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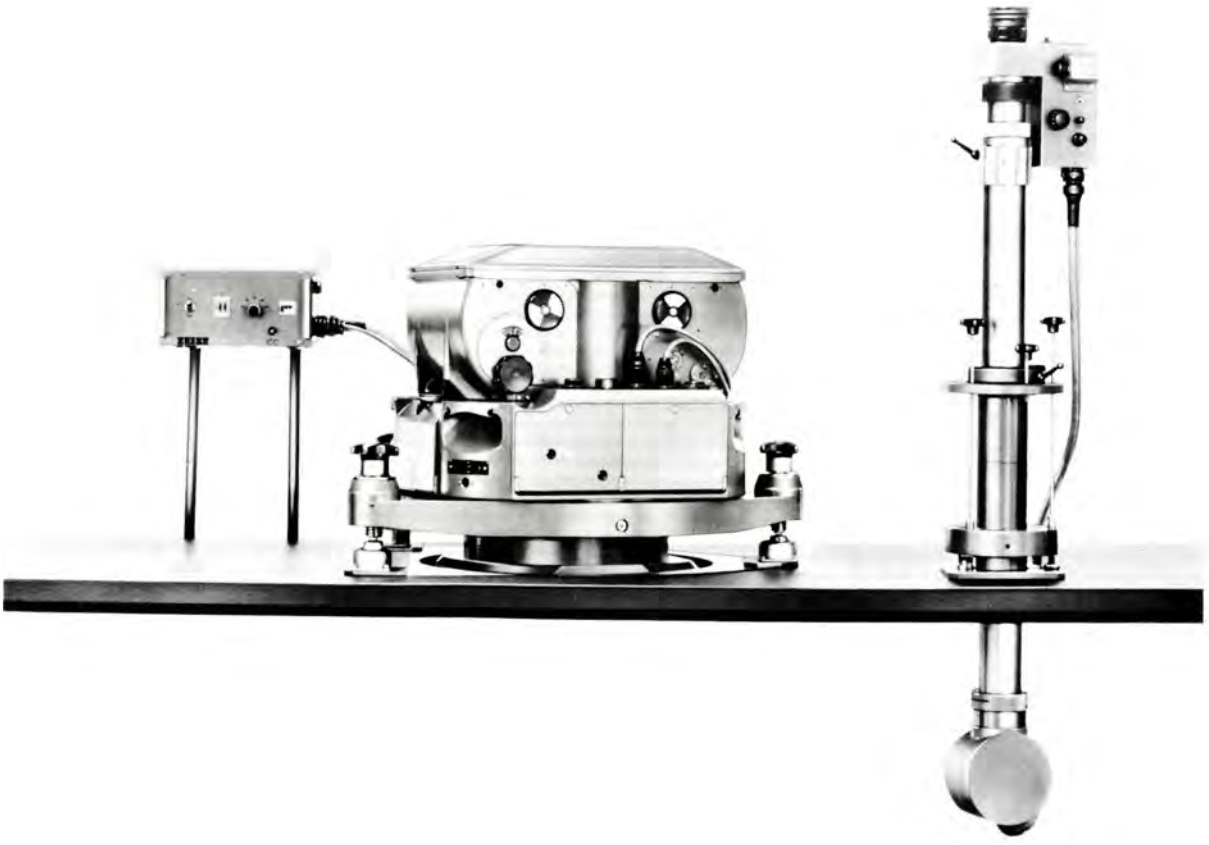
Photoflight

NT-1/NT-2
Navigation Telescopes

Operation
Installation
Adjustment



This manual is applicable to telescopes of serial number

125 130 and higher

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1. Technical data

NT-1 and NT-2 viewing systems	Angular field 90°. Field of view from 5° below the horizon up to 5° behind the nadir point. Panoramic vision by rotating the Navigation Telescope through 360° with click stops at intervals of 45°. Magnification 0.46x (with 8x eyepiece).
NT-1 and NT-2 navigation systems	Lengthwise and crosswise levelling ± 5°. Drift setting ± 30°. Graduated course circle adjustable by 360°. Orientation circle adjustable by 360°. Interchangeable navigation reticule.
Camera control (only in NT-2)	Overlap control for v/h-range of 0.002 to 0.2/sec. Triggering of serial photography. Triggering of separate exposures. Indicators for camera cycle, overlap, drift correction, shutter speed, aperture, blower motor and film transport. Simultaneous control of several camera units is possible.
Overall length of NT-1 (NT-2)	Standard: 1165 mm (1175 mm) Short: 1015 mm (1025 mm) Long: 1315 mm (1325 mm) Additional eyepiece extension up to 200 mm.
Weight	NT-1, complete 16 kg NT-2, complete 18 kg

2. Description

2.1 General

Precise navigation is indispensable for photographic flying missions. In general, the flight crew will have to rely on visual navigation. However, most types of aircraft presently used for photographic purposes do not provide a sufficient ground and forward view. In these cases, a Navigation Telescope that can be installed anywhere in the aircraft allows proper visual navigation. It is available in three different lengths so that it can be adapted to the different types of aircraft.

Two different versions of the Navigation Telescope are available:

a) The NT-1 (Fig. 1) is the basic model. It is designed exclusively for photoflight navigation, including drift measurement. A special eyepiece is available for high-altitude flights (5000 m and higher, depending on visibility).

b) The NT-2 (Fig. 2) also acts as a camera-control system, which includes overlap control. In conjunction with an ICC Central Interval Computer it thus also serves as a basic unit for remote control of the camera system (Figs. 15 - 19).

The NT-1 can be subsequently converted into an NT-2. In this case, it is only necessary to exchange the eyepiece (1/5) for the synchro head (2/6) of the NT-2.

The outstanding features of the Navigation Telescope are the following:

- Fixed viewing angle of 40° from the vertical, the field of view ranging from 5° behind the nadir point to 5° below the horizon (Fig. 3). Photoflight navigation is considerably facilitated by the fact that there is no need to switch over to other viewing angles. Since the Navigation Telescope can be rotated through 360° about its axis, the viewing range can easily be adapted to any type of practical work:

o The nadir point is visible even in the normal navigation setting (forward viewing), thus allowing easy checking of pin-point photography.

o If the NT-2 is used, the forward viewing position also allows overlap control.

o In the rear viewing position recommended for drift measurement, displacement of specific ground points in relation to the nadir can be detected with ease.

o The lateral viewing position may be used for an occasional check on lateral strip alignment.

o For photoflight navigation over unmapped regions, outstanding ground features have to be determined during the flight in order to check on the line of flight. Even this can be accomplished with ease if the standard reticule is exchanged for a special-purpose reticule (ITC Next-line Grid).

- Graduated course circle and orientation circle.
  In conjunction with drift measurement, these allow the direct readout of course data. As a result, these values no longer have to be noted down and converted so that the corresponding sources of error are eliminated.

- Easily interchangeable reticules.
  The telescope reticules, which are designed to aid photoflight navigation, can be easily exchanged to permit adaptation to different types of work. If an NT-2 is used, overlap control is not affected by an exchange of reticules. As a result, the reticule very often need not be changed in connection with an exchange of cameras. Standard equipment of the Navigation Telescope includes a combined reticule for wide and normal-angle photography.

- Simultaneous control of several camera units.
  This is possible with a standard NT-2, even if the different cameras have different focal lengths and are used with different overlap ratios (Fig. 18).

2.2 Components

The major components of the Navigation Telescope are the following:
Suspension mount (1/1),
Guide tube (1/2),
Objective head (1/3),
Eyepiece extension (1/4) with eyepiece (1/5) in the case of the NT-1,
with synchro head (2/6) in the case of the NT-2.

2.2.1 Suspension mount

The suspension mount consists of the base plate (1/7) that is permanently installed in the aircraft and the leveling guide (1/8) in which the Navigation Telescope can be axially shifted by max. 560 mm and rotated 360° about its axis. The clamp lever (1/9) allows the telescope to be locked in its mount. However, this is necessary only in certain cases, for instance during take-off and landing. During normal operation, the clamp lever should be left open. At the upper end of the guide there is the plate (1,4/10) which features the most essential controls of the Navigation Telescope:

- The knobs (2,4/11) and (2,4/12) allow longitudinal and transverse tilting by ± 5°. Leveling is possible with the aid of the circular level (4/13).
- With the drift-control knob (2,4/14) depressed, the Navigation Telescope can be turned through ± 30° about its axis. In this case, the clamp lever (1/9) must be released. As the fine adjustment is released, the telescope is locked in the desired drift setting by the self-locking clamp (1/15). Tightening of the clamp lever (1/9) is therefore not normally required. Rotation of the telescope is indicated by the outer index (4/16) and the inner index (4/17). Index (4/16) indicates the drift angle on the inner graduation. Course data can be directly read off the graduated course circle after the necessary basic setting.
- After loosening clamp (1,4/19), the graduated course circle (4/18) can be set to the desired starting value.
- The orientation circle (4/22) is connected to the guide tube (1/2) by the clamp ring (1/20).

The interior ring of the plate (1,4/10) is designed as a supporting plate for the guide tube (1/2). This supporting plate can be adjusted by the fine drift adjustment (2,4/14), in which case it will drive the attached guide tube via the clamp ring (1/20). The driving pin of the clamp ring must engage one of the eight grooves of the supporting plate.

2.2.2 Guide tube

The guide tube (1/2) is the connecting element between the objective head (1/3) and the eyepiece extension (1/4). It contains the relay optical system. The guide tube is available in three different lengths and thus allows convenient adaptation to varying types of aircraft (Fig. 13).

Connection to the suspension mount (1/1) is ensured by the clamp ring (1/20). Screw (1/21) permits the ring to be clamped on the guide tube in the desired position. The guide tube with the objective head (1/3) is thus vertically adjusted.

The clamp ring (1/20) rests on the supporting plate of plate (1,4/10). There is a driving pin on the underside of the clamp ring. The eight grooves in the supporting plate of the suspension mount are distributed so that the pin will engage one of them in one of the major viewing directions of the telescope (forward, rear, lateral as refered to the line of flight) or at intervals of 45^{o} in any intermediate direction. To turn the Navigation Telescope to one of these click-stop positions, it is only necessary slightly to lift and rotate the guide tube. In this case, reference to the drift value set will always be retained, since the supporting plate of the suspension mount is clamped by the drift lock (1/15).

The orientation circle (4/22) is secured to the clamp ring (1/20) by permanent magnets and thus rotates together with the guide tube. For orientation, the graduated circle can be lifted off the magnetic support and set to the desired starting value. After this basic adjustment, the course can be read off at the index (4/17) for any intersected target point.

2.2.3 Objective head

The objective head (1/3) is mounted on the guide tube (1/2) by means of the knurled collar (2/23). It can only be attached in a position that is defined by a pin in the connecting tube of the objective head and the corresponding groove in the guide tube. The knurled collar (2/23) is held in place by a hexagon socket screw.

The objective (2/24) makes an angle of 40° with the axis of the guide tube. It is protected against mechanical damage by a cover glass whose mount is secured to the objective head by means of three hexagon socket screws. The mount of the cover glass has venting slots. These serve to counteract misting in the objective head that may occur in the case of rapid temperature fluctuations.

2.2.4 Eyepiece extension with navigation reticule

The eyepiece extension (1,5/4) can be shifted by 200 mm in the guide tube (1/2). This allows easy adaptation to the viewing position of the navigator without having to vary the overall height of the Navigation Telescope. The clamping system (2,5/25) serves as a connection with the guide tube. The lower part of the clamping system is secured to the guide tube (1/2) by means of the hexagon socket screw (5/26). The knurled collar (5/27) serves as a gripping surface for turning the telescope. The upper part of the clamping system is used to guide the eyepiece extension. Clamp lever (5/28) serves to lock the eyepiece extension in the desired position.

The upper end of the eyepiece tube features an adapter ring that is secured by a headless screw. This ring normally remains firmly connected to the eyepiece extension. However, it is different in the NT-1 and NT-2 so that it has to be exchanged should an NT-1 be converted into an NT-2:

a) The eyepiece (5/5) is screwed into the adapter ring (5/29) of the NT-1. Part of the adapter ring is rotatable. This rotatable ring holds the head rest (5/30) so that the navigator need not remove his head from the rest when turning the telescope. Clamp screw (5/31) serves to lock the head rest at the desired height.

b) The adapter ring (6/35) of the NT-2 is almost completely concealed by the knurled collar (6/36) serving to secure the synchro head (6/6). The latter can be attached only in a position that is defined by a pin in the adapter ring and the corresponding bore in the synchro head.

The adapter ring also accommodates the interchangeable navigation reticule that may be used both in the NT-1 and the NT-2. The different marks of the reticule are identified in Fig. 7 as follows:

a = Strip axis
b = Lateral limits of flight strip
c = Limit of forward half of photograph with nadir point as photograph center
N = Nadir point
N'= Next photograph center for picture limited by the corners ABCD
Q = Axial point of adjacent flight strip in lateral viewing position of Navigation Telescope. Unless otherwise specified, Q applies to 30 % side lap.

All these data are applicable to mapping cameras covering the angular field specified on the reticule, for example 93° (standard RMK A 15/23 Wide-angle Camera). A few reticules also include the axes of adjacent flight strips. In this case, the corresponding side lap is also given in per cent.

The International Institute for Aerial Survey and Earth Sciences (ITC) has developed a special technique for photoflight navigation over unmapped areas. This is based on the determination of outstanding ground features to check on the next-following line of flight. A special reticule (ITC Next-line Grid) is available for this technique. In order to obtain an adequate viewing range for the adjacent line of flight as well, the Navigation Telescope is rotated to a click-stop position 45° to the left or right of the forward viewing position. To make allowance for ground relief that has to be estimated by the navigator, the reticule contains auxiliary lines.

The reticules available for the Navigation Telescope are illustrated in Fig. 8. Standard equipment of the telescope includes a combined reticule for wide and normal-angle photography.

2.2.5 Eyepiece (for NT-1)

The eyepiece (5/5) is secured to the adapter (5/29) of the eyepiece extension by means of ring (5/32). The eyepiece ring (5/33) serves for focusing. A yellow filter can be screwed onto the eyepiece after removing the eyecup (5/34).

Standard equipment of the NT-1 includes an 8x eyepiece. A special 16x eyepiece is available for high-altitude flights. This is recommended for flight heights above 5000 m, depending on visibility.

2.2.6 Synchro head (for NT-2)

The synchro head (6/6) is secured to the eyepiece extension (6/4) by means of the knurled collar (6/36). The position in which the synchro head should be attached is marked by a pin in the adapter ring (6/35) of the eyepiece extension and a corresponding bore in the synchro head. The synchro head of the NT-2 not only allows photoflight navigation but also control of the camera by the navigator. All controls are on one side (6/44) of the synchro head so that they are readily accessible in the forward viewing position most frequently used. The different indicators serving to monitor operation of the camera are combined in the front panel (9/45).

2.2.6.1 Photoflight navigation

The navigator observes the ground image in the reticule plane through the eyepiece (6/37) provided with an eyecup. This allows the telescope to be used for all kinds of navigation work.

2.2.6.2 Overlap control

In addition, however, a number of moving luminous lines are reflected into the field of view. To control overlap, the velocity of these lines is varied by means of knob (6/38). The velocity thus determined is a measure of the ratio between ground speed and flying height above ground, the so-called v/h-value, that is needed by the ICC Central Interval Computer for calculation of the required exposure interval. The lamp serving to illuminate the moving lines is mounted on the lamp housing (6/41) with socket (6/40). Knob (6/39) serves to adapt the brightness of the moving lines to the ground image.

2.2.6.3 Shutter tripping

Switch (6/42) serves to switch the camera on for serial photography. The first exposure is made immediately after the switch has been flipped; subsequent shutter-trip pulses are transmitted in accordance with the desired overlap ratio. Pin-point photography can be triggered with pushbutton (6/43) regardless of the setting of switch (6/42). It should be noted, however, that the camera remains locked after an exposure until the entire exposure cycle including

film transport has been completed. The duration of this shutter-tripping lock is indicated by the pulse lamp (9/46). In other words, depression of the shutter release (6/43) has no effect as long as the pulse lamp is lit. If, on the other hand, the exposure cycle of a pin-point photograph is not completed in time for the next serial exposure, the latter will be skipped. However, this will have no effect on the following serial exposures. In other words, the camera does not get out of step.

The exposure lock will also cause the suppression of individual serial exposures if the exposure interval computed by the ICC is shorter than the shortest cycling time of the camera so that photography of uncontrolled overlap would be obtained. In order to avoid this from happening, the ICC continuously compares the computed exposure interval with the cycling time set on it. As soon as this limit is exceeded, the camera will be triggered at intervals corresponding to its shortest cycling time. As a result, photography of uniform overlap will be secured in this case also, even if the overlap is less than that selected on the ICC. The actual overlap is indicated on the digital display (9/47). The test button (9/48) serves to check operation of the display. This allows the overlap set on the ICC, which is not normally displayed, to be read off at the NT-2.

2.2.6.4 Checking drift correction

The NT-2 Navigation Telescope may be equipped with an optional DCON-NT-2 drift transmitter (see item 2.2.7). The latter will automatically transmit to the camera mount the necessary drift correction measured. The DRIFT lamp (9/49) lights up when the suspension mount reaches its limit position of approx. $\pm$ 30°. This display function can be tested by depressing button (9/48).

2.2.6.5 Checking operation of the camera

The indicators described in the following are operative only if a camera is used that is wired for remote control.

Aperture

The aperture indicator "f/" (9/50) indicates the aperture selected, provided that the camera is equipped with an EMI-2 or EMI-3 Exposure Control. The lamp DE (9/51) lights up if the aperture range is insufficient for securing proper exposure under existing conditions, that is, if over or under-exposure is likely. This indicator operates even if automatic aperture control is switched off at the EMI-2 or EMI-3. It works in two steps:

Flashing = range exceeded by up to one f-stop.
Continuous = range exceeded by more than one f-stop.

Shutter speed

The shutter speed selected can be checked on the indicator "t" (9/52) if the camera is equipped with an EMI-2 or EMI-3 Exposure Control. The EMI-3 also allows the shutter speed to be set automatically as a function of the maximum admissible image motion set on the EMI-3. In the case of larger v/h-values, the maximum admissible image motion may be exceeded even at the highest shutter speed. Lamp DS (9/53) will light up in this case. The indicator operates even if the automatic shutter-speed control is switched off at the EMI-3. Here again, there are two steps:

Flashing = maximum value exceeded by up to factor 2.
Continuous = maximum value exceeded by more than factor 2.

Film transport and blower motor

The FILM (9/54) and VAC (9/55) lamps indicate malfunctioning of the film transport and the blower motor, respectively. For this purpose, the camera must be equipped with an FI Remote Indicator. Lamp (9/55) operates in two steps:

Flashing = power consumption of blower motor exceeds tolerance.
Continuous = blower motor does not work.

Operation of the remote indicators described here can be checked by depressing button (9/48).

2.2.6.6 Test button

Operation of the overlap display (9/47) can be checked by depressing the test button (9/48). The display indicates the overlap set on the ICC, an occasional difference of 1 % being possible. However, if a value was displayed already before depression of the button (see item 2.2.6.3), the display remains unchanged.

The signal lamps (DRIFT, DE, DS, FILM, VAC) described under 2.2.6.4 and 2.2.6.5 will light up upon depression of the test button only if the RMK is equipped with the corresponding control system (DRIFT in conjunction with DCON Drift Control, DE and DS with EMI-2 or EMI-3 Exposure Control, FILM and VAC with FI Remote Indicator).

2.2.7 Drift correction

The DCON-NT-2 Drift Transmitter is available as an optional accessory for the NT-2 Navigation Telescope. The plate (1,10/10) is prepared for installation of the DCON-NT-2 both in the NT-1 and the NT-2. In the case of conversion by the user, it is therefore only necessary to screw the drift transmitter (10/56) to plate (10/10) and to adjust it (see item 3.5). The drift transmitter is connected to the corresponding receptacle (6/67) of the synchro head by means of cable (10/57).

The drift signal is transmitted via the ICC to an RMK suspension mount equipped with a DCON-AS-2 or DCON-AS-5 Drift Control. This allows the drift measured in the Navigation Telescope to be automatically transmitted to the suspension mount of the camera.

3. Installation

The Navigation Telescope with its accessories and spare parts is supplied in a transport case. Figs. 11 and 12 show the distribution of parts for the NT-1 and the NT-2.

3.1 Installation in the aircraft

The Navigation Telescope should be installed in the aircraft in a suitable position in front of the navigator's seat. The RMK system offers a great variety of different configurations so that optimum adaptation to the conditions encountered in the aircraft and the number of crew members is possible.

As is evident from the installation drawing (Fig. 13), four holes of 9 mm dia. have to be drilled concentrically with the telescope aperture. Place the shock-absorbing rubber buffers (11,12/59) on the holes. Position the base plate (1/7) over the telescope aperture so that the drift scale of plate (1/10) faces the navigator. Suitably level the base plate roughly in the normal flying attitude of the aircraft and align it so that the zero direction of the drift scale is parallel to the fore-and-aft axis of the aircraft. Then secure the base plate to the floor of the aircraft by means of four M8 screws. Secure the screws from below with nuts.

Loosen the hexagon socket screw (5/26), push the eyepiece extension (5/4) or (6/4) fully into the guide tube (1/2) and turn it until the red index of the clamping system (5/25) coincides with the corresponding mark on the guide tube. Clamp the eyepiece extension on the guide tube by means of hexagon socket screw (5/26).

Hold the guide tube (1/2) fast and loosen the hexagon socket screw (1/21) on clamp ring (1/20). Then shift the guide tube down far enough to allow mounting of the objective head (1/3). Should the guide tube resist shifting, loosen clamp lever (1/9). Retighten the hexagon socket screw (1/21) in the desired position. Attach the objective head (1/3) so that the pin in the connecting piece of the head engages the corresponding groove in the guide tube (1/2). Firmly tighten the knurled collar (2/23) and secure it by tightening the hexagon socket screw.

Next, slide the guide tube (1/2) down until the aircraft fuselage clears the field of view. Clamp the guide tube in this position by lever (1/9), loosen hexagon socket screw (1/21) and shift clamp ring (1/20) fully up to plate (1/10). Turn clamp ring (1/20) until the white line on the inner ring is opposite the red line on the guide tube (1/2). Firmly retighten the hexagon socket screw (1/21) and release clamp lever (1/9). Then turn the guide tube (1/2) until the pin on the underside of clamp ring (1/20) engages one of the eight grooves in plate (1/10). In the forward viewing position of the telescope, the red index on the guide tube (1/2) is opposite the index (4/17).

After releasing clamp lever (1/28), pull the eyepiece extension (1/4) up to the desired viewing position, but not further than the red ring (5/60). Turn the eyepiece extension so that the reticule agrees with the forward viewing position of the telescope and the lateral marks on the reticule coincide with the wedge-shaped edge marks R (Fig. 7). Focus the eyepiece (5/33) or (6/33) on the reticule.

In the NT-1, slip the head rest (5/30) into the holder of adapter ring (5/29) and secure it by clamp screw (5/31).

To check out the mounted telescope, level it with the aid of knobs (4/11) and (4/12), turn it to forward viewing position and set zero drift. The drift lock (4/14) is released as the knob is pressed. Using a suitable target, it is now possible to check whether the Navigation Telescope is parallel to the fore-and-aft axis of the aircraft. If necessary, turn the base plate (1/7) as required after loosening the four screws. Finally, retighten the screws firmly and secure them.

In the NT-2, plug the connecting cable (2/65) to the ICC into receptacle (6/66).

3.2 Exchanging the navigation reticule

- In the NT-1, unscrew the eyepiece (5/5) by turning ring (5/32).
- In the NT-2, loosen the knurled collar (6/36) of synchro head (6/6) and remove the latter by pulling it off. Unscrew the reticule retaining ring.

The reticule can now be removed from the eyepiece extension. The reticule mount is not threaded but rests on the seating face of adapter ring (5/29) or (6/35) of the eyepiece extension. Removal of the reticule is easier if the eyepiece extension is pulled up and then fully pushed down. The air pressure will slightly push the reticule up. Insert the new reticule, turning it slightly to and fro to avoid tilting. Orientation of the reticule is defined by a pin in the adapter ring and a groove in the reticule mount.

3.3 Inserting a filter

After removing the eyecup, a filter can be screwed onto the eyepiece. Filters B and D are supplied with the equipment in the transport case.

3.4 Converting an NT-1 into an NT-2 (synchro head)

Unscrew eyepiece (5/5) by turning ring (5/32) and loosen headless screw (5/61) of eyepiece extension (5/4). The adapter ring (5/29) can now be unscrewed with the aid of a pipe wrench or a similar tool. Be sure to protect the thread to which the pipe wrench is applied by a strip of leather or similar material. Remove the spacer ring (5/62) together with adapter ring (5/29).

Next, screw the synchro head (6/6) with the adapter ring (6/35) and the spacer ring in place in the eyepiece extension (6/4). Remove the reticule from the eyepiece of the NT-1 as described under 3.2 and insert it into the synchro head. Check by turning the eyepiece focusing ring (6/33) whether the ground image and the reticule can be focused together. Should this not be the case, vary the thickness of spacer ring (5/62). The necessary thickness can easily be found by moving the synchro head to proper distance from the eyepiece extension (6/4) by turning the adapter ring (6/35), if necessary after removing the spacer ring (5/62). Once the spacer ring has been suitably adjusted, firmly tighten adapter ring (6/35) and secure it by the headless screw (5/61).

Note:
Any NT-1 of serial number 110 369 and higher can be converted in this manner outside the factory. However, some of the telescopes are not yet equipped with the new clamping system (5/25). The new version which also ensures reliable clamping action in conjunction with a synchro head is available as an optional accessory.

3.5 Installing the DCON-NT-2 Drift Transmitter

Due to the confined space in an aircraft, it will generally be advisable to remove the Navigation Telescope. Since the drift transmitter is mounted on the suspension mount (1/1), the guide tube (1/2) with the synchro head (2/6) can be removed for greater ease of installation. In the following, it is assumed that the camera with its own suspension mount is ready for operation and connected to the synchro head via the ICC. As the camera is switched on, the drift motion will then advance towards the white 30° position.

On the underside of plate (1,10/10), the aperture for installation of the drift transmitter is covered by a round plastic cap. Upon removal of this cap, part of the gear rim becomes accessible, which transmits the drift setting (4/14) to the gear wheel of the drift transmitter. To prepare for installation, unscrew the cover (10/58). Carefully slacken the four clamp screws holding the potentiometer on the housing just far enough to allow the potentiometer still to be slightly turned by hand.

For coarse adjustment, set zero drift on the Navigation Telescope. Connect the drift transmitter by cable (10/57) to receptacle (6/67). After switching on the RMK, wait until the camera suspension mount has moved to a certain drift value. Then slowly turn the gear wheel of the drift transmitter to find the position in which the camera suspension mount moves to zero drift. It should be noted, however, that outside the drift range of $\pm 30^{\circ}$ (equivalent to a 300° angle of rotation of the potentiometer), the drive will move to one of the end positions. With the suspension mount in one end position it may therefore happen that slight rotation of the drift transmitter will suddenly cause the drive to switch over to the opposite end position. When zero has been found, carefully attach the drift transmitter to plate (10/10) and secure it with the aid of the two hexagon socket screws. Then use the drift setting (4/14) to check whether the gear wheel of the drift transmitter meshes properly over the entire range.

For fine adjustment carefully turn the potentiometer of the drift transmitter by hand until optimum agreement is obtained between readings at the Navigation Telescope and the camera suspension mount. Finally, retighten the four clamp screws, once more check drift transmission and secure the cover (10/58).

4. Preparing for the flying mission

It is assumed that the Navigation Telescope is installed in the aircraft and ready for operation. If an NT-2 telescope is to be used, connecting cables must be in place between

- aircraft power supply and camera body,
- camera body and ICC,
- ICC and NT-2 (cable 10/65),
- ICC and pilot monitor.

In addition, the following connections are required for automatic drift correction (see 2.2.6.4) and remote monitoring of film transport and blower motor (see 2.2.6.5):

- Drift transmitter and synchro head (cable 10/57),
- camera suspension mount and camera body (or adapter in cameras without remote-control wiring, see Fig. 16)
- film magazine (contactor) and camera body.

For automatic exposure control (see 2.2.6.5), the automatic aperture or shutter-speed control must be switched on at EMI-2 or EMI-3.

4.1 Functional checkout (applicable only to NT-2)

To avoid film waste during the tests, make sure that the serial-exposure switch (6/42) of the NT-2 is set to OFF. Switch the RMK on by the master switch at the camera body. The green lamp at the ICC should then light up. If this is not the case, check whether

- the dark slide of the magazine is fully open,
- the lens cap has been removed,
- the aircraft supplies the proper voltage,
- the RMK is connected to the aircraft power supply with proper polarity. (The polarity protector of the ICC disconnects the unit automatically to avoid damage).

4.1.1 Overlap control

Set the focal length and the desired overlap on the ICC (use click-stop positions!).

The brightness of the moving luminous lines in the field of view of the NT-2 can be controlled by means of knob (6/39) and their speed by knob (6/38). Should the lines remain invisible, check illumination (6/40).

The exposure cycle may also be observed on the pilot monitor connected to the ICC if the serial switch is set to OFF.

4.1.2 Test button

Depression of the TEST button will cause the overlap display to light up. With the exception of IMPULSE, all lamps are lit if the RMK is equipped with the corresponding controls.

Should one of the lamps fail to light up, this may be due to the following causes, except for a burnt-out lamp:

- DRIFT: Camera suspension mount with DCON is not connected.
- FILM: Contactor of film magazine is not connected to camera body.

If one of the lamps fails, the corresponding control will operate nontheless so that the photoflight need not necessarily be called off. However, there is a higher risk that a possible failure during the flight will pass unnoticed.

4.1.3 Shutter tripping

After the SINGLE exposure button has been pressed, the IMPULSE lamp will stay lit until the entire exposure cycle including film transport has been completed.

4.1.4 Signal lamps (DRIFT, DE, DS, VAC, FILM)

These lamps will light up only in the case of malfunctioning. Should one of these lamps light up during checkout, the trouble can frequently be corrected by following the hints given below:

- DRIFT: No drift signal is transmitted to the camera suspension mount so that the latter moves to its white 30° end position. Check whether the connecting cable between drift transmitter and synchro head is properly connected.
- DE: This lamp is normally lit during checkout because the photodetector of the EMI-2 or EMI-3 Exposure Control receives only very little light.
- DS: A very high speed of the moving luminous lines has been set on the synchro head so that for the corresponding v/h-value the maximum admissible image motion preset on the EMI-3 would be exceeded.
- VAC: The blower motor does not work properly. Check plug of connecting cable and carbon brushes.
- FILM: The contactor of the film magazine was not actuated by the supply-spool signal disk during film transport. Check whether the supply spool rotates during film advance. If necessary, check the contactor.

4.1.5 Indication of aperture and shutter speed

The corresponding indicators will operate only if the camera is remote-control wired and equipped with an EMI-2 or EMI-3 exposure control. These units allow the operation of automatic exposure control to be checked from the NT-2 during the flight. In the following cases, however, the indicators will signal disconnection of the automatic control even during the test run:

- The camera aperture is not fully open although the DE lamp is lit.
- The shutter speed does not vary although the speed of the moving luminous lines is varied at the synchro head over the entire range.

Before starting, the RMK must be switched off in order to prevent the rotating shutter disks from being damaged by shocks.

4.2 Precautions before take-off

Turn the Navigation Telescope to rear-viewing position in order to protect the objective from mechanical injury. In addition, the telescope can be clamped in this position by lever (1/9). If possible, the objective head may be further pulled back into the aircraft by moving up the guide tube and clamping it with the aid of lever (1/9).

5. Operation during the flight

It is assumed that the operator is sufficiently familiar with operation of the equipment. Only additional hints will therefore be given in the following.

After take-off, hold the guide tube with one hand, release clamp lever (1/9) and carefully lower the tube onto the supporting plate if it had been moved up for take-off. The telescope may now be turned to the desired position.

5.1 Leveling the telescope

Level the suspension mount with the aid of the two foot-screws and the circular level.

5.2 Measuring drift and reading the graduated circles

Set zero drift. Set the map course of the first flight strip on the graduated course circle.

The pilot now approaches the strip with the calculated compass course (= map course).

The navigator turns the telescope to rear viewing position and sets drift so that the target point previously overflown moves along the axis of the flight strip. The drift index then indicates the following:

- the drift angle at the inner graduation,
- the compass course to be flown at the graduated course circle.

To set the orientation circle, turn the Navigation Telescope to forward viewing position:

- After setting to the map course of the flight strip, the corresponding map course can be read for any target point that is intersected.
- After setting to zero, the angle between any intersected target point and the basic course (line of flight) can be read off.

5.3 Camera control (applicable only to NT-2)

In the following paragraphs, it is assumed that the RMK master switch is set to ON and that all necessary settings have been made at the RMK.

5.3.1 Overlap

Set the focal length and the desired end lap on the ICC.

Turn the Navigation Telescope to forward viewing position. Use the speed control to synchronize motion of the luminous lines in the field of view of the NT-2 with the ground image. The brightness of the moving lines can be adapted to the ground image. Be sure to check on synchronization during the entire photoflight.

If the overlap indicator lights up, the shortest cycling time of the RMK is no longer sufficient for the overlap set on the ICC. The actual overlap value is displayed. If necessary, check the settings of the ICC (focal length and overlap).

5.3.2 Serial photography

If the first photograph is to be triggered over a specific target point, observe this point through the NT-2. As soon as it has reached the nadir point on the reticule, flip the SERIAL switch. This will immediately trip the shutter for the first exposure. All subsequent serial exposures will be automatically triggered at the intervals corresponding to the preset end lap. The red pulse lamp lights up from the shutter-trip pulse to the end of the complete exposure cycle.

5.3.3 Pin-point photography

Observe the selected target point through the NT-2. As soon as it reaches the nadir point on the reticule, press the SINGLE button.

The next exposure can be triggered only after the red pulse lamp has gone out.

5.3.4 Serial photography with intermittent pin-point exposures

An immediate separate exposure can be triggered between any two serial exposures by depression of the SINGLE button, provided that the preceding exposure cycle has been completed (pulse lamp off).

If the cycle of the separate exposure is not completed in time for the next serial exposure (pulse lamp still lit), that serial exposure will be skipped. However, this will have no effect on the following serial exposures. In other words, the exposure series will be continued in the proper order.

5.3.5 Indicators

For overlap display, see 5.3.1.

If the camera is wired for remote control and equipped with an EMI-2 or EMI-3 Exposure Control, the NT-2 will indicate aperture and shutter speed.

The signal lamps provide the following information:

- DRIFT: The automatic drift correction at the camera suspension mount has reached its $\pm$ 30° position.
- DE: Over or underexposure, depending on f-stop readout, must be expected. If necessary, check setting of film speed and filter factor on EMI-2 or EMI-3.
- DS: Maximum admissible image motion is exceeded. If necessary, check setting of DS and RMK switches of EMI-3.
- VAC: Blower motor does not work properly. Flashing of the lamp may occur at very high altitudes (about 8000 m and higher) although there is no malfunction.
- FILM: No film transport. Will also light up when the film supply is exhausted.

5.3.6 Test button

The test button (item 4.1.2) can be pressed at any time without disturbing control of the camera.

5.3.7 Simultaneous control of several cameras

Several cameras can be simultaneously controlled by a single Navigation Telescope without any accessories (Fig. 18). In this case, the following should be noted:

- When the SERIAL switch is actuated, the first exposure will be triggered simultaneously in all the cameras connected. All subsequent exposures will be separately controlled for each camera as a function of focal length and end lap.
- The indicators and the test button refer exclusively to the one camera whose ICC is directly connected to the NT-2. To check an overlap, it is advisable to use this connection for the camera that has to operate at the shortest exposure interval.
- Separate checking of all cameras is possible if an additional CCON/NM Remote Control is used (Fig. 19).

5.3.8 Winding up

The SERIAL switch can be set to OFF whenever desired. An exposure cycle in progress will be completed.

Before landing, switch the RMK off in order to protect the rotating shutter blades from damage due to shocks.

5.4 Precautions for landing

Prepare the Navigation Telescope as described under 4.2.

6. Maintenance

6.1 Cleaning

Keep all glass surfaces meticulously clean. Remove the eyecup before cleaning. Use the special brush supplied to remove dust. More resistant stains such as fingerprints may be removed with the aid of a clean, soft cotton or linen cloth lightly moistened with pure alcohol.
It is advisable occasionally to clean the head rest and the eyecup with lukewarm soapy water. At the end of the flying season, these parts should be treated with talcum or pure glycerin to keep them soft and flexible.

6.2 Lubrication

The supporting plate carrying the clamp ring (1/20) of the guide tube should be cleaned from time to time and protected by a film of acid-free grease.

To maintain smooth operation of the drift lock (1/15), occasionally apply a drop of oil to its shaft.

6.3 Lamps

Exchange of the lamp illuminating the moving lines is very easy if the lamp socket (6/40) is unscrewed. Be sure to use exclusively the spare lamps (12/72) supplied (28 v, frosted).

6.4 Exchanging the moving-line tape

The moving luminous lines are printed on a special tape that may be exchanged if damaged. A spare tape (12/72) is contained in the transport case.

Remove the seven screws at the edge of the lateral cover of the synchro head. Carefully swing the cover out of the way, taking care not to damage the cable harness. After separating the connector (14/69), the cover can be removed.

Push the movable guide roller (14/63) inwards against the spring (14/68) and remove the damaged tape (14/64). Insert the spare tape with the guide roller depressed. Then slowly release the guide roller to tension the new tape.

Finally, reconnect the cable harness of the cover plate to connector (14/69) and mount the cover.

6.5 Adjusting the aperture and shutter-speed indicators

Should adjustment of these indicators become necessary, remove the lateral cover of the synchro head (see item 6.4).
The potentiometer (14/70) serves to adjust the shutter-speed indicator, potentiometer (14/71) adjusts the aperture indicator.

6.6 Storage

In normal conditions, the transport case ensures safe storage of the equipment. However, this type of storage is not recommended in humid and hot tropical climate. In this case, all components should be kept well ventilated and in the light, but protected against direct sunlight and dust. Another possibility is to keep the equipment hermetically sealed. In this case, however, a sufficient amount of efficient desiccant will have to be included.

7. Scope of equipment

7.1 Standard equipment, NT-1

1 Transport case,	27 kg	120 cm x 46 cm x 34 cm
containing:		
1 NT-1 Navigation Telescope 1 Head rest 1 Filter B 1 Filter D 4 Rubber buffers 1 Hexagon socket wrench, 6 mm 1 Hexagon socket wrench, 3 mm 1 Spare cover glass, mounted 3 Spare hexagon socket screws for objective cover glass 1 Dust brush for optical surfaces 1 Cloth for optical surfaces	16 kg	

7.2 Optional accessories for NT-1

- Additional navigation reticule (see Fig. 8)
- Special 16x eyepiece for high-altitude flights
- Synchro head for conversion to NT-2
- DCON-NT-2 Drift Transmitter (for exclusive use in conjunction with synchro head).

7.3 Standard equipment, NT-2

1 Transport case,	27 kg	120 cm x 46 cm x 34 cm
containing:		
1 NT-2 Navigation Telescope 1 Filter B 1 Filter D 4 Rubber buffers 1 Hexagon socket wrench, 6 mm 1 Hexagon socket wrench, 3 mm 1 Spare cover glass, mounted 3 Spare hexagon socket screws for objective cover glass 1 Spare moving-line tape 3 Spare lamps, 28 V 1 Dust brush for optical surfaces 1 Cloth for optical surfaces	18 kg	

7.4 Optional accessories for NT-2

- Additional navigation reticule (see Fig. 8)
- DCON-NT-2 Drift Transmitter

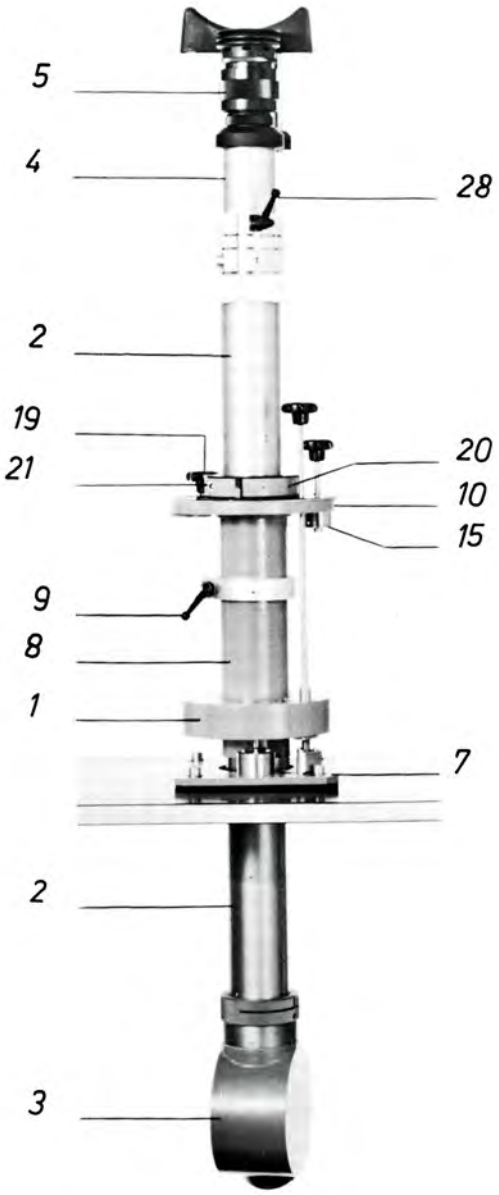
8. List of illustrated parts

Fig. No.	Part No.	Designation
1	1	Suspension mount
1	2	Guide tube
1	3	Objective head
1, 5, 6	4	Eyepiece extension
1, 5	5	Eyepiece (NT-1)
2, 6	2	Synchro head
1	7	Base plate
1	8	Guide
1	9	Clamp lever
1, 4, 10	10	Plate
2, 4	11	Longitudinal-tilt knob
2, 4	12	Transverse-tilt knob
4	13	Circular level
2, 4	14	Drift setting
1	15	Drift lock
4	16	Reading index for drift and graduated course circle
4	17	Reading index for orientation circle
4	18	Graduated course circle
1, 4	19	Clamp of graduated course circle
1	20	Clamp ring
1	21	Hexagon socket screw (6 mm)
4	22	Orientation circle
2	23	Knurled collar (objective head)
2	24	Objective
2, 5	25	Clamping system
5	26	Hexagon socket screw (6 mm)
5	27	Knurled collar (eyepiece extension)
1, 5	28	Clamp lever
5	29	Adapter ring for NT-1

Fig. No.	Part No.	Designation
5	30	Head rest
5	31	Clamp screw
5	32	Ring
5, 6	33	Eyepiece focusing ring
5	34	Eyecup
6	35	Adapter ring for NT-2
6	36	Knurled collar (synchro head)
6	37	Eyepiece with eyecup
6	38	Overlap-control knob
6	39	Moving-line brightness control
6	40	Lamp socket
6	41	Lamp housing
6	42	Serial-photography switch
6	43	Pin-point button
6	44	Control side
9	45	Front panel with indicators
9	46	Camera-cycle signal lamp
9	47	Overlap display
9	48	Test button
9	49	Drift signal lamp
9	50	Aperture indicator
9	51	Exposure signal lamp (over/under)
9	52	Shutter-speed indicator
9	53	Image-motion signal lamp
9	54	Film-transport signal lamp
9	55	Blower-motor signal lamp
10	56	DCON-NT-2 Drift Transmitter
10	57	Cable connecting drift transmitter and synchro head
10	58	Cover
11, 12	59	Rubber buffer
5	60	Red ring
5	61	Headless screw
5	62	Spacer ring
14	63	Movable guide roller
14	64	Moving-line tape

Fig. No.	Part No.	Designation
2, 10	65	Cable connecting NT-2 and ICC
6	66	Receptacle for connection of ICC
6	67	Receptacle for connection of drift transmitter
14	68	Spring
14	69	Connector
14	70	Adjustment of shutter-speed indicator
14	71	Adjustment of aperture indicator
12	72	Spare lamps, spare moving-line tape

1



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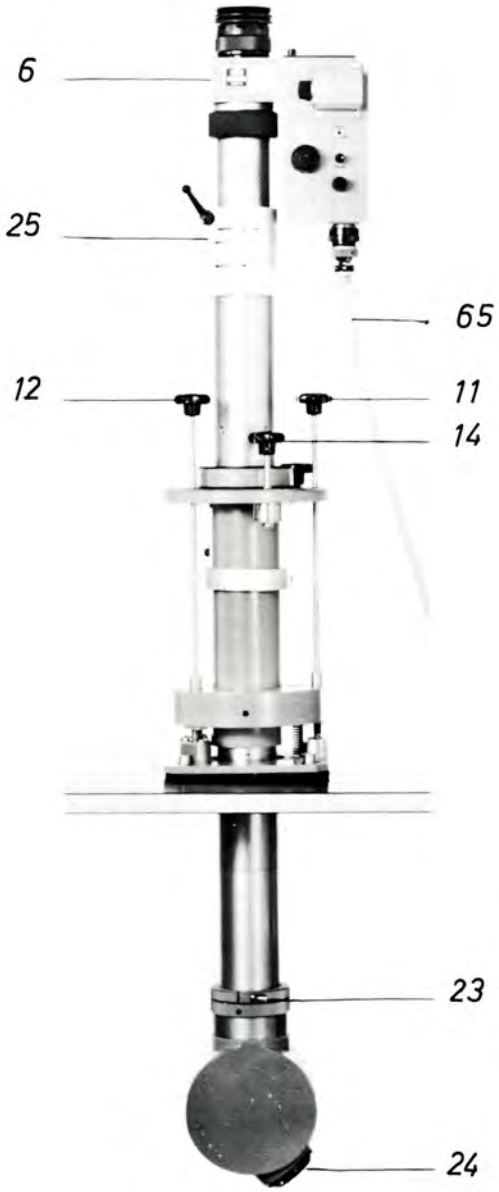

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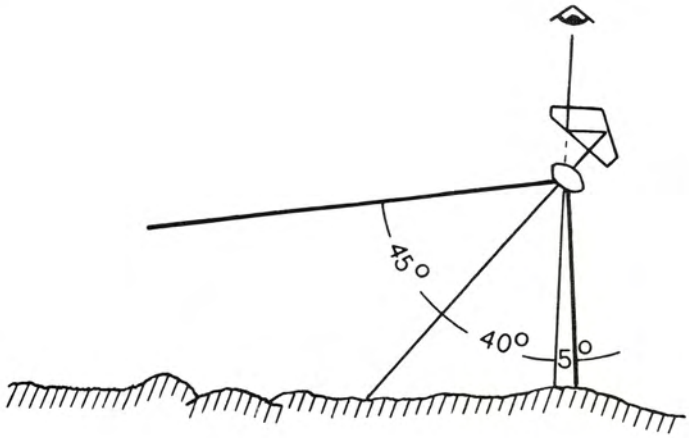

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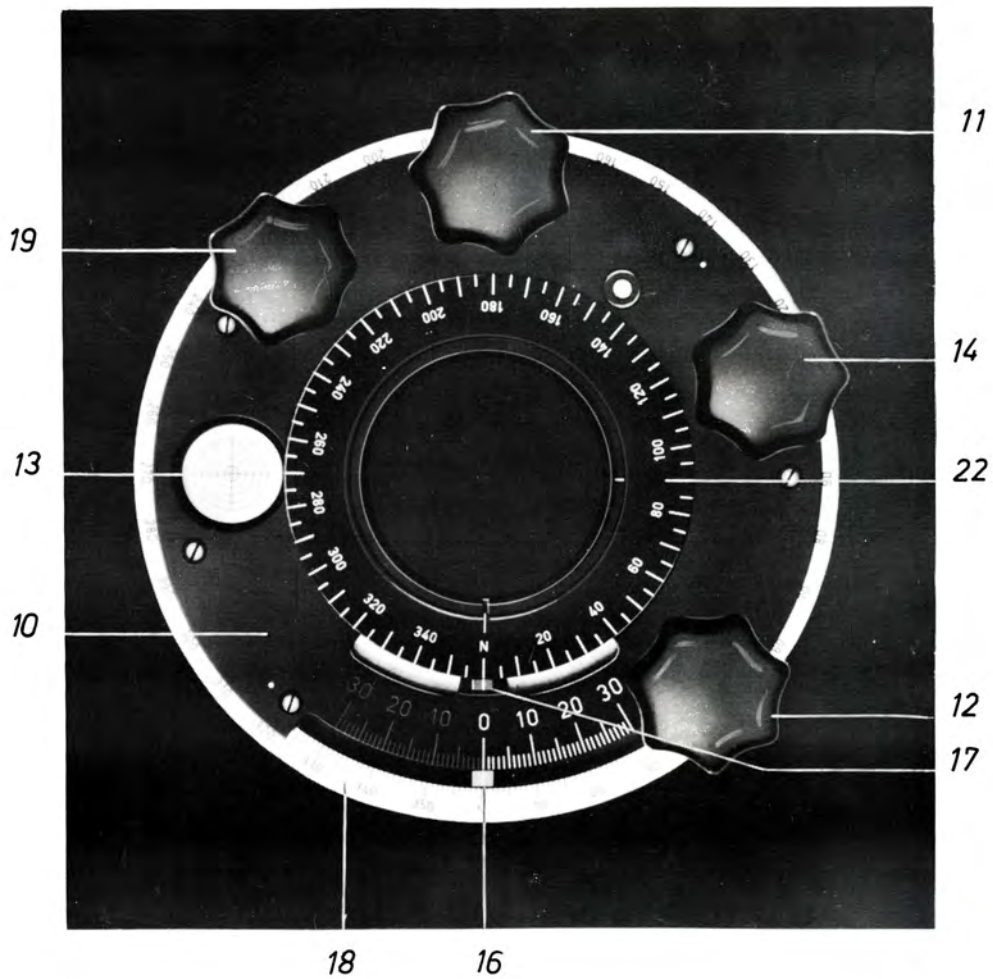

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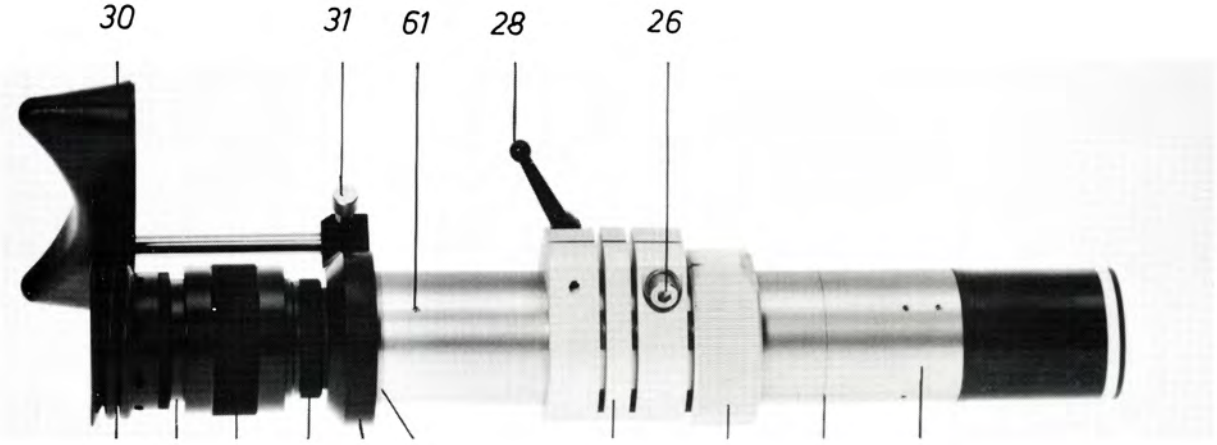

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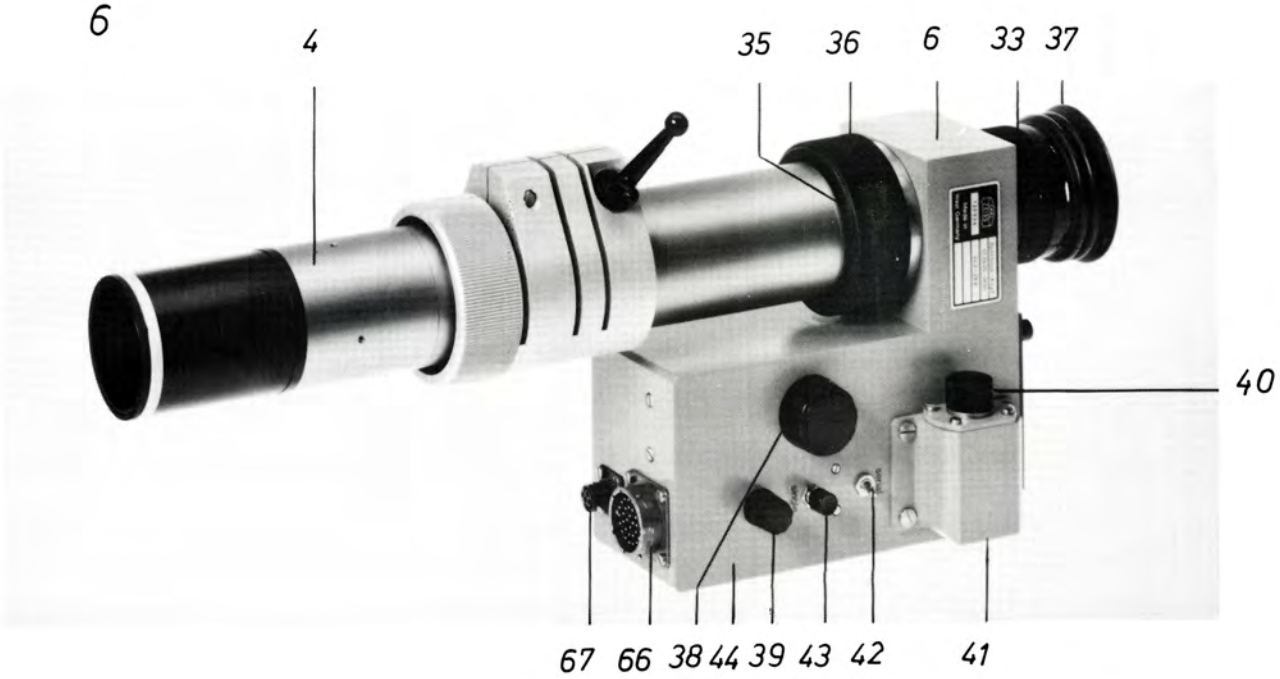

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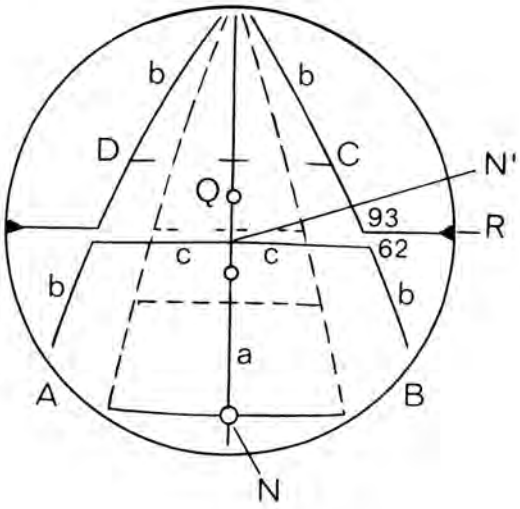

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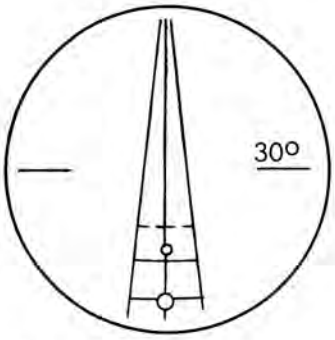

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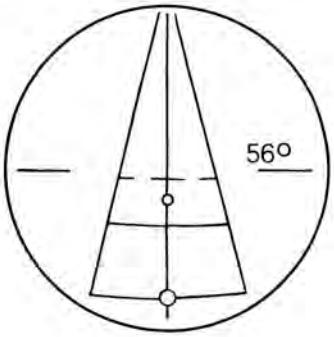

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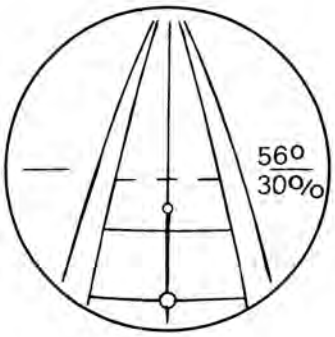

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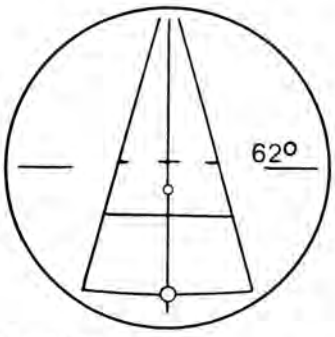

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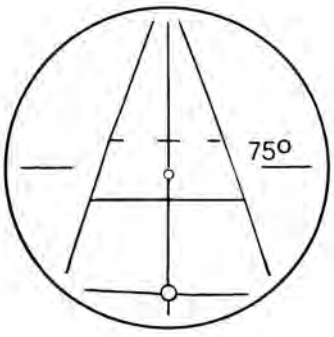

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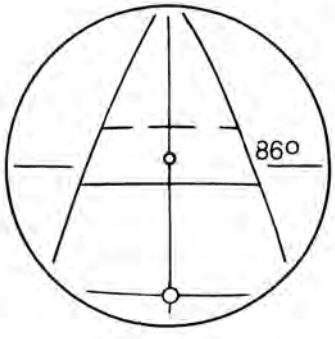

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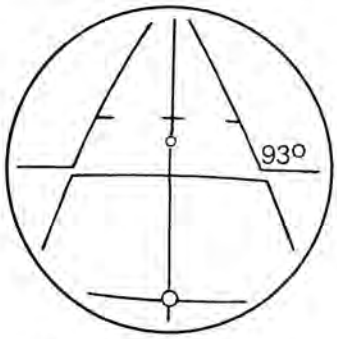

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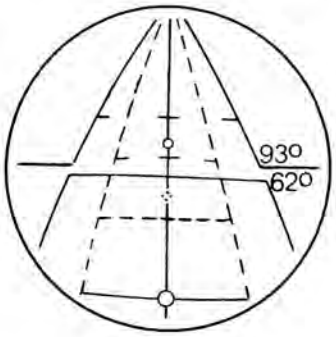

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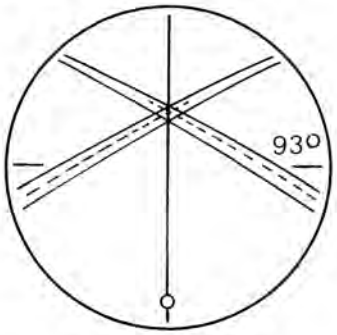
(ITC Next-Line Grid)



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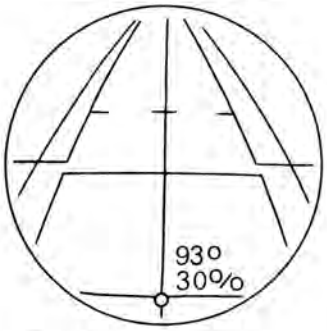

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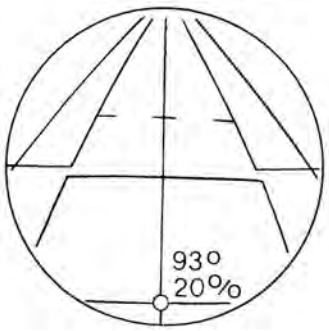

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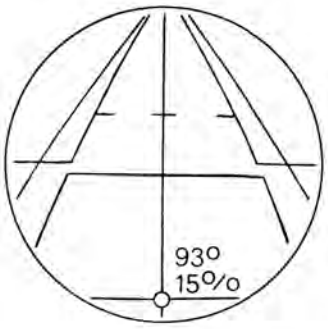
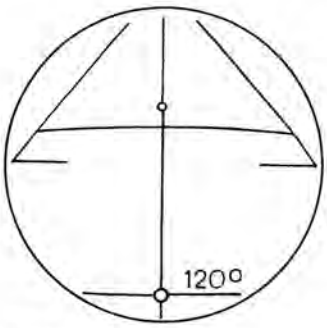


- 8060

Wild f = 88 mm



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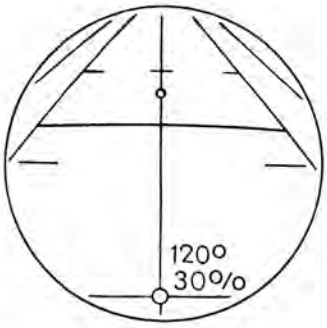

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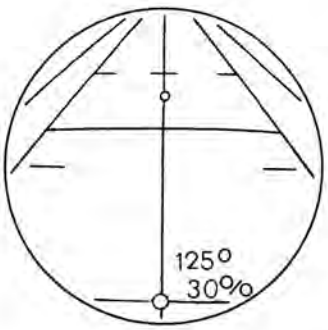

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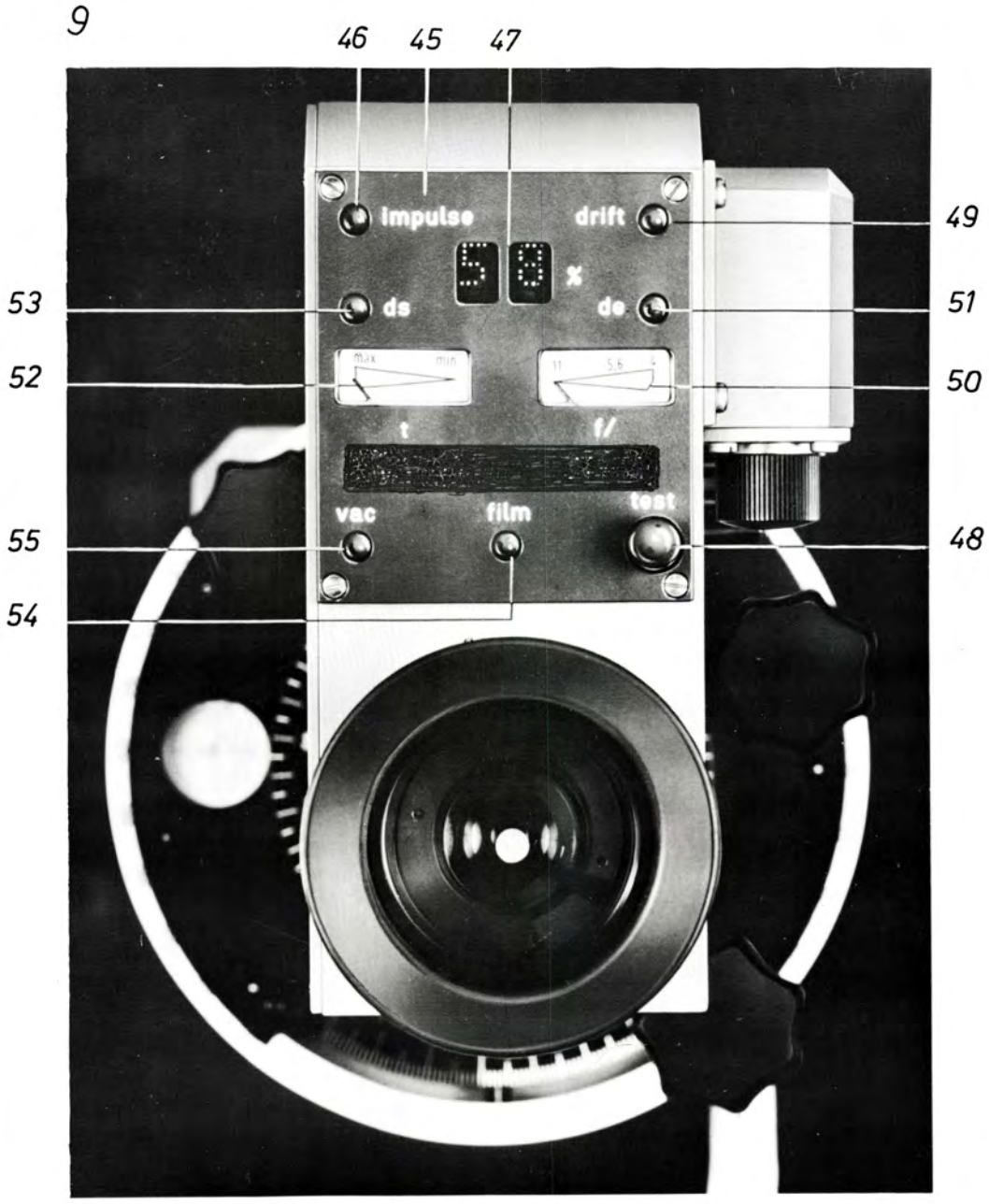

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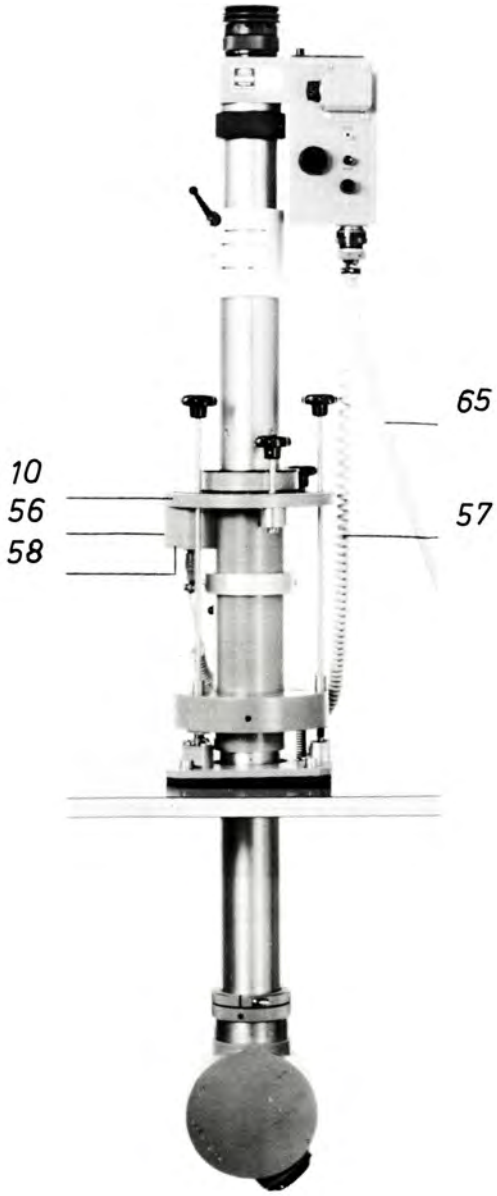

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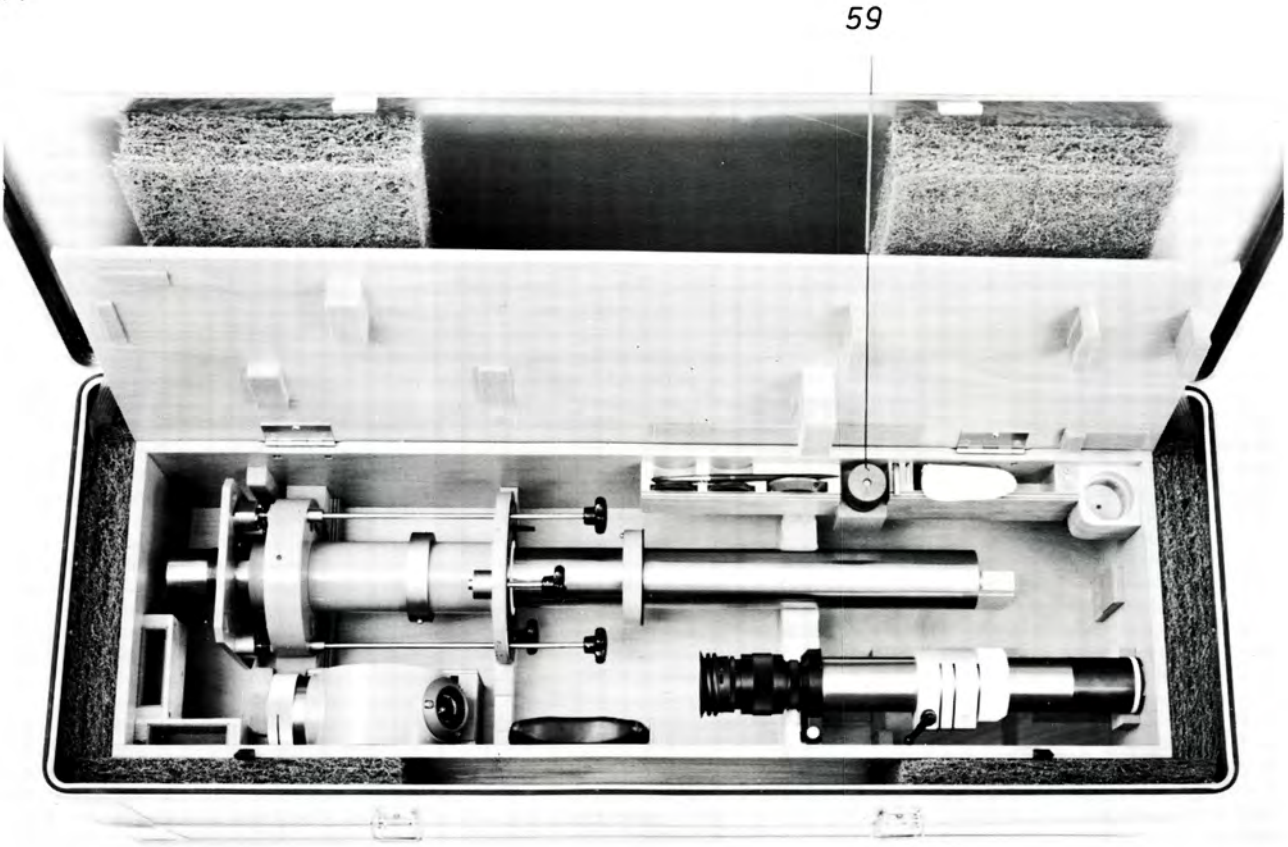

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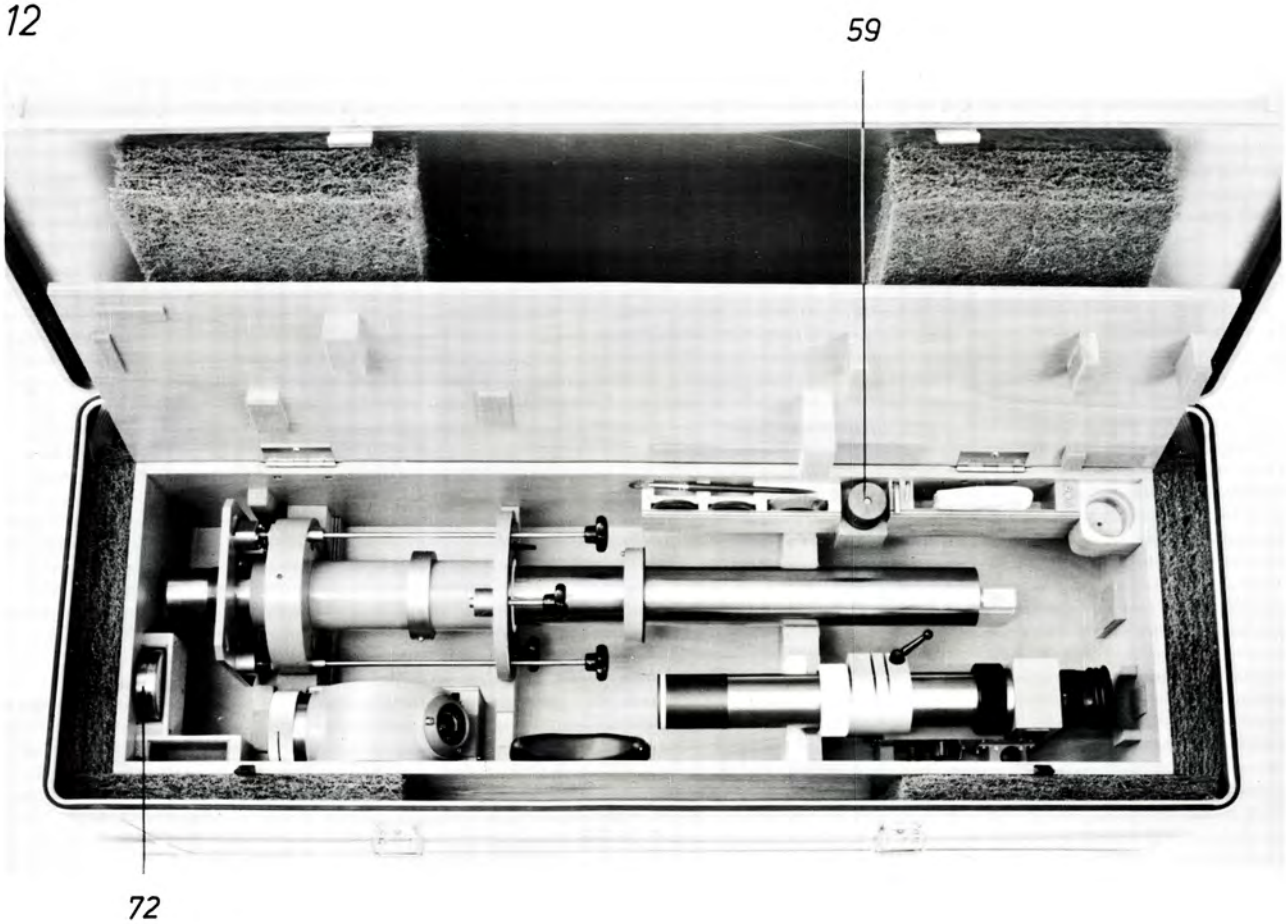
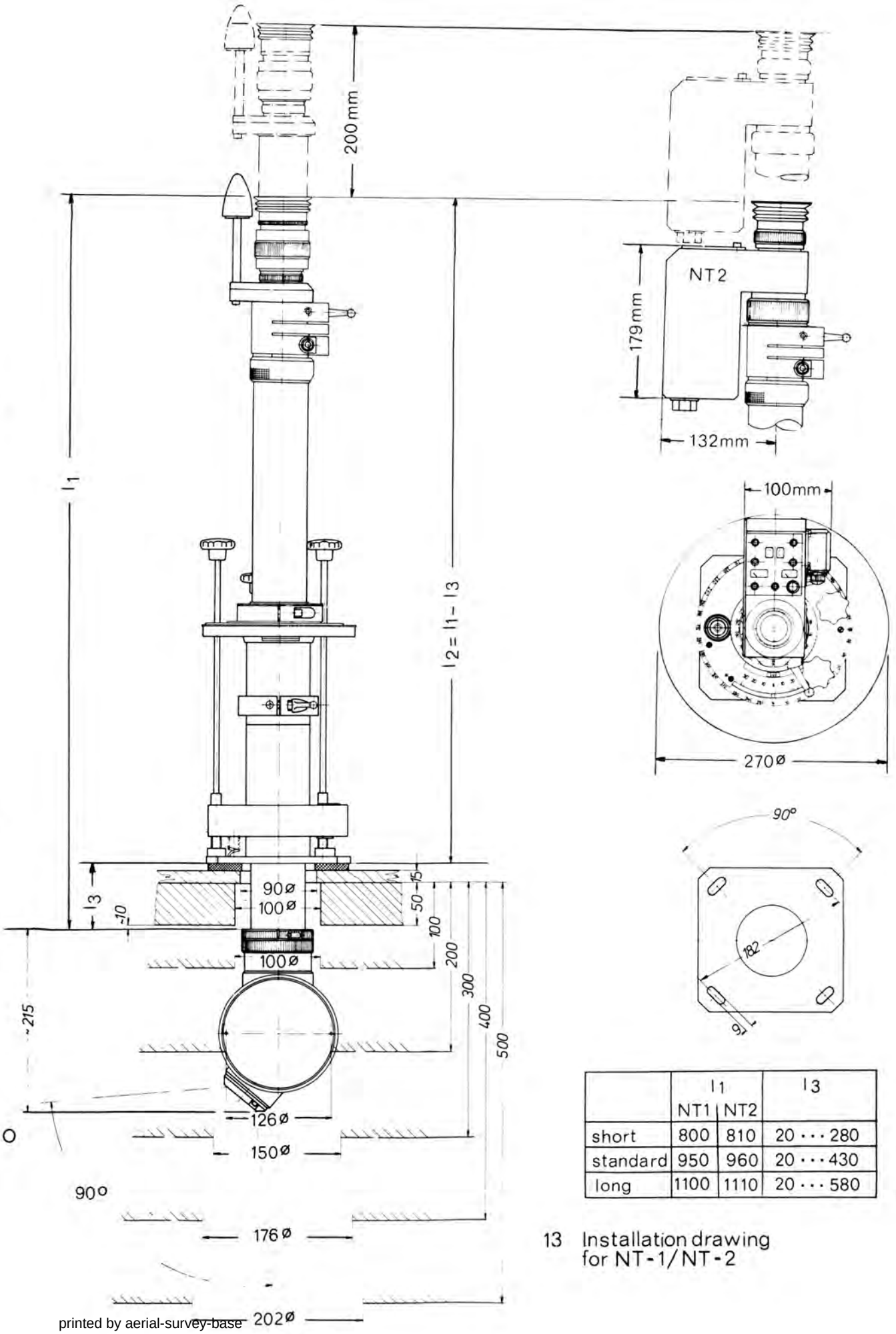
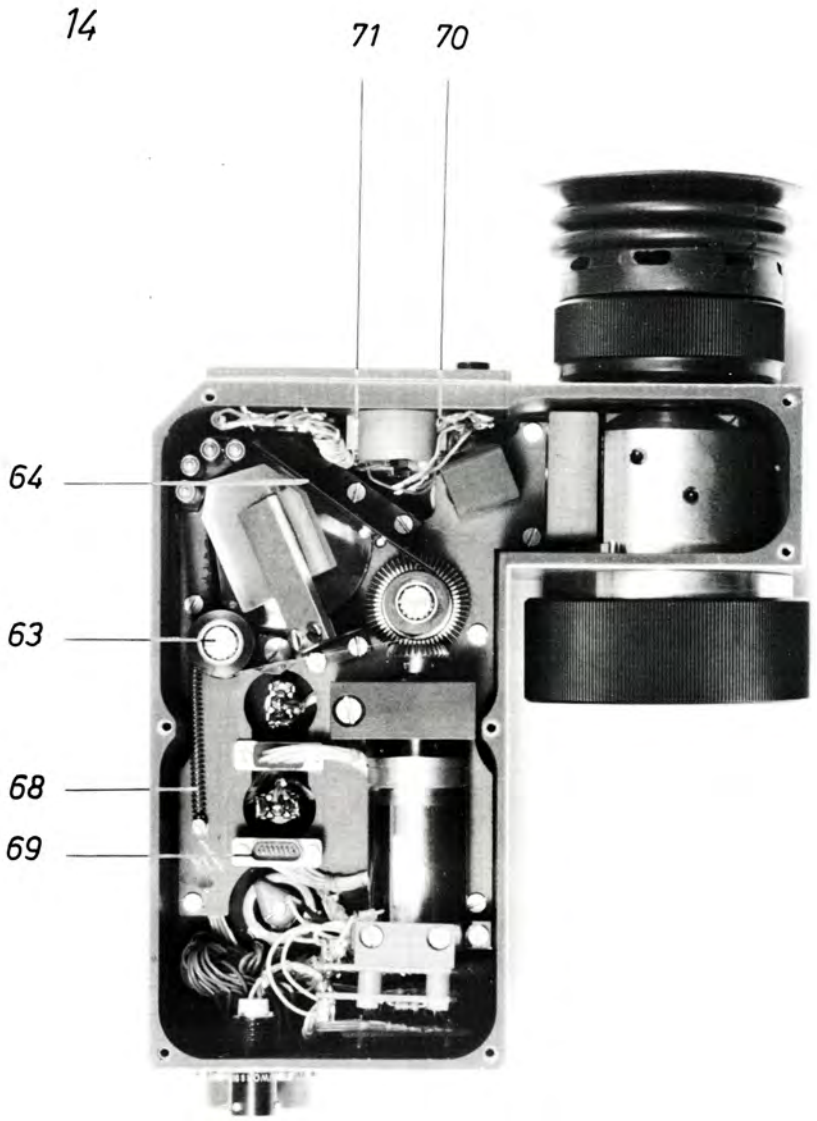
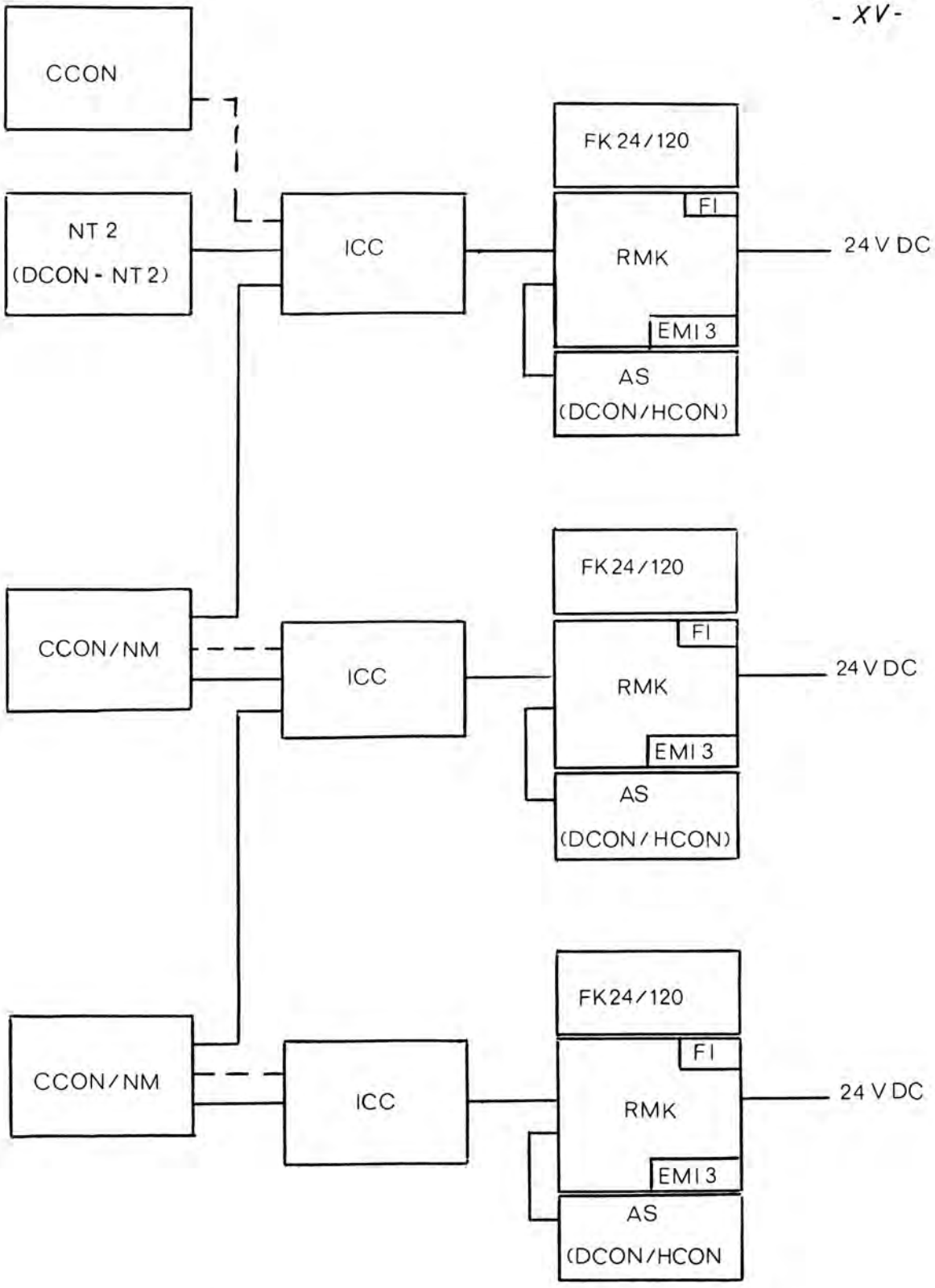




	l1		l3
	NT1	NT2	
short	800	810	20 · · · 280
standard	950	960	20 · · · 430
long	1100	1110	20 · · · 580

13 Installation drawing for NT-1/NT-2

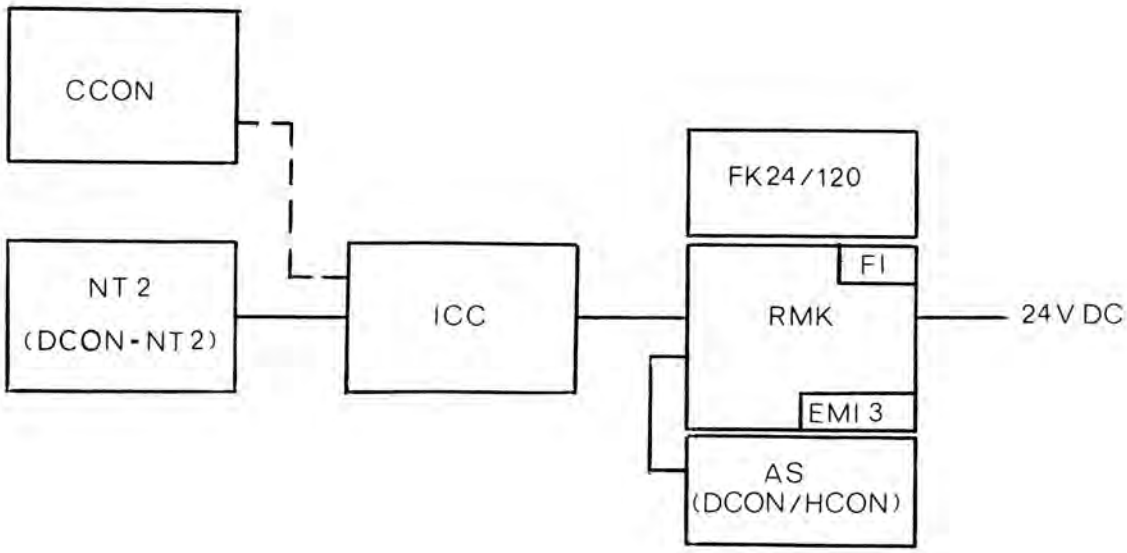




For RMK with remote-control wiring

Same control as shown in Fig. 17 (NT-2 indicators available at CCON/NM).

Fig. 19: Remote control of several cameras with NT-2 and CCON/NM



For RMK with remote-control wiring

Automatic controls:

- EMI-2 or EMI-3 Exposure Control (incorporated in RMK).
- HCON Automatic Leveling System (incorporated in AS).

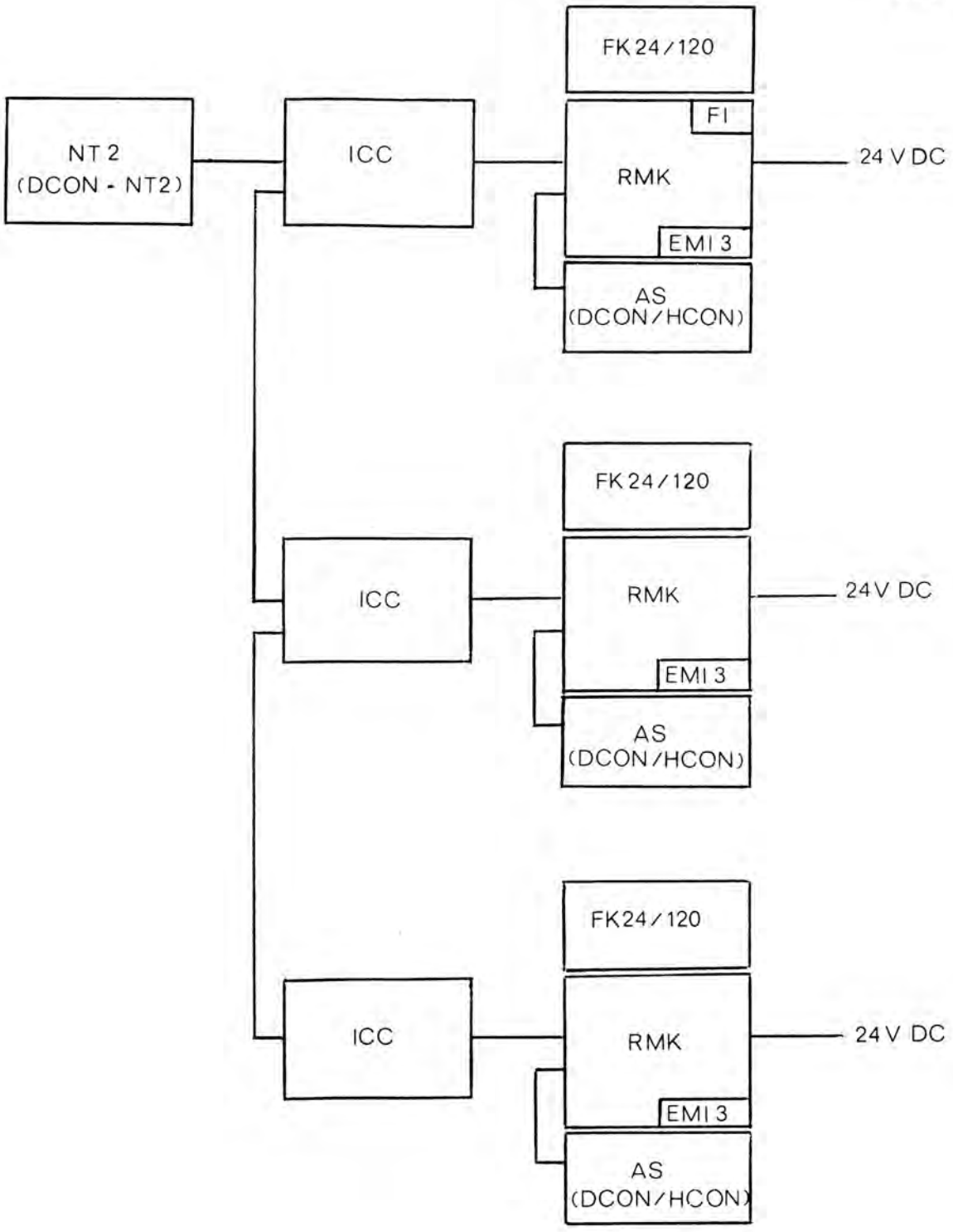
Controlled from NT-2 (optional accessories for standard equipment):

- Drift Control (with signal lamp).
- Indicators for EMI-2 or EMI-3.
- Signal lamps for film transport and blower motor.

Controls of CCON:

- RMK master switch.
- Automatic leveling switch.
- Automatic leveling signal lamp.
- Exposure control switch.
- Aperture and shutter-speed setting.

Fig. 17: Remote control of RMK with NT-2 and CCON



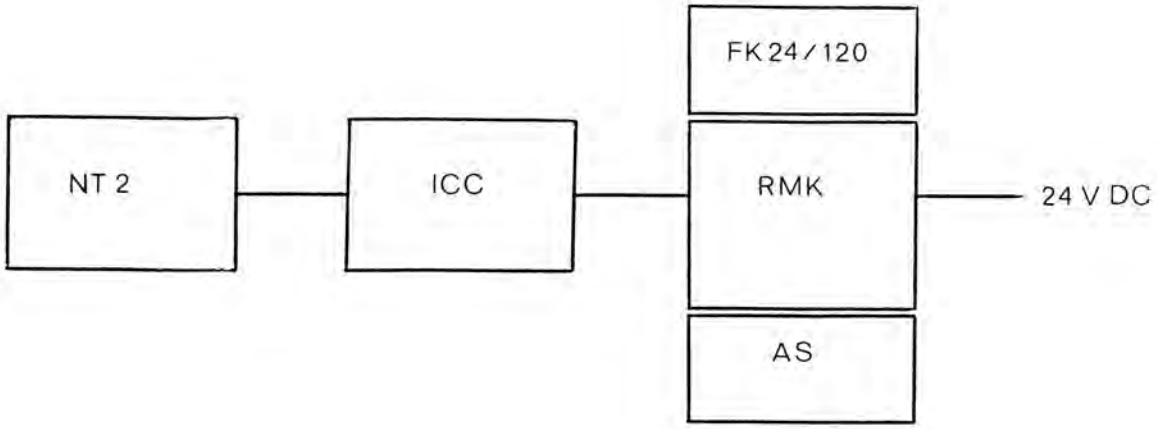
For RMK with or without remote-control wiring

Same control as shown in Fig. 16 (no differences for RMK without remote-control wiring).

Controls of NT-2:

All indicators apply exclusively to the camera whose ICC is directly connected to the NT-2 (see item 5.3.7).

Fig. 18: Remote control of several cameras with NT-2



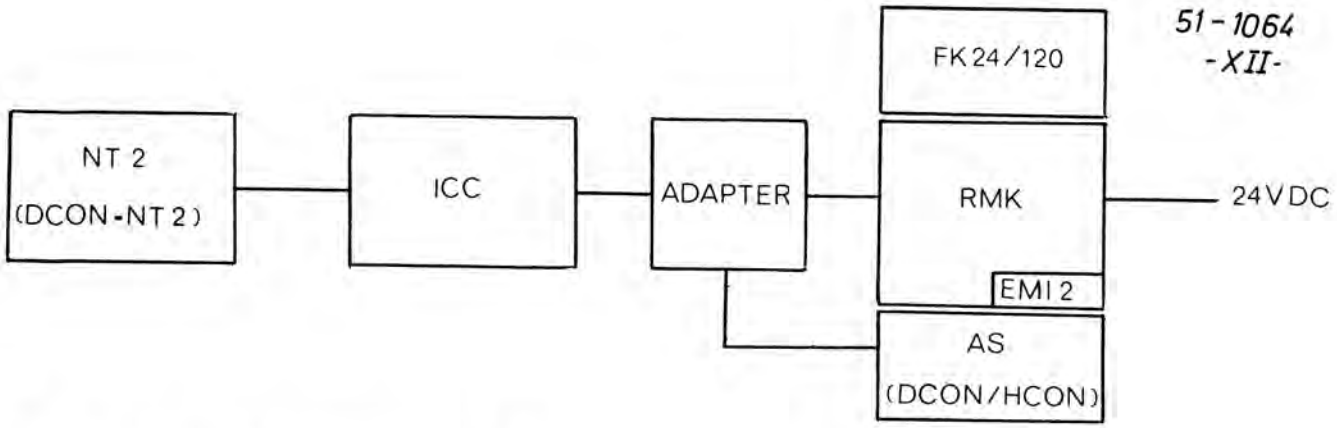
For RMK with or without remote-control wiring

(for RMK without remote-control wiring, the connecting cable between ICC and camera must have a five-pin plug for connection to RMK).

Controlled from NT-2:

- Overlap (with display).
- Shutter tripping for serial and pin-point photography (with signal lamp).

Fig. 15: RMK control with NT-2 (standard equipment)

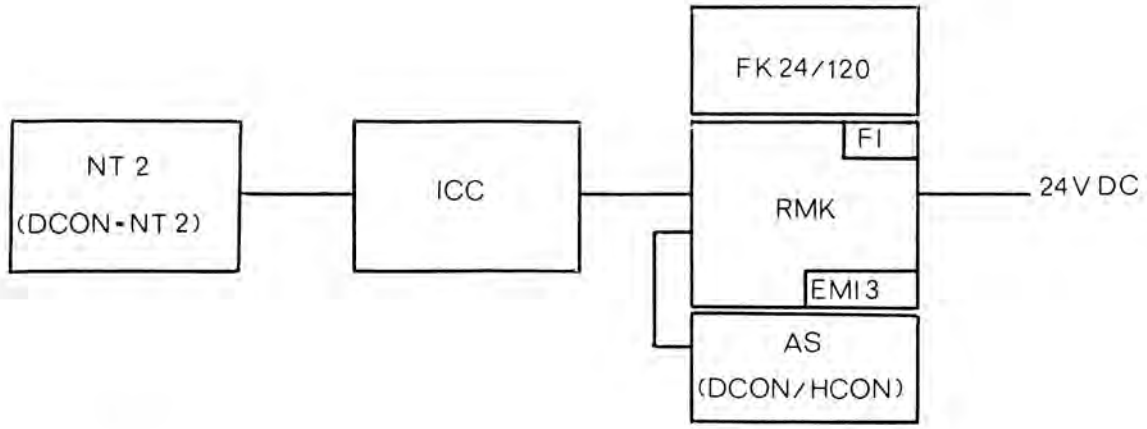


For RMK without remote-control wiring

Automatic controls:

- EMI-2 Exposure Control (incorporated in RMK).
- HCON Automatic Leveling System (incorporated in AS).

Controlled from NT-2 (optional accessory for standard equipment):
Drift Control (with signal lamp).



For RMK with remote-control wiring

Automatic controls:

- EMI-2 or EMI-3 Exposure Control (incorporated in RMK).
- HCON Automatic Leveling System (incorporated in AS).

Controlled from NT-2 (optional accessories for standard equipment):

- Drift Control (with signal lamp).
- Signal lamp for EMI-2 or EMI-3.
- Signal lamp for film transport and blower motor.

Fig. 16: Remote control of RMK by means of NT-2