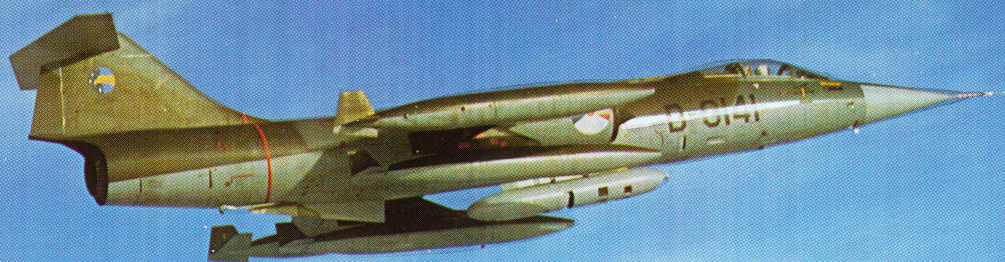




# ORPHEUS

the advanced day and night aerial reconnaissance system



# ORPHEUS for day and night aerial



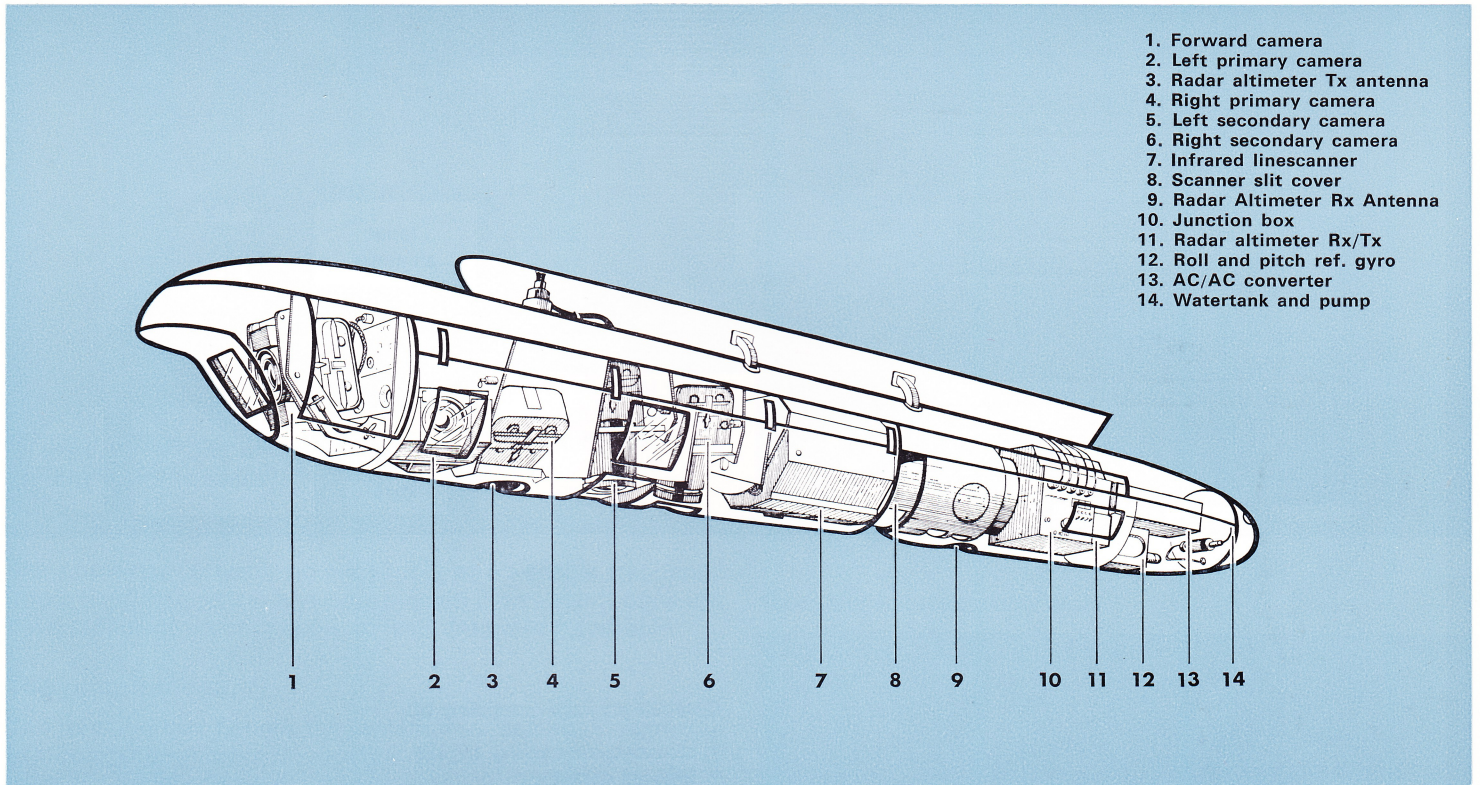
## Introduction

The N.V. Optische Industrie "de Oude Delft" has developed an advanced day and night aerial reconnaissance system for tactical purposes, housed in an external pod. The size and shape of the pod is of such dimensions that it can be fitted under any type of modern aircraft.

The system has been designed to provide aerial reconnaissance during night and day at low and medium altitudes by high performance aircraft. Reconnaissance is achieved by means of a far-infrared linescanner with a 120 degrees scan angle and five aerial cameras providing horizon-to-horizon coverage and forward-looking capability.

Because of the autonomous character of the Orpheus pod concept, it is possible to remove the pod rapidly as a flightline operation, so as to use the same reconnaissance aircraft for a strike role, which is considered to be very combat effective. In the design emphasis has been laid on a high degree of automation with a minimum of controls, operation in a military environment and easy handling and maintenance.

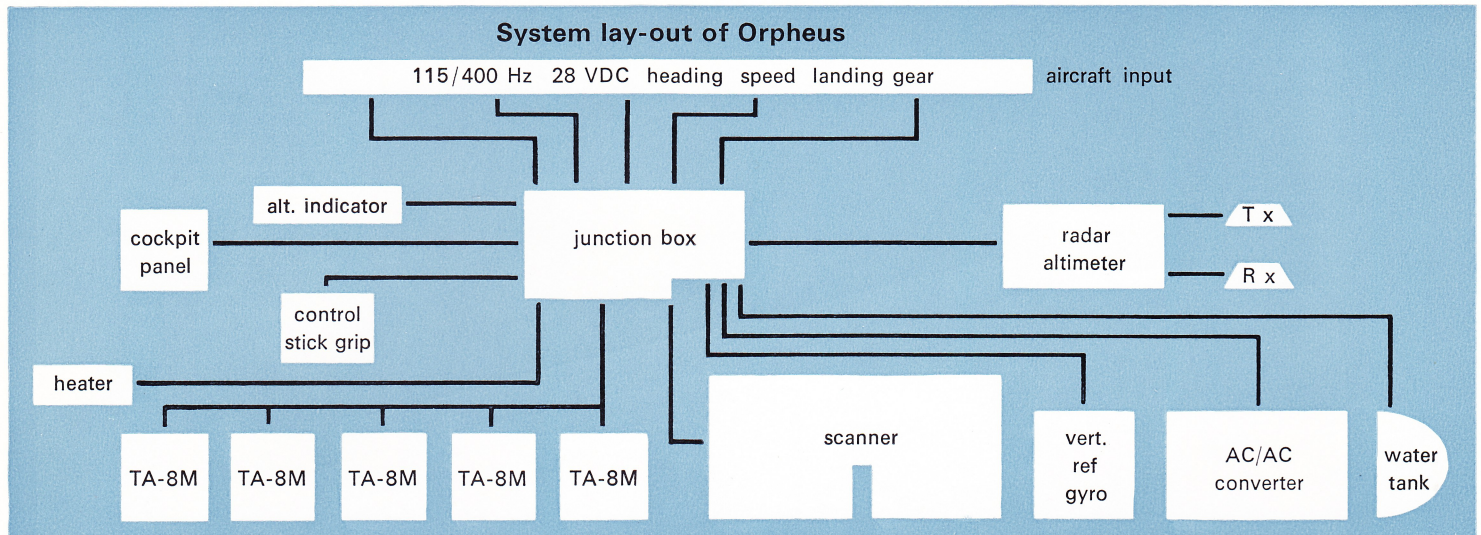
# reconnaissance missions



▼ Pod with closed window covers



# General description of the ORPHEUS system



Detector package consisting of:

- closed-cycle cooling engine
- infrared detector
- preamplifier
- detector-temperature sensor
- elapsed time indicator

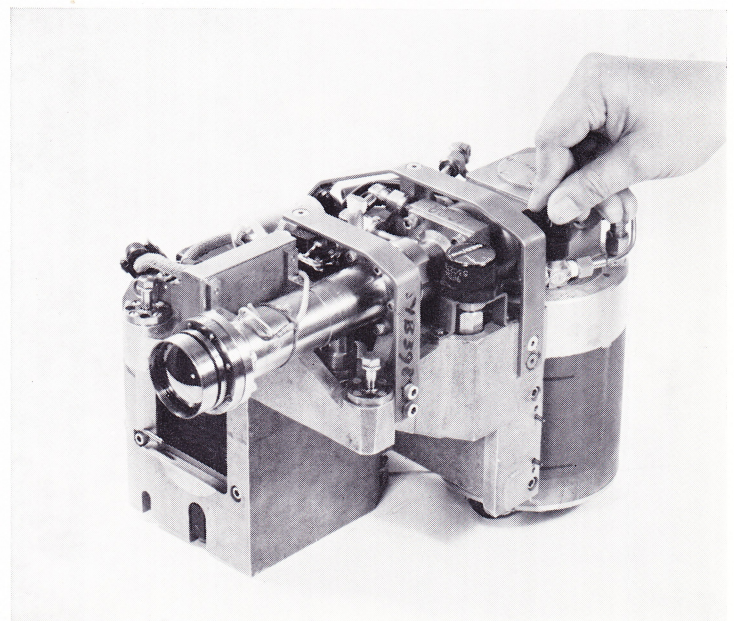
**The Orpheus system consists of the following main components:**

## The pod

The pod has been derived from the BLU1-C/B. It has a length of 3.75 metres and has a cylindrical shape with a diameter of maximum 472 mm.

The pod is connected to the 19 inch centre-line bombrack. The only other connection to the aircraft consists of an electrical cable connector. In the body of the pod servo-operated covers are provided to protect the camera windows and the scanner slit. They are opened when the camera and the scanner are switched into the STAND BY position and automatically closed during take-off and landing by interlock with the landing gear.

The pod is equipped with an airconditioning system to keep the incoming air temperature at a level acceptable to the various components under all ambient conditions. The pod is designed to be flown at subsonic and supersonic speeds and can be jettisoned in case of an emergency.



Close-up of part of reconnaissance pod with access doors ajar. The TA-8M aerial cameras are clearly visible

### Five TA-8M aerial cameras

One forward-viewing and two lateral-viewing cameras are mounted in a fixed position. Two more lateral-viewing cameras can be placed in split-vertical or high-oblique positions for the use of objectives with different focal lengths and to satisfy operational requirements. The cameras are mounted in a rack which is roll-damped.

### The infrared linescanner

The infrared linescanner is roll-stabilized in three adjustable oblique positions, vertical, right or left (typical 25°) for both slow roll and fast turbulence induced roll motion. The roll-stabilization system is referenced to an external vertical gyro, housed in the pod. The infrared linescanner is equipped with an interchangeable detector package. The replacement is a flightline operation and requires no adjustment.

### The static frequency converter

The converter converts power supply of a variable frequency into a fixed frequency. It is only needed if an aircraft does not have sufficient power supply of fixed frequency available.

### The junction box

The junction box houses the system interface equipment, the v/h computer and the connection to the external test equipment for automatic preflight tests.

### The radar altimeter

To provide altitude to the v/h computer. The altimeter can be left out if already installed in the aircraft.

### The cockpit control panel

For control of the system operation and for system status-monitoring, including failure indications.

### The trigger switch

Located on the pilot's control stick grip and to initiate the operation of the cameras and the infrared linescanner. All other controls are set during starting up.

The system components are easily accessible through access doors and inspection covers and can be rapidly replaced due to the modular design concept. The film magazines are easily interchangeable and have no electrical connection.

The system includes automatic adjustment of camera frame rates and scanner film transport speed according to the aircraft velocity-to-altitude ratio (v/h). The automatic adjustment may be overrun by manual control.

The cameras and the infrared linescanner are operated either simultaneously or separately.



Example of a cockpit control panel



## Infrared radiation and detection

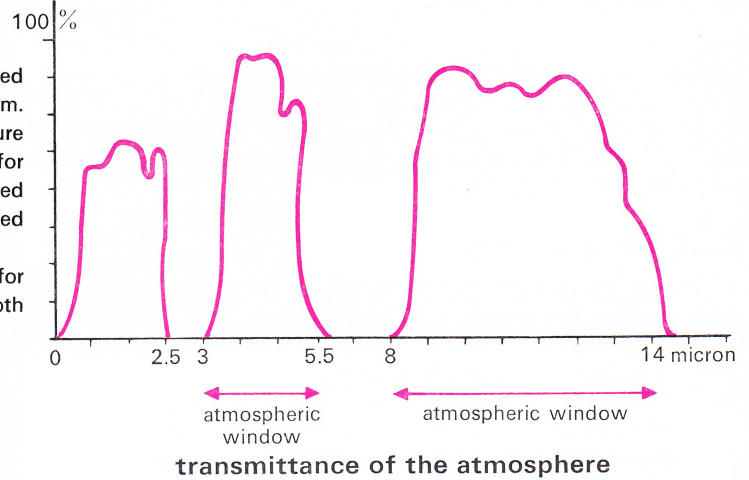
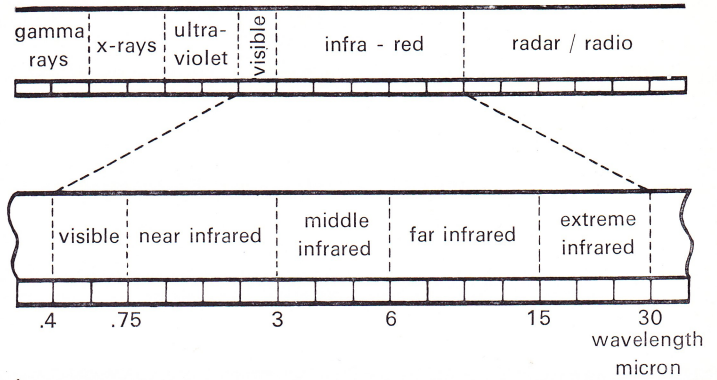
The electro-magnetic spectrum is divided into several bands. The infrared region extends from about  $0.75 \mu$  to  $1000 \mu$  and is subdivided into the near, middle, far- and extreme-infrared. Each portion of the infrared region has its specific properties.

The far-infrared region is the specific region of interest for passive infrared reconnaissance systems. It derives its practical use from the fact that objects at ambient temperature emit a maximum of thermal energy in this spectral range. This energy can be detected during day as well as during night, provided use is made of sensitive and fast infrared detectors which are cooled to low temperatures. Thus any target that differs in temperature from its surroundings or has a different emissivity, can be detected by far-infrared techniques, even when camouflaged. Even the thermal shadows which remain after an object has been removed will show up.

Due to the atmospheric absorption not all wavelengths can be used but only the so-called atmospheric windows as shown in the diagram. The maximum transmission under the normal ambient temperature conditions will occur in the  $8-14 \mu$  window. Sensitive detectors for this range are available. Another infrared window in the middle infrared region, i.e. between  $3-5.5 \mu$  can be used with a somewhat reduced performance.

The design of the Old Delft scanner has therefore been optimized for use in the  $8-14 \mu$  window. However, detector packages for both ranges are available.

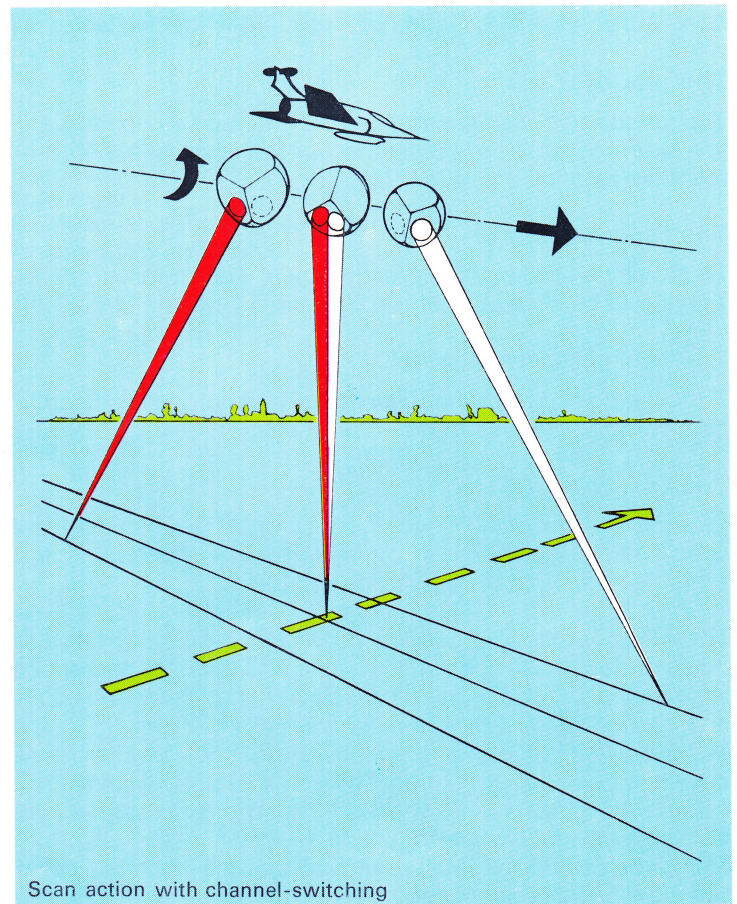
## The electromagnetic spectrum



## THE INFRARED LINESCANNER\*

### Description of the scan action

The mapping with the linescan technique originates from the one-dimensional movement of the scanning device in the aircraft, while for the second dimension use is made of the forward motion of the aircraft. Scanning is achieved by rotating a three-sided pyramid-shaped mirror giving three scans per revolution. The incoming radiation is then directed to the infrared detector. By using two optical channels A and B alternately, the infrared detector never looks into the relatively hot interior of the scanner and a high scan rate is obtained with no dead-time between the successive scans.



## Signal processing and recording

The infrared detector generates an electrical signal which is amplified, processed and converted into a beam of modulated visible light, and then recorded on photographic film. The film transport speed varies with the v/h ratio. Much effort has been put into obtaining an image that satisfies both readability and resolution in flight direction. To achieve this, the width of the recording lines on the film varies proportional to the filmspeed with a unique variable slit length adaptation in the recorder head, thus resulting in a contiguous recording. On the film relevant flight data are recorded.

## Main characteristics of the standard Old Delft infrared linescanner

A scan rate of 600 scans per second.

A scan angle of 120° perpendicular to the flight path.

An angular resolution of 2 mrad.

A thermal resolution of 0.15° C.

Easily exchangeable detector packages in the 8-14  $\mu$  or 3-5.5  $\mu$  spectral region; the incorporated closed cycle cooler requires no refill between maintenance periods.

Variable slitlength adaptation for optimum display.

Recording on standard photographic 70 mm perforated film.

Note: The film transport speed will be varied according to v/h. The v/h ratio is still classified.

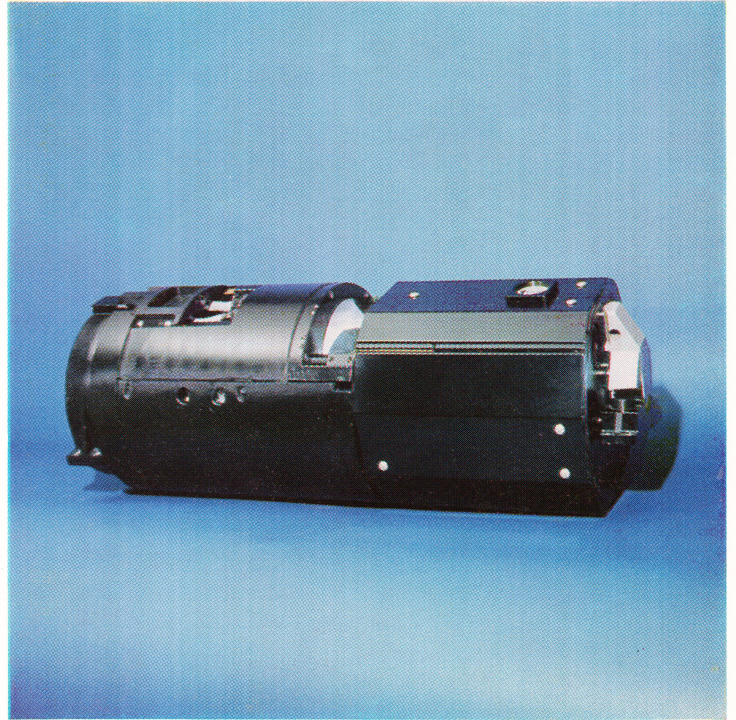
Power requirement: less than 2.7 KVA.

Weight: 85 kg.

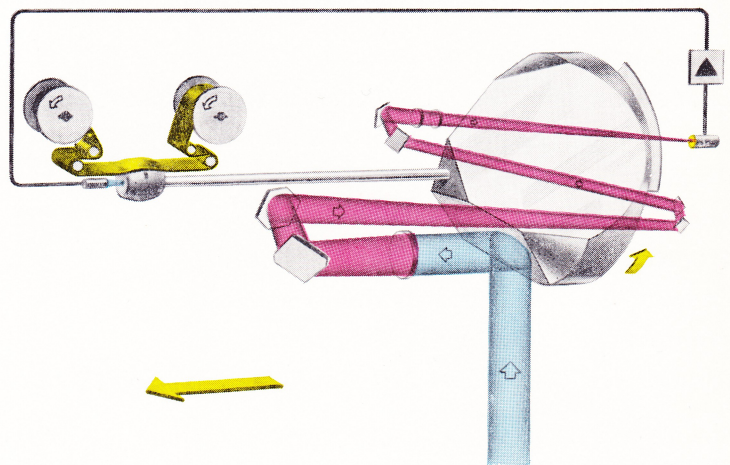
Dimensions: length: 90 cm  
width: 35 cm  
shape: cylindrical.

The Old Delft far-infrared linescanner is not limited to a system housed in a pod but can also be built directly into an aircraft and used as an autonomous system.

The scanner parameters, such as scan rate and resolution, may be varied within limits depending on the type of application.



Old Delft far-infrared linescanner. Note the scanner slit with the 3-sided mirror partly visible



Optical path of the IR-radiation inside the scanner

# TA-8M aerial camera system

## Camera description

The TA-8M is a further development of the well-known TA-7M camera, now in use with several airforces. The camera has been designed for tactical aerial reconnaissance at low and medium altitudes and high velocities. Each camera consists of a camera body and a film magazine and it can be equipped with a variety of interchangeable objectives with removable minus-blue filters. Typical data of these lenses are specified in table 1.

The camera is equipped with a double rotary disc focal plane shutter. The shutter speed is coupled to the frame rate.

The diaphragm control is based on measuring the incoming light inside the camera with a light sensor. In this way no adjustment is required after the change of lenses or filters. The diaphragm control will be preset for a range of film sensitivities. The film transport is continuous for image motion compensation. The frame rate can be varied by a factor of 20 under automatic or manual control. The space between consecutive exposures is used for the recording of relevant flight data. The TA-8M camera can be supplied in various configurations to optimally suit the operational requirements in terms of v/h range, angle of depression and minimum light level.

## Deltamar objectives

Optical data of some selected Deltamar lenses.

TABLE 1:

<i>Focal length</i>	<i>Relative aperture</i>	<i>Field of view</i>
52 mm	f/2.7	56.5°
70 mm	f/1.6	44.4°
100 mm	f/1.4	31.5°
150 mm	f/2.8	21.0°

## Main parameters of the TA-8M aerial camera

Frame rate typical 0.25–5 fps or 0.5–10 fps.

Exposure times from 1/180 second to 1/6000 second.

Film: standard 70 mm perforated film.

Frame size 57 x 57 mm.

Film sensitivity 100–800 ASA.

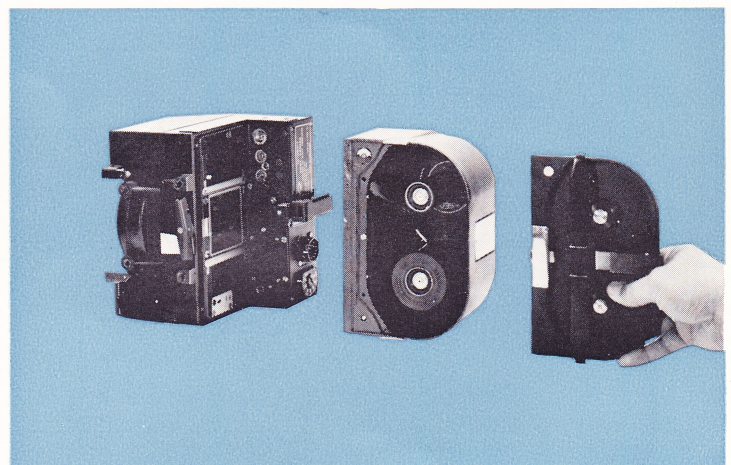
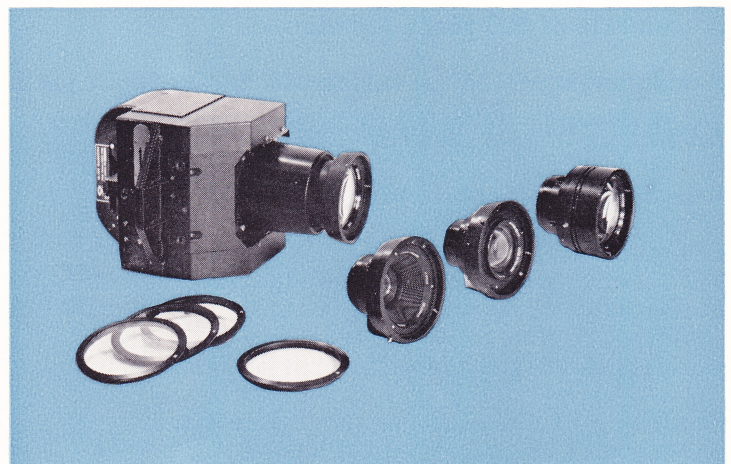
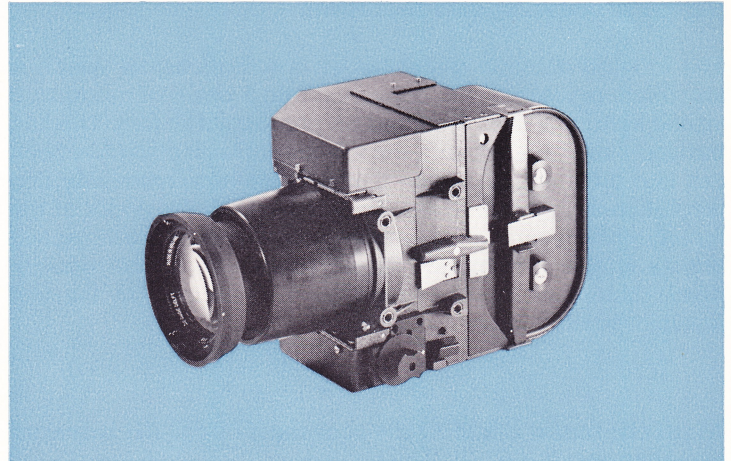
Magazine capacity 100 ft normal base.

Power requirements: less than 150 W.

Weight: 6 kg with loaded magazine.

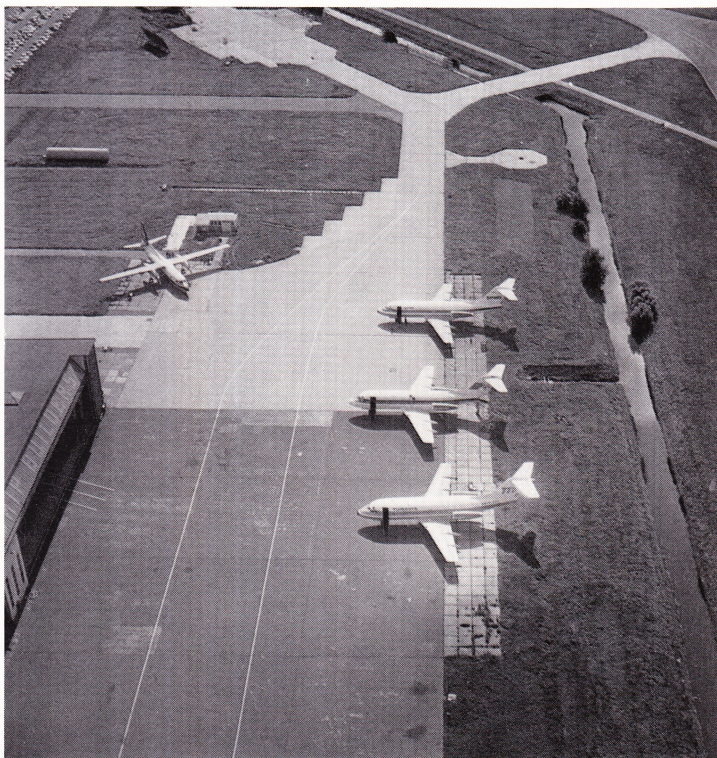
Dimensions 190 x 200 x 220 mm, excluding objectives.

The TA-8M camera is of a compact construction and of a relatively simple design, yet incorporating all features for modern aerial photography. It is easy to maintain and fitted for adaptation in several types of aircraft.

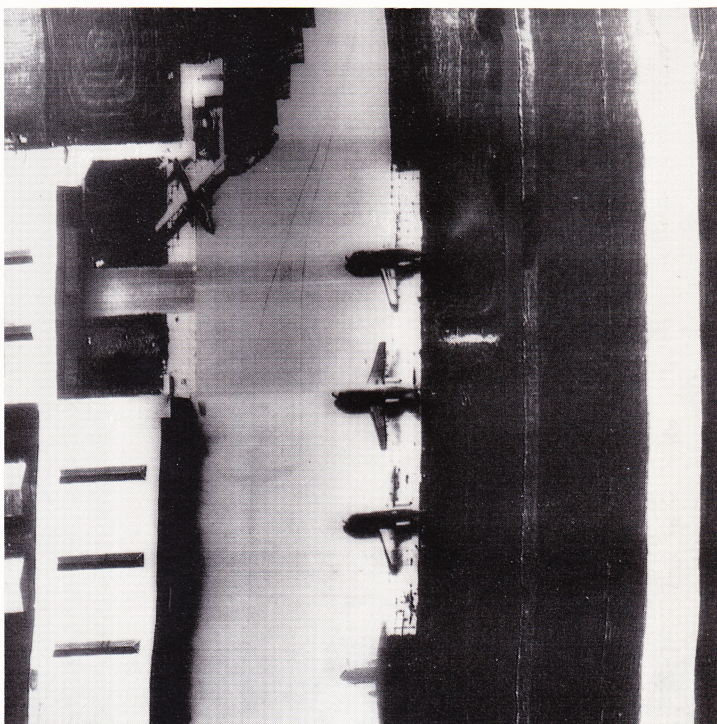


The TA-8M aerial camera with film magazine and various Deltamar objectives

*The utmost care has been taken to secure the best possible reproduction of the thermal pictures. Only the original negatives however, do justice to the actual definition.*



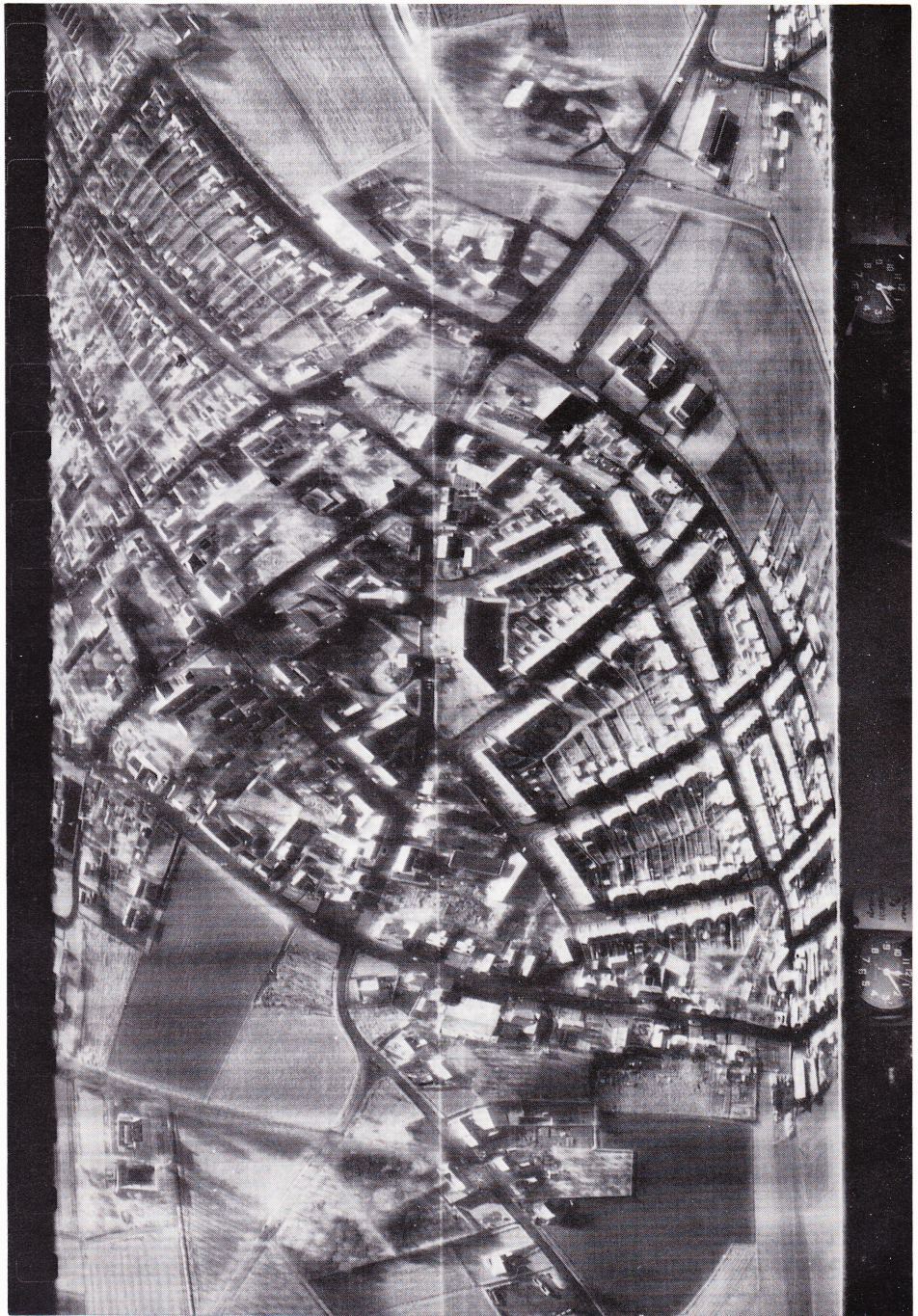
Picture taken with the forward TA-8M camera

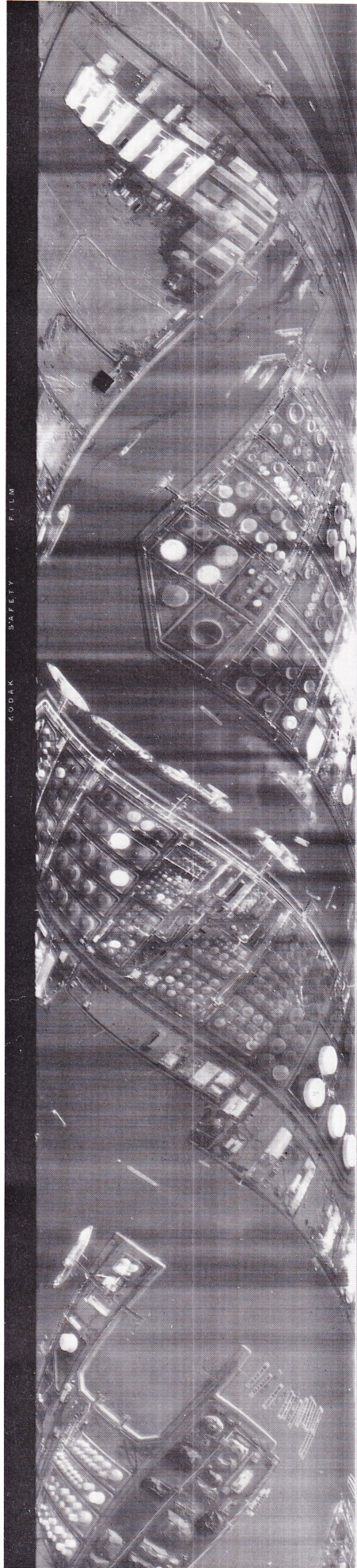


Same picture taken with the far-infrared linescanner. Note the two thermal shadows of aircraft which already left.



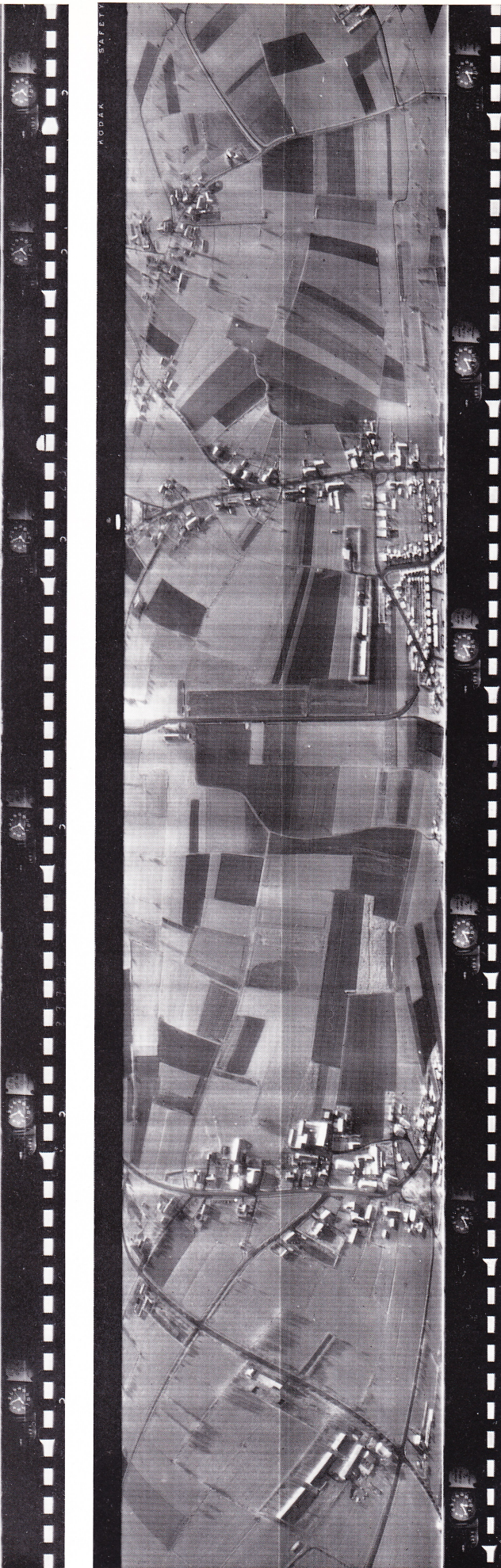
Contact print with enlargement  
Target: village  
Altitude: 1,000 feet, descending  
Ground speed 400 knots  
v/h automatic

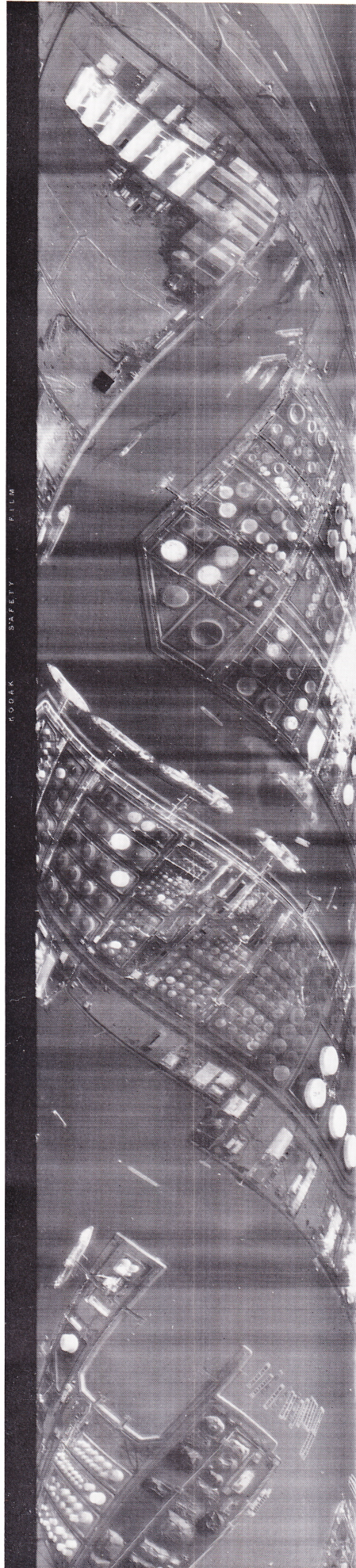




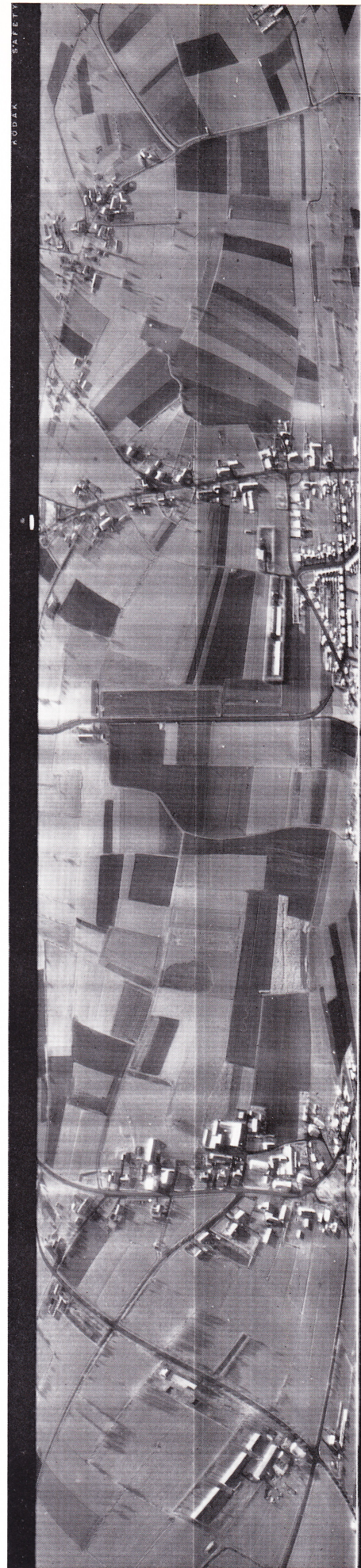
Contact print  
Target: Europoort  
Altitude: 1,000 feet  
Ground speed 420 knots  
v/h automatic  
The places of activity are clearly shown

Contact print  
Target: pasture  
Altitude: 1,200 feet  
Ground speed 420 knots  
v/h automatic





KODAK SAFETY FILM



Contact print  
Target: Europoort  
Altitude: 1,000 feet  
Ground speed 420 knots  
v/h automatic  
The places of activity are clearly shown

Contact print  
Target: pasture  
Altitude: 1,200 feet  
Ground speed 420 knots  
v/h automatic



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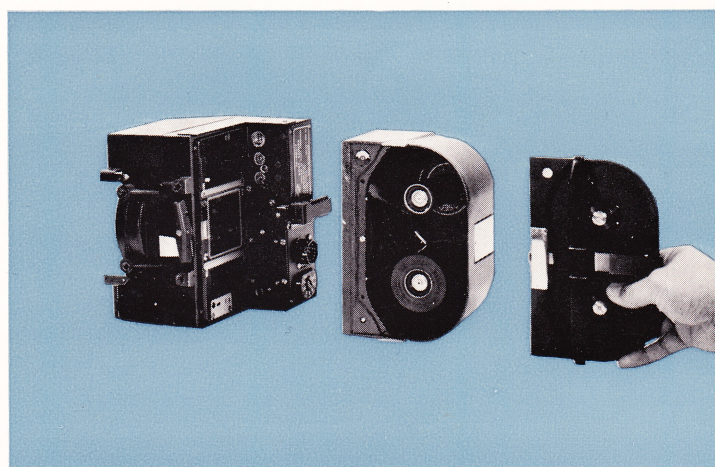
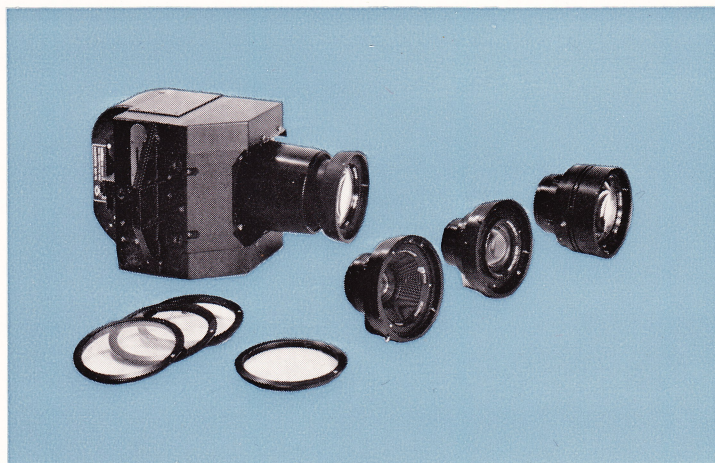
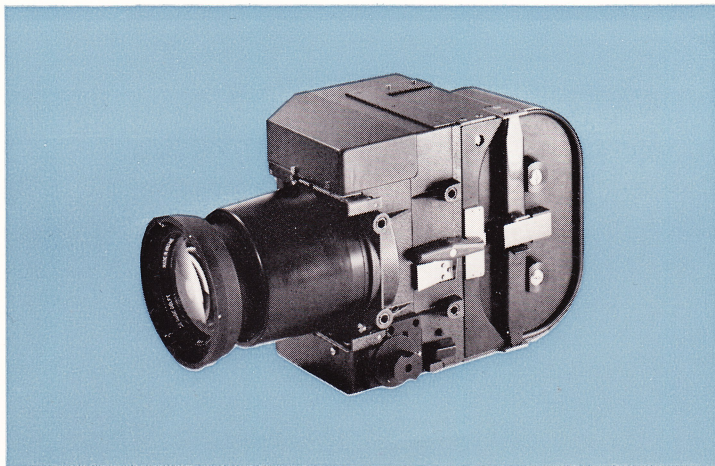
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# TA-8M aerial camera

The TA-8M camera is the latest development of the well-known Old Delft aerial cameras, specially designed for tactical aerial reconnaissance at low and medium altitudes and high velocities. It can be equipped with a variety of interchangeable objectives with removable minus-blue filters. Typical data of these lenses are specified below.

The camera features automatic diaphragm control. The film transport is continuous for image motion compensation. The frame rate can be varied by a factor of 20 under automatic or manual control. Recording of relevant flightdata is incorporated.

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## Optical data of some selected Deltamar lenses

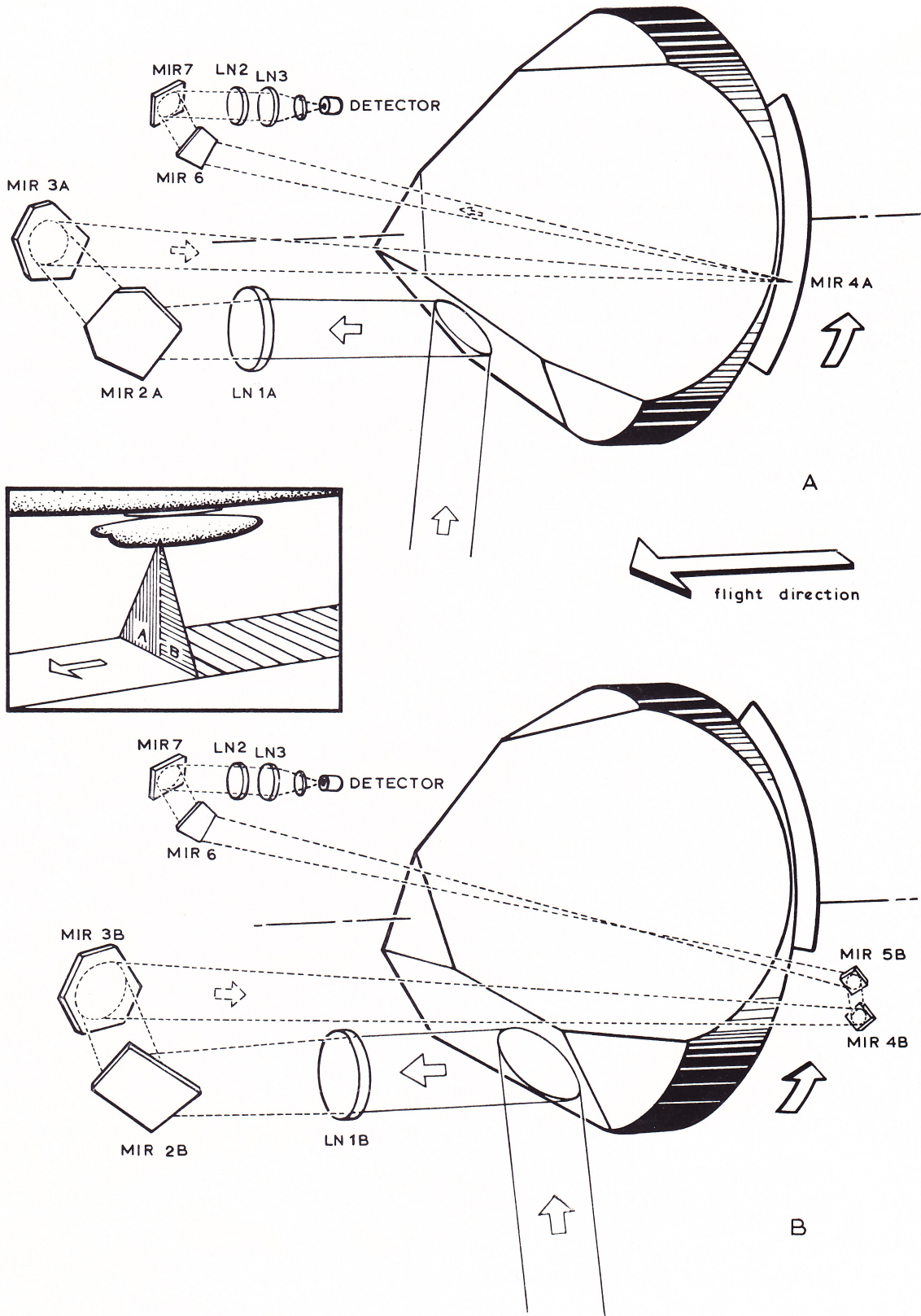
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## Main parameters of the TA-8M aerial camera

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- Exposure times from 1/180 second to 1/6000 second
- Film: standard 70 mm perforated
- Frame size 57 x 57 mm
- Film sensitivity 100-800 ASA
- Magazine capacity 100 ft normal base
- Power requirement less than 150W
- Weight 6 kg with loaded magazine



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The Old Delft Infrared Linescanner uses a unique scan system which has no deadtime between consecutive scans. The infrared detector receives ground radiation alternately via two different optical channels.