two photos.

Furthermore a photo taken from the assumed spot on Rävåskullen in the 1930s shows a similar viewing angle of a house also existent on photo Figure 11–11 from 1897.

Review of Literature on Nobel

Many biographies and overviews of the life, work, and achievements of Alfred Nobel have been published during the last century. The first major biography, published by the Nobel Foundation in 1926,[11] only lists the rocket camera and aerial mapping in a list of English patents. No mention is made whatsoever of the real activities for this invention.

The book by Ragnar Sohlman,[12] the personal assistant of Nobel and the person who handled and supervised all activities after the death of Nobel, only mentions the rocket camera and aerial mapping twice as examples of the diversification of Nobel's activities. No details whatsoever, except that this project was, soon after Nobel's death, terminated as "would not lead to practical and useful results." No photo was reproduced in this book.

In a later biography by Erik Bergengren, responsible for the Nobel Collection Archive at the Nobel Foundation for many years[13] and thus with an excellent knowledge of this material, only a reference to the idea of a rocket-borne camera is mentioned, referring to Nobel's letter to Sohlman.[14]

Sigvard Strandh, the former director of the Technical Museum (Tekniska Museet) in Stockholm, in 1983 published a biography[15] evaluating the work of Nobel, by putting it into a technical historical perspective. In this book, the rocket camera is not even mentioned at all. This despite the fact that Sigvard Strandh wrote in 1975 the text to a catalog for an exhibition of Nobel's technical achievements, in which the rocket camera is described.[16] But this earlier document merely makes the statement that the picture (Figure 11–11) is taken by a camera sent up with a rocket, but without any references or proof of fact.

Thus the review of these authors' work, where one would expect a deeper knowledge of the actual activities by Nobel, and at Björkborn, gives no information to prove a real use of rockets for taking these two photos.

The Nobel Collection at Riksarkivet

In the early 1970s, the author searched the Nobel Collection for information on the rocket camera and the contacts between Nobel and Unge. Also a brief

search was done by the Riksarkivet staff this year. These searches have not provided any further information, other than what is described above (the photos, letter, shutter drawings, et cetera). No information on how the testing was done in April 1897 has been revealed.

It is also to be noted that no description or drawing of a "camera" rocket has been found, nor has a rocket from such a test been preserved, like from other rocket tests of significant importance (see Figure 11–3).

Aerial Mapping

In the cause of the work on developing this idea of a rocket-borne camera, Nobel must have come to realize that military applications were limited, which is also noticeable from the wording in the final English patent. His camera was designed to take vertical pictures of the terrain from a descending parachute. But this is not very practical. The camera would probably land on the enemy side, if vertical photos were to be taken. For the military application a side-looking camera would be needed, which was not so precise for land survey.

But for aerial mapping the vertical picture is a perfect method, projecting the taken photo, with some known fixed points on a grid system. By this method, large areas could be covered. But using a rocket launch for each picture would require large logistics and might also be more expensive. But once airplanes came more frequently into use some 10 years later, the aerial mapping according to Nobel's idea became realistic and was later put into operational use.

Conclusions

The limited amount of documentation on the rocket camera invention and the aerial mapping idea and no definitive documentation on the actual picture-taking event on 26 April 1897 only permits a comparison of one alternative, rocket or no rocket, using circumstantial evidence.

The inventor of the original idea was Alfred Nobel, but the person responsible for the design, manufacturing, and testing of the rocket camera was probably one of two likely persons, Oscar Ljungström or Wilhelm T. Unge. If the drawings were actually made at Björkborn, as indicated on the two shutter drawings preserved, then Ljungström is the most likely person for the design. Unge, as the expert on rocket development, might have supported him in this respect.

The critical issue, under which circumstances the two preserved rocket-camera photos were taken, cannot be answered with absolute certainty. No written documentation has been found giving an absolute clarification.

In the past it has merely been assumed that photos by a rocket camera must have been taken using a rocket. Clearly the photos are taken from "above" the ground. But now the exact location for taking these photos is known, and it is a hill. Taking the facts on the low vertical viewing angle, different focusing, and an almost identical aerial view altogether into consideration, it is very likely that the two photos were taken statically mounted from the top of Rävåsen. The landscape would have permitted such photos. The camera could only take one picture at a time and thus two rocket launches would have been necessary. But with such strong winds, causing the low vertical angle, it is not likely that the view on the two photos would have been so identical. Furthermore from the safety point of view, it is questionable if a rocket could be launched over the buildings in the front. But final proof is still to be found.

Nobel's idea on aerial mapping, as described in his two patents, is correct, but was premature for his time. Aircraft were not invented, and the rocket concept was in the end not practical. But years later the principle idea turned to be correct using aircraft, modern camera technology, and reel film.

After the death of Alfred Nobel, the work on the rocket camera was stopped by mid-1897, and also on many other projects at Björkborn. No activities have been documented after the two photos were taken in April 1897.

The conclusions on who actually designed the rocket camera and took the two photos, and the exact circumstances when the photos were taken are given by circumstantial evidence. No final documentation has been found so far that leaves no doubt as for the one or the other of the alternatives. But it cannot be totally excluded that such evidence might still be buried in some old documentation in an archive, still to be recovered.

Acknowledgements

The author would like to thank the many people who have helped in providing historical material and analysis of such material, which led to the conclusions made in this chapter.

The Nobel Museum in Stockholm: Olov Amelin, Senior Curator, and Susan Ronvall, for material from and information on the Nobel Collection. The Nobel Museum in Björkborn: Elisabeth Röckert, Chief Curator, for material on the rocket camera specimens. Karlskoga Hembygdsförening: Karin Öman for information on locations of buildings and land survey maps of the area.

Rolf Lindelöf, former head of the Bofors Air Defence Missile Systems, has also worked for the Nobel Museum in Björkborn. He is former president of Nobelmuseets Vänner (Nobel Museum Björkborn supporting society) in Karlskoga and a scholar on Alfred Nobel and his achievements. Rolf Lindelöf has provided information on the local area of Karlskoga, contacts to the many archives with material from Alfred Nobel, and valuable analysis of the rocket camera photos and their possible origins.

Last, but not least, Frank H. Winter, former Curator, Rocketry, National Air and Space Museum, Washington, DC, for a discussion over the past 40 years on the topics of rocket-borne cameras and their inventors.

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