Zeiss **RMK**

Aerial Survey Cameras and Accessories

for Aerial Photogrammetry and Interpretation

Infracolor

Infra

Color

Pan

ZEISS

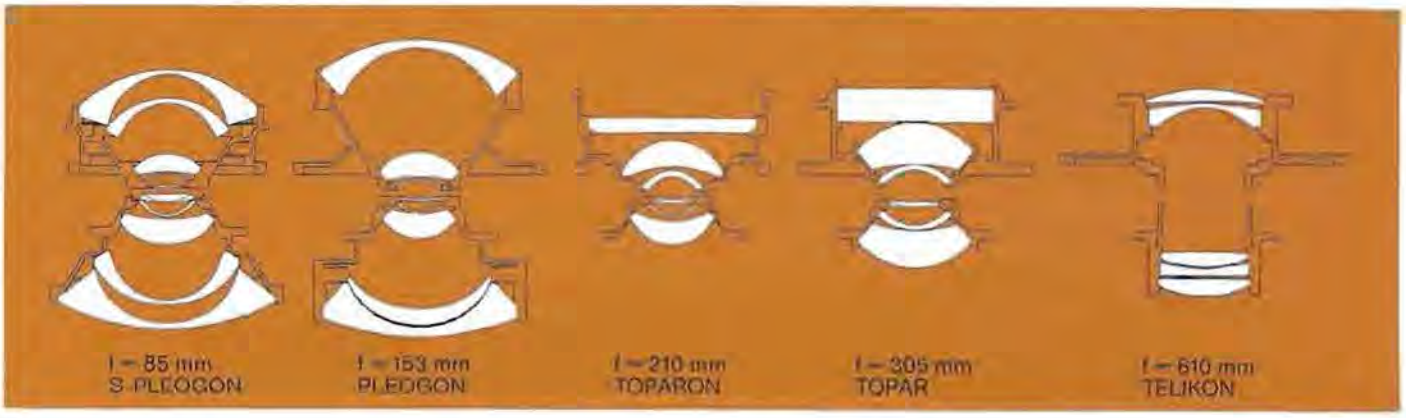
West Germany

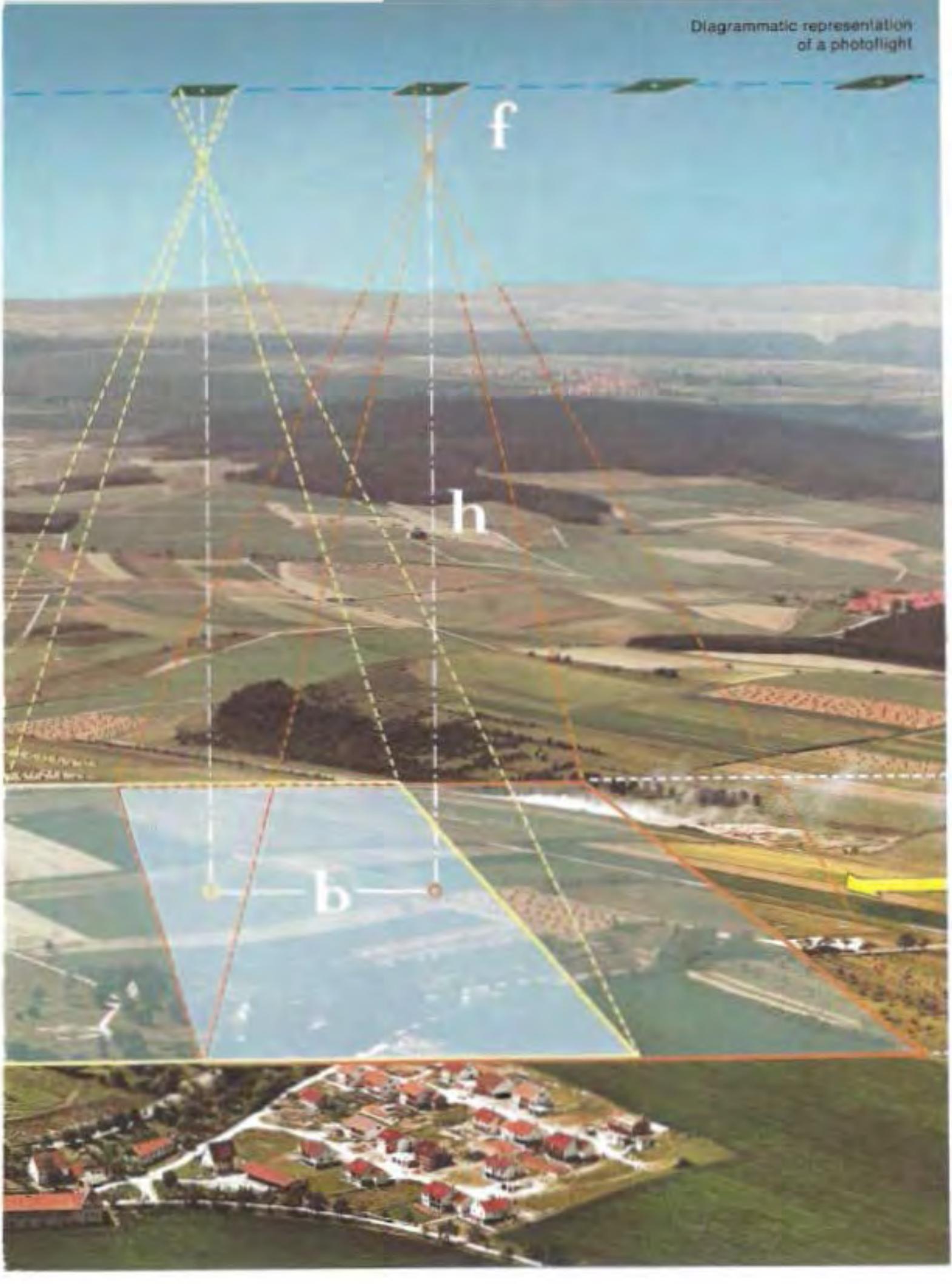
Aerial Survey Cameras

Zeiss aerial survey cameras for the standard negative size of 23 cm x 23 cm (9" x 9")

Designation	Type	Lens	Aperture (f-stops)	Angular field 2 α diagonal (lateral)	Max. nominal distortion	Principal uses
RMK A 8.5/23	**125°super wide-angle camera**	S-Pleogon A 3⅓" (85 mm)	f/4 f/5.6 f/8	125° (107°)	7 µm	**Large-area photographic coverage** for small scale mapping, above all with low-ceiling aircraft; special-purpose flights below cloud cover.
RMK A 15/23	**Standard wide-angle camera**	Pleogon A 6" (153 mm)	f/4 f/5.6 f/8 f/11	93° (74°)	3 µm	**General work,** i.e. aerotriangulation, topographic and large-scale mapping.
RMK A 21/23	**Intermediate angle camera**	Toparon A 8¼" (210 mm)	f/5.6 f/8 f/11	75° (57°	4 µm	**Aerial photo maps and mapping** if normal-angle camera cannot be used, e.g. because available plotters are unsuitable for handling 12" (305 mm) focal length.
RMK A 30/23	**Standard normal-angle camera**	Topar A 12" (305 mm)	f/5.6 f/8 f/11	56° (41°)	3 µm	**Aerial mosaics, orthophoto maps, first-order mapping and base maps for urban areas** (reduction of dead spaces!)
RMK A 60/23	**Narrow-angle-camera**	Telikon A 24" (610 mm)	f/6.3 f/9 f/12.5	30° (21°)	50 µm	**Special purposes:** a) high-altitude photography; b) city surveys; c) 1:250 or 1:500 scale flights, to reach permissible flying heights; d) aerial mosaics and orthophoto maps of urban areas with high-rise buildings.

Inquiries are invited for **reseau cameras.** The grid plate which in these cameras is mounted in front of the focal plane not only serves to detect film deformation but will also reveal any deviation of the film from a true plane at the instant of exposure.





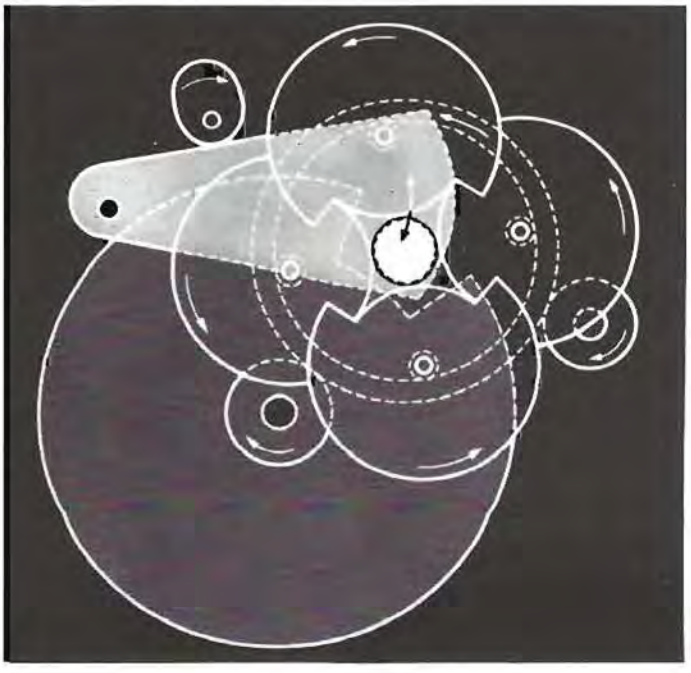
Diagrammatic representation
of a photoflight

1 Auxiliary flight data
2 Digital auxiliary flight data (DAS Data Annotation System)
3 Shutter open
4 Shutter closed

1

2

3



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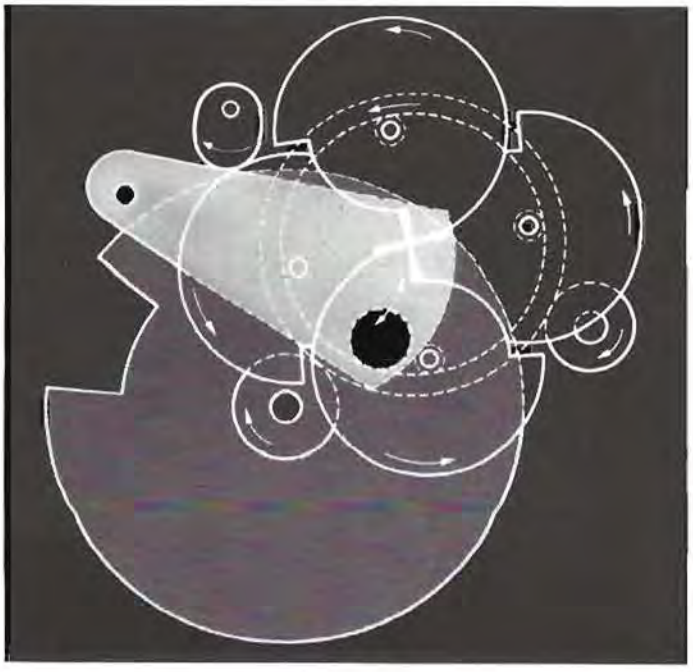


Filters:
Filters for aerial photography serve two purposes:

- Spectral filtration
to reduce the effect of atmospheric haze or to cut out unwanted radiation and allow only specific wavelenghts, such as infrared, to pass.
- Compensation of light fall-off
in wide-angle lenses with the aid of a more or less neutral anti-vignetting coating applied to the filter glass.

All filters have metrical characteristics and satisfy the highest demands regarding plane parallelism and flatness.
Non-interchangeable filter mounts for the different lens types.
Simple change of filters even while in the air, due to rapid locking feature.

The **anti-vignetting coating** to compensate for the light fall-off of lenses also counteracts the tendency to color distortion towards the edges in color aerial photography. Anti-vignetting coatings are identified by their transmittance in the center of the filter:

Lens-type	S-Pleogon	Pleogon	Toparon
Filter	22%	60%	60%

Filters with other anti-vignetting coatings for optimum adaptation to the photographic conditions can be supplied on request.

The following **filter glasses** are available:

Filter	Cut-off wavelength	Comparable to Wratten
KL	Clear glass	–
A1	415 nm	HF-3 (2B)
A2	425 nm	HF-3/HF-4
A3	435 nm	2E
A	460 nm	3
B	490 nm	8
C	525 nm	15
D	535 nm	16
F	600 nm	25
H	635 nm	29
J	670 nm	70
L	720 nm	89 B

The cut-off wavelength stands for 50% internal transmittance. Inquiries for other types of filter are invited.

Sandwich filters (identified by an additional -F, e.g. KL-F) consist of a clear-glass plate with anti-vignetting coating to suit the lens type and photographic conditions and a second plane-parallel plate in the form of one of the aforementioned filter glasses. These filters can be used to combine a graded-density filter with various filter glasses or to insert a gelatine filter. However, commercial gelatine filters are extremely sensitive to humidity. They should therefore be used only for very specific purposes, for instance as conversion filters for a certain color reversal emulsion.

Standard equipment includes the filters KL, B and D and covers the most frequent applications:

KL – Color film.
- Black-and-white panchromatic film and favorable atmospheric conditions (good visibility, low altitude).

B – Black-and-white panchromatic film and average atmospheric conditions, to enhance image contrast

D – Black-and-white panchromatic film in unfavorable atmospheric conditions, to enhance image contrast.
- Infrared film (black-and-white and false-color), to cut off short-wave radiation.

Special infrared filters (H or L for black-and-white and C-F for false-color film) can in many cases be dispensed with.

= Standard equipment with RMK A 15/23

= Control variants

= Interchangeable components

NA CON

S 2c

NA

CCON/NM

DAS

RMK A 60/23

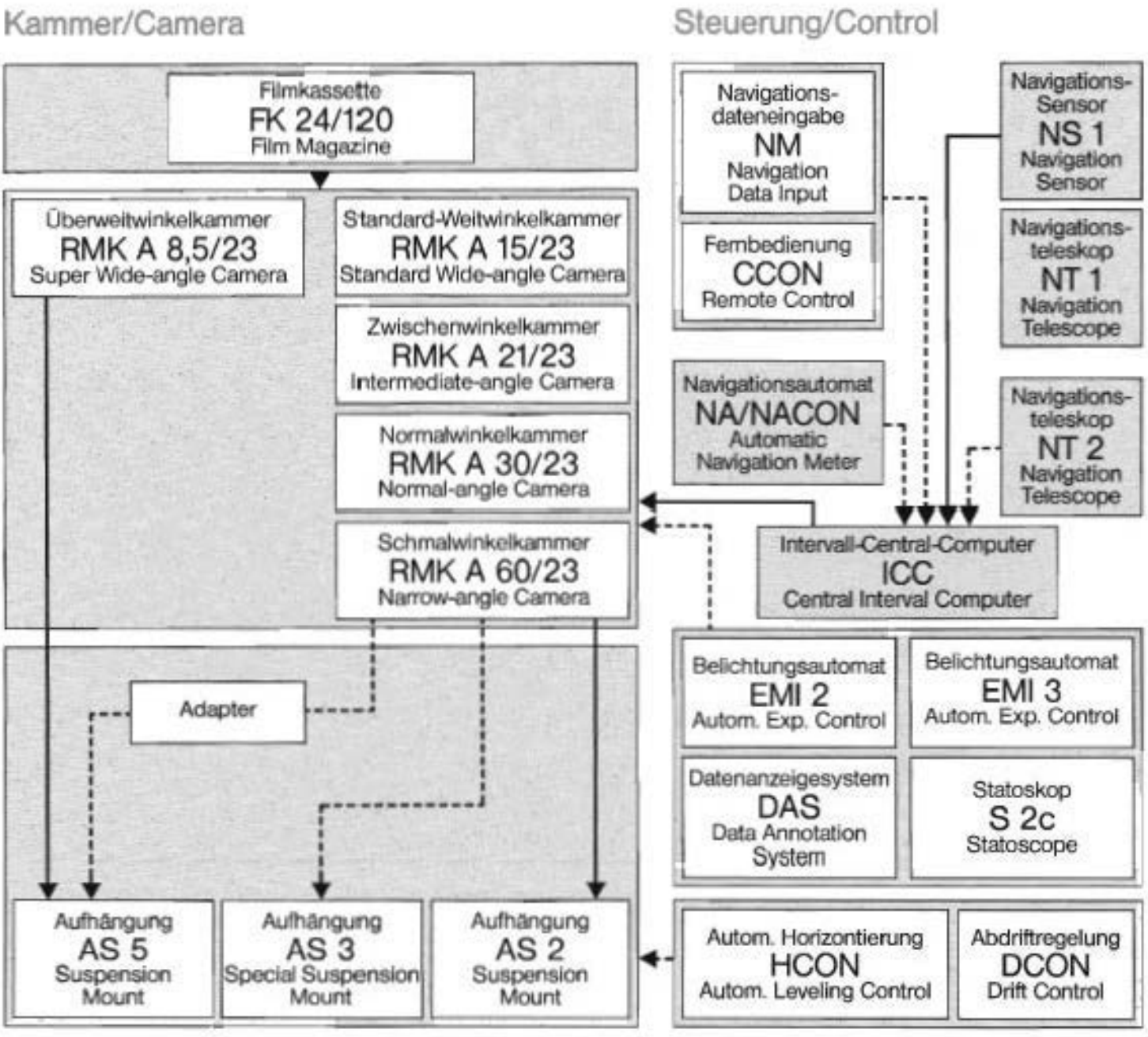
RMK A 8,5/23

EMI 3

AS 5 + Adapt + DCON/HCON

AS 5

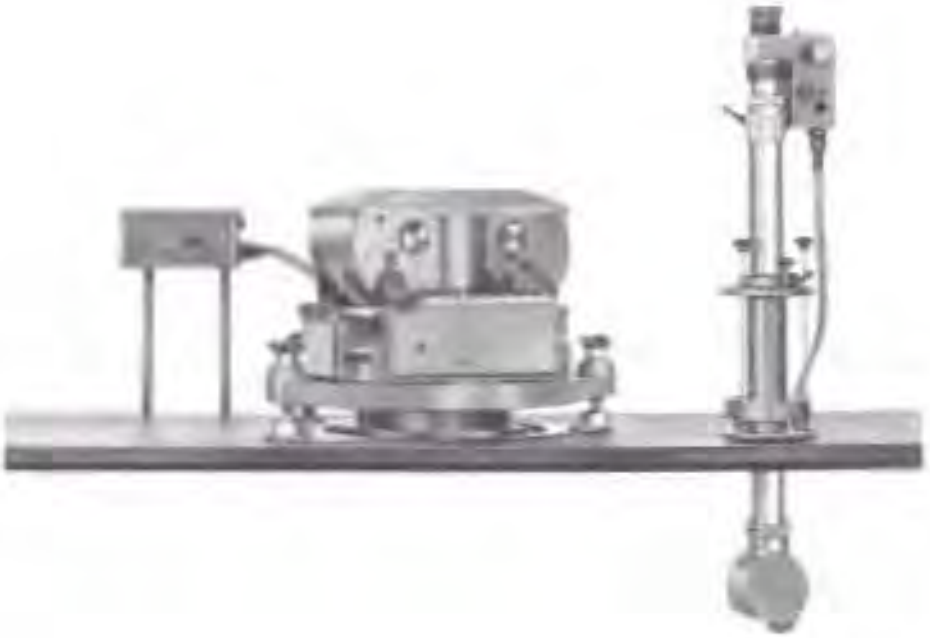
AS 5 + DCON/HCON



Examples of practical use of RMK System of Interchangeable Camera Bodies

Photoflight with a crew of three
Navigation: NT-1. Camera control: ICC + NS-1.
Camera: RMK A 30/23 in AS-5 + adapter (with extension knobs for leveling in the case of deep ports), tilted back for exchange of filter.

Photoflight with a crew of two
(minimum equipment)
Navigation and camera control: ICC + NT-2.
Camera: RMK A 8.5/23 in AS-5.



Photoflight with a crew of two
(standard equipment)
Navigation and camera control: ICC + NT-2 with DCON.
Camera: RMK A 15/23 with EMI-2 and Fi, in AS-2 with DCON/HCON.

Pilot-only flights
Here, the camera is totally remote-controlled and its operation monitored from the pilot's seat with the aid of the **FS-2 Remote Control.** The entire camera assembly is prepared for operation before take-off. As the beginning of the flight strip is reached, the pilot will only flip the master switch, whereupon the exposure cycle is automatically controlled in accordance with the preset values.
If control by preset data is impossible, the **NA Automatic Navigation Meter** may be used as an additional component. In this case, the navigation data (v/h-value and drift) are measured automatically.

Photoflights with a well-trained **crew of three** undoubtedly are the best approach to perfect photography of large areas. A three-man crew considerably reduces the risk of reflights and largely avoids the loss of signalized points, mismatches in the sheet layout, etc. Based on a large number of test flights we therefore recommend crews of three as a basic configuration. However, using the aforementioned, slightly enlarged equipment will also create favorable conditions for economical and precise photoflights with a **crew of two.**

The following is a summary of the characteristic features of the different components that can be used in conjunction with our aerial cameras.

Zeiss RMK A 8.5/23
and RMK A 15/23
aerial survey cameras
installed in the aircraft

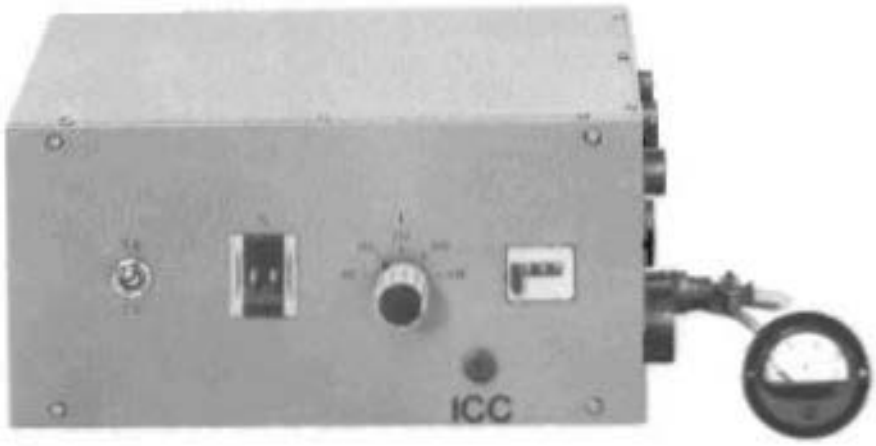
RMK Aerial Survey Cameras-Accessories

ICC Central Interval Computer

Principal features
Central control unit for aerial survey cameras of the standard 23 cm x 23 cm (9" x 9") negative size.

Purpose
Digital computer for determining RMK exposure intervals. Tripping and monitoring of camera according to the computed data. Central link between the camera and its accessories, also suited for simultaneous control of several cameras of identical or different focal length.

Settings
Camera focal lengths of 85, 153, 210, 305 and 610 mm;
overlap in increments of 1% from 0 to 99%;
switch for reduction of minimum exposure interval from 3 sec. to 2 sec. (possible only at shutter speeds faster than $^1/_{300}$ sec. or $^1/_{150}$ sec. in the case of RMK A 8.5/23).

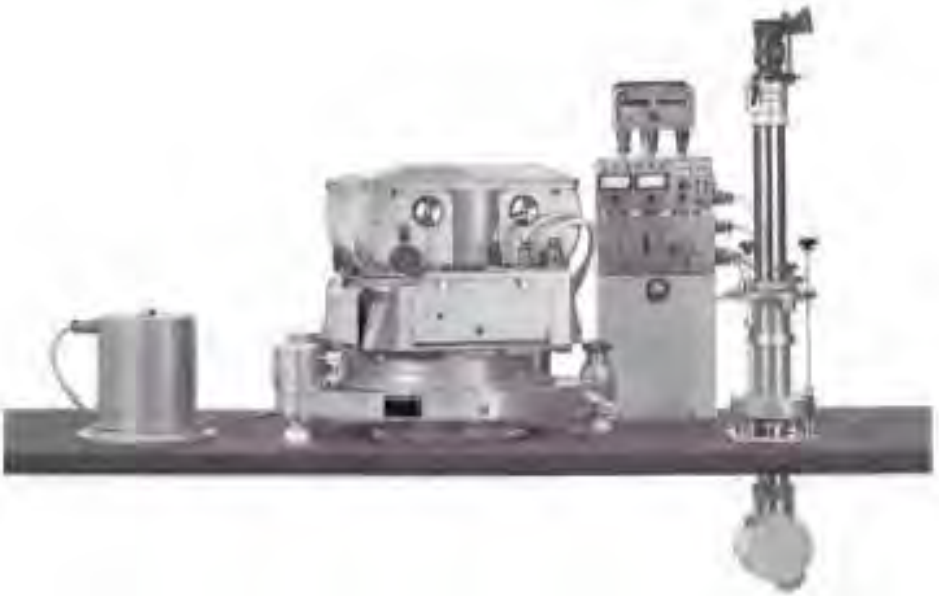


Data imput
from navigation instrument:
v/h-signal,
drift signal (with DCON Drift Control).

Display
Three-digit exposure counter with zero-setting feature; cockpit monitor for continuous indication of imminent exposure instant (to avoid course corrections at the instant of exposure);
signal lamp for power supply of RMK system.

Electrical connectors
aerial camera,
navigation instrument
(NS-1, NT-2, NM),
proximity-to-exposure indicator,
additional ICC unit (for series connection of several ICCs in the case of multi-camera operation),
CCON Remote Control,
S-2c Recording Statoscope.

Photoflight with a crew of two
(in difficult flying conditions)
Navigation and camera control:
ICC + NT-2 + NA + NACON.
Camera: RMK A 15/23 with EMI-3
and Fi, in AS-5 with DCON/HCON +
adapter.



Photoflight with a crew of two
(total remote control,
also suited for pilot-only flights)
Navigation and camera control:
NT-1 + ICC + CCON/NM + NA +
NA CON.
Camera: RMK A 15/23 with EMI-3
and Fi, in AS-5 with DCON/HCON +
adapter.

Pilot-only flights
(special applications,
with given setting data)
Camera control: ICC + CCON/NM.
Camera: RMK A 15/23 with EMI-3
and Fi, in AS-2 with DCON/HCON.

Equipment for Mapping Camera Control and Photoflight Navigation

Depending on the type of work concerned and the aircraft available, we distinguish between several crew configurations:
Photoflight with a crew of three.
Photoflight with a crew of two.
Pilot-only photoflights.
For each of these cases we have developed suitable camera control systems. These are:
ICC Central Interval Computer.
NS-1 Navigation Sensor.
NT-1 Navigation Telescope.
NT-2 Navigation Telescope.
NA Automatic Navigation Meter.
FS-2 Remote Control.

The **FS-2 Remote Control** includes the following components that can be incorporated as additional controls in various basic units:
DCON Drift Control (incorporated in RMK suspension mount).
HCON Automatic Leveling Control (incorporated in RMK suspension mount).
EMI-3 Automatic Exposure Control (incorporated in RMK camera body).
FI Remote Monitors for film transport and vacuum motor (incorporated in RMK camera body and film magazine). The central control for the entire RMK system is the **CCON Remote Control with NM Navigation Data Input.**
However, the different components may also be used separately and combined as individual modules.

The **ICC Central Interval Computer** is the central electronic unit of the control system. Its primary purpose is automatic triggering of the aerial camera at specified intervals. In addition, the ICC is the central link between the different components of the RMK system and serves as power supply. During the photoflight, the ICC does not normally require any attention and can therefore be installed anywhere in the aircraft.

The other components are used as follows:

On flights with a crew of three (pilot, navigator and camera operator)
In this case, the camera is controlled from the **NS-1 Navigation Sensor** which should preferably be installed near it. The **NT-1 Navigation Telescope** is installed separately from the NS-1, within easy reach of the navigator. The pilot concentrates fully on flying the aircraft. He receives instructions about possible corrections of course from the navigator. The latter in turn concentrates entirely on comparing the flight strip plotted on the flight map with the terrain image observed through the Navigation Telescope, that is on checking the flight strip for proper location. If necessary, the navigator will also observe reference points for adjacent strips. The camera operator attends exclusively to the aerial camera and gives special attention to careful synchronization of the NS-1, making due allowance for changes in speed or general elevation of the terrain, and to precise drift setting on the NS-1 as well as the camera suspension mount.

On flights with a crew of two (pilot and navigator/camera operator)
The camera is controlled from the **NT-2 Navigation Telescope.** The latter can be installed anywhere in the aircraft where optimum working conditions can be secured for the navigator/camera operator. Instructions regarding corrections of course can be given to the pilot via the intercom. Here also, the pilot can devote all his attention to flying.
The navigator/camera operator will check the location of the flight strip through the NT-2 and at the same time take care of synchronization.
In general, it will be advisable to equip the NT-2 with automatic drift transmission to the camera **(DCON Drift Control).**

Additional controls may be used to support the camera operator. In particularly difficult flying conditions, for instance in the case of low-altitude large-scale photography, the **NA Automatic Navigation Meter** will considerably relieve the navigator who will then only have to check on the automatic functions of the camera control.

Instead of the NA, an **Inertial Navigation System** (INS) may likewise be used for camera control, if the photographic aircraft is equipped with a suitable INS. The Litton Inertial Navigation Systems LTN-72 and LTN-76 can be modified specifically for photogrammetric uses. This modification consists of an interface to the RMK, which allows two cameras to be operated simultaneously, and a special application program for the INS computer. This program is essentially based on the use of visible ground points whose coordinates are known or which can at least be unambiguously identified (absolute or relative reference points). The NT-2 Navigation Telescope is particularly well suited to make optimum use of this procedure and, in addition, to operate and monitor the RMK. Digital recording of the INS data on the film is achieved by the **DAS Data Annotation System,** which can be subsequently installed in an RMK camera body. Inquiries for detailed information are invited.

Zeiss RMK System

A Standard RMK A 15/23 Wide-angle Camera should be employed wherever the objective is to cover **the widest possible field of applications** with a single camera. If in addition large numbers of aerial mosaics are required, a Standard RMK A 30/23 Normal-angle Camera should be added, which may also be used for precise coordinate measurement and photography of built-up or forest areas.
These two standard models will be entirely sufficient for the great majority of photogrammetric projects. However, the principle of the **Zeiss RMK System of Interchangeable Camera Bodies** allows simple adaptation to any imaginable project, the

- suspension mount (AS-5 with adapter),
- FK 24/120 film magazine,
- ICC central interval computer

as well as the different navigation instruments and accessories being identical for all cameras. Great care is taken to keep this modular system intact even as new components are added. Thus, the camera bodies built today are fully compatible with suspension mounts and film magazines built as far back as 1956 and can also be operated with the control units from that period. In many cases, this will considerably reduce the outlay for a new outfit.

A special advantage of the System of Interchangeable Camera Bodies is its stability or interior orientation even in extreme conditions. The lens and focal-plane frame are perfectly protected inside the camera body. The focal-plane frame is exposed only during an exchange of magazines, which is extremely simple and takes only seconds, so that it is optimally protected against mechanical injury during operation of the camera. The camera bodies of different focal length can be quickly and easily exchanged even during the flight.

The fact that all cameras or lenses with an "A" in their type designation have **A-characteristics** further increases the number of possible uses of the System of Interchangeable Camera Bodies. A-characteristics as a design feature were introduced into photogrammetry by Zeiss. They are based on a new approach to the correction of chromatic aberrations. The term implies that photographs can be taken in the entire panchromatic and infrared region – both on black-and-white and color as well as false-color film – without optical accessories or defocusing of the lens.

The versatile modular camera control system is based on the ICC Central Interval Computer which is the central control unit for the RMK, providing the link to the different accessories.

- NS-1 Navigation Sensor and NT-1 Navigation Telescope for flights with a crew of three;
- NT-2 Navigation Telescope for crews of two;
- NT-2 Navigation Telescope and NA Automatic Navigation Meter for crews of two in difficult flying conditions;
- NA Automatic Navigation Meter and NM Navigation Data Input plus CCON Remote Control for pilot-only flights;
- NM Navigation Data Input with CCON Remote Control for special purposes, such as pilot-only flights by preset data or for use of an inertial navigation system for camera control.

Several cameras can be controlled simultaneously by a single navigation instrument. Since every camera has its own ICC, allowance can easily be made for different focal lengths and overlap ratios.

Remote control and automatic control are available in different versions to facilitate the operator's work:

- DCON Drift Control with drift transmitter on navigation instrument;
- HCON Automatic Leveling Control;
- EMI-2 or EMI-3 Automatic Exposure Control;
- CCON Remote Control.

The data of exterior orientation can be determined with the aid of auxiliary equipment and recorded on the photographs for subsequent evaluation:

- S-2c Recording Statoscope to keep track of differences in flying height;
- DAS Data Annotation System for recording the additional data supplied by an inertial navigation system.

ICC

NT 1

NT 2

FK 24/120

NS 1

RMK A 15/23

RMK A 21/23

RMK A 30/23

AS 2

AS 2 + DCON/HCON

AS 3

RMK Survey Cameras
Main Characteristics

Lens:
High-performance lens with A-characteristics
in all camera types.
Outstanding image quality even in low-contrast photography.
Negligible distortion in all lenses of focal lengths 85 mm to 305 mm.
Uniform illumination over the entire field due to minimum light fall-off and additional compensation by anti-vignetting filters.
Standard speed f/4 in all lenses of wide angular coverage, providing an ample margin to compensate for the loss of light introduced by the anti-vignetting filters.
Simple exchange of filters during the flight in all lenses from 153 mm to 305 mm focal length.
Lens cap protecting the lenses during take-off and landing, interchangeable for filter, with provisions preventing accidental use during camera operation.
Focal-plane frame:
Fiducial marks in the centers of negative sides with optically reproduced center dots; illumination of fiducial marks by the light reflected from the ground, i.e. no additional illumination required; fiducial-mark separation 226.0 mm.
On request, additional fiducial marks in the frame corners.
Auxiliary fligh data combined next to one negative side for easy reading.
Located in picture area:
- Three-digit exposure counter with zeroing button.

Located in marginal strip:
- Standard altimeter with metric or feet scale for measuring ranges of 0–9000 m or 0–27000 ft; can be exchanged for Statoscope indicator; optional digital display for aircraft altimeter or statoscope;
- circular level for recording camera tilt up to ±5° during exposure;
- serial number and calibrated focal length of camera;
- clock with second hand;
- data card.

Intensity of auxiliary-data illumination variable in 10 steps; recording system easily accessible even during the flight. Special version (DAS Data Annotation System) for recording the additional data supplied by an inertial navigation system.
Shutter: Extraordinarily efficient Aerotop shutter with four continuously rotating high-speed disks.
Shutter drive by integral DC motor that can be easily exchanged even after installation of the camera in the aircraft.
Shutter speeds available in standard version: $^1/_{100}$ – $^1/_{1000}$ sec. or $^1/_{50}$ – $^1/_{500}$ sec. (in RMK A 8.5/23); infinitely variable during flight, either manually on the camera or remote control or automatically by EMI-3 Exposure Control. Speed indicator always reads the true open time computed from the speed of the shutter disks, instead of the nominal speed.
Tripping of single exposures or serial photography is possible from the navigation instrument connected; minimum cycling time 2 sec.; cockpit exposure monitor for continuous indication of imminent exposure instant.
Aperture control: During the flight, the aperture of the iris diaphragm can be continuously varied by hand directly on the camera or by remote control, or automatically by means of EMI-2 or EMI-3 Exposure Control.
Suspension mounts: AS-5, as a standard mount suitable for any of the 23 cm x 23 cm cameras (directly for RMK A 8.5/23, with an adapter for other models); differences in installation height of camera can be compensated by suitable adapters.
AS-2, especially small version also suited for installation in small aircraft (not compatible with RMK A 8.5/23).
AS-3, special version for installation in aircraft with a thick floor when a camera well is not feasible (unsuited for RMK A 8.5/23).

Absorption of vibrations even at low temperatures due to integral dampers.
Leveling by three spindles with extension knobs for convenient operation in wells; leveling range ±5°. HCON Automatic Leveling Control as an optional accessory.
Drift setting ±30°, with clamp. DCON Drift Control as an optional accessory.
Film magazine: FK 24/120 for all cameras of the 23 cm x 23 cm series.
Film 24 cm wide (9½"), unperforated; length of film 120 m (400 ft) with 0.13 mm film base and 150 m (500 ft) with 0.10 mm film base; footage counter in magazine cover.
Film advance by integral shutter motor, with provision for statics and reflections from pressure plate.
Film flattening by vacuum system in camera body, with alternation between vacuum and air pressure.
Four indicator disks for monitoring film advance, two each for the take-up and supply spools; FI Remote Monitors for film transport and vacuum motor as optional accessories (in conjunction with NT-2 Navigation Telescope or CCON Remote Control).
Film punch for marking certain lengths of film during the flight.
Exchange of magazines within seconds during the flight; reliable safeguards against operating errors. No film lost when changing magazines in the middle of the film roll.

RMK Aerial Survey Cameras

Standard RMK A 15/23
Wide-angle Camera
with ICC/NS-1
and NT-1
Navigation Telescope.

Zeiss Aerial Survey Cameras – Special Features

Systematic aerial photography for the production of topographic symbol or photo maps and large-scale plans or for the numerical determination of ground coordinates is obtained with the aid of aerial survey cameras. These cameras serve to take strips of aerial photographs. Exposure intervals within flight strips are so controlled by supporting equipment that the photographs overlap by the desired amount – usually 60% for stereoplotting. Adjacent flight strips are designed with a lateral overlap (side lap) of approximately 30%, which ensures perfect coverage of the area to be photographed.

Aerial mapping cameras have to satisfy very exacting demands regarding their optical system and reliable control.

The Zeiss system of aerial mapping cameras for the 23 cm x 23 cm negative size (9″ × 9″) is based on complete, interchangeable camera bodies with high-performance lenses for angular fields of 30° to 125°, enough to solve any photogrammetric problem.
Navigation and control elements are of the modular type and can easily be expanded: from simple standard equipment for a flight crew of three right up to remote control and fully automatic overlap and exposure control.

In view of the high performance of their lenses, all aerial mapping cameras are likewise ideally suited for photointerpretation work. In addition, a program of special reconnaissance cameras for manned and unmanned aircraft is available. Inquiries are invited regarding detailed information.

Simple operation and the elimination of operating errors are particularly important considering the high demands made on the camera operator during a photoflight. This is achieved by:

- Concentration of all controls and meters required during the flight in one location, namely on the navigation instrument.
- Particularly easy-to-read monitoring system on navigation instrument: signal lamps will light up only if the corresponding function has failed and the operator's intervention is required.
- Optimum adaptation of the different navigation instruments to the specific control requirements involved.
- Overlap control and triggering of camera shutter from the navigation instrument are possible only after the lens cap has been removed and the magazine slide opened.
- Opening the dark slide is possible only with the film magazine properly seated.
- Removing the film magazine is possible only with the dark slide closed.
- Film magazines can be quickly and easily changed during the flight without any loss of film or frames in the case of partially exposed rolls. The operator himself need not load the film.

The separate installation of camera and navigation instrument offers additional advantages:

- Optimum positioning of navigation instrument for operation, independently of camera type used.
- Exchange of camera bodies without variation of navigation instrument.
- Relatively small camera port. In most photographic aircraft it is much simpler to provide two small holes instead of one big port.

NS-1 Navigation Sensor

Principal features
Optical instrument for determining the navigational data required for camera control and control unit for operation and monitoring of the camera during the flight.

Viewing System
Ground-glass viewfinder, 14 cm x 14 cm (5.5" x 5.5"), for binocular viewing in a conveniently seated position; angle of view 56°, as in normal-angle camera.

Measurement
Determination of v/h-value (ground speed/flight height above ground) by synchronizing the chain of splines moving across the viewfinder field with the terrain image; determination of drift angle by turning the NS-1 until the motion direction of the chain of splines coincides with that of the ground image.

Control of camera functions
Pushbutton for instantaneous tripping of single exposures or additional exposures in serial mode; switch for instantaneous starting of serial photography, that is, the first exposure of the series can be made precisely above a target point without further accessories.

Monitoring of camera functions
Interval lamp indicating instant of exposure and release lock during film advance;
within ground-glass field of NS-1: digital display of actual overlap if the exposure interval computed by the ICC is shorter than the minimum cycling time of the RMK, that is if the ovelap ratio set on the ICC can no longer be obtained; indicators for EMI-2 and EMI-3.

NT-2 Navigation Telescope

Principal features
Instrument for photoflight navigation, same as NT-1, combined with an optical unit for determining the navigational data required for camera control and a control unit for operating and monitoring the camera during the flight.

Viewing system:
Eyepiece viewing with standard 8x eyepiece;
viewing angle 90° so that the fixed forward angle of 40° provides 85° forward and 5° backward coverage from the nadir;
lateral and backward viewing by turning the telescope about its vertical axis (click stops from 0° to 315° at 45° intervals).

Navigation system
Same as in NT-1 Navigation Telescope; the navigation reticules can be used in either of these instruments.

Measurement
Determination of v/h-value (ground speed/flying height above ground) by synchronizing moving luminous lines with the terrain image in the forward-looking position, that is without switching the telescope over from navigation to overlap control; determination of drift angle by turning the NT-2 until the direction of the flight line or of a lateral side line on the reticule coincides with the motion direction of the ground image.

Control of camera functions
Pushbutton for instantaneous tripping of single exposures or additional exposures in serial mode; switch for instantaneous starting of serial photography, that is, the first exposure of a series can be made precisely above a target point without further accessoires.

Monitoring of camera functions
Interval lamp indicating instant of exposure and release lock during film advance;
digital display of actual overlap if the exposure interval computed by the ICC is shorter than the minimum cycling time of the RMK, that is, if the overlap ratio set on the ICC can no longer be obtained;
indicators for film transport and vacuum motor (operative only if FI Remote Monitors are incorporated in camera body and film magazine), DCON, EMI-2 and EMI-3; push-button for testing the different components.

Installation
See data for NT-1 Navigation Telescope.

NA Automatic Navigation Meter

Principal features
Optical measuring instrument for the automatic determination of the angular velocity v/h. The value thus determined is transferred to the camera and, together with the data set on the ICC, is used for the automatic triggering of the camera according to a preselected overlap.

Application
- Photoflights with a crew of two are now possible in applications which have posed problems so far, e.g. in large-scale photography.
- High reliability is ensured in one-man photoflights.

Measuring range
v/h value: 0.01 to 0.2 rad/s

Operation
The NA is operated via the NACON.

HCON Automatic Levelling Control

Principal features
Automatic levelling of aerial mapping cameras in the line of flight according to aircraft's mean pitch attitude.

Use
Whenever manual levelling of the camera during the flight presents problems, particularly in the case of photoflights with a crew of two (see page 10).

Operation
The pitch attitude of an aircraft generally varies as a function of load and flying height. As a result, changes of pitch may occur, which have a systematic effect over prolonged periods. This effect of pitch attitude can be automatically corrected with the aid of a simple tilt sensor. The control is designed so that brief accidental deviations from mean pitch will remain uncorrected. Across the line of flight, on the other hand, only minor and short-term accidental variations due to aircraft roll need be expected. Correcting these changes of roll therefore is not necessary, nor would it be possible with simple means.
The HCON Automatic Leveling Control thus works on the same principle as the camera operator who will likewise set only a mean value.

AS 5+HCON

Leveling
Manual tilt setting ±2.5° as referred to aircraft floor; automatic leveling range ±2.5° as referred to tilt setting; levelling speed 2°/sec.; in other words, no effect on image motion during exposure.

Installation
In RMK suspension mount AS-2 or AS-5.

EMI-3 Automatic Exposure Control

Principal features
Aerophotogrammetric exposure control for mapping cameras, for automatic setting of an optimum combination of aperture and shutter speed.

Detector
See EMI-2 Exposure Control.

Computer
See EMI-2 Exposure Control.

Computer setting ranges
Film speed 18–30 DIN (equivalent to 50–800 ASA) in 12 steps;
filter factor 1–16x in 12 steps;
admissible image motion 10–40 µm in 5 steps;
auto/manual mode.

Shutter-speed setting
Automatically by the computer via servomotor according to admissible image motion and v/h-value measured;
indicator on navigation instrument;
manual aperture setting is possible by switching off the computer;
indication of shutter speed on RMK, NT-2 Navigation Telescope and CCON Remote Control.

Aperture control
See EMI-2 Exposure Control.

Installation
See EMI-2 Exposure Control.

EMI 2

EMI 3

Zeiss – The Complete Photogrammetric Instrument System

Cameras and Film Processing

RMK
Aerial Cameras

Laboratory Equipment

TMK
Terrestrial Cameras

SMK
Stereo Cameras

Point Transfer Instrument and Comparators

PM 1
Transfer Instrument

PK 1
Precision Monocomparator

PSK 2
Precision Stereocomparator

Analog Plotters

DP 1
Double Projector

F 3 Planitop
Topographic Plotter

E 3 Planicart
Precision Plotter

D 3 Planimat
Precision Plotter

Mapping and Digitization

DZ 7
Digital Tracing Table

Ecomat 12
Data Recording Unit

Direc
Data Transfer Unit

DTM 3
Measuring Device for Digital Terrain Models

Analytical Plotters

G 3
Stereocord

C 100
Planicomp

C 120
Planicomp

C 130
Planicomp

Rectification Equipment

Z 2 Orthocomp
Analytical Orthoprojector

SEG
Standard Rectifier

Computer Programs

PLANIMAP **PLANI-AS** **PK-AS** Computer supported plotting	**PAT M** Block adjustment with independent models	**PAT B** **BLUH** Block adjustment with bundles	**HIFI** Digital Height Models

ZEISS

Carl Zeiss
D-7082 Oberkochen
West Germany

51-618-e Printed in West Germany W-H-X/83 Boo

Principal features

Differential altimeter electrical pickoff, designed for determining differences in flying height between exposure stations.

Use
As an indicator facilitating flying at a constant height;
as an indicator of departures from the prescribed flying height to be taken into account in aerotriangulation (aerial leveling). Suitable for combination with cameras of other manufacture.

Operating principle
Liquid manometer with coaxially arranged legs of different diameter. The principle of the time-tried and simple liquid manometer has intentionally been preserved in this modified form.

Measuring range
Varying as a function of barometric level:
at sea level
approx. 40 m (130 ft)
at 2,000 m (6,500 ft)
approx. 50 m (160 ft)
at 5,000 m (16,500 ft)
approx. 60 m (200 ft)
at 10,000 m (33,000 ft)
approx. 120 m (400 ft)
Each of these measuring ranges corresponds to about 50 scale intervals.

Accuracy of measurement
Varying as a function of barometric level:
at sea level
approx. ±0.40 m (1.5")
at 2,000 m (6,500 ft)
approx. ±0.50 m (2.0")
at 5,000 m (16,500 ft)
approx. ±0.60 m (2.5")
at 10,000 m (33,000 ft)
approx. ±1.20 m (5.0")

Pickoff of results
Capacitative in bridge circuit with series-connected amplifier. No setting motors, hence statically simple.

Indicators
Three electrical measuring instruments on statoscope, in camera (optional digital display), on instrument panel in the cockpit. Normally, only two of these indicators are in operation simultaneously. The indicator in the aerial camera is reproduced directly on the film, thus warranting perfect correlation of statoscope record and aerial photograph.

The indicator in the cockpit is so designed that it gives the pilot a direct indication of the direction in which possible corrections have to be made.

Sensitivity of tilt
Due to the coaxial arrangement of the measuring feeler, the instrument is largely insensitive to pitch and roll (φ and ω).

Temperature control
By simple ice-water filling in thermos bottle. Here also, a complicated electrical temperature control system whose accuracy is not always fully reliable has been intentionally avoided.

Measuring liquid
Special mixture supplied with the instrument.

Connection
To static pressure line of aircraft.

Pressure compensation
By electrically operated solenoid valve.

Technical Data

Electrical data

Operating voltage:	22 – 31 VDC
Max. residual ripple:	2 Vpp

The entire RMK system is supplied with power from the electrical system of the aircraft through the camera body. The power consumptions given below refer to an input voltage of 24 volts at normal temperature.

Power consumption:	
Camera body with ICC (continuous operation)	8 amps
(during 3 sec. after switching on)	15 amps
NS-1 Navigation Sensor	0.3 amp
NT-2 Navigation Telescope	0.5 amp
NA Automatic Navigation Meter	0.5 amp
DCON Drift Control	0.3 amp
HCON Automatic Leveling Control	1.0 amp
EMI-2 Automatic Exposure Control	0.4 amp
EMI-3 Automatic Exposure Control	0.7 amp
CCON Remote Control	0.2 amp
NM Navigation Data Input	0.2 amp
S-2c Recording Statoscope	1.5 amps

Weight

RMK A 8.5/23 camera body	62.2 kg
Filter	2.4 kg
Lens cap	0.9 kg
RMK A 15/23 camera body	59.6 kg
Filter	1.3 kg
Lens cap	0.6 kg
RMK A 21/23 camera body	43.7 kg
Filter	1.0 kg
Lens cap	0.4 kg
RMK A 30/23 camera body	55.3 kg
Filter	1.0 kg
Lens cap	0.5 kg
RMK A 60/23 camera body	51.4 kg
Filter	0.5 kg
Lens cap	0.2 kg
Cover for focal-plane frame	1.8 kg
EMI-2 Automatic Exposure Control	1.2 kg
EMI-3 Automatic Exposure Control	1.6 kg
FK 24/120 Film Magazine, empty	17.4 kg
Film spool, empty	0.9 kg
Film spool with 150 m (500 ft) of film	7.0 kg
FI Remote Monitors	0.2 kg
AS-2 Suspension Mount	19.1 kg
Drilling templet	0.7 kg
DCON Drift Control	1.0 kg
HCON Automatic Leveling Control	4.0 kg
AS-3 Suspension Mount	14.6 kg
Drilling templet	1.0 kg
AS-5 Suspension Mount	14.5 kg
Drilling templet	0.7 kg
Adapter for RMK A 15/23...60/23	9.0 kg
DCON Drift Control	1.0 kg
HCON Automatic Leveling Control	4.0 kg
2 extension knobs for leveling	1.1 kg
ICC Central Interval Computer	2.9 kg
Proximity-to-exposure indicator with cable	0.3 kg
NS-1 Navigation Sensor	8.3 kg
NT-1 Navigation Telescope (standard length)	16.0 kg
NT-2 Navigation Telescope (standard length)	18.0 kg
DCON/NT-2 Drift Transmitter with cable	0.3 kg
NA Automatic Navigation Meter	5.6 kg
NACON	1.2 kg
CCON Remote Control	2.1 kg
NM Navigation Data Input (slide-in unit)	0.3 kg
S-2c Recording Statoscope (flight weight)	15.0 kg
Connecting cables	
Standard equipment RMK and ICC	2.5 kg
ICC-ICC for multi-camera operation (0.8 m)	0.2 kg
CCON-ICC (0.8 m)	0.2 kg
NA-NACON	0.7 kg
Adapter DCON/HCON-RMK (up to ser. no. 123802)	0.6 kg

Subject to alteration.

S-2 c
Recording Statoscope

On photographic flying missions, the aircraft–and thus the aerial camera–should be maintained at a **constant flight height.** If the photographs are to be used for **aerial levelling,** i.e. for bridging uncontrolled areas, the unavoidable departures from the prescribed flying height should, in addition, be measured and recorded so that they may later be used as known quantities during plotting. Both these tasks are performed by the statoscope. Radio altimeters are unsuitable for this kind of measurement because they measure only the distance to the ground, which is equally influenced by the differences in flight height to be determined and by the ground profile.

The statoscope uses ambient atmospheric pressure for height measurement. Regarding the physical limits and the accuracy to be attained by this technique, reference is made to literature quoted below.

All our aerial survey cameras are equipped for connection of a statoscope. In order to record the statoscope reading on the film, the standard altimeter in the camera is exchanged for a statoscope indicator. A digital display is available as an option.

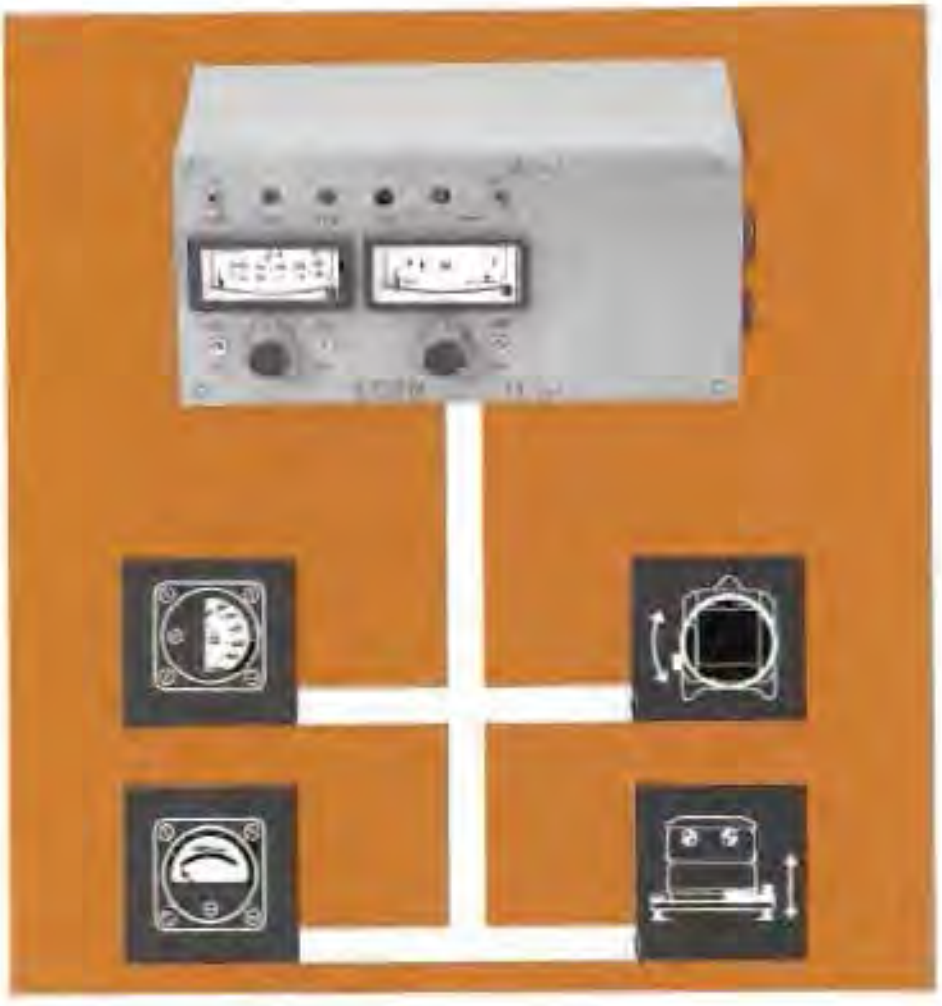
CCON
Remote Control

Principal features
Unit for remote control and monitoring of aerial mapping cameras (except for exchange of filters and film magazines).

Use
For cameras installed outside the cabin and operation in conjunction with a navigation instrument,
for pilot-only flights (see page 13) in conjunction with an NM or NA navigation instrument;
in multi-camera mode for operation of all cameras from one control center.

Remote control
RMK master switch;
switch for exposure control and camera-leveling modes (auto/manual);
manual setting of shutter speed and aperture (operative only if EMI-3 is incorporated in RMK).

Remote monitoring
Display of shutter speed aperture set on RMK;
signal lamps for DCON and HCON;
signal lamps for film transport and vacuum motor (operative only if FI Remote Monitors are installed in camera body and film magazine).



FS-2
Remote Control

This designation covers several control modules, all of which are operated from the CCON/NM Remote Control (see page 10).

There are many different factors which influence the "optimum exposure" of an aerial negative: First, the maximum exposure time depending on the admissible amount of image motion has to be determined and the speed of the aerial film selected. Allowance has to be made for the filters to be used and the desired gamma as a function of exposure latitude and the contrast range resulting from light height, illumination and reflectance.

The Zeiss EMI-1 was introduced in 1968 as a simple aid to average exposure metering during photoflights. This meter serves to determine the proper aperture for a given shutter speed, film speed and multiplying factor. The aperture found is then set manually on the aerial camera.

The Zeiss EMI-2 was the first aerophotogrammetric exposure control, introduced in 1972, providing **automatic aperture control** as a function of preset shutter speed, film speed and multiplying factor. The EMI-2 sensor and the electronic analog computer with servocontrol for aperture setting can also be installed in any Zeiss RMK-A camera previously supplied.

The Zeiss EMI-3 that has meanwhile been made available is an exposure control that will also determine shutter speed as a function of admissible preset image motion. In other words, the EMI-3 will automatically determine and set an optimum combination of aperture and shutter speed.

EMI-2 Automatic Exposure Control

Principal features
Aerophotogrammetric exposure control for automatic aperture setting in aerial mapping cameras.

Detector
Optimally adapted to the spectral sensitivity of panchromatic films and thereby also suitable for infrared-sensitive films. (The Effective Aerial Film Speeds provided in the film data sheets were determined from empincal data in order to give relative exposure values corresponding to those of aerial panchromatic-sensitized films which have no appreciable infrared sensitivity). Mean angle of acceptance ±30°, at which the effect of the incident light has dropped to 50% of the value on axis.

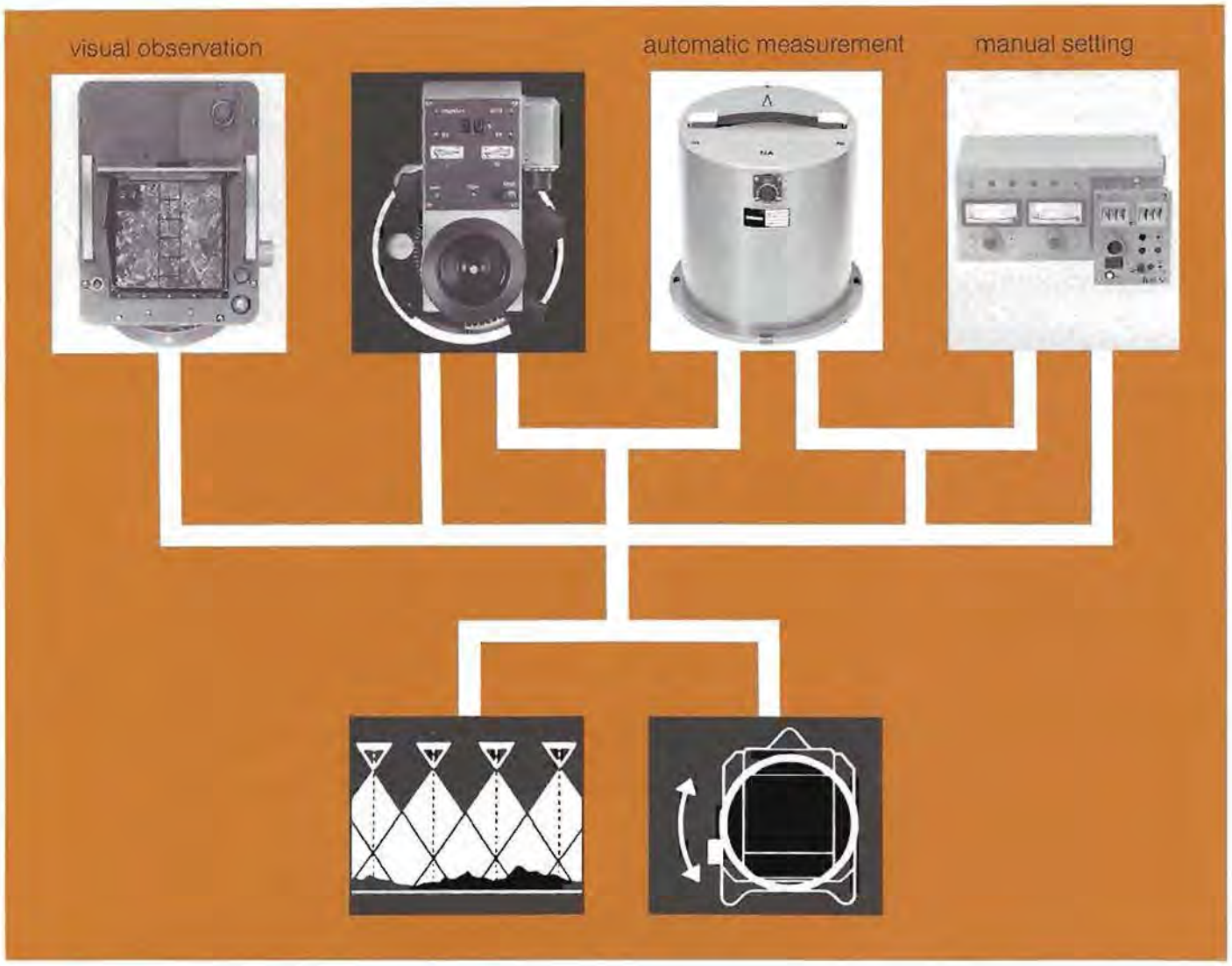
Computer
Simple adjustment over ±1 f-stop; simple expansion into EMI-3 computer by two additional printed circuit boards.

Computer setting ranges
Film speed 18–30 DIN (equivalent to 50–800 ASA) in 12 steps;
filter factor 1–16x in 12 steps;
auto/manual mode.

Shutter-speed setting
Manually on RMK;
automatic sensing of shutter-speed setting for the computer.

Aperture control
Automatically by the computer via servomotor, in accordance with the camera setting and the illuminance measured;
indication of aperture limits on navigation instrument;
manual aperture setting is possible by switching off the computer;
indication of aperture setting on aperture control knob of RMK and indicators of NT-2 Navigation Telescope as well as CCON Remote Control.

Installation
In RMK camera body, that is without any modification of aircraft.



DCON
Drift Control

Principal features
Automatic drift transmission from navigation instrument (NS-1, NT-2, NM or NA) to aerial camera.

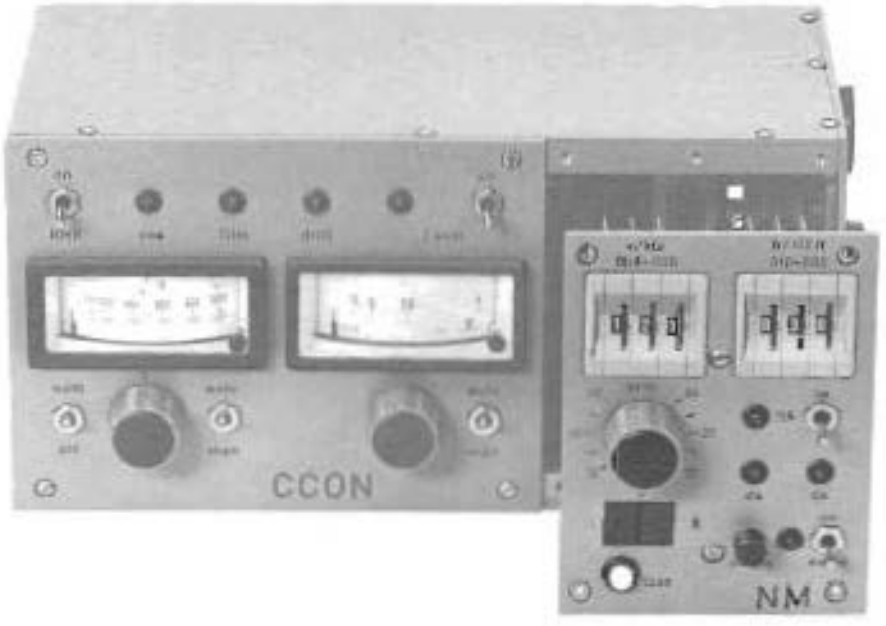
Use
Whenever manual drift setting on the camera is possible only with difficulty during the flight, that is above all when flying with a crew of two (see page 10);
when drift is measured automatically by means of the NA.

Operation
Potentionmeter-controlled servomotors act on a suitably equipped camera suspension mount – and thus on the camera in it – so that it automatically follows the drift settings made on the NS-1, NT-2 or NM navigation instrument or the drift value measured by the NA Automatic Navigation Meter.

Drift transmission
Range ±30°;
setting speed 1,5°/sec.; in other words, the setting has practically no effect on image motion during exposure.

Installation
Drift transmitter in NS-1 or NT-2 navigation instrument; servocontrol in RMK suspension mount.

NM
Navigation
Data
Input



Principal features
Unit allowing manual or automatic input of the navigational data required for camera control and control unit for operation and checking of camera functions during the photoflight.

Use
For camera control without an NS-1 or NT-2, that is without visual observation;
in the case of automatic determination of navigational data by NA or an aircraft navigation system, that is whenever a simple system will suffice to control the RMK; in the multi-camera mode, for independent checking of several cameras.

Settings
Ground speed 50–600 knots in increments of 1 knot; flight height above ground 1000–60000 ft in increments of 100 ft;
drift angle ±30°.

Control of functions
Pushbutton for instantaneous tripping of single exposures or additional exposures in serial mode;
switch for instantaneous starting of serial photography, that is, the first exposure of the series can be made precisely above a target point without further accessories; mode selector switch for input of navigational data (automatic from NA or manual).

Monitoring of camera functions
interval lamp indicating instant of exposure and release lock during film advance;
digital display of actual overlap if the exposure interval computed by the ICC is shorter than the minimum cycling time of the RMK, that is if the overlap ratio set on the ICC can no longer be obtained;
indicators for EMI-2 and EMI-3;
pushbutton for testing the different components;
indicator for NA.

Installation
Additional slide-in unit for CCON Remote Control.

NT-1 Navigation Telescope

Principal features
Instrument for photoflight navigation offering 360° coverage up to 5° below the horizon.

Viewing system:
Eyepiece viewing with standard 8× eyepiece; optional 16× eyepiece for high-altitude flights, depending on visibility, above approx. 5000 m (15000 ft); **viewing angle** 90° so that the fixed forward angle of 40° provides 85° forward and 5° backward coverage from the nadir;
lateral and backward viewing by turning the telescope about its vertical axis (click stops from 0° to 315° at intervals of 45°);
head rest mounted on ball bearings on the tube so that the observer's head retains full contact during rotation of the telescope.

Navigation system:
Navigation reticule in the eyepiece image plane;
information on reticule:
line of flight, lateral limits of flight strips, frame limits, nadir point, axial point of adjacent strips for 30% side lap (with side-looking telescope);
reticules for cameras with angular fields of 125°, 93°, 75°, 56° and 30°.
Special reticules on request, for instance ITC grid-like grid for photoflight navigation over unmapped areas (in 45° position of telescope).

Leveling of telescope by means of two footscrews.

Drift setting by means of a knob, with lock; direct readout of drift angle to be set on RMK and of compass heading.

Installation
The variable length of the telescope allows optimum adaptation of the thickness of the fuselage, the seat height and the viewing position desired by the navigator; size of hole required in fuselage: approx. 300 mm.