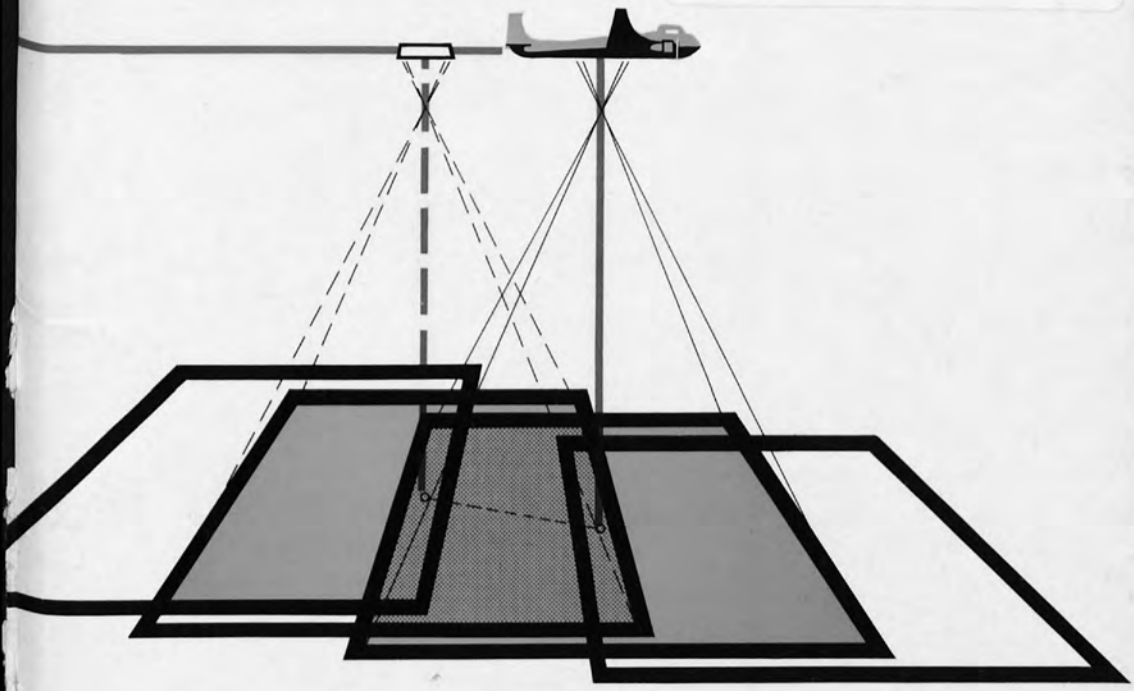
Änderungen
Seite 6, 9, 29, 35
Bild 4
Schaltplan Fig. 38

Handexemplar

C20 - BMS 3199



Aerial Survey Camera

RMK A 15/23

The figures appearing in the text in parentheses refer to the picture plates. The first numeral is the picture number, whereas the numeral behind the slash identifies the particular part.

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*) 3 copies of this schedule on waterproof cardboard are also included in this Manual

❶ Special characteristics

of the RMK A 15/23 Survey Camera
The RMK A 15/23 is an optically and technically improved model of the RMK 15/23 camera.

Lens	153 mm (6") high-performance Pleogon lens
Excellent astigmatic and chromatic correction	
Distortion (computed value) This low residual distortion is maintained almost to the very edges of the field. In addition, it is newly adapted to chromatic correction.	maximum 5 microns
Angle of field	93°
Negative size	9×9" (23×23 cm)
Filters Reduced influence of aerosol through standard equipment, in addition, with	Minus-blue filter B (470 mμ, factor 1.5)
Convenient exchange of filters while in the air	Orange filter D (530 mμ, factor 2.0)
During take-off and landing, the respective filter can be easily replaced by a lens cap (= stone guard)	
Shutter (manufactured in series since 1951)	Aerotop rotating disk shutter (between-the-lens shutter)
Shutter speeds Elimination of image motion at low flying heights	$^1/_{100} - ^1/_{1000}$ sec.
Genuine exposure times, no nominal shutter speeds	
Indicated exposure times guaranteed also at low temperatures	
High degree of light efficiency	76 – 90 % (depending on f-stop)
F-stops available	f/5.6 f/8 f/11
for infrared photography no special infrared lens, no exchange of lens cones no additional filters no additional focal-plane frames	only special-purpose film required

Auxiliary flight data recordings	3-digit counter within negative size watch with secondhand bubble level calibrated focal length data card (easily accessible during the flight)
for height recording alternative use of:	standard altimeter or Statoscope indicator
Overlap control Large, convenient ground-glass viewfinder	continuous, within a range from 20 – 90 %
Shortest cycling time	2 sec.
in the case of longer exposure times	3 sec.
Short exposure intervals, permitting stereoscopic photography also at low flying heights	
Suspension mount equipped with special shock-absorbing elements guaranteeing the absorption of vibrations even at low temperatures	
Length of film strips	120 – 150 m (394 – 492 ft), depending on film thickness, = 450 – 560 photos per magazine load
Width of film strips	24 cm (9½"), unperforated
Film flattening	by blower motor incorporated in camera body
Safe operation also at high altitudes Control at indicator	
No static discharges	
No reflex of pressure platen on the exposed film	
Upon request, **remote control device for:**	Impulse transmission Exposure time Tilt (lengthwise inclination) Crab angle
Operating voltage	24 – 28 V D.C.
Power consumption	8 amp.
$c = \frac{\text{negative size}}{\text{c. f. l.}} = \frac{230}{153}$	= 1.50 (to be set on IRU)
Reading of bubble level	1 scale division = 1°

❷ Scope of equipment

The entire camera assembly comes in 4 carrying cases. The lid of each carrying case contains a diagram which illustrates the proper way of packing the various elements.

The various components of the camera unit are packed as follows:

	Dimensions	Weight
Case No. 1:	74×60×51 cm (29.1×23.6×20.1 inch.)	30 kg
Camera body (RMK A 15/23)		57 kg
Protective cover for focal-plane frame		
Lens cap		
1 connecting cable, 3-pole		
8 spare tubular lamps (24 V, 7 W)		
16 spare brushes (8 of which for main motor, 8 of which for blower motor)		
Case No. 2:	63×49×40 cm (24.8×19.3×15.7 inch.)	20 kg
Film magazine (FK 24/120)		20 kg
2 film spools		
2 magazine keys		
1 carrying board		
Case No. 3:	49×50×40 cm (19.3×19.7×15.7 inch.)	16 kg
Universal Intervalometer (IRU)		17 kg
Installation templet		
1 connecting cable, 5-pole		
1 spare coupling		
6 spare bulbs, 24 V, 3 W with 2 spare sleeves		
1 duster		
1 dust brush		
8 spare brushes		
3 plexiglass disks		
Case No. 4:	83×66×34 cm (32.7×26.0×13.4 inch.)	27 kg
Suspension mount (AS II)		31 kg
Crab correction device		
Installation templet		
2 extensions for leveling spindles		
1 socket-head cap screwdriver		
1 neutral filter, 1 Filter B (minus-blue filter), 1 Filter D (orange filter) — in case		

❸ Description of camera

The fully automatic RMK A 15/23 Aerial Survey Camera is designed for obtaining aerial photography for the purposes of photogrammetry. The impulses for shutter tripping, film transport as well as all the other functions required for the exposure are released and controlled by the command post of the camera unit, the IRU Universal Intervalometer.

Due to its focal length of 6" (153 mm) and a negative size of 9×9" (23×23 cm), the RMK A 15/23 counts among the type of wide-angle cameras. Its distortion-free lens and its rotating-disk-type shutter permit the production of perfect photographs without evident image motion even from flying heights of less than 3000 ft (1000 m). In addition, the large capacity of the film magazine is a guarantee of great economy.

3.1 Camera suspension

The suspension mount (3/1) will permit the secure mounting of the camera within the aircraft. Simultaneously, the suspension mount serves for leveling the camera and for compensating for picture swing produced by the crab of the airplane. It is so designed that it practically absorbs the vibrations transmitted from the airplane to the camera, also at extremely low temperatures.

To overcome the picture swing produced by a crab angle, the swivel ring (3/2) may be rotated $\pm 40^{g}$. The swivel ring is clamped with a spring-loaded clamp lever (3/3) which can be turned up or down. The swivel ring is provided with a two-color graduation (3/4) and corresponds to that of the intervalometer. The crab index (3/5) provided at the swivel ring indicates the swing which has been set by the operator.

For leveling the camera within the aircraft, the suspension mount is provided with three leveling spindles with star knobs (3/6). In special cases, where the camera is installed in a well, two extensions (3/7) to be slipped on the star knobs of the leveling spindles may be used for more convenient leveling.

The suspension mount is so dimensioned that the camera body can be tilted forward for exchanging filters. An adjustable bracket (4/8) will maintain the camera in this position and protect it from dropping.

To fasten the suspension mount in the aircraft, the three base plates (4/9) which have three holes each, are secured to the floor of the aircraft with bolts. The type of bolts to be used will depend on the conditions encountered in the airplane. When the camera is packed, the three base plates are bolted to a drilling and installation templet (4/10). This templet will help prepare the mounting of the crab ring within the aircraft.

3.2 Camera body

The camera body (4/11) consists of a solid casting. The drive and control elements contained in it are therefore largely protected agains damages. Large protective flaps provided with rubber seals guarantee perfect accessibility of all important elements. The camera housing contains the following parts:

a) **Lens cone** (11/12) with shutter (7/14) and focal-plane frame (6/13)
b) **Main motor** (9/15) with drive unit
c) **Blower motor** (11/16)
d) **Auxiliary flight data** (6/17 and figs. 13, 14)

3.21 Control elements and electrical connections

The control elements as well as the sockets for the electrical connections are provided on the upper side of the camera body, to the left and the right of the focal-plane frame. They are:

a) **Master switch** (4/18)

b) **Socket for connection to aircraft power supply** (5/19)

c) **Socket for electrical connection to IRU** (5/20)

d) **Socket for electrical connection to Statoscope** (5/21)
(this socket will be protected by a screw cap if there is no Statoscope in use)

~~e) Socket for remote control (4/22)~~

Note for b)–~~e)~~:
All cable plugs are equipped with caps which may be screwed onto the camera sockets, so that an accidental disconnection is effectively prevented. **The plugs are not interchangeable.**

f) **Setting knob for exposure time** (5/23) **with indicator** (5/24)
Continuous setting and reading of exposure times between $^1/_{100}$ sec. and $^1/_{1000}$ sec.

g) **Vacuum indicator** (5/25)
Owing to the great importance of perfect film flattening, the camera is equipped with an indicator which shows whether the blower motor (11/16) which is to produce the required vacuum, works normally. In this case, the pointer will stand in the green sector. Otherwise, if the instrument's deflection should be too large or too small, the electrical connections to the blower motor as well as the motor itself should be carefully checked.
Only at very high altitudes (exceeding 8,000 m = 26,000 ft) the pointer will get close to the lower red section. However, this is normal and without influence on film flattening.

h) **Bubble level for leveling of camera unit** (5/26)

i) **Setting knob for iris diaphragm** (5/27)
Continuous setting from f/5.6 to f/8 and f/11

j) **Knob for controlling the illumination of the auxiliary flight data** (5/28)

Approximately the following settings should be employed for the various film speeds:

1 = 2 = 3 =	24° DIN = 200 ASA
4 = 5 = 6 =	20° DIN = 80 ASA
7 = 8 = 9 =	18° DIN = 50 ASA

3.22 Lens cone with shutter and focal plane frame

Together with the focal plane frame (6/13), the lens cone (11/12) forms a single integral unit of high dimensional stability which contains the lens (6/38) and the shutter (7/14). The combination of lens and focal-plane frame in one single unit guarantees an extraordinary constancy of interior orientation, i. e. of the position of the fiducial marks with respect to the projection center of the lens. The lens is the practically distortionfree high-performance Pleogon f 5.6/153 mm (6").

a) **Shutter**
The "Aerotop"-shutter (7/14) is a rotating-disk-type shutter located between the front and rear optical elements of the lens. It allows very short exposure times. From the moment the camera is switched on at the beginning of the photoflight until it is turned off, the shutter blades rotate with a constant speed corresponding to the exposure time. From the large number of "opentime" positions produced during the rotation of the blades (7/172), one blade (7/173) which rotates at a slower speed and a capping disk (7/162), controlled by the intervalometer select the desired exposure. The opening of the shutter can be regulated continuously with the aid of the rotary knob (5/23) to last from $^1/_{100}$–$^1/_{1000}$ sec., at a light efficiency of approx. 76–90 % (depending on f-stop). The exposure time is indicated by measuring the speed of the continuously rotating blades. This will ensure that the indicated exposure time corresponds at all times to the true exposure time produced by the shutter. If extremely low temperatures should slow down the speed of rotation of the blades so as to produce longer exposure times, this fact will be indicated by the exposure time indicator (5/24). Adjusting the rotary knob (5/23) permits regulating the speed of rotation of the blades and hence the desired value of the exposure time. The shutter is therefore practically insensitive to cold.

b) **Focal Plane Frame**
The focal plane frame (6/13) serves for holding the film in place at the correct distance from the lens, which is determined by the calibrated focal length. For this purpose, the upper surface of the focal plane frame is polished. This **polished surface must by all means be protected against any injury.** Furthermore, the focal plane frame limits the image aerea to 9×9" and carries the four fiducial marks (6/39). The point of intersection of the connecting lines of these fiducial marks is so adjusted that it will coincide with the principal point of the image, i. e. the point of intersection of the optical axis with the negative plane, with an accuracy of $^1/_{100}$–$^2/_{100}$ mm. The fiducial marks must by all means be protected against any mechanical contact. They are designed as mechanical pointers and as optical point marks. The distance between two point marks on two opposite sides is 226.00 mm. The checking of this distance on the exposed film is used for the determination of regular film shrinkage. At the side of the focal plane frame is a small strip (6/17) 1.5×23 cm in size for recording the auxiliary flight data. The total size of a negative including recorded data is therefore 230×250 mm.
As long as there is no magazine on the camera body, the protective cover (5/40) must be in place, so as to protect both the focal plane frame and the lens as well as the interior of the lens cone against injuries and dust. In addition, this protective cover shields the connection for the suction hose (6/45), which ensures film flattening, and effictively prevents plugging up by the penetration of dirt. The protective cover is fastened on the focal plane frame in accordance with the red index marks (5/41) and with the two clamp levers (5/46). A small window (5/43) permits checking the functioning of the camera with the protective cover closed.
Normally, the camera can only be operated with the magazine fastened in position. When the magazine is in place and the magazine slide is open, a pin at the magazine (16/47) will depress the pin (6/47) recessed in the focal plane frame, thus tripping a

contact which permits operating the camera. To permit an independent control of the camera body, the protective cover is also provided with a pin (8/47) which trips this contact. Operators are warned against actuating this contact (6/47) with any extraneous object, since this is liable to cause damage.

3.23 Main motor and drive unit

The main motor (9/15) drives the shutter and, after the exposure, the film advance mechanism, over the so-called drive unit.

The shutter is driven continuously through the friction drive (10/53) which can be regulated in accordance with the desired exposure time.

The drive unit with friction drive (10/53) becomes accessible after opening the protective flap (10/52) on the left side of the camera.

The film is advanced over a coupling (10/55). With the magazine on the camera body, both connecting pieces (6/54) can be checked for perfect engagement with the aid of a plexiglass viewer (10/42) and the luminous mark (10/44).

3.24 Blower motor

The blower motor (11/16) is housed in the right side of the camera body. It is the task of the blower motor to produce the vacuum required for film flattening.

The rear end of the motor's armor contains a cooling turbine (11/67). Through the two small nozzles (11/68, 11/69) on the side of the motor, the cooling air is drawn in (11/68) and blown out (11/69), respectively. Rubber seals and air filters (11/70) are provided in the flap (11/56), where these nozzles touch the flap. During operation of the camera, these openings provided with air filters must always be free.

3.25 Auxiliary flight data

The auxiliary flight data which are recorded on a marginal strip beside the aerial photograph are housed in the front part of the camera body and are easily accessible once the protective flap (12/71) has been opened.

They are:

a magnetic counter for photo numbers (13/72) and

a bubble level (13/74) engraved with the serial number of the camera and the calibrated focal length.

These parts are firmly mounted.

The upper side of the flight data compartment contains:

a watch with data card (13/75) and, on one side, the statoscope indicator (13/78) or a standard altimeter.

These parts can be removed.

The magnetic counter (13/72) can be read from the outside over a prism (13/80). Before take-off, the white button (13/79) is pressed in order to set the counter (13/72) to 000.

Watch and data card (14/75) can be easily removed as a unit from their support (14/77), so that the watch can be wound and set, while at the same time notes can be made on the data card. The data card is held on its base by fixing magnets (14/76) and can be easily exchanged.

Statoscope indicator (14/78) and standard altimeter can be easily exchanged after loosening the foremost knurled screw (14/81).

In the case of the standard altimeter (14/78), only a sector of the respective scale is reproduced on the photo. It is therefore necessary to loosen the lateral knurled screw (14/82) and rotate the scale in such a manner that the **height range in which the flight is to be carried out faces the lens.**

3.3 Film magazine

The film magazine (15/83) has the function of providing light-tight accommodation from the film and to effect film transport, film flattening and accurate location of the film on the focal plane frame. The magazine will hold up to 400 feet of 0.15 mm thick film. This corresponds to approximately 450 exposures. If especially thin film is used, the magazine's capacity can be increased to 500 feet and approximately 560 exposures. If films thicker than 0.15 mm are used, one magazine load should not surpass approx. 330 feet.

The magazine consists of a solid cast frame whose top is closed with the magazine cover (15/84), whereas the bottom is sealed with the magazine slide (16/85). White arrows (17/86) in the magazine mark the direction of film travel.

The film travels from the supply spool (18/132) over the movable (18/88) and the stationary reversing roller (18/87) underneath the platen (18/89) to the take-up spool (18/133). Two transport rollers (splined roller [18/90] and rubber roller [18/91]) take care of film transport proper and are actuated over the coupling (16/54) from the camera body. The two film spools are of the friction type and are moved according to the amount of film required or supplied, as the case may be. The movable rubber roller (18/91) will be pressed by springs towards the splined roller (18/90). At the same time, the movable reversing roller (18/88) actuates the brake provided at the supply spool. This brake will be released as soon as the film excercises a slight pull on the roller.

The design of the magazine cover insures perfect light sealing. There is ~~no~~ *a* protection against erroneous positioning of the magazine cover which may be put in place 180° in error. In order to avoid such mistakes, the cover carries two index screws (18/134, 18/135) on the back and one on the front side for sealing the magazine. These index screws will also serve for feeling the correct position of the magazine cover in the dark room.

The magazine cover mounts an indicator (15/94) of the amount of film which is still available for exposure. The indicator is actuated by a feeler lever (17/95) mounted on the inside of the magazine cover. When the magazine cover is fastened in position, this feeler lever rests on the supply spool. In addition, the magazine cover contains a data card (15/96).

The bottom of the magazine is closed by the light-tight magazine slide (16/85). The slide is closed or opened with the aid of the rotary knobs (17/97). **To prevent erroneous operation, the magazine slide can only be opened when the magazine is fastened into position on the camera body.** When mounting the magazine, the safety pin (16/100) is pushed into the magazine, thus releasing the slide. In addition, the two safety latches (16/99) at the camera body are automatically brought into engagement. It is therefore impossible to remove the magazine with the slide open with the resultant spoiling of an exposed film.

The bottom of the magazine also mounts the coupling for the drive mechanism (16/54) and the connection for the vacuum hose (16/98). Both parts are coupled automatically when the magazine is fastened in position or operated.

Between the film spools is the centrically seated pressure plate (18/89) which presses the film against the focal plane frame during the exposure. At the same time, it has the

function of keeping the film flat. The surface against which the film is held is provided with a large number of small orifices, so that the film is sucked against this platen. The vacuum is produced by an air turbine within the camera body and transmitted to the pressure plate over a hose (18/101) in the interior of the camera body and the respective magazine coupling.

The film spools are seated between two axle pins (17/102) which project through the wall of the magazine. At the outside, the axle pins are provided with **black-and-white signal disks** (17/103) serving as indicators of film transport during operation. **If, for instance, the film should tear, this malfunction will immediately become visible in that only one of the disks rotates.**

At the front left of the magazine is a push button (27/108) with which feeler marks can be punched on the film, for instance at the end of a strip or for singling out a particular exposure.

3.4 IRU Universal Intervalometer

The Universal Intervalometer (19/109) is the command post of the camera. From the data of the camera, the flying speed and the desired overlap ratio it computes the exposure intervals required, transmitting the electrical impulses required for shutter tripping to the camera.

The upper side of the IRU features a ground glass screen (19/112) onto which the image of the terrain is projected by a lens on the lower side of the instrument. A folding hood (19/110) increases the brightness of the ground glass image and protects the ground glass against injuries. In order to open the hood, it is necessary to push the lock (20/113) to the right.

The ground glass screen also shows the image of a chain of moving splines, the speed of which can be controlled with the aid of a rotary knob (19/114) on the right side of the housing. **This rotary knob governs two speed ranges.** If the final position has been reached in the first range, a further turning of the knob against slight resistance will automatically switch over to the second speed range. There is a certain overlapping in these two ranges, so that the chain of splines will advance somewhat slower immediately upon switching over. Adjustment in the second speed range is made in the accustomed manner. In order to determine the relative flying speed, the chain of splines and the image of the terrain must be adjusted to the same advancing speed. This will set the IRU for the required value of flying speed.

In front of the ground glass view finder there are two rotary knobs. The left-hand knob (20/115) serves for setting the desired amount of overlap in per cent, while the right-hand knob (20/116) governs the ratio C = negative side : calibrated focal length (focal length) of the respective camera (i. e. 23 : 15 = 1.50 for the subject RMK A 15/23 camera). The IRU can be used in combination with any camera that is controlled by electrical impulses. It is therefore not necessary to exchange the intervalometer when changing over from normal-angle camera to wide-angle camera. **When setting the factor C, this knob** (20/116) **should be pressed down firmly and turned.** No setting will be effected when the knob is turned without being pressed down. The purpose of this feature is to prevent any accidental disadjustment during the flight. When both knobs have been set correctly and when the image of the chain of splines has been synchronized with the movement of the image of the terrain, the IRU will convey the shutter-tripping impulses to the camera in the required intervals.

The upper side of the intervalometer also carries the switches for IRU and camera. The right-hand switch (20/117) switches the intervalometer on, while the left-hand switch (RMK) (20/118) controls the serial photography by the camera. The first serial photograph will be made immediately upon operating the "RMK" switch. This makes it possible to commence a series of photographs at a certain point. The signal lamp (20/119) in front of the "RMK" switch lights up as long as the camera is blocked either by the exposure or by the film transport.

For especially short exposure intervals for low-altitude photography as well as for the method of 80 or 90 % overlapping photography, the shortest exposure interval of three seconds can be reduced to two seconds with the aid of the switch (19/120). However, the "2 sec." setting is effective only at exposure times of $^1/_{300}$ sec. and shorter.

The counter (19/121) which can be set to "0" by means of the push button (19/122), shows the number of impulses transmitted, i. e. the number of exposures.

The **pilot indicator** (20/123) (voltmeter) permits to optically demonstrate the working cycle of the RMK camera. This voltmeter shows very exactly the instant of every exposure, thus making it possible for the pilot to effect changes of course or any other corrections between two exposures and to maintain the aircraft in an optimum position during the instant of exposure. The pilot indicator is connected to the IRU by means of a cable with plug (20/124).

If the "RMK" switch is left off, the push button (20/125) can be used for releasing single photographs **(pin point photography).** Single photos can even be released when the camera is set for serial photography. In this case, however, an automatic locking mechanism takes care that such single exposures are released only at such instants when the camera is not busy with serial photography. This is indicated by the light of the small signal lamp.

The intervalometer can be rotated in its base ring (20/126). The amount of rotation can be read at a scale (20/127). The instrument can be fixed in its position by means of the clamping lever (20/128) at the left.

Such a rotation is required in order to determine the amount of crab. For this purpose, the IRU is rotated until a certain terrain point does not wander away to one side with reference to the chain of splines. Once this has been accomplished, the crab value is read at the respective scale and transfered to the identical scale on the suspension mount of the camera.

Beside the motor cap (19/130) there is a socket for the special plug (19/131) featured on the connecting cable to the camera. This plug is provided with a screw cap which must be secured.

❹ Installation of camera and IRU in the aircraft

4.1 Installation requirements

In the aircraft, the camera unit shall be conveniently accessible to the operator for crab setting, levelling, exchange of filters, exchange of magazines, overlap control, observation of statoscope, etc. A seat shall be provided for the photographer directly beside the camera and the intervalometer.

The camera port must be large enough in order not to produce any vignetting effect. In this connection, allowance must not only be made for the angular field of the lens proper, but it must also be taken into consideration that

a) the camera can be levelled by approx. $\pm 2^1/_2{}^g$;

b) there is a provision for setting the crab angle which varies according to the flying speed of the aircraft and which in the case of slow planes (160 km/h) may reach 30°, in the case of fast planes (800 km/h) some 10°.

If there is sufficient space, the camera port may be given a round shape or – in the case of limited space – a square one.

Depending on the conditions encountered in the aircraft, and especially on the thickness of the plane's floor, the installation can or must be carried out in various ways.

In the case of relatively thin plane floors one will generally

a) mount the camera on the interior floor. The camera port must then be given a somewhat conical form towards the exterior fuselage of the aircraft, so as not to restrict the angle of view (fig. 21). It goes without saying that in the case of favorable floor conditions we may also choose a cylindrical camera port, for instance, which may have the dimensions required at the outer fuselage.

In the case of the **thick floors,** and in an attempt to avoid large camera ports,

b) the camera will frequently be installed in a well and mounted as close to the exterior fuselage as possible (fig. 22). In this case, special care must be taken, that those parts of the camera and the magazine which are located in the well do not knock against the well's edge. The camera or magazine clearance indicated in fig. 23 will then be decisive for the size of the well.

c) The suspension mount of the camera and the intervalometer must be oriented very exactly (± 1°) with the zero positions of their crab scale according to the longitudinal axis of the airplane.

d) In the majority of aircraft types, the angle of pitch increases in proportion with the flying height. In order to prevent a vignetting effect of the frequently rather small camera ports due to this angle of pitch, this factor must be taken into consideration when computing the dimensions of the camera port in the line of flight. It is recommended to determine the angle of pitch of the photographic aircraft under full load and in horizontal flight at various altitudes on the occasion of a test flight. Since the levelling range of the RMK A 15/23 in the line of flight is approximately ± 2½° for vertical photography, it may become necessary to install the suspension mount of the camera inclined from the very start by the value of the angle of pitch, if the photo flight has to be carried out at an altitude at which the aircraft's pitch angle exceeds this levelling range. Such an inclined installation is relatively easy, if a few conical wooden frames are prepared on which the camera suspension can be mounted according to the task on hand. These wooden frames may then be secured to the floor of the aircraft in their correct position, for instance with a few wing nuts.

e) In addition, care must be taken during installation – especially if the camera is set up in a well – that there is sufficient space for hinging the camera back for the exchange of filters.

4.2 Size of camera ports

The installation diagrams (figs. 23 and 24) indicate the outer dimensions of the camera unit and the diameters of round camera ports for various floor thicknesses. The dimensions for the camera ports include the maximum tilt values for levelling the camera. In addition, the drawings indicate the clearance diameters of camera and magazine, which must be taken into account for setting the crab angle – above all in a well – as well as the position of the camera hinged back for the exchange of filters.

The size of square or rectangular camera ports in dependence of the maximum crab angle to be expected (see 4.1) is indicated in table 1.

RMK A 15/23 floor thickness mm \ crab angle	0°	5°	10°	15°	20°	25°
0	352	352	352	352	352	352
50	352	352	352	352	352	352
100	420	436	452	465	475	480
150	545	565	585	595	605	608
200	670	695	715	728	735	737

Table 1 Lateral length of square camera ports for RMK A 15/23 camera (symmetrical to lens cone)

4.3 Electrical connections

The RMK A 15/23 is equipped for operation on 24 – 28 volt direct current. If the electrical system of the aircraft should have another voltage, the voltage required for the operation of the camera must be produced with the aid of a transformer, or efficient storage batteries must be installed in the airplane. The initial power consumption of the camera is approx. 250 watts (10 amp.) ,the normal operating input being approx. 200 watts (8 amp.).

It is recommended to check during the flight with all airborne equipment fed by the intermediate battery (such as autopilot, gyroscope, radio, etc.) and with the camera in operation wheter a nominal voltage of 24 volts is reached, thus proving that the capacity of the intermediate battery is sufficient. Additional storage batteries installed specifically for the operation of the camera should be recharged before every flight.

If the camera unit is connected to the electrical system of the aircraft, this circuit should be protected by a fuse. In general, a 10 amp. fuse (delay fuse) will be sufficient for single camera units.

When connecting the camera to the electrical system of the aircraft, care should be taken not to confuse the plus and minus poles of the camera cable with the plus and minus poles of the aircraft connection. Correct polarity is indispensable for protecting the outfit from damage and in order to guarantee the correct direction of deflection of the indicators incorporated in the camera.

4.4 Statoscope connection

The statoscope which may be used in connection with the camera is a precision barometer which – owing to the pilot indicator – makes it possible for the pilot to keep the aircraft at a certain, uniform flying height, while at the same time a second indicator incorporated in the camera records the differences of flying height between the various air stations. The statoscope can work perfectly only after it has been connected to the static pressure line of the aircraft with which for instance the air-speed indicator is coupled. For connecting the hose supplied with the statoscope, for instance a (T-shaped) branching-off piece may be introduced at a convenient point in the static pressure line of the aircraft. (For detailed description and operating instructions of the statoscope see Manual M 279.)

❺ Operating instructions

5.1 General

To ensure a full success of the photographic mission, it will be indispensable for the operator to familiarize himself thoroughly with the operation and functions of the camera. If 24 volt direct current is available, this can be done either at the laboratory or after installation of the equipment in the aircraft. However, even if a laboratory test has been made, a brief test in the airplane should follow in order to check correct electrical connection, sufficient freedom of movement and absence of vignetting.

5.2 Preliminary operations

5.21 Loading the film magazine

The magazine should be thoroughly cleaned before loading and after unloading. Little dust or film particles between platen and the running film may cause zones of lacking sharpness in the photo or of parallaxes in the stereo model. Dust and any foreign matter that may have accumulated must be removed. By pressing the safety pin (16/100) the magazine slide may be opened for cleaning. No force must be used when operating the rotary knobs (17/97).

Unless film with a sufficient leader is used, **the loading and unloading of the film should be practiced several times in daylight and in the darkroom** with an old or unserviceable strip of film of sufficient length, since with the panchromatic film material which is largely used nowadays, these operations must be performed in complete darkness. Only when the photographer is absolutely sure of all manipulations both in daylight and in the darkroom, unexposed film may be loaded for the photographic flight.

The magazine is removed from the carrying board (15/107) and placed on the table in such a manner that its small side accommodating the supply spool (18/132) (the side with the two index screws [18/134]) is facing the operator. Open and remove the magazine cover by rotating the locking knobs (15/93) on both sides of the magazine with the aid of the special key (17/92). Shift the wire brackets (18/104) so that they engage in the notches (18/106), then remove the empty take-up spool (18/133) (magazine side featuring one index screw (18/135) from the notch. By turning both signal disks (17/103), the axle pins and the locator pins for the take-up spool are caused to snap into position. An exact fit has been achieved when the wire bracket (18/104) is pressed against the front stop by the power of a spring. By no means must the bracket be pressed into this position by the application of force.

If the film to be loaded in the magazine has not been supplied from the manufacturer on a Zeiss spool, it must first be transferred to the supply spool of the film magazine. It is not necessary to remove paper leaders, since they will pass through the magazine without difficulty. To fasten the film on the spool, the beginning of the film or the leader is cut to form a taper. When winding the film on the supply spool, the emulsion side must face toward the core of the spool.

Then place the supply spool in such a way between magazine and operator that the free **end faces** the magazine **with the emulsion side down.** Introduce the film or the leader in the magazine in accordance with the respective arrows. It will thus pass over the two reversing rollers (18/87, 18/88, and fig. 25) between the pressure plate (18/89) and the

magazine slide (16/85 and fig. 25) until the tapered end of the film appears between the transport rollers (18/90, 18/91). With the thumb of one hand the grip (18/136) of the rubber roller (18/91) is then pressed in the direction of the front of the magazine, so that this roller is lifted off the splined roller underneath. The free end of the film can now be grasped with the other hand, pulled forward between the rollers and introduced in the slot of the take-up spool (emulsion side facing the core of the spool). The supply spool is cautiously inserted in the magazine and locked in the same way as the take-up spool. (Remove wire bracket [18/104] from the notch [18/106] and turn both signal disks [17/103] until the axle pins and the locator pins snap into position.)

The take-up spool is then turned by hand in the opposite direction of the operator until the film is tight on its entire length between both spools, so that perfect guidance is guaranteed. At the same time, the grip (18/136) of the rubber roller must again be pushed forward. The film shall run along the spool flanges without any friction.

Replace the magazine cover (15/84) and lock it by turning the locking knobs (15/93) on both sides of the magazine with the special key (17/92). When replacing the magazine cover, watch out for correct position. The index screws (18/134, 18/135) in the magazine cover must coincide with the index screws on the magazine itself. Make sure by touch. After the magazine is locked, the slots will point in the direction of the red index marks. Once the magazine has been locked, check the exact fit by turning the right and left signal disk in opposite directions. There must be a rough stop.

The couplings and the magazine slide must by all means be protected against injury. The magazine must always be strapped to the carrying board (15/107) whenever it is not in position on the camera. This applies especially to transport from the aircraft to the darkroom.

5.22 Unloading of film magazine

The film is removed from the magazine following exactly the reverse sequence as during the loading operation. If a roll of film has been exposed only in part, roll another 3 to 6 feet on the take-up spool before cutting the film. This will prevent that exposed film is lost during the development process.

5.3 Installation of camera body on suspension mount

For putting the camera in place on the suspension mount, the handgrips (6/30) are hinged up after withdrawing the latch bolts (6/31). Place the camera in position paying attention to the red index marks (3/29, 6/29) and hinge the handgrips down again until the latch bolts engage. Suspension mount and camera are then firmly locked.

5.4 Removal of lens cap and exchange of filters

In order to remove the lens cap (4/32) during the flight or to exchange a filter, pull up the rear handgrip (4/30) on the camera body and hinge the camera up around the front lock, keeping it in its hinged-up position with the aid of the bracket (4/8).

The lens side of the camera body features a lock (26/34) for color filters and lens cap. A latch (26/35) releases the lock (26/34).

The camera will not operate if the lens cap (26/32) is not removed, since the switch pin (26/33) will break the contact.

5.5 Putting the magazine in place on the camera body

Also putting the magazine (27/83) in place on the camera body (27/11) is facilitated by red index marks (27/36). The upper side of the camera body features two guide strips (6/37) facilitating the positioning of the film magazine. For putting the magazine in place, use the hand grips (17/105). Once these hand grips have been released, they will automatically return to their original position, thus locking the magazine firmly on the camera body.

5.6 Operation during the photo flight

If the preparatory operations have been performed with adequate care, the operator will have little to do during the photo flight.

Before take-off of the aircraft, prepare the camera for exposure, i. e. remove lens cap, install yellow or orange filter. Place magazine in position, make notations on the data card, wind and set the watch. Set exposure time and, if necessary, lens aperture, adjust illumination intensity for flight data recording. Set data on IRU. Check cable connections, open magazine slide and make short test run of camera and IRU. Check film travel, operation of ladder, shutter noise and flashing of signal lamp. **Give special attention to correct vacuum indication!** Disconnect RMK!

In aircraft in which the camera port cannot be closed, the lens cap should then be replaced on the lens, in order to protect the lens during take-off.

After the aircraft has taken off, remove lens cap and replace the desired yellow filter with the RMK still disconnected.

Shortly before the airplane reaches the territory to be photographed, level the camera, turn on the camera switch and adjust exposure time; then turn on the "IRU" switch at the intervalometer and synchronize the chain of moving splines with the motion of the terrain image. At the same time, allow for crab by rotating the intervalometer until the terrain does no longer wander out of the viewfinder laterally to the ladder. Set the crab reading of the intervalometer at the camera crab ring.

On reaching the territory to be photographed, set the camera in motion by operating the "RMK" switch on the intervalometer. During the survey flight, check constantly synchronization and crab at IRU, level position and exposure time of camera, proper film travel (black-and-white disks) and the supply of unexposed film.

Attention! In order to avoid any film deformations, every flight strip should begin with a "flying start", i. e. some ten photos at the beginning of **every flight strip** should be taken outside the survey area proper.

If it is doubtful whether the film supply will suffice for the next flight strip, magazines should be changed after completing one strip.

At the end of the mission, turn off all three switches on camera and IRU, close magazine slide, remove magazine and strap to carrying board. Fasten protective cover on focal plane frame. Write "exposed" on the magazine data card. Tilt camera upward, remove filter and replace lens cap.

Special care must be taken that filters are exchanged or the lens cap put in place on the lens only with the camera disconnected, i. e. with the shutter blades not rotating any more.

Also before landing, camera and IRU must be switched off, so that the rotating blades will not be damaged by landing bumps.

After landing, pack the camera, if necessary dismantle and pack camera suspension and intervalometer.

These operations aresummarized in annex 5.7.

5.7 Photoflight operations

(Note: The figures indicate the sequence of the various operations.)

Preparation and checks before take-off

Magazine	Camera	Intervalometer
	❶ Check contact of commutator brushes in blower motor Check feed voltage: 24 – 28 volt direct current	
❷ Load magazine with film Mount magazine on camera		
	❸ Remove lens cap Mount filter Record date, flying height, area, etc. on data card Set height range of altimeter Wind and set camera watch Set illumination for recorded data according to type of film Approximate equivalents: Characteristic No. 2 = 24° DIN = 200 ASA 5 = 20° DIN = 80 ASA 8 = 18° DIN = 50 ASA	❹ Set side – focal length ratio and desired overlap
❻ Open magazine slide	❺ Check connection to aircraft power supply Check connecting cable to IRU	
	❼ Turn on main switch Check lamps of recorded data	❽ Turn on switches "IRU" and "RMK"
❾ Check film travel	Check vacuum indicator	
	❿ Check shutter operation	⓫ Check ladder adjustment and signal lamp

Then turn off all electric switches, remove filter and mount lens cap.
Take-off of aircraft.

Photography

During approach, remove lens cap and mount filter.

Immediately before beginning of exposure

	❶ Level camera Turn on camera switch Adjust exposure time (see exposure diagram) Set diaphragm Check vacuum indicator	❷ Turn on "IRU" switch Synchronize IRU ladder with terrain image Set crab angle
	❸ Set crab angle	
During photography		❶ Turn on "RMK" switch Check synchronization Check crab angle
❸ Watch film transport (black and white signal disks)	❷ Check levelling of camera Check exposure time Check vacuum indicator	

After exposure

❶ Close magazine slide Write "exposed" on magazine data card	❷ Turn off main camera switch	❸ Turn off "IRU" and "RMK" switches

Remove filter and mount lens cap.

After the photo flight

❶ Remove magazine from camera Strap to carrying board	❷ Fasten protective cover on focal plane frame Disassemble camera	❸ Disassemble "IRU"

❻ Photographic data, film development and film treatment

In the course of flight planning, the following photographic data must be determined among others:

1. Flying height
2. Flying speed
3. Exposure interval
4. Film speed
5. Filter
6. f-stop and exposure time

Flying height

For the RMK A 15/23 camera, more or less the following flying heights will be chosen for civil photography:

for single objects (e. g. colume determination for open-pit mining):	h = 500 m
for maximum accuracy (e. g. reallotment):	h = 2000 m
for topographic mapping (e. g. German basic map):	h = 3000 m
for triangulation:	h = 5000 m

Decisive for determining the flying height is above all the desired plotting accuracy, the identification of details and the economy. In this connection, economic photography means on the one hand to cover the largest possible surface with the smallest possible number of models – and consequently with a small number of control points. However, economic photography may also mean that one entire map sheet of a certain scale is covered by one single model.

Flying speed

Taking into account usual photographic aircraft and in order to create favorable photographic conditions, the following values should generally be used:

v_g not inferior to 150 km/h, not larger than "1/5 of the flying height"
Example: h = 2000 m, v_g not larger than 400 km/h.
The recommended range is shaded in diagram 1.

Exposure interval

Normal exposure intervals will result from an overlap of 60 % to be set on the IRU.

For certain purposes, an overlap of 80 % is recommended. In this case, it will be possible to choose between two photo pairs, selecting for instance that one offering the most favorable situation for the respective plot.

And finally, an overlap ratio of 90 % is recommended especially for the production of single map sheets, for the orientation of adjacent flight strips or for rectification in the case of hilly terrain, i. e. in all those cases where a large number of possible choices is of great importance. The higher consumption of film brought about by this method of photography is generally not very critical if the share of the photographic flight is compared with the total cost of map production.

Film speed

As a compromise between film grain and film speed, films of 20° DIN and – under unfavorable lighting conditions – of approx. 24° DIN will nowadays be generally employed.

Filters

Aerosol, haze and dust particles may reduce the image quality quite considerably. Even if (as judged from the ground) the air seems to be very clear, it is therefore recommended to use color filters for the increase of contrasts. The Zeiss KI neutral filter should only be used for flying heights inferior to 1000 m. The Zeiss B minus-blue filter should be employed at higher altitudes. The Zeiss D orange filter has been expressly included in the standard equipment of each RMK A 15/23 camera in order to further increase the image quality. It should therefore be used as often as possible.

f-stops and exposure time

Diagram 1 (fig. 28) contains recommendations as to the combination of filters, f-stops and exposure times. The basic idea of this diagram is to choose the longest possible exposure time limited only by the required elimination of image motion. This brings us as close as possible to the so-called optimum diaphragm of the lens, while at the same time the aerosol is given maximum consideration. The diagram is based on the experience gained in the Zeiss laboratories as well as on numerous test flights.

For a standard photo flight of

v_g = 220 km/h
h = 3000 m

we will, for instance, find the following settings in the diagram for a film speed of 20° DIN:

filter: B
f-stop: 11
exposure time: 1/100 sec.

Using approx. 1/750 sec., the neutral filter KI and an aperture of f/5.6 would, in the same case, produce inferior results, although the same degree of blackening would be achieved on the emulsion.

For a flight at an altitude of 500 m the following example should be quoted, in which no image motion will become visible in the aerial photo inspite of the low flying height:

v_g = 250 km/h
h = 500 m
film: 20° DIN
filter: KI
f-stop: f/5.6
exposure time: 1/750 sec.

Attention:

The shutter times indicated in diagram 1 (fig. 28) are applicable only to the Zeiss RMK, since this camera produces genuine shutter times instead of nominal shutter times.

In addition, diagram 1 is adapted to normal lighting conditions as are prevalent in Central Europe (Zeiss Ikophot lightmeter with difusion disk, lightmeter pointed at the sky at a setting of 20° DIN; light value approx. 15; exposure time at f/11 approx. 1/250 sec.). In desert areas, the same diagram should be used for 20° DIN film with the values indicated for 24° DIN. The same holds true for other variations of lighting. Inspite of this, however, the shutter speeds should be chosen exactly as indicated in diagram 1.

Infrared film – color film

In order to take infrared photography, it is only necessary to load the magazine with infrared film and to mount the filter D on the lens. Diagramm 1 indicates, for instance, the following example:

v_g = 300 km/h
h = 4000 m
film: infrared
filter: D
f-stop: f/8
exposure time: 1/100 sec.

For color photography, the KI filter must be mounted on the lens. All other factors are again taken from diagram 1 (color). It is not recommended to take color photographs without neutral filter, since this filter is provided with a special coating of varying density which counteracts the natural fall-off of light.

Film development

In general, the respective instructions given by the film manufacturer will be followed. According to latest investigations made in various countries, a gamma value below 1.0 is preferred in developing films exposed in the lower atmosphere. Photos developed with a gamma value of 0.5 or 0.7 will generally evidence a contrast which the superficial observer may consider unsatisfactory, but which permits maximum identification of details. These developing techniques have, however, not yet imposed themselves in general practice.

By standard developing techniques we will obtain gamma values of approx. 0.9 to 1.4. In this case, the developing time for certain standard commercial developers will be around 10 minutes. Special attention must be given to the increase of developing time in the case of long rolls of film:

Film length:	Approximate factor of developing time:
20 m	1
60 m	3
120 m	5

Film treatment

In order to obtain maximum accuracy, the following measures should be given special attention in the treatment of the aerial films:

1. In order to avoid **film deformations,** development and especially drying in special-purpose instruments, such as Zeiss FE 120 and TG 24.
2. In order to avoid **film affinities,** the film should always be stored as a roll. Never change the direction of winding (emulsion inside). Wind film on spool immediately after drying. Do not rewind film, i. e. the first photos of a flying mission should always be on the outermost layers of the film on the roll. Try to prevent any rewinding of the unexposed film.
3. In order to avoid **local defects,** apply wetting agent between fixing and drying.

As was mentioned already in section 5.6, every flight strip should begin with a "flying start", i. e. some ten photos at the beginning of **every flight strip** should be taken outside the survey area proper.

⑦ Introduction of additional marks in the viewfinder of the IRU

Occasionally the desire was expressed to dispose of additional marks in the visual field of the IRU intervalometer, such as e. g. various longitudinal lines in the center or at a certain distance from the edges, horizontal lines, etc. In order to enable every customer to add such complementary marks at his discretion, the IRU is now supplied with three transparent plastic foils which may be provided with the desired marks and installed in the intervalometer.

The simplest manner to engrave such marks is by means of a scriber or with the point of a compass. The mark will then distinctly appear in the visual field as a fine line. Even stronger marks will be obtained by printing or by photographic reproduction. If desired, the engraved lines may also be filled with Indian ink or printing ink.

The foil is of exactly the same size as the ground-glass screen. Place the foil between the Fresnel lens and the ground glass of the IRU. For this purpose, open the finder hood (19/110) and remove the mounting strips (19/111) of the finder hood (front, left and right sides). At the same time remove the locking screw (20/113). The ground glass (19/112) is now freely accessible from above and may likewise be removed (if necessary, with the aid of Scotch tape or some similar material). Then put the foil with its engraving or the emulsion facing upwards on the Fresnel lens (before, clean carefully with dust brush) and put the ground glass on top (matted side facing downwards and line marks in the direction of flight). If the matted side of the ground glass should have been stained by contact with the hand, it may be washed with lukewarm soapy water.

Then fasten the bellows of the finder hood (19/110) with the aid of the retaining strips (19/111). Care should be taken that the retaining strip is placed above and the small metal strip below the bellows. It is recommended to first introduce all screws into the retaining strip and the bellows and then to slip on the metal strip, before folding and tightening it altogether. Otherwise, the edge of the bellows might get caught in the thread, so that the screws could not be introduced.

⑧ Operating description

8.1 General

The following outlines are intended essentially as an explanation of the wiring scheme (fig. 29, 30), and the wiring diagram.

In figure 29 the following functional circuits will be recognized:

a) camera motors and auxiliary flight data
b) IRU impulse interval control and impulse generation
c) shutter tripping

8.2 Camera motors and auxiliary flight data

The entire camera unit is supplied with electric power from the electric system of the aircraft through the socket (29/19) of the camera. The master switch of the camera (29/18) interrupts the power supply for the entire camera unit. By switching on the camera master switch, the following circuits are energized:

a) socket for statoscope power supply (29/21)
b) camera drive motor (29/15)
c) camera blower motor (29/16)
d) illumination system of auxiliary flight data (29/73) with regulator (29/28).

Closing of the aforementioned circuits will have the following effect:

a) The drive motor (29/15) starts running and makes the shutter blades and the generator voltmeter tachometer (31/145) rotate. As a consequence, the voltmeter (29/24) indicates the speed of rotation of the shutter and, due to this voltmeter being calibrated as an exposure indicator, the actual exposure time.

b) The blower motor (29/16) starts running. The pointer of the ammeter (29/25) connected in series with this motor stands in the green range (vacuum).

c) The illumination of the auxiliary flight data (29/73) flashes up.

8.3 Operation interlocks

The power input in the IRU depends on two factors which are incorporated in the entire system for reasons of safety. The circuit leading to the IRU cannot only be interrupted by the master switch (29/117) but also by the safety switch (29/146) on the lens cap and the safety switch (29/147) on the film magazine. Both the magazine (29/83) and the protective cover of the focal plane frame are provided with a switch pin (29/47).

In the case of the protective cover of the focal plane frame, this switch pin is always in operation as soon as the cover is firmly in place. The switch pin will then close the IRU circuit over the magazine safety switch (29/147).

In the case of the film magazine, the operation of the switch pin depends on two more factors:

a) The switch pin (29/47) cannot close the contact until the magazine slide (29/85) has been fully opened.

b) However, the magazine slide can only be opened if the magazine is properly placed on the camera, so that no light can penetrate to the film.

The switch pin (29/33) provided on the lens cap (29/32) operates as a contact breaker i. e. **when the lens cap is in place, the IRU power supply is interrupted by the open lens cap safety switch** (29/146).

Since both safety switches (29/146 and 29/147) are connected in series, the intervalometer will start to operate only after the lens cap has been removed and the magazine slide opened.

8.4 Impulse interval control

With the aid of the IRU master switch (29/117), the IRU motor (29/129) driving the chain of splines and the serial impulse generator is switched on. **After the serial impulse switch** (29/118) **has been switched on** (designated on the camera with "RMK"), **the IRU intervalometer will take over the automatic control of the camera,** i. e. it will control series exposures according to the overlap selected by the impulse interval control (29/148). The impulse interval control (29/148) in turn is operated by means of the knobs (33/115 and 33/116). When the chain of splines is moving, the photographer may vary its speed with the aid of the knob (29/114). The synchronizer step switch (29/149) is automatically operated by this knob (29/114), **while single exposures can be released at the single impulse button** (29/125).

Special attention is called to the **stop magnet** (29/150) which serves as a coupling between the drive of the impulse generator and the cam (29/151) and which permits **"pin-point" serial photography.**

When the serial impulse switch (29/118) has been turned off, the impulse interval control (29/148) will keep operating until the next exposure impulse is imminent. Only then will it be switched off. As a result, the first exposure impulse will leave the impulse interval control immediately upon reconnecting the serial impulse switch.

8.5 Automatic serial impulse control (shutter tripping)

In the case of automatic shutter tripping, the following operations are alternatively released in the intervalometer and the camera:

The tripping impulse produced by the impulse generator (29/152) is transmitted to the tripping magnet (29/153) in the camera and to the impulse signal lamp (29/119, 33/119) on the intervalometer, and at the same time through the rest contact K_3 (29/139) at the release lever (29/154) to the retaining relay Ma 4 (29/141) in the intervalometer. This relay closes the make contacts Ma $4/_3$ (29/144), Ma $4/_2$ (29/143) and Ma $4/_1$ (29/142). Over the make contact Ma $4/_3$ (29/144) and the rest contact K_1 (29/137) on the magazine drive strip cam (29/155) the relay Ma 4 (29/141) is now retained, and over the make contact Ma $4/_2$ (29/143) the impulse, so that the impulse generator (29/152) and the push button for single photographs (29/125) are bridged and thus disconnected.

The make contact Ma $4/_1$ (29/142) finally advances the magnetic counter (29/121) on the IRU by ½ place.

When the release lever (29/154) engages, the rest contact K_3 (29/139) is opened (as soon as the release magnet has drawn up completely), so that the circuits for the release magnet (29/153) and the retaining relay (29/141) are broken.

After the exposure has been made, the film transport is mechanically released by the shutter. During film advance the trip cam (29/155) makes one full revolution.

At the beginning of this revolution, the rest contact K_4 (29/140) is opened, and closed again only at the end of the revolution. As a consequence, the lamps for auxiliary data recording (29/73) are turned off during film transport. This is only a safety measure which will prevent the spoiling of photographs even if the shutter for the flight data should be defective.

In addition, the trip cam (29/155) closes and reopens the make contact K_2 (29/138) during the revolution (film transport). As a consequence, the exposure counter (29/72) in the auxiliary data compartment is advanced by one digit.

Only at the end of its revolution the trip cam (29/155) opens and again closes the rest contact K_1 (29/137). This disconnects the retaining relay Ma 4 (29/141) in the intervalometer, so that it falls off and opens the make contacts Ma $4/_1$ (29/142, Ma $4/_2$ (29/143), and Ma $4/_3$ (29/144), i. e. the retaining of the relay Ma 4 (29/141) has come to an end.

Through the opening of Ma $4/_2$ (29/143) the release magnet (29/153) falls off and the impulse pilot lamp (29/119, 33/119) in the IRU is disconnected. Finally the magnetic counter (29/121, 33/121) is advanced by one half figure through the opening of Ma $4/_1$ (29/142), i. e. the counter is now set to the next exposure number.

The camera is now again in resting position, so that it is ready for the next impulse.

8.6 Drive unit

During correct functioning of the camera equipment, the following operations must be carried out rhythmically:

a) aspiration of film through vacuum

b) transmission of impulse from intervalometer

c) shutter release
d) exposure of auxiliary flight data
e) film transport

The coordination of these operations one with respect to the other is effected in part electrically and partly mechanically in the drive unit (31/156) or in the shutter.

The drive unit (31/156) is firmly coupled to the drive motor (31/15) by means of the drive shaft (31/157). Figure 35 is a schematic diagram of the operation of the drive unit.

The friction wheel (31/159) runs on the friction disk (31/158) connected with the motor. An adjustment made on the shutter speed regulator (32/23) effects a displacement of the friction wheel (31/159) in vertical direction on the shaft (31/160). This changes the speed of revolution of the gear (31/161) which serves as a power transmission to the shutter system.

Apart from the shutter, the gear (31/161) is also driving the generator voltmeter tachometer (31/145). A tension produced by the rotation of the generator voltmeter tachometer is measured by the voltmeter (29/24) which is calibrated as an exposure indicator. As a consequence, the value indicated is always the actual exposure time (speed of revolution of the shutter) and not a nominal exposure time. This is especially important in the case of low temperatures.

The various magazine functions are released mechanically from the shutter.

Thies means: When the tripping magnet (29/153) draws the diaphragm (31/162) into the open diaphragm space, the cam (31/168) which is firmly connected with the diaphragm to the diaphragm shaft (31/163) is also operated. During its forward motion, this cam releases the shutter for the auxiliary flight data, and on its way back the magazine drive through the coupling (10/55).

8.7 Shutter for auxiliary flight data

The cam (31/168) operates the angular lever (31/164) through the hammer represented in figure 31. In its resting position, the release lever (31/171) lies at the angular lever (31/164) against the power of the spring (31/165), as is shown in figure 35. When the angular lever is operated by means of the little hammer, the release lever (31/171) is pushed against the tension lever (31/166), at the same time transmitting a rotary impulse to the shutter roller (31/167). This impulse produces a rotation of the shutter roller, so that the auxiliary flight data are exposed. The shutter roller is then returned to its resting position by a spring not indicated in the diagram.

The shutter for the auxiliary flight data is wound by the rotation of the magazine drive coupling (10/55). The cam (31/169) provided on the magazine drive shaft displaces the tension lever (31/166) to the left against the release lever (31/171). The angular lever (31/164) which up to now rested on the angular part of the release lever (31/171) is freed and allowed to drop back into its basic position. When the tension lever (31/166) moves back, the release lever (31/171) falls against the angular lever (31/164), so that the shutter for the auxiliary flight data is ready for the next exposure.

9 Maintenance of camera, magazine and IRU

Maintenance of the camera and the film magazine consists above all in the following careful cleaning which should be carried out with utmost care **after every flying mission:**

Clean the interior of the lens cone as well as all its delicate parts from dust with the aid of a brush. If necessary, wipe them with a clean, newly washed linen rag. Extreme caution is mandatory for all cleaning operations in order to prevent damage to delicate parts, such as the fiducial marks, etc.

Also the outer faces of the lens are cleaned from dust with the newly washed linen rag. It is absolutely necessary to carefully clean and inspect the magazine before loading it with film. In this connection also the magazine slide should be withdrawn in order to prevent any small pieces of film, sand grains or other foreign bodies from hiding between the slide and the pressure platen. (For instructions how to withdraw the slide with the magazine removed from the camera body, see section 5.2).

Since some parts within the magazine are more or less inaccessible, it is recommended to clean the magazine at regular intervals with compressed air.

The camera is permanently lubricated with a temperature-resistant grease. **Drive mechanism and other moving parts** should therefore **not** be lubricated. The use of improper grease and/or oil will jeopardize the proper functioning of camera and magazine at extreme temperatures.

After approximately 100 working hours it will be necessary to exchange the commutator brushes of the blower motor and after 1000 working hours those of the main drive motor.

For **exchanging the blower motor** (35/16) open the lateral flap (11/56). The blower motor (35/16) can be withdrawn on the base plate (11/58) after loosening the knurled screw (11/57). Before, the hose connections (34/59 and 34/60) for the magazine must be loosened. For the purpose, remove the main motor (9/15), so that the non-interchangeable hose couplings (34/61 and 34/62) behind it become accessible. After loosening the nuts (34/63), the connections can be separated and the blower motor (35/16) removed. For re-insertion proceed in inverse sequence.

When coupling the hoses, attention must be given to careful positioning, so that the hoses are not bent.

The blower motor (35/16) itself is not armored. The casing carries a movable collar (35/64). When **exchanging the commutator brushes** (35/65), this collar must be pushed back and the commutator as well as the brush carrier be cleaned from carbon dust with the aid of compressed air before the new brushes are inserted. The new brushes must be so inserted that they cannot get caught in the feed strands (35/66) of the blower motor. These feed strands must therefore be well twisted.

It is recommended to check the commutator brushes for perfect contact before every flying mission and – if necessary – to exchange them.

The main motor (9/15) can be easily exchanged. For this purpose open flap (36/48) by pressing the locking latch (36/49) and turning it to the right.

Then swing out the latch bolt (34/50) and hinge the upper half of the divided support (34/51) back. The motor can now be withdrawn to the right from its seat and removed from the compartment. For re-insertion proceed accordingly. Care should be taken that the motor is pushed all the way to the left into the socket. **It is recommended to check the commutator brushes of the main motor every 1000 working hours and – if necessary – to replace them.**

After removing the screw cap (19/130) on the upper side of the IRU, the motor (20/129) becomes accessible and may be removed.

It is recommended to check the commutator brushes every 100 working hours and – if necessary – to exchange them.

When inserting the motor, it should be turned in such a way that the coupling pin engages in the catch slot. Before replacing the protective cap, the IRU should be put in operation and the perfect coupling of the motor controlled.

For exchanging the control lamp (20/119) on the IRU, unscrew the plastic ferrule holding the glass disk and lift off. The bulb with socket may then be raised off. The bulb can only be inserted with the socket. Care must be taken not to lose this socket or discard it together with the unserviceable bulb.

Plastic hoods for aerial survey cameras (37/170)

In order to protect the aerial camera to the largest possible extent against moisture and dust, each camera unit is supplied with a plastic hood. Protection against moisture seems indicated in tropically moist climates for general storage of the equipment on the ground, furthermore during operation in the air, so as to avoid that the instruments which are considerably undercooled on high-altitude flights, will get covered with moisture as soon as the aircraft descends into lower strata of warmer, moist air. The same hoods are used for protection against dust during operation in desert areas or if the photographic plane has to take off from and land on dusty auxiliary airports and if the floor camera ports cannot be closed during take-off and landing.

According to the particular requirements, the hood may be put around the camera and magazine as installed in the suspension mount in the aircraft, or camera and magazine are taken out of the suspension mount as soon as the photography has been completed and before the aircraft descends from its working altitude, so that they can be inserted in the transparent hood.

Also when storing the camera equipment on the ground in moist, tropical climates, it seems indicated to slip the hood over the instruments. In addition, a bag of calcium cloride may be introduced in an open box in the plastic hood, so as to further absorb air humidity.

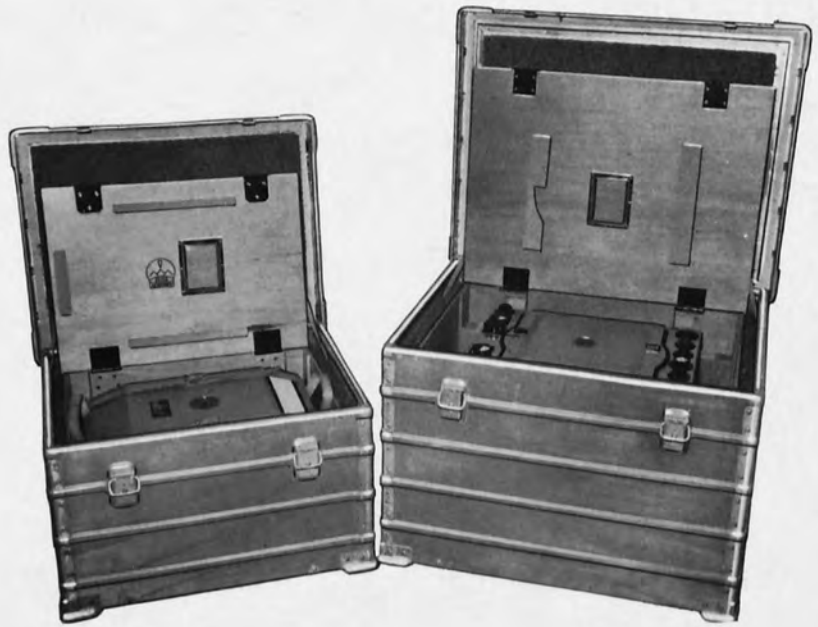
⑩ List of illustrated parts

Figure No.	Part No.	Nomenclature
3	1	Suspension mount
3	2	Swivel ring
3	3	Spring-loaded clamp lever for swivel ring
3	4	Graduation on suspension mount
3	5	Crab index
3	6	Leveling spindles with star knobs
3	7	Extensions for leveling spindles
4	8	Bracket
4	9	3 base plates
4	10	Drilling and installation templet
4, 27	11	Camera body
4, 11	12	Lens cone
6	13	Focal-plane frame
7	14	Shutter
9, 29	15	Main motor
11, 29, 35	16	Blower motor
6	17	Space for auxiliary flight data
4, 29	18	Master switch
5, 29	19	Socket for connection to aircraft power supply
5, 29	20	Socket for electrical connection to IRU
5, 29	21	Socket for electrical connection to Statoscope
4	22	Socket for electrical connection of remote control
5, 32	23	Setting knob for exposure time
5, 29	24	Exposure time indicator
5, 29	25	Vacuum indicator
5	26	Bubble level for leveling of camera unit
5	27	Setting knob for iris diaphragm
5, 29	28	Knob for controlling illumination of auxiliary flight data
3, 6	29	Red index mark "camera body/suspension mount"
4, 6	30	Handgrips on camera body
6	31	Latch bolt
4, 26, 29	32	Lens cap
26	33	Switch pin on lens cap
26	34	Lock for color filters and lens cap
26	35	Latch
27	36	Red index mark "camera body/magazine"
6	37	Guide strips on camera body
6	38	Lens
6	39	Fiducial marks
5	40	Protective cover for focal-plane frame
5	41	Index mark on protective cover of focal-plane frame
10, 32	42	Plexiglass viewer
5	43	Window in protective cover of focal-plane frame
10, 32	44	Luminous mark
6	45	Connection for suction hose
5	46	Clamp lever for protective cover of focal-plane frame
6, 8, 16, 29	47	Pin on magazine or focal-plane frame cover
36	48	Protective flap for main motor
36	49	Locking latch of protective flap for main motor
34	50	Latch bolt on support of main motor
34	51	Support of main motor
10	52	Protective flap for friction drive
10	53	Friction drive
6, 16, 31	54	Magazine drive coupling
10	55	Magazine drive coupling
11	56	Protective flap for blower motor
11	57	Knurled screw for blower motor
11	58	Base plate of blower motor

Figure No.	Part No.	Nomenclature
34	59	Suction hose connection
34	60	Pressure hose connection
34	61	Coupling of suction hose
34	62	Coupling of pressure hose
34	63	Nuts for couplings of suction/pressure hoses
35	64	Collar on casing
35	65	Commutator brushes in blower motor
35	66	Feed strands on blower motor
11	67	Cooling turbine
11	68	Suction nozzle on cooling turbine
11	69	Pressure nozzle on cooling turbine
11	70	Air filter
12	71	Protective flap for auxiliary flight data
13, 29	72	Magnetic exposure counter
29	73	Lamps for auxiliary data recording
13	74	Bubble level for recorded data
13, 14	75	Watch with data card
14	76	Fixing magnets on data card
14	77	Insertion of watch data card
13, 14	78	Statoscope indicator or standard altimeter, respectively
13	79	Push button on magnetic counter
13	80	Prism
14	81	Front knurled screw on statoscope indicator or standard altimeter, respectively
14	82	Lateral knurled screw on statoscope indicator or standard altimeter, respectively
15, 27, 29	83	Film magazine
15	84	Magazine cover
16, 29	85	Magazine slide
17	86	Direction arrows in magazine
18	87	1 fixed reversing roller
18	88	1 mobile reversing roller
18	89	Pressure platen
18	90	Splined roller
18	91	Rubber roller
17	92	Special key for magazine cover
15	93	Locking knobs on magazine
15	94	Film supply indicator
17	95	Feeler lever
15	96	Magazine data card
17	97	Rotary buttons for magazine slide
16	98	Connecting piece for suction pipe in magazine
16	99	Safety latch on magazine
16	100	Safety pin on magazine slide

Figure No.	Part No.	Nomenclature
18	101	Connecting hose for pressure plate
17	102	Axle pins for film spools
17	103	Signal disks on magazine
18	104	Wire bracket on magazine
17	105	Magazine handgrips
18	106	Notch on wire bracket
15	107	Magazine carrying board
27	108	Push button for punch
19	109	IRU Intervalometer
19	110	Hood of viewfinder
19	111	Mounting strips of viewfinder hood
19	112	Ground-glass screen
20	113	Lock
19, 29, 33	114	Speed regulator for chain of moving splines
20, 33	115	Overlap control button
20, 33	116	Adjusting knob for constant c
20, 29, 33	117	Main switch IRU
20, 29, 33	118	"RMK" switch for consecutive photographs
20, 29, 33	119	Pilot lamp on IRU
19	120	Throw-over switch for shortest cycling time
19, 29, 33	121	Exposure counter
19	122	Push button for exposure counter
20	123	Pilot indicator (voltmeter)
20	124	Socket for connection of pilot indicator
20, 29, 33	125	Push button for single photographs
20	126	Base ring on IRU
20	127	Scale on base ring of IRU
20	128	Clamp lever for base ring
20, 29, 33	129	IRU motor
19	130	Screw cap for IRU motor
19, 33	131	Socket for connection to RMK by special plug
18	132	Feed spool
18	133	Take-up spool
18	134	2 index screws on feed-spool side
15, 18	135	1 index screw on take-up spool side
18	136	~~Grip~~ Handle
29, 32	137	Contact K_1
29, 32	138	Contact K_2
29	139	Contact K_3
29	140	Contact K_4
29	141	Magnet Ma 4
29	142	Contact Ma $4/_1$ on Magnet Ma 4
29	143	Contact Ma $4/_2$ on Magnet Ma 4
29	144	Contact Ma $4/_3$ on Magnet Ma 4
29, 31	145	Generator voltmeter tachometer

Figure No.	Part No.	Nomenclature
29	146	Safety switch on lens cap
29	147	Safety switch on focal-plane frame for switch pin of magazine or protective cover of focal-plane frame
29, 33	148	Impulse interval control
29, 33	149	Synchronizer step switch
29	150	Stop magnet
29, 33	151	Cam
29, 33	152	Impulse transmitter
29	153	Release magnet
29	154	Release lever
29	155	Magazine drive trip cam
31, 32	156	Gear unit
31	157	Drive shaft
31, 32	158	Friction disk
31, 32	159	Friction wheel
31	160	Shaft of friction wheel
31	161	Gear wheel
31	162	Capping blade
31	163	Shaft of capping blade
31	164	Angular lever
31	165	Tension spring
31	166	Cocking lever
31	167	Flight data shutter
31	168	Cam above shaft of capping disk
31	169	Cam on magazine drive shaft
37	170	Plastic hood
31	171	Release lever for recorded data
7	172	Rotating blades
7	173	Capping disk
21	–	Installation drawing for RMK
22	–	
23	–	
24	–	Installation drawing for IRU
28	–	Diagram
29	–	Functional diagram
30	–	Functional diagram
38	–	Wiring diagram RMK A 15/23
39	–	Wiring diagram IRU



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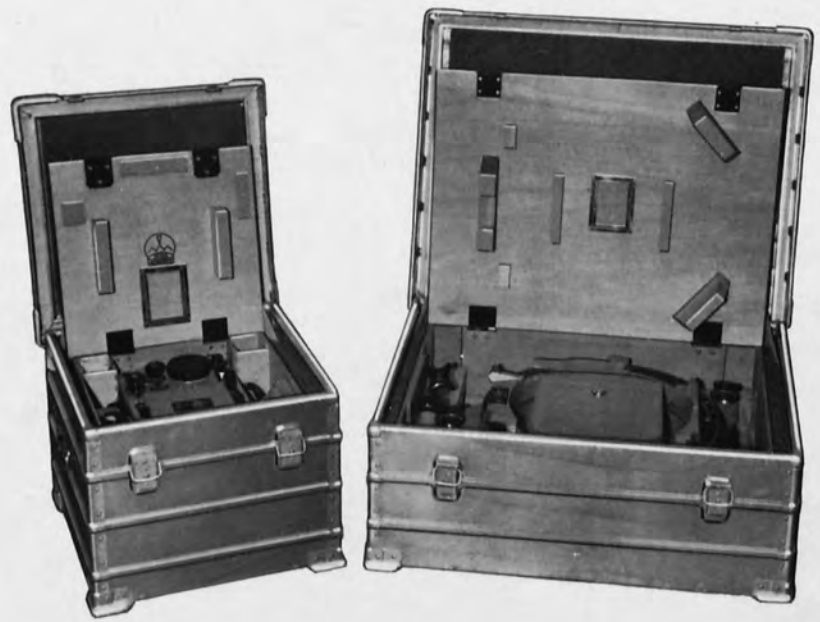

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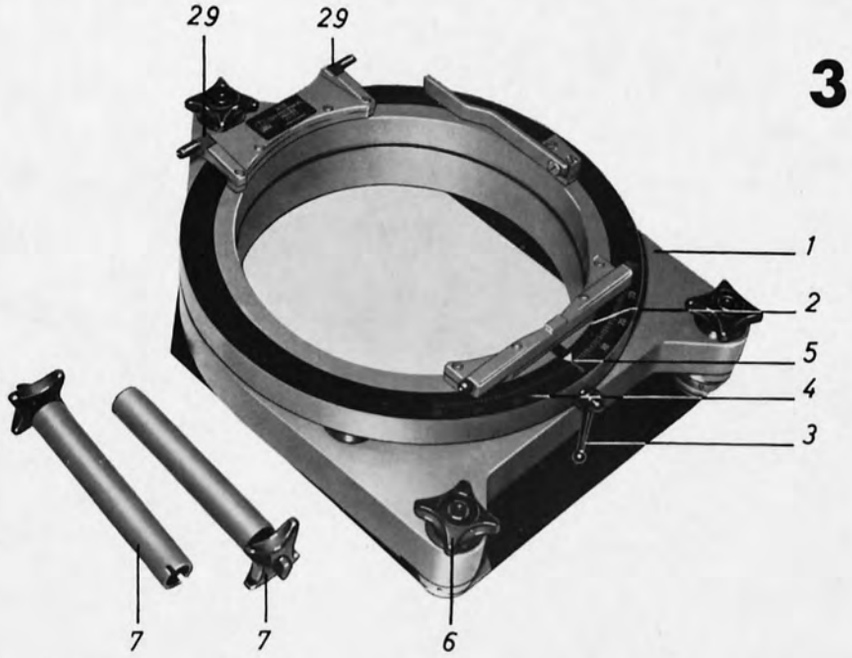
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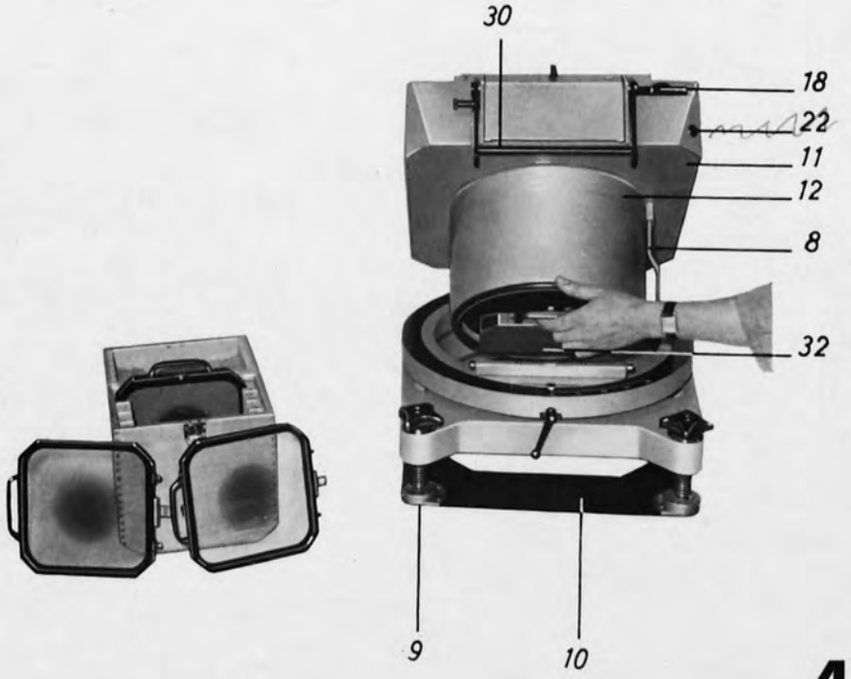
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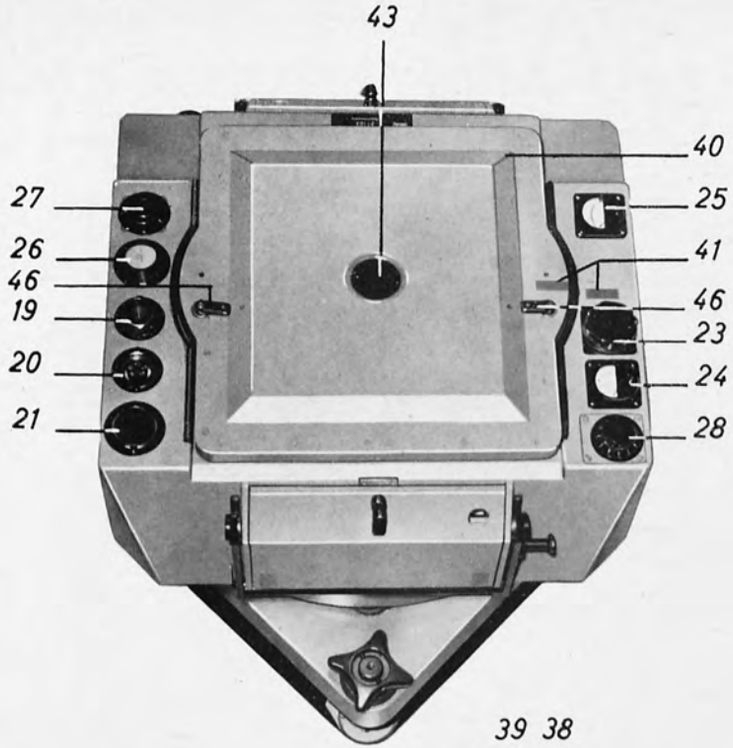
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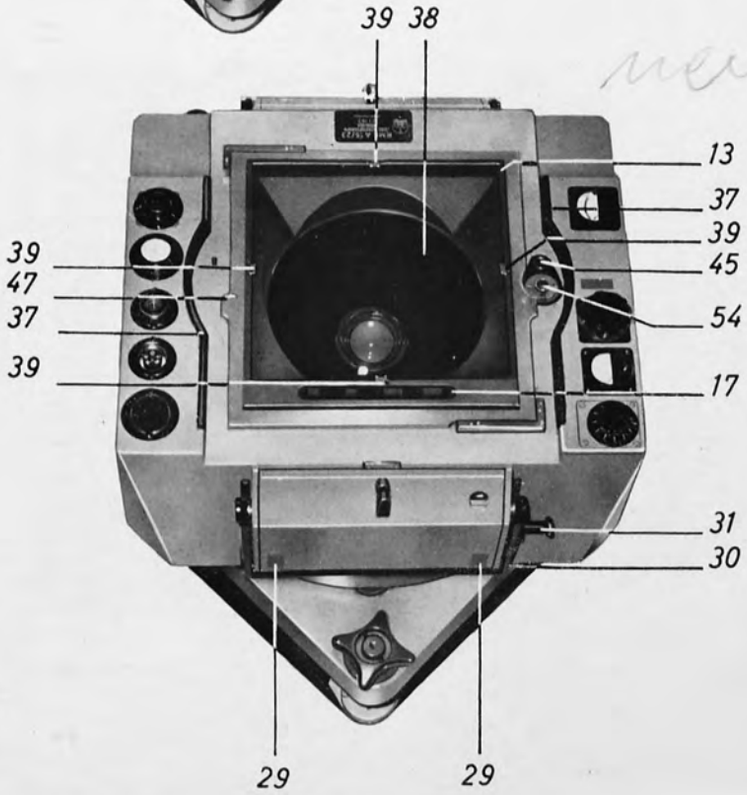
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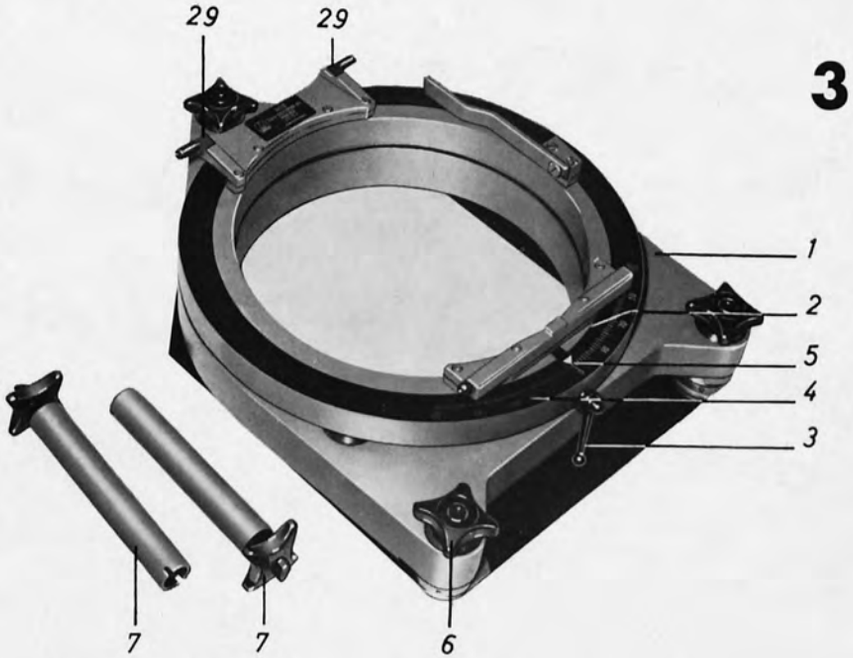
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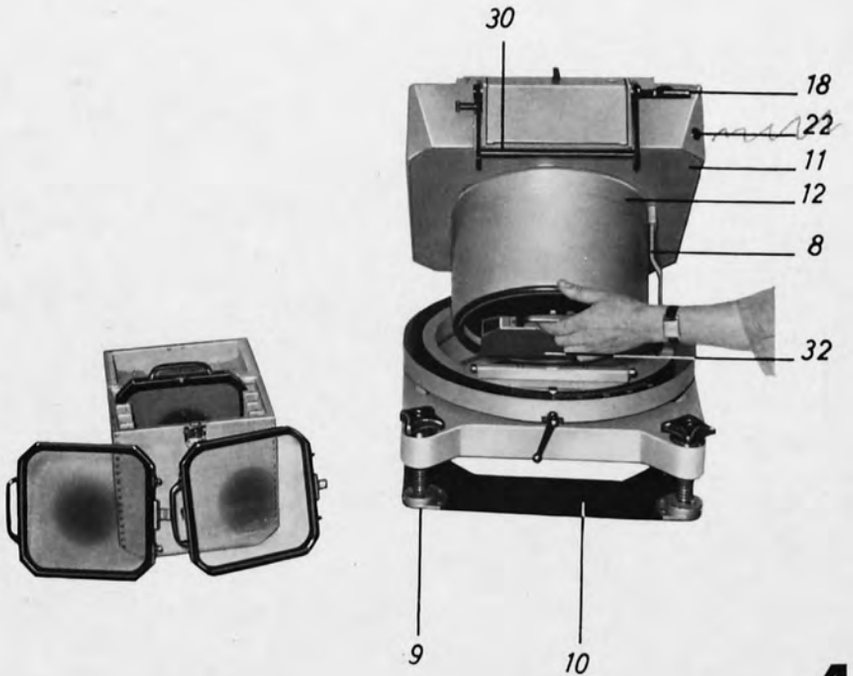
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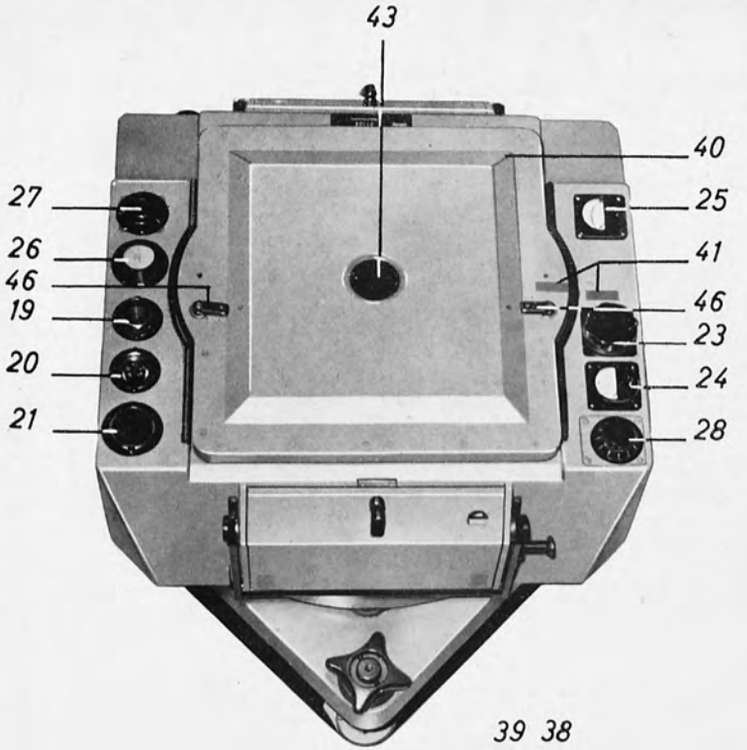
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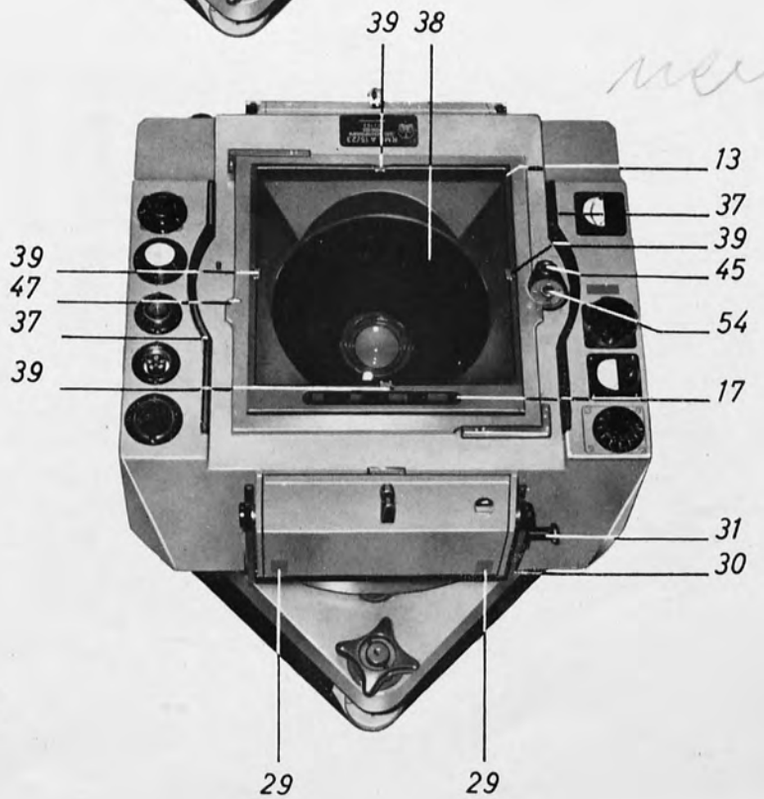
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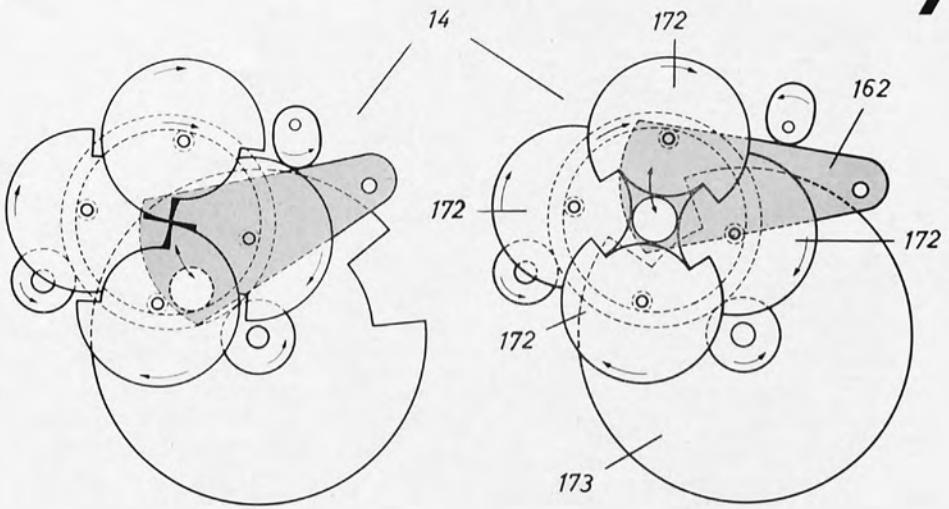

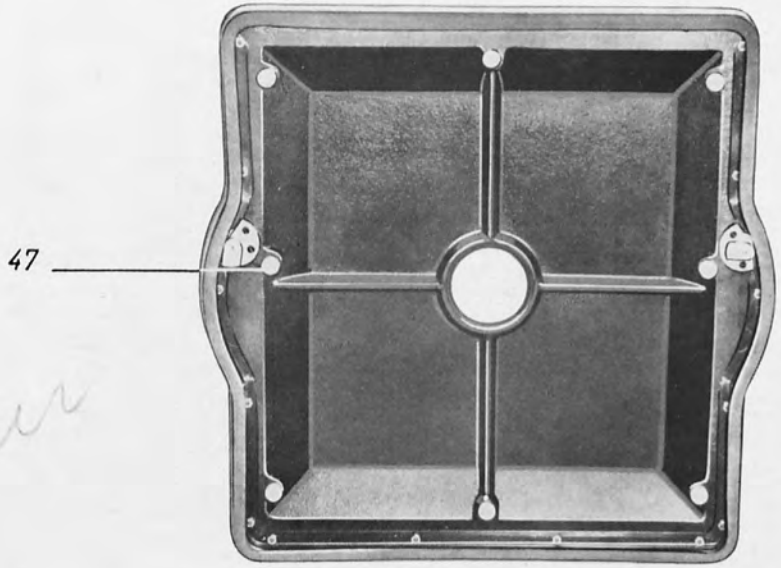

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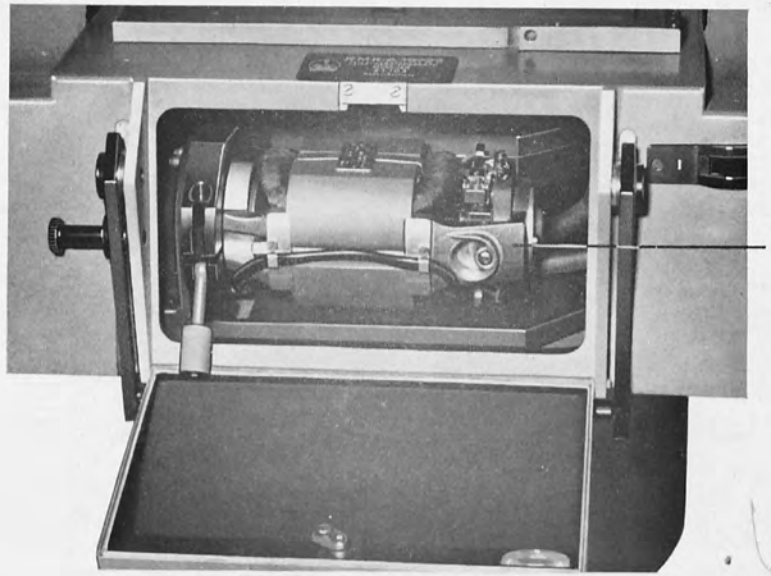

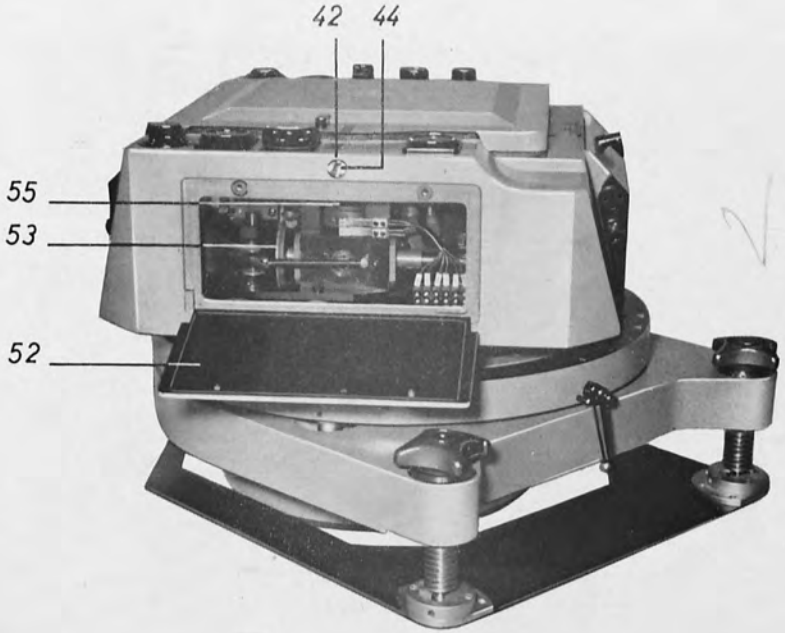

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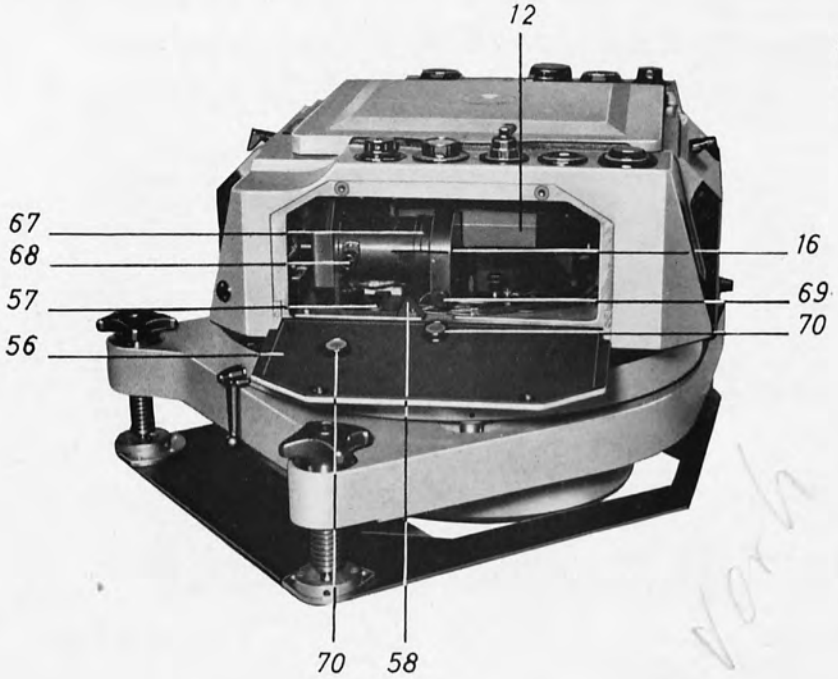

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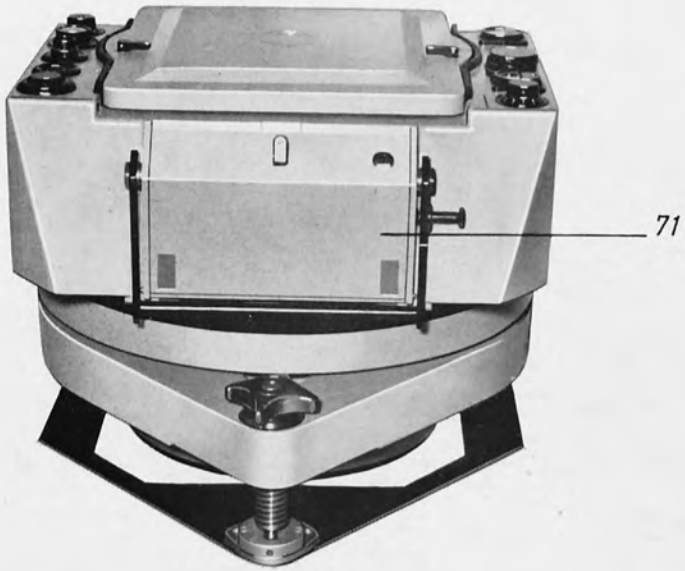

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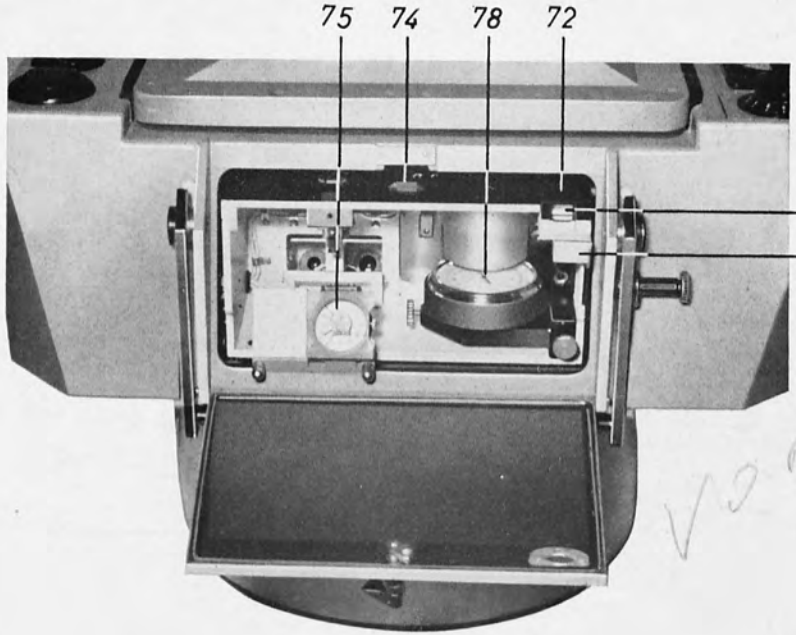

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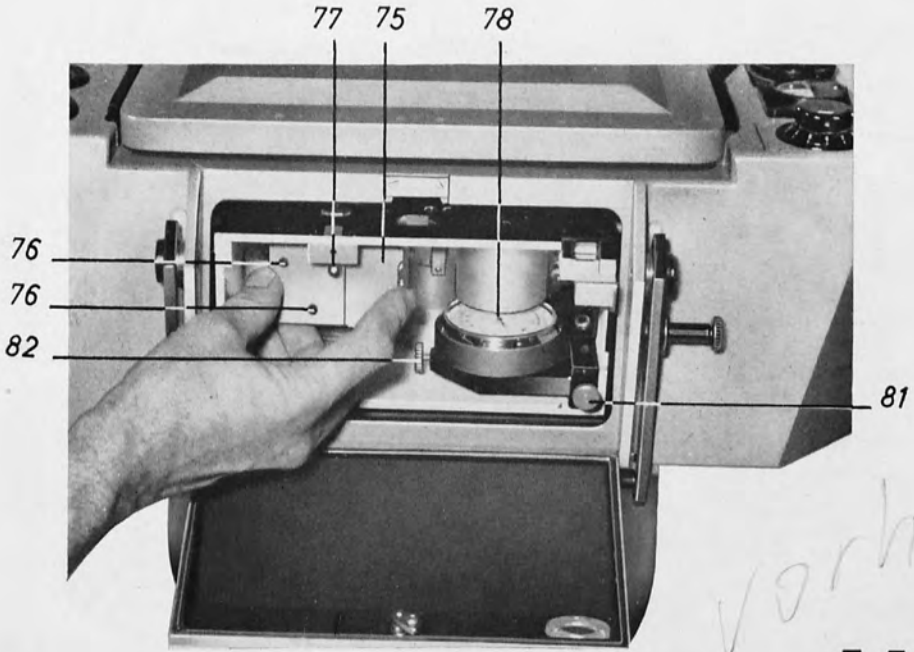

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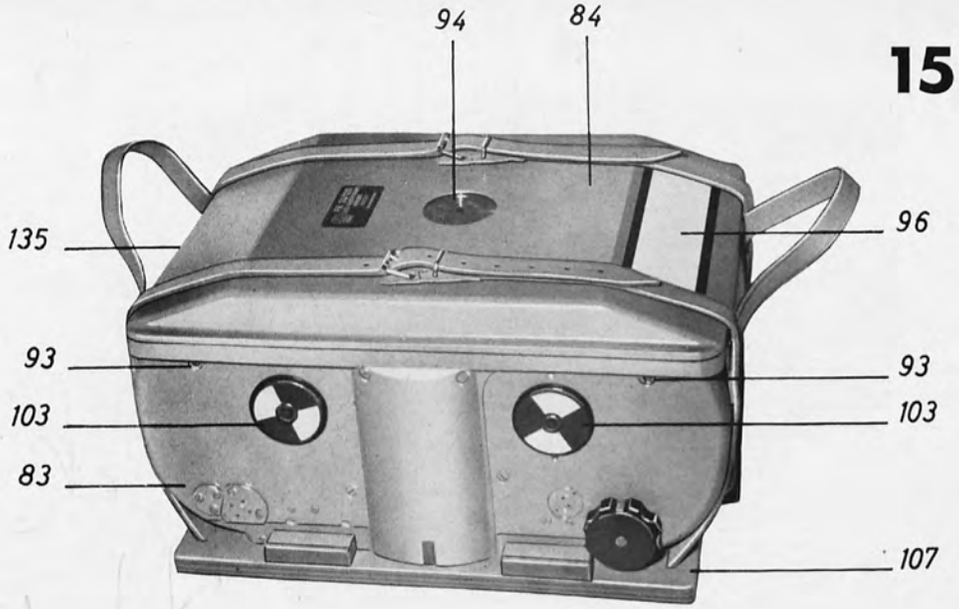
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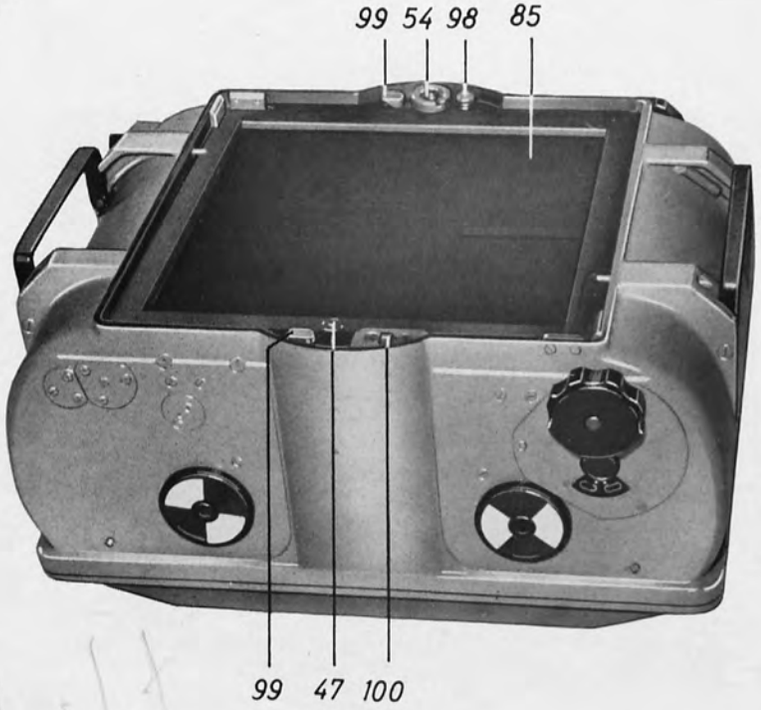
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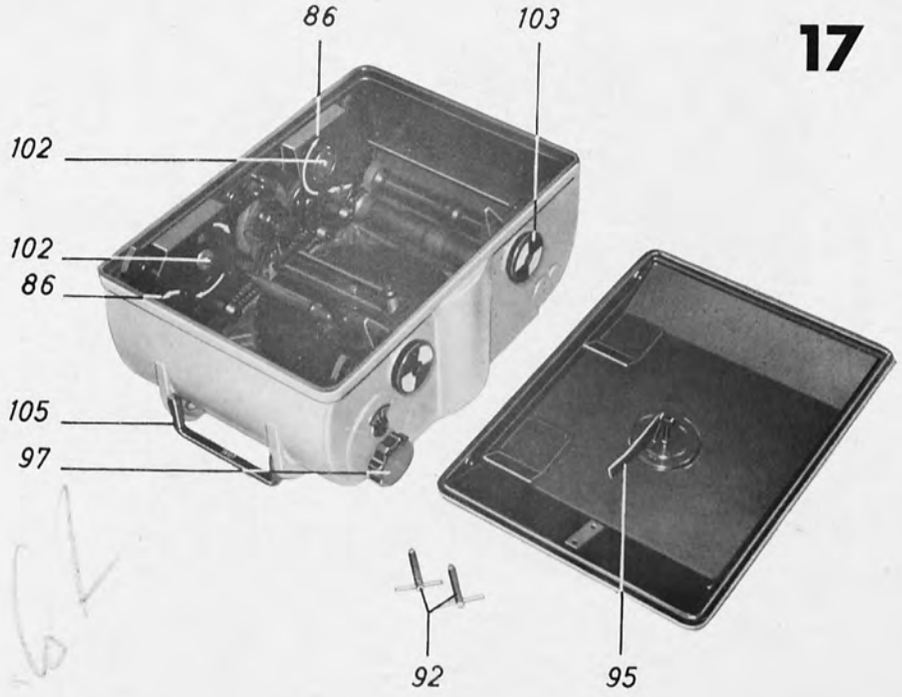
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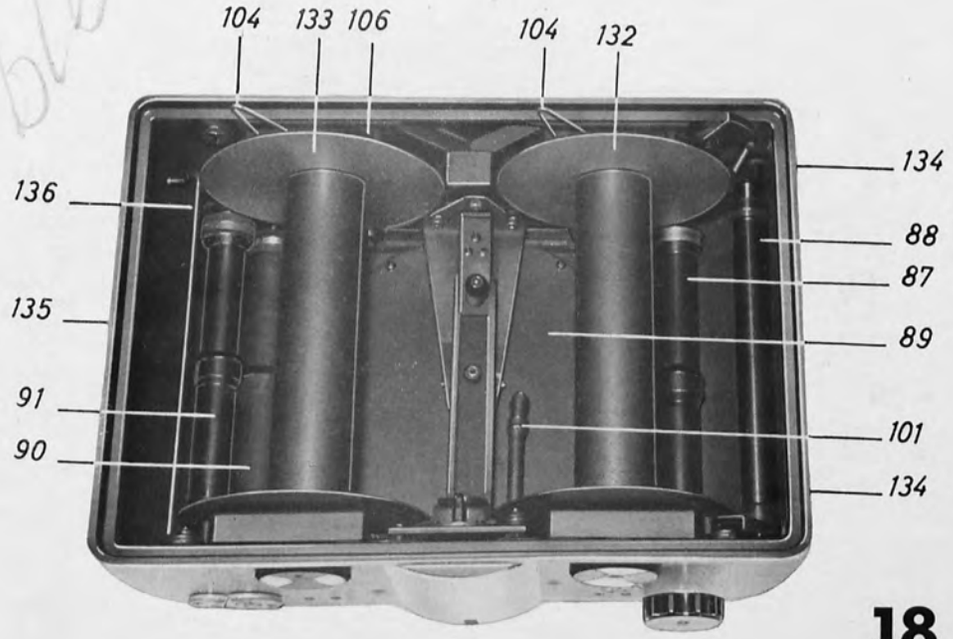
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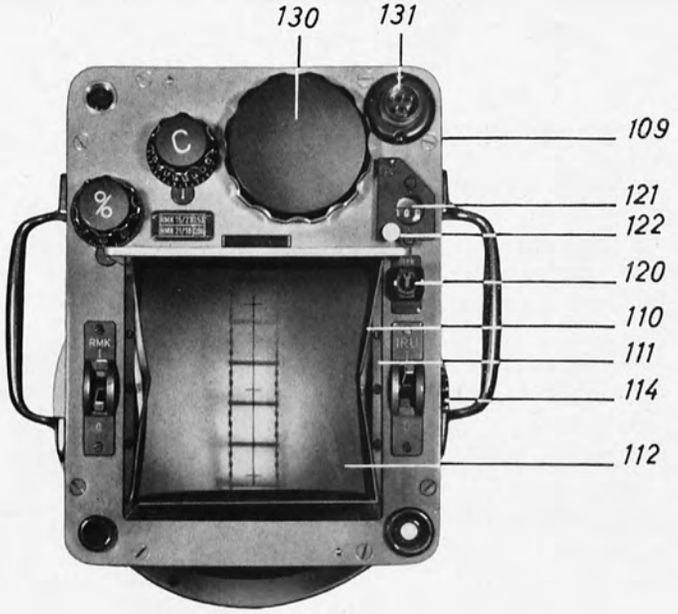
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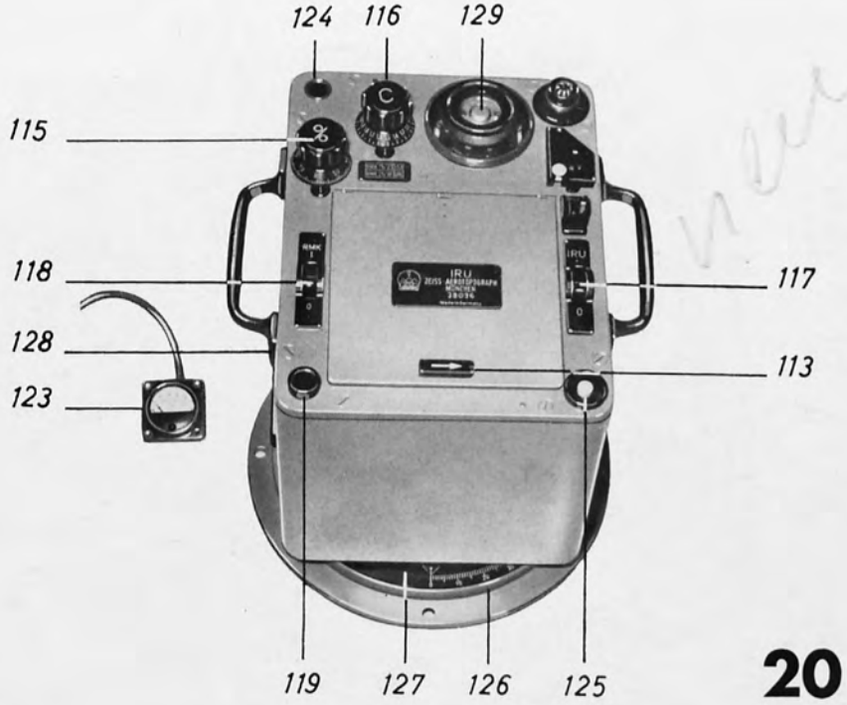
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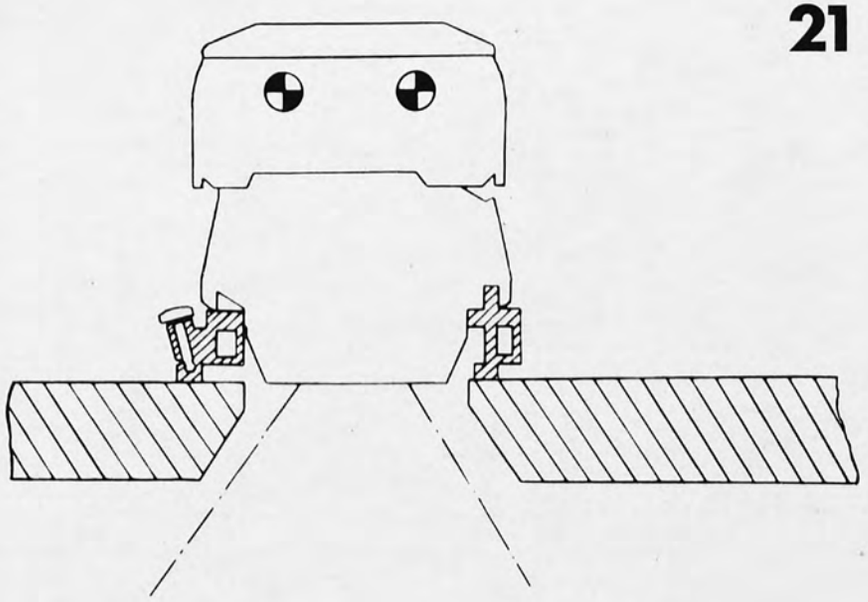

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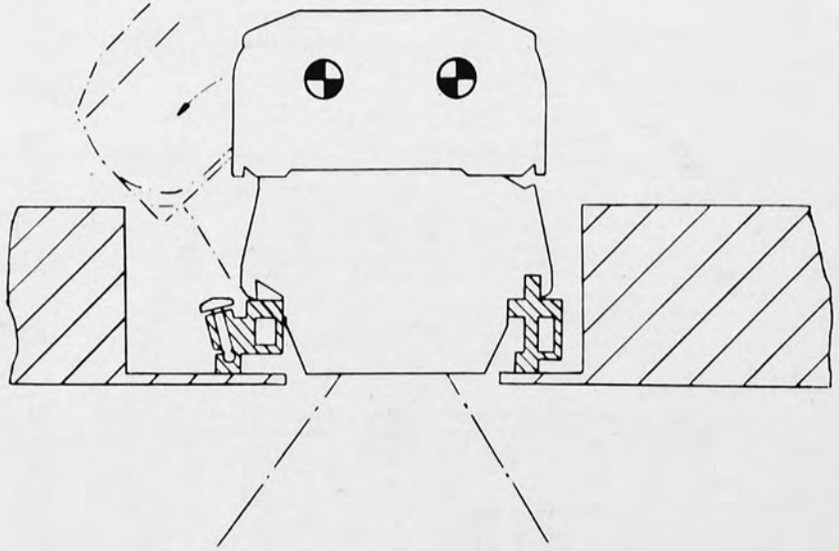

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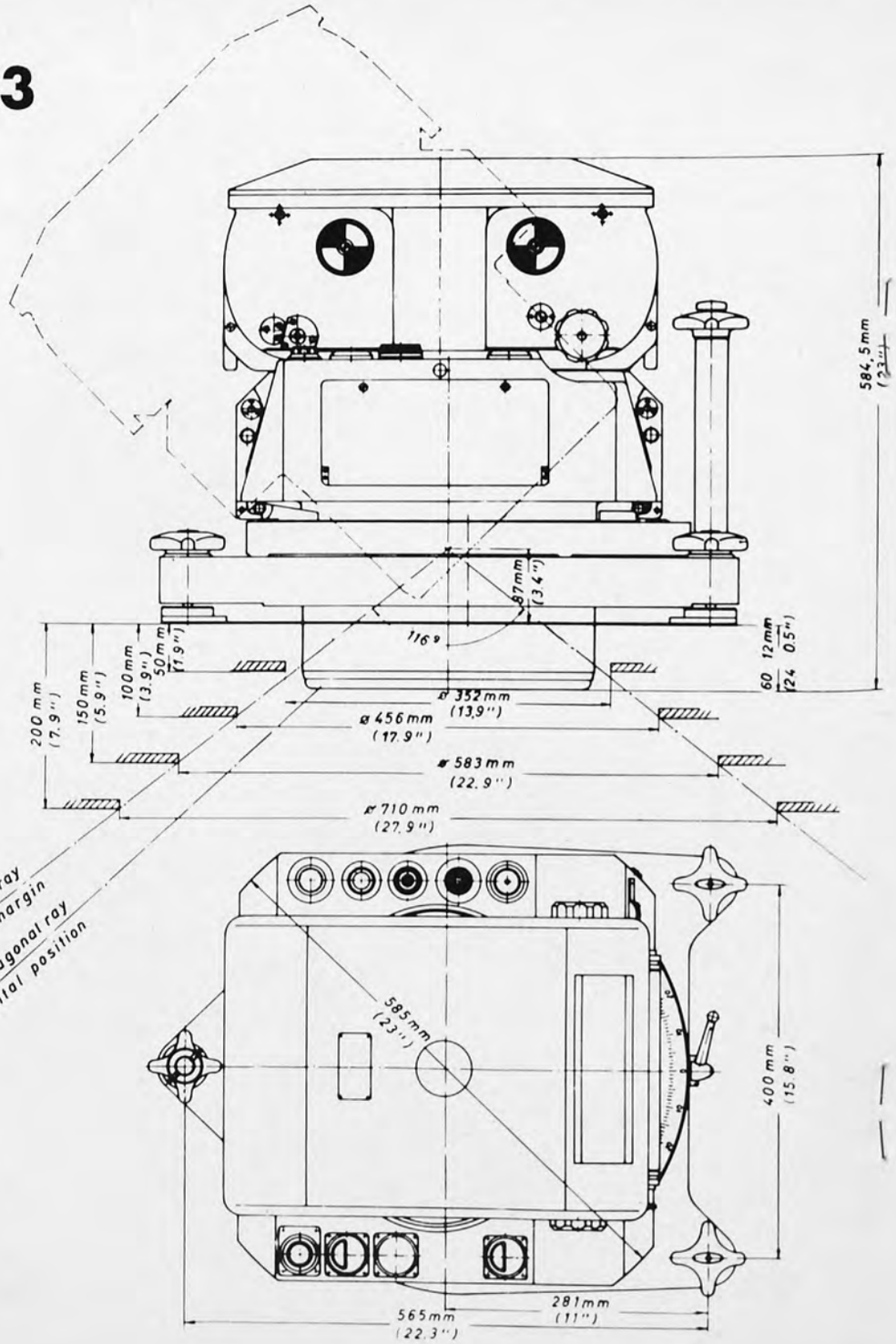

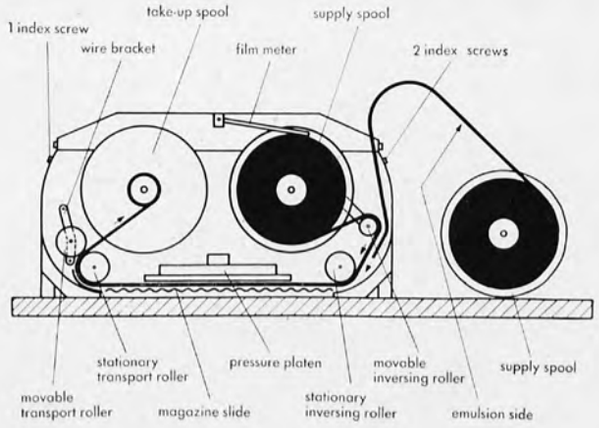

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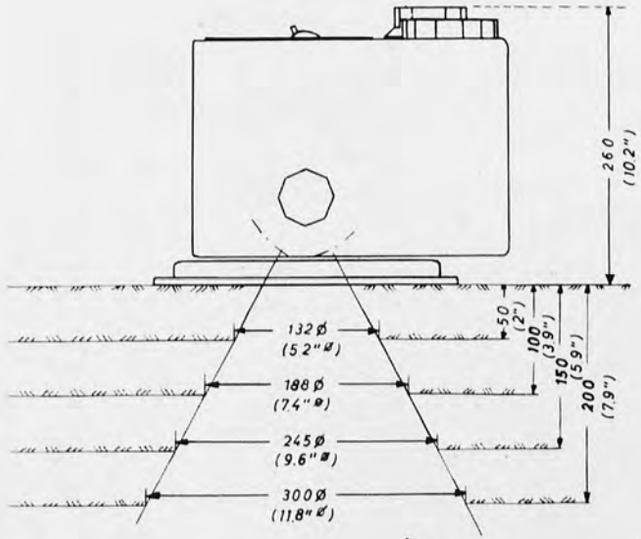

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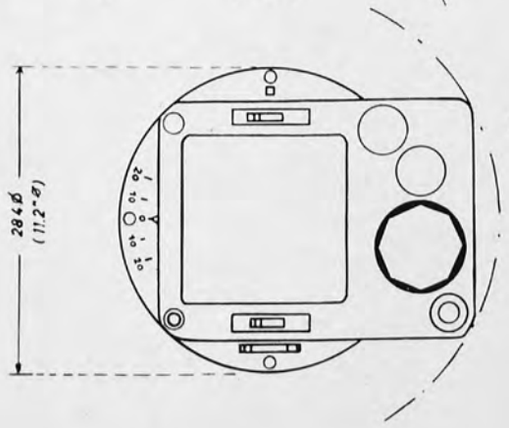

Clearance diameter 430 ϕ

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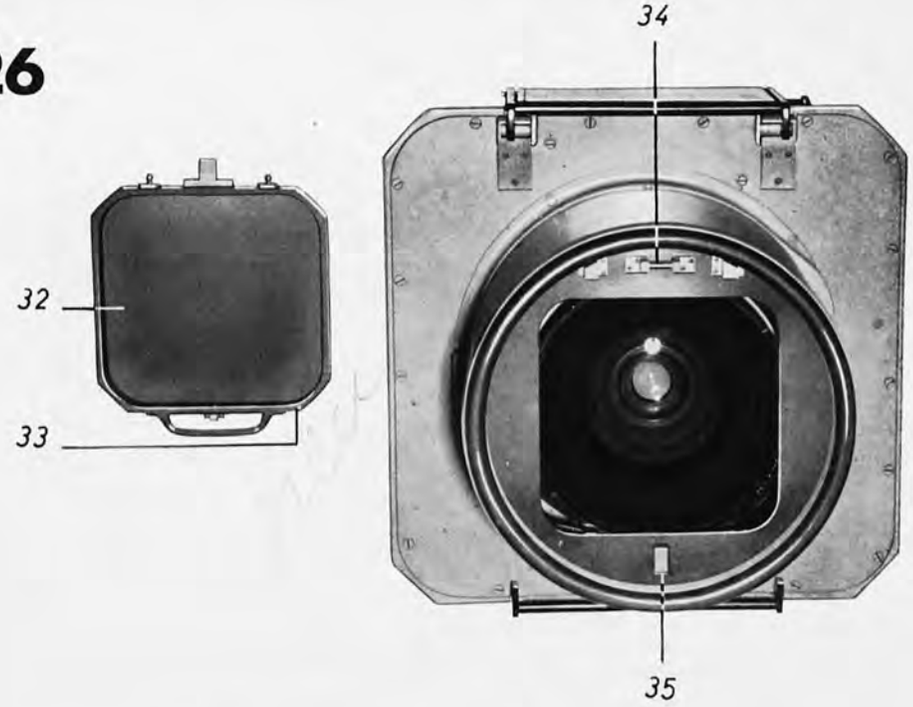


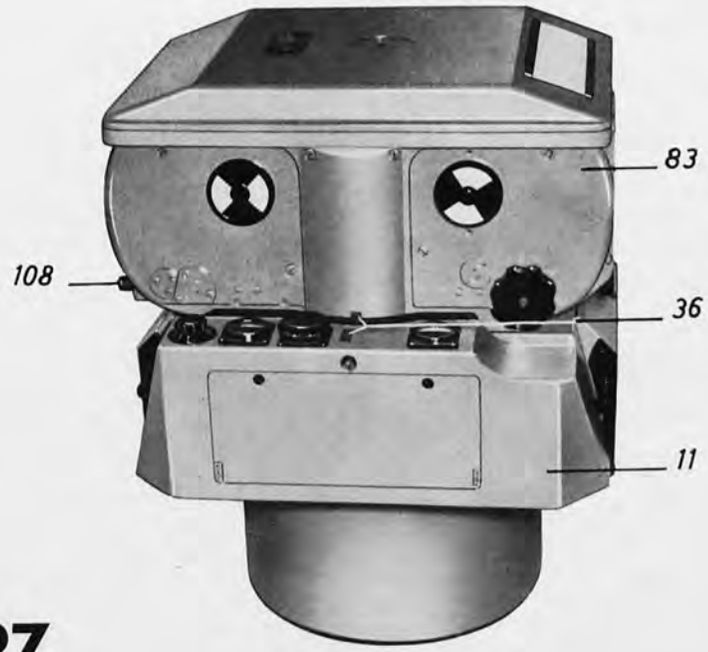
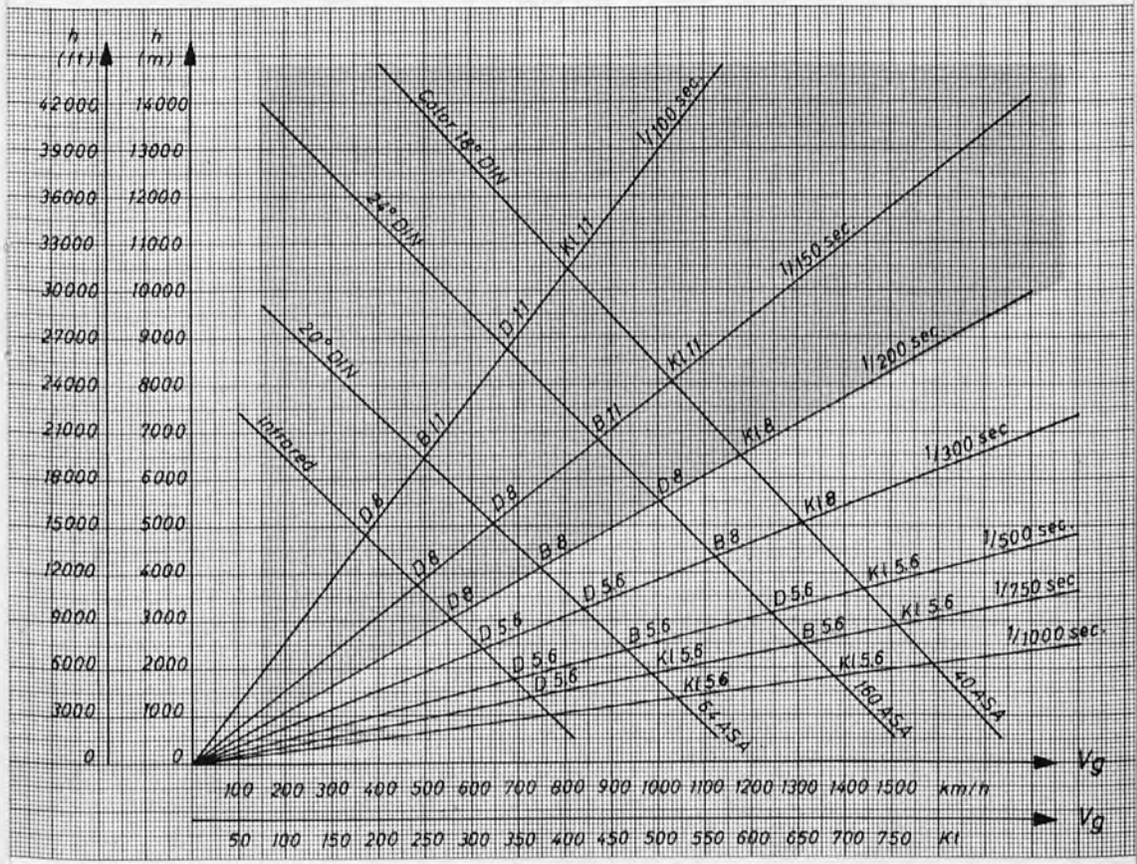


Diagram 1



filter	f stop	factor
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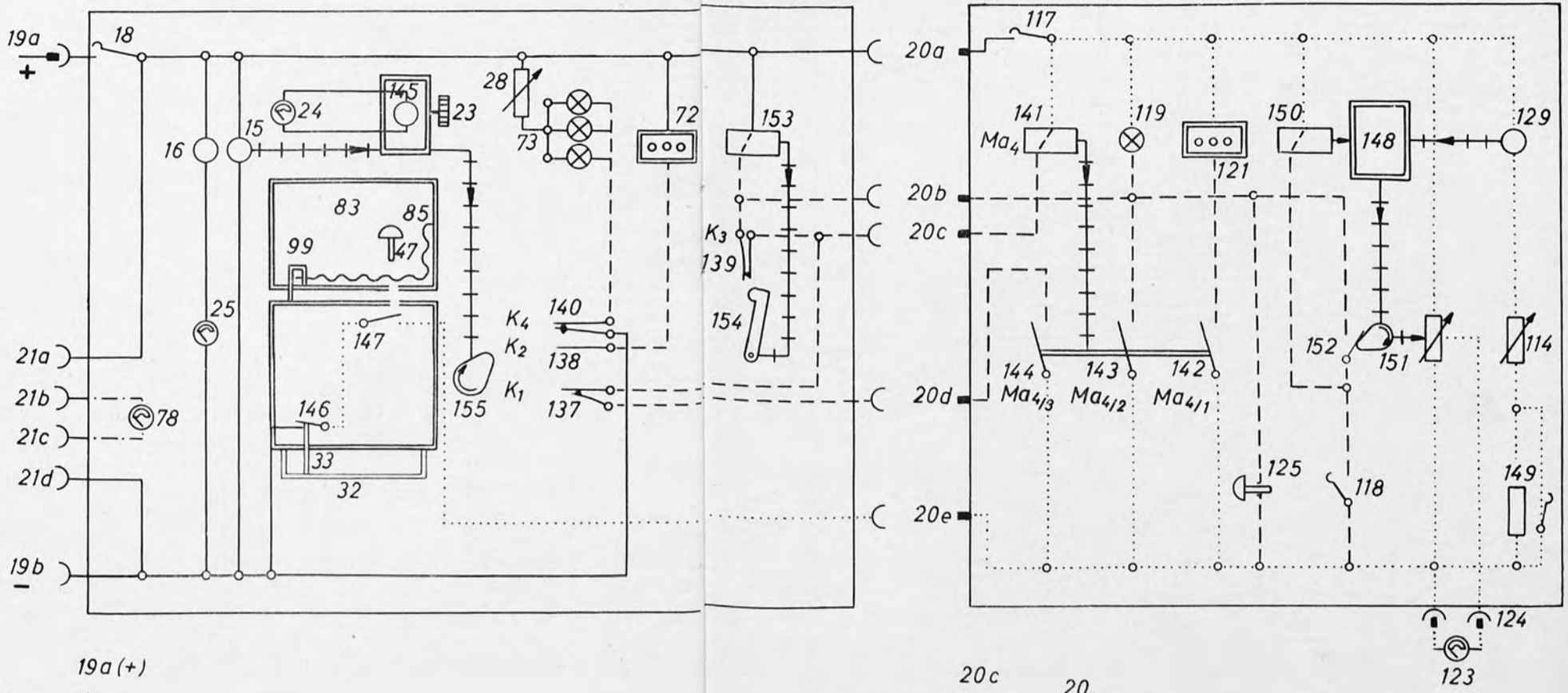
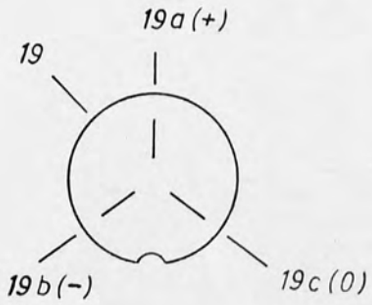
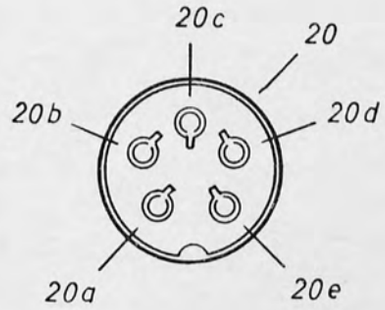
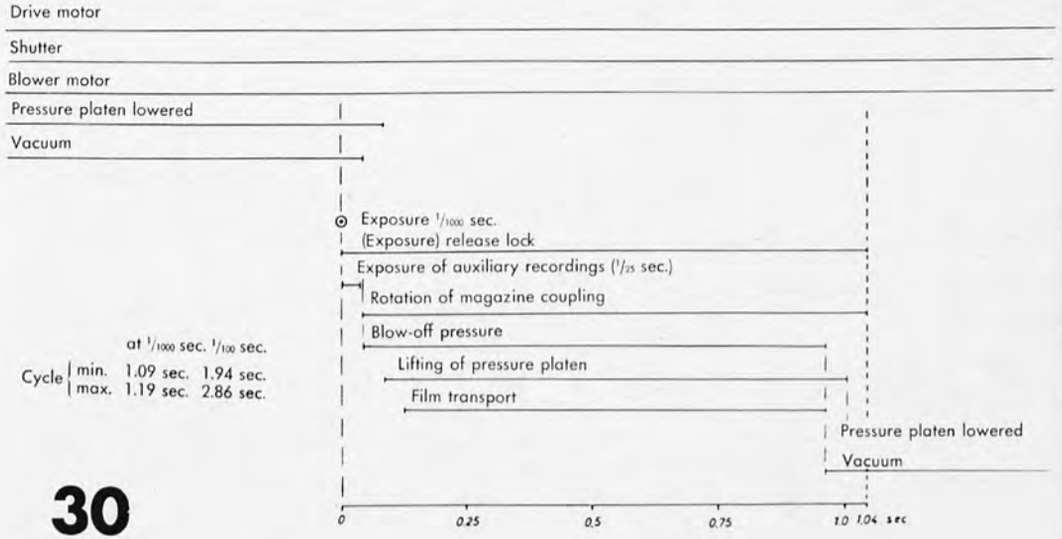
B	11	6
D	8	4
B	8	3
D	5.6	2
B	5.6	1.5
Kt	5.6	1


19a
+
18
16
15
24
145
23
28
73
72
153
83
85
99
147
25
147
140
K_4
K_2
138
K_1
137
155
146
33
32
K_3
139
154
21a
21b
21c
21d
78
19b
−
20a
20b
20c
20d
20e
117
141
Ma_4
119
121
150
148
129
152
151
114
144
$Ma_{4/3}$
143
$Ma_{4/2}$
142
$Ma_{4/1}$
125
118
149
124
123


19a (+)
19
19b (−)
19c (0)

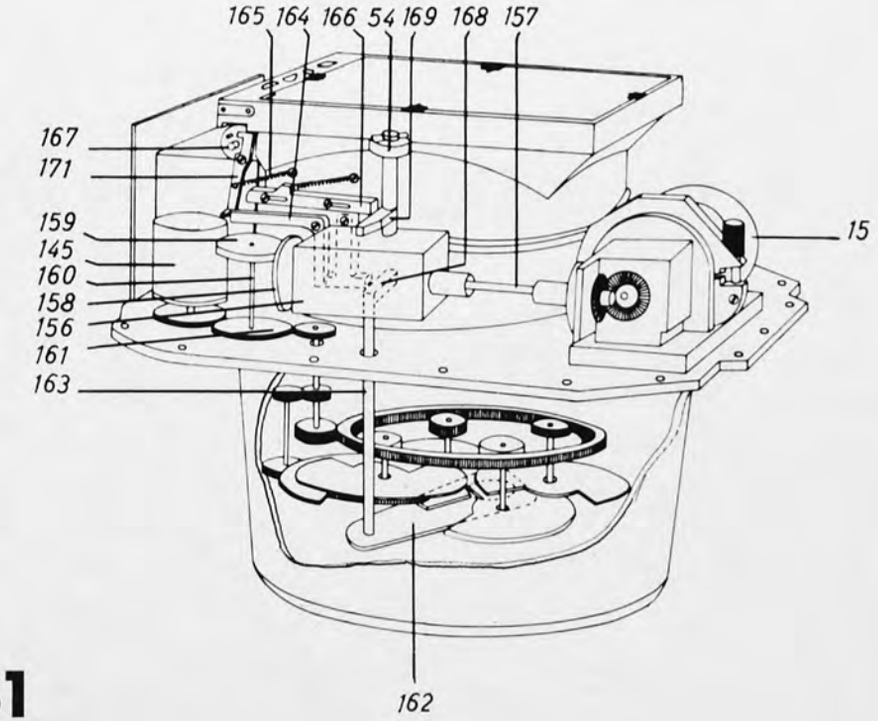

20c
20
20b
20d
20a
20e

Sequence of camera functions



Cycle	at 1/1000 sec.	1/100 sec.
min.	1.09 sec.	1.94 sec.
max.	1.19 sec.	2.86 sec.

30



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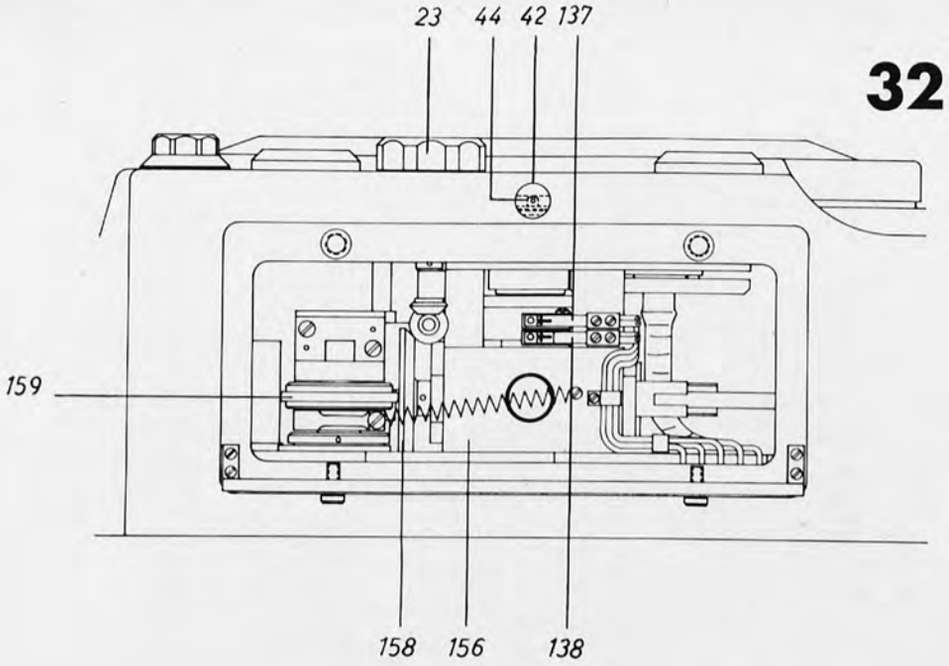

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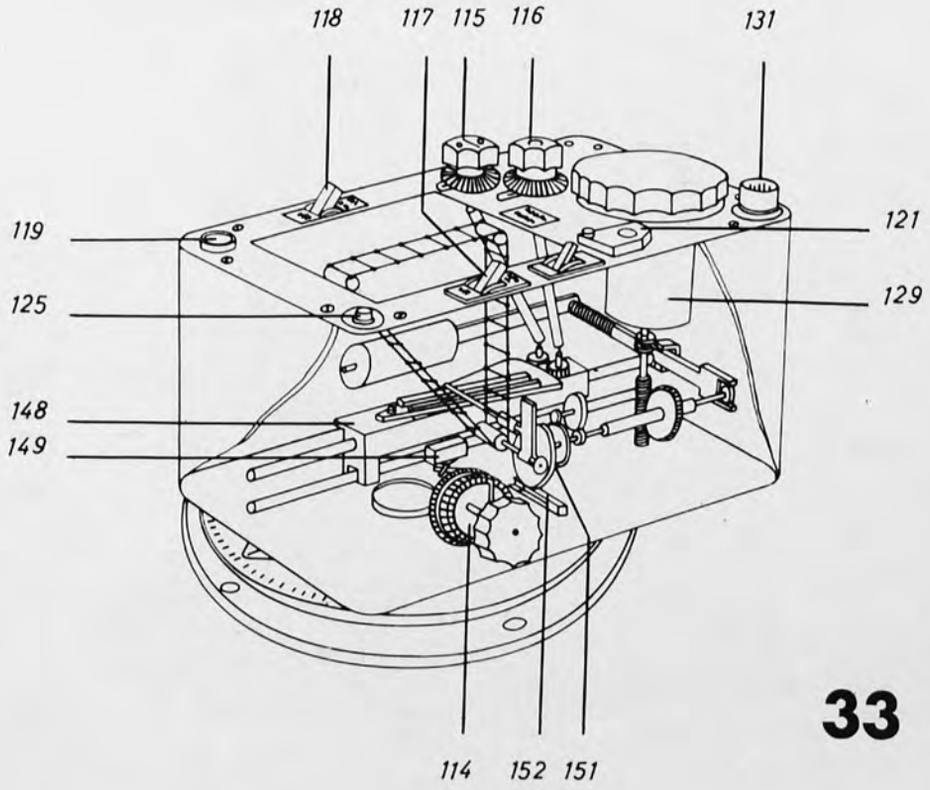

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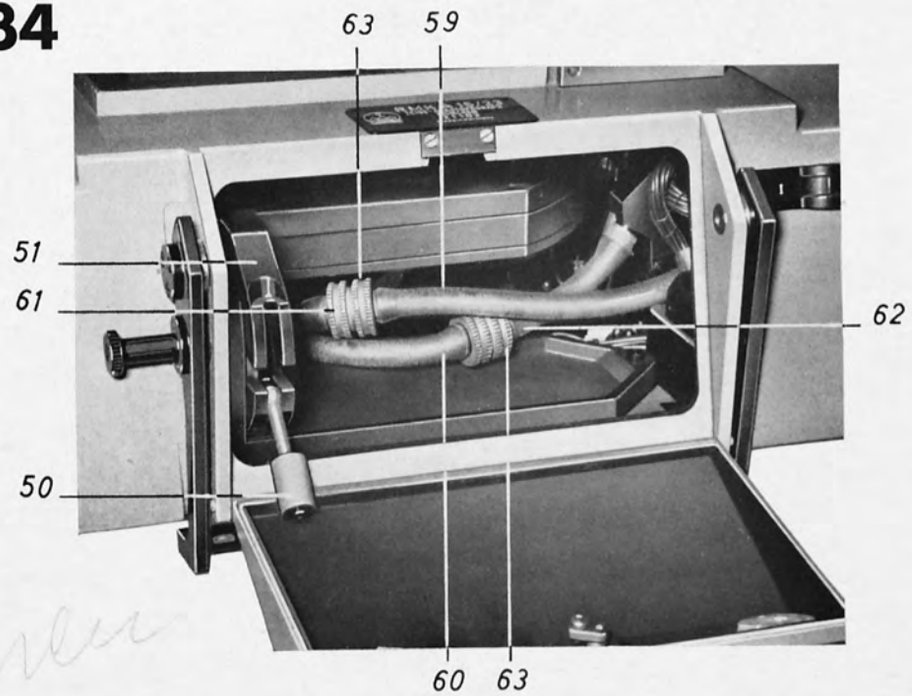

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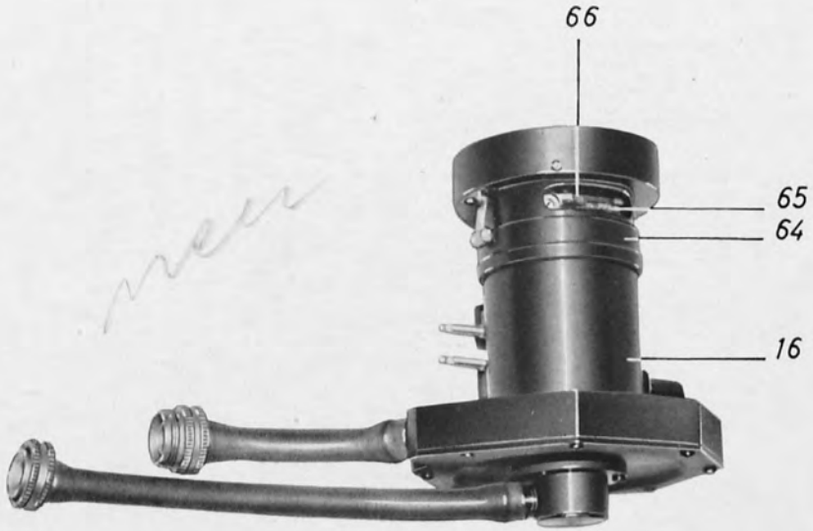

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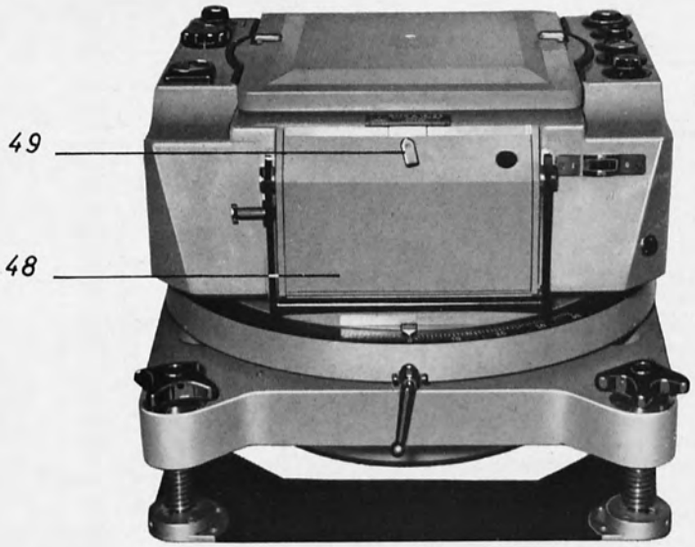

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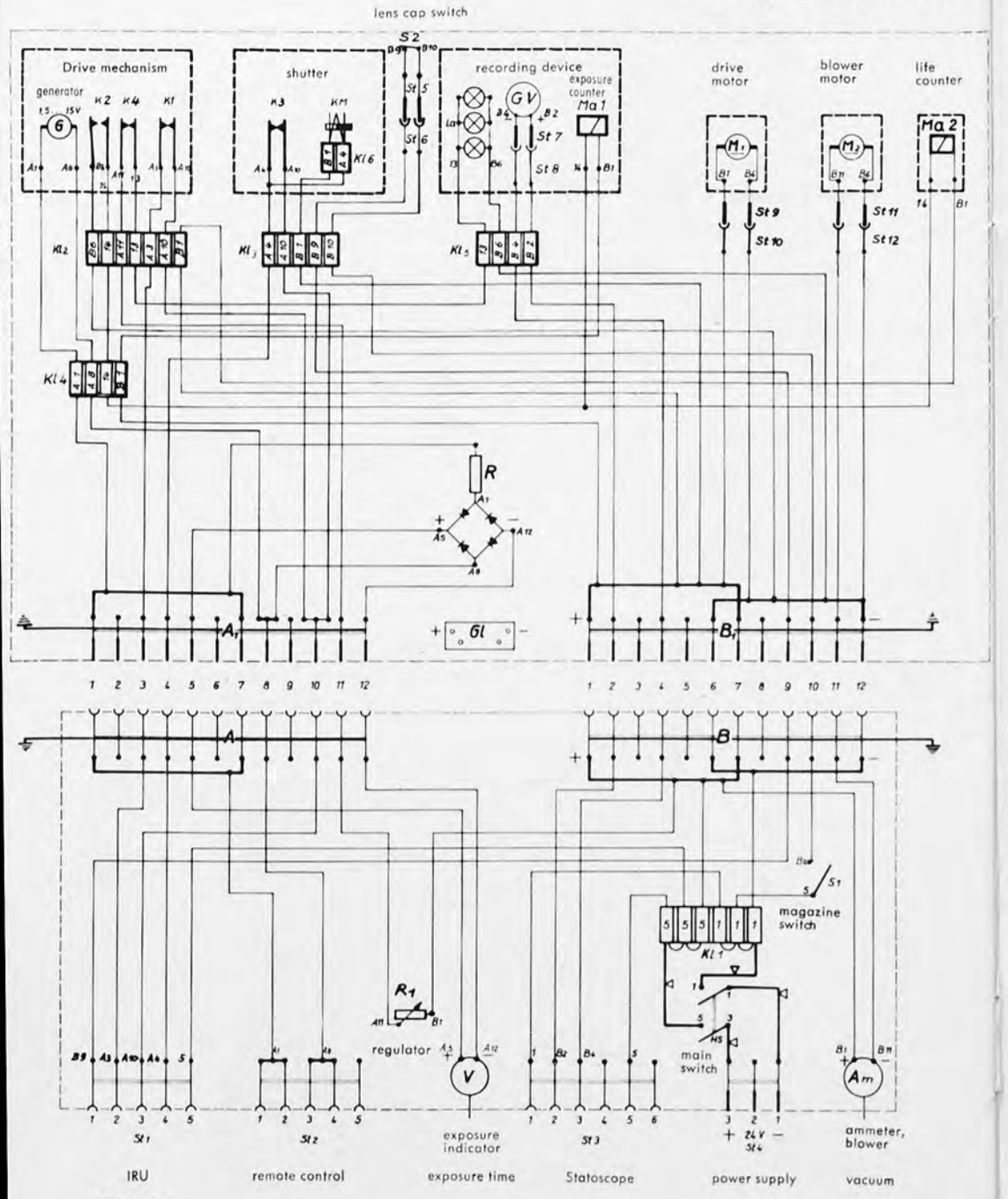
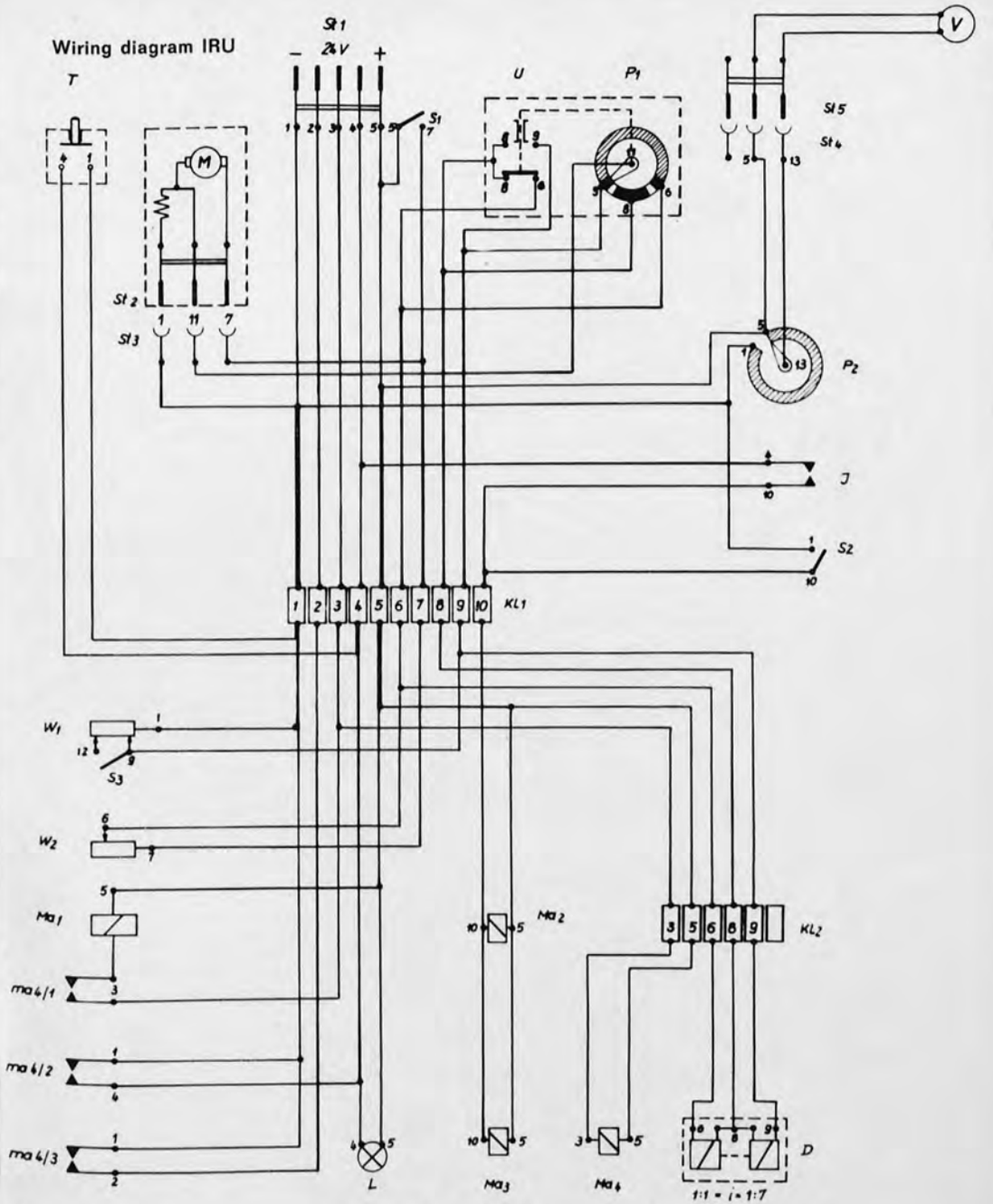
Wiring diagram RMK A 15/23



Wiring diagram IRU



D	double magnet	Ma 4	magnet for contacts ma 4/1 – ma 4/3	St 3	3-pole flanged socket
J	impulse contact	ma 4/1	make contact	St 4	3-pole plug
Kl 1	10-pole terminal strip	ma 4/2	make contact	St 5	3-pole plug
Kl 2	6-pole terminal strip	ma 4/3	make contact	T	push button
L	signal lamp	P 1	potentiometer	U	automatic change-over switch
M	24 V-motor; 2000 rpm	P 2	potentiometer	V	voltmeter
Ma 1	exposure counter	S 1	cut-out, motor	W 1	resistance, 15 ohm
Ma 2	magnet for "pin-point" photography	S 2	cut-out, serial impulse	W 2	resistance, 50 ohm
Ma 3	magnet for "pin-point" photography with remote indicator	S 3	cut-out, 2 or 3 sec.		
		St 1	5-pole flanged socket		
		St 2	3-pole plug		

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Achtung!
letzte Bilder
[illegible]

Bedienungs-Schema

beim Bildflug

Bild

Bedienungs-Schema beim Blindflug

(Anmerkung: Die folgenden Zahlen kennzeichnen die Reihenfolge der vorzunehmenden Arbeiten.)

Vorbereitung und Kontrolle vor dem Start

Kassette	Kammer	Überdeckungsregler
	❶ Kollektorkohlen des Gebläsemotors auf guten Kontakt überprüfen Anschluß-Spannung überprüfen: 24 – 28 V Gleichstrom	
❷ Einlegen von Film in die Kassette Aufsetzen der Kassette auf die Kammer	❸ Abnehmen des Objektiv-Schutzdeckels Aufsetzen des Filters Auf Notiztafel Datum, Flughöhe, Gebiet usw. notieren Eindrehen des Höhenbereiches des Höhenmessers Aufziehen und Stellen der Kammer-Uhr Einstellen der Beleuchtungsstärke für die Hilfsablesung je nach Filmart Es entsprechen etwa: 2 = 24° DIN = 200 ASA 5 = 20° DIN = 80 ASA 8 = 18° DIN = 50 ASA	❹ Einstellen Seiten/Brennweiten-Verhältnis und gewünschtes Überdeckungs-Verhältnis
❻ Öffnen des Kassettenschiebers	❺ Kontrolle des Bordnetz-Anschlusses Kontrolle der Kabelverbindung zum IRU	
	❼ Einschalten des Hauptschalters Kontrolle der Hilfsabbildungslämpchen Kontrolle der Vakuum-Anzeige	❽ Einschalten der Schalter »IRU« und »RMK«
❾ Kontrolle des Filmlaufes	❿ Kontrolle der Verschluß-Funktion	⓫ Kontrolle der Sprossenkette und der Kontroll-Lampe

Danach Ausschalten sämtlicher elektrischer Schalter, Abnehmen des Filters und Aufsetzen des Objektiv-Schutzdeckels.
Start des Flugzeuges.

Bildaufnahme

Während des Anfluges Abnehmen des Objektiv-Schutzdeckels und Aufsetzen des Filters.

Kurz vor Beginn der Aufnahme

	❶ Horizontieren der Kammer Einschalten des Kammer-Schalters Einregulieren der Belichtungszeit (siehe Belichtungs-Diagramm) Einstellen der Blende Kontrolle der Vakuum-Anzeige ❸ Einstellen der Abtrift	❷ Einschalten des Schalters »IRU« Synchronisieren der Sprossenkette mit dem Geländebild Einstellen der Abtrift

Während der Bildaufnahme

❸ Beobachten des Filmtransportes (schwarz-weiße Kontrollscheiben)	❷ Nachhorizontieren der Kammer Überprüfung der Belichtungszeit Kontrolle der Vakuum-Anzeige	❶ Schalter »RMK« einschalten Überprüfen der Synchronisierung Überprüfen der Abtrift

Nach Beendigung der Bildaufnahme

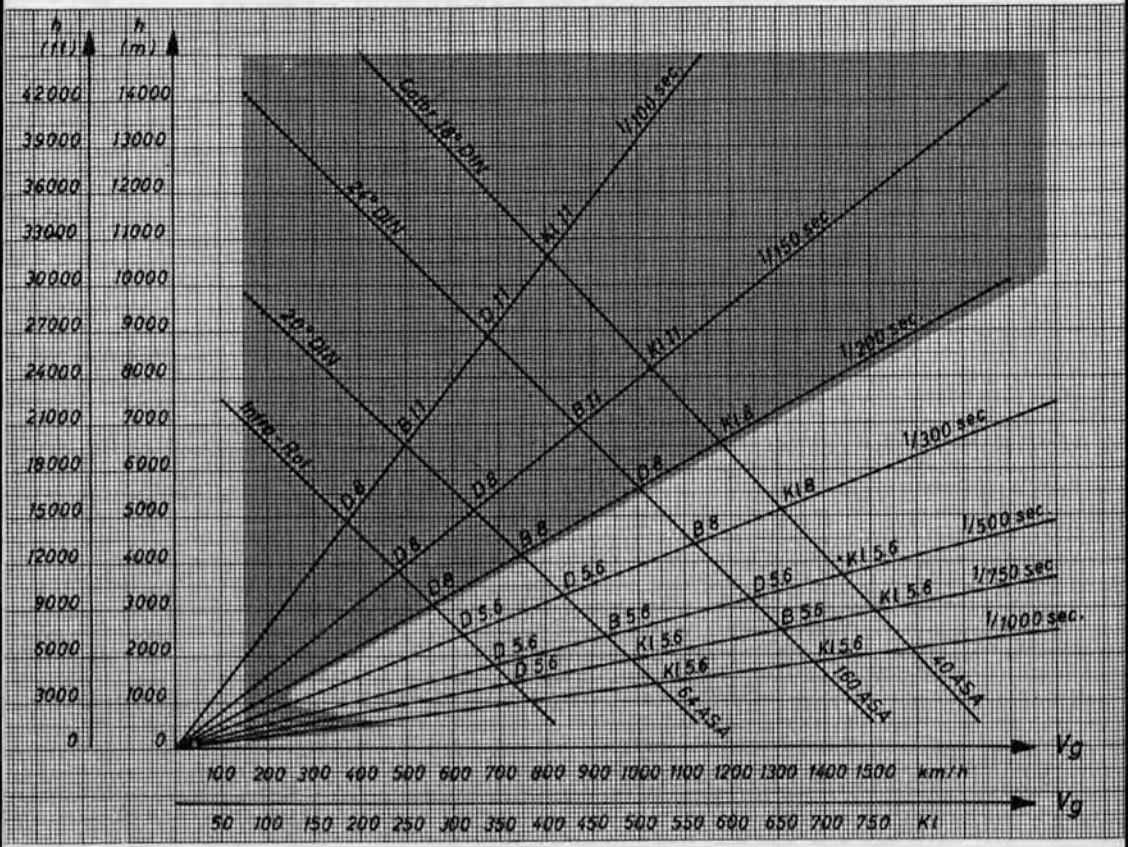
❶ Schließen des Kassettenschiebers Notiz auf der Schreibtafel an der Kassette »Belichtet«	❷ Ausschalten des Kammer-Hauptschalters	❸ Ausschalten der Schalter »IRU« und »RMK«

Abnehmen des Filters und Aufsetzen des Objektiv-Schutzdeckels

Nach dem Flug

❶ Abnehmen der Kassette von der Kammer Aufsetzen auf das Tragbrett	❷ Aufsetzen des Schutzdeckels auf dem Anlegerahmen Ausbau der Kammer	❸ Ausbau des »IRU«

Wahl der Aufnahme-Daten



Filter	Blende	Faktor
D	11	8
B	11	6
D	8	4
B	8	3
D	5,6	2
B	5,6	1,5
Kl	5,6	1

Beispiel:

Gegeben: $v_g = 220$ km/h
$h = 3000$ m
Film: 20° DIN

Aus Tabelle: Filter: B
Blende: 11
Belichtungszeit: $^1/_{100}$ sec