GLADIOLUS
movie camera

1. INTRODUCTION

This description and manual are purposed for learning recording camera “Gladiolus-1”. It contains all information necessary for full use of the camera features and to correct operation.

2. PURPOSE

The recording camera Gladiolus is purposed for shooting processes (including fast-flowing ones) from moving vehicles (both air and surface). It can be used:

1) By operator holding the camera in his hands in limited space.
2) By operator holding the camera in his hands or having it mounted on a support outdoors.
3) On immovable support.

3. SPECIFICATIONS

Film type	35mm
Film movement	Direct only, in one plane
Number of films in the film channel	1
Shooting speed, fps	24, 48, 96, 144, 192, 216-240
Speed deviation, %	+/-2.5
Image deviation, mm, no more - at 24-96fps - at 144-240fps	 0.02 0.04
Starting time, sec, no more	3
Available lenses, F, mm	18, 28, 40, 75, 150, 300
Flange focal length?	57+0.01
Mag capacity, m	60, 120
Magnification of the viewfinders, x - attached viewfinder - monocular - collimator sight - prismatic sight	 6 8 1 3
Shutter	Disc-shaped, single-blade, variable angle (30, 60, 90, 120, 145 degrees)
Drive	DC motor MU-332A with tacho-generator and separate control unit
Power source	DC 27V+/-2.7V with no more than 3% pulses allowed
Consumption current without heater, A, no more	32
Consumption current of the heater, A, no more	24
Control tools	Footage counter, voltmeters, ammeters
Tripod nut	3/8’’
Allowable temperatures, centigrade	+5 (-40 in box) to +35
Atmosphere pressure, kPa (mm of mercury)	613-1066 (460-800)
Ability to work (except power source, control unit, and remote control) after:	
1. Vibration overload, Hz	10 to 200 with acceleration 50 m/sec^2 (5G).
2. Continuous linear acceleration with	40 (4)

overloads, m/sec^2 (G)	
3. Multiple impact loads with overloads, m/sec^2 (G)	40 (4), impact time is 0.01sec
Ability to work of the remote control after vibrations, Hz	10-20, with 20m/s^2 acceleration (2G)
Ability to work of the camera after exposure to maximum relative humidity, %	90 at 20°C
Transportation conditions (without power source):	
1. Transportation overloads with acceleration of m/s^2 (G)	30 (3), 80-120 strikes per minute
2. Air temperature, °C	–60 to +60
Dimensions (with 120m mag and 150mm lens), mm	620x180x190
Dimensions of the control unit, mm	330x190x195
Dimensions of the remote control, mm	250x165x160
Dimensions of the power source, mm	295x250x170
Dimensions of the monitoring unit, mm	315x290x100
Dimensions of the terminal box, mm	175x110x100
Dimensions of the box with heater, mm	660x390x395
Weight with 60m mag and 150mm lens, without box, kg	17
Weight of the control unit with cable, kg	6.5
Weight of the remote control, kg	4.5
Weight of the power source (without electrolyte), kg	9.7
Weight of the monitoring unit, kg	2.1
Weight of the terminal box, kg	1.6
Box weight (without heater), kg	7

4. DELIVERY SET

Name, index	Document name	Quantity	Note
Recording camera Gladiolus-1 with parts mounted on it:	4RKS.00.000	1	
- 120m mag	4RKS.03.300	1	
- lens mount cap	3RKS.00.00.050	1	For the lens mount
Bracket	4RKS.01.350	1	Small one
60m mag	4RKS.03.200	2	With two cores
120m mag	4RKS.03.300	1	With two cores
18mm lens	4RKS.23.100	1	OKS5-18-1
28mm lens	4RKS.21.100	1	OKS7-28-2
40mm lens	4RKS.20.000	1	OKS1-40-1
75mm lens	4RKS.19.100	1	OKS6-75-1
150mm lens	4RKS.17.000	1	OKS1-150-1
300mm lens	4RKS.15.000	1	OKS1-300-1
Monocular	4RKS.13.000	1	Wit cap for optics
Viewfinder	AGD5.811.001-01	1	Wit cap for optics, collimator
Hand support	4RKS.10.000	1	
Tripod 5ShKS	TU19.275-79	1	In case
Remote control unit	4RKS.07.000	1	
Control unit	4RKS.08.000	1	
Power source unit	4RKS.31.000	1	Electrolyte is in separate packing
Heater	AGD5.863.000	1	
Monitoring unit	4RKS.30.000	1	
Bracket	4RKS.12.100	1	For the viewfinder mounting
Bracket	4RKS.12.100-01	1	For the viewfinder mounting
Bracket	4RKS.12.100-02	1	For the viewfinder mounting
Set of light filters	4RKS.27.000	1	For the 18, 28, 40, 75, 150,

			300mm lenses
Set of lens hoods	4RKS.26.000	1	For the 18, 28, 40, 75, 150, 300mm lenses, 5 pieces total
145° shutter	4RKS.01.340	1	
90° shutter	4RKS.01.360	1	
60° shutter	4RKS.01.370	1	
30° shutter	4RKS.01.380	1	
Ring	4RKS.11.020	1	
Ring	4RKS.11.040	1	
Bracket	4RKS.11.050	1	Big one
Housing	4RKS.11.070	1	
Box	AGD5.285.000-01	1	
Ring	AGD8.249.051	1	
Cap	4RKS.04.070	1	
Attachment	4RKS.04.110	1	
Cap	4RKS.04.210	1	
Cable #1	33K.000	1	3m
Cable #2	34K.000	1	1.5m
Cable #3	35K.000	1	3m
Cable #4	36K.000	1	30m
Cable #5	37K.000	1	5m
Cable #6	103K.000	1	2.5m
Friction tester	AGD5.178.011-01	1	
Box #1	4RKS.35.100	1	
Box #2	4RKS.35.200	1	
Box #3	4RKS.35.300	1	
Box #5	4RKS.35.700	1	
Box #6	4RKS.35.600	1	AKA ‘traveling’
Box #7	AGD6.875.058	1	
Box #8	AGD6.875.057-01	1	
Box #9	AGD6.875.060-01	1	
ZIP set		1	In accordance with 4RKS.00.000ZI
Operational documents			
Technical description and operational manual	4RKS.00.000 TO	1	
Logbook	4RKS.00.000 FO	1	
ZIP list	4RKS.00.000 ZI	1	
Operational documents list	4RKS.00.000 ED	1	

5. CONSTRUCTION AND PRINCIPLES OF WORK

5.1. Principle of work

The principle of work of the movie camera is based on synchronous work of the claw mechanism (transporting a film with intermittent motion) and the shutter providing exposure of the film during pause of the film movement.

5.2. Construction

General view of the camera is shown at the Figure 1.
The camera consists of the following basic parts and accessories:

1) The camera with motor;
2) Mag;
3) Lens;
4) Viewfinder;
5) Remote control unit;
6) Control unit;
7) Power source unit;
8) Tripod;
9) Hand support;
10) Brackets for heavy lenses;
11) Viewfinder brackets;

12) Box;
13) Heater;
14) Cables.

Depending on shooting requirements, you can mount any lens from the supplied set. Electric coupling is provided by cables. Installed motor is MU-332A. The remote control unit or control unit accomplishes camera control.

To maintain the camera in operable state at temperatures of +5 to –40°C, it should be placed into the box with heater. The remote control unit or control unit accomplishes camera control.

Operator can hold the camera by means of the hand support. The camera can be placed onto tripod (without the box or in the box). The camera used in either hand-held or stationary mode.

Hand-held setup consists of:

1) The camera;
2) 60m mag;
3) Collimator sight;
4) Hand support;
5) Set of the lenses, lens hoods, and light filters;
6) Control unit.

Stationary setup consists of:

1) The camera;
2) 60m and 120m mags;
3) Set of the lenses, lens hoods, and light filters;
4) Brackets for heavy lenses;
5) Control unit;
6) Remote control unit;
7) Stationary support (the box support).

Figure 1. Camera "Gladiolus-1" on the demonstration tripod. General view

5.3. Kinematics

The kinematics of the camera is shown on the Figure 2.

It provides a movement transmission from the motor to the claw mechanism, film-transporting mechanism, shutter, mag, and film counter. It also generates electrical pulses into external circuit.

Principles of the camera kinematics are described below.
Rotation of the motor (1) is transmitted to the main shaft (I) by means of the pair of oblique-cog wheels (2,3), and to the tacho-generator (5) by means of the coupling (4). From the shaft (I) the rotation is transmitted to the shaft (II) by means of the pair of the cone gears (6,7). From the shaft (II) the rotation is transmitted to the shutter shaft (III) by means of the pair of the screw gears (8,9). Intermittent motion of the film is accomplished by the claw mechanism (11) which shaft (IV) is coupled with the claw shaft (II) by means of the coupling (12).
The rotation is transmitted to the shaft (V) of the transporting 24-teeths sprocket (15) by means of the pair of oblique-cog wheels (13,14).
Take-up core is actuated from the shaft (V) by means of two pairs of the intermediate shaft oblique-cog wheels (14,17) and (18,19), and tooth-type coupling (20).
Steady film feeding from the core (21) to the film channel is accomplished by means of the sprocket (15).
Leaving the film channel, the film forms a free loop and transported to the mag take-up core (16).
Both feeding and take-up lugs have dry friction clutches (22), (23).

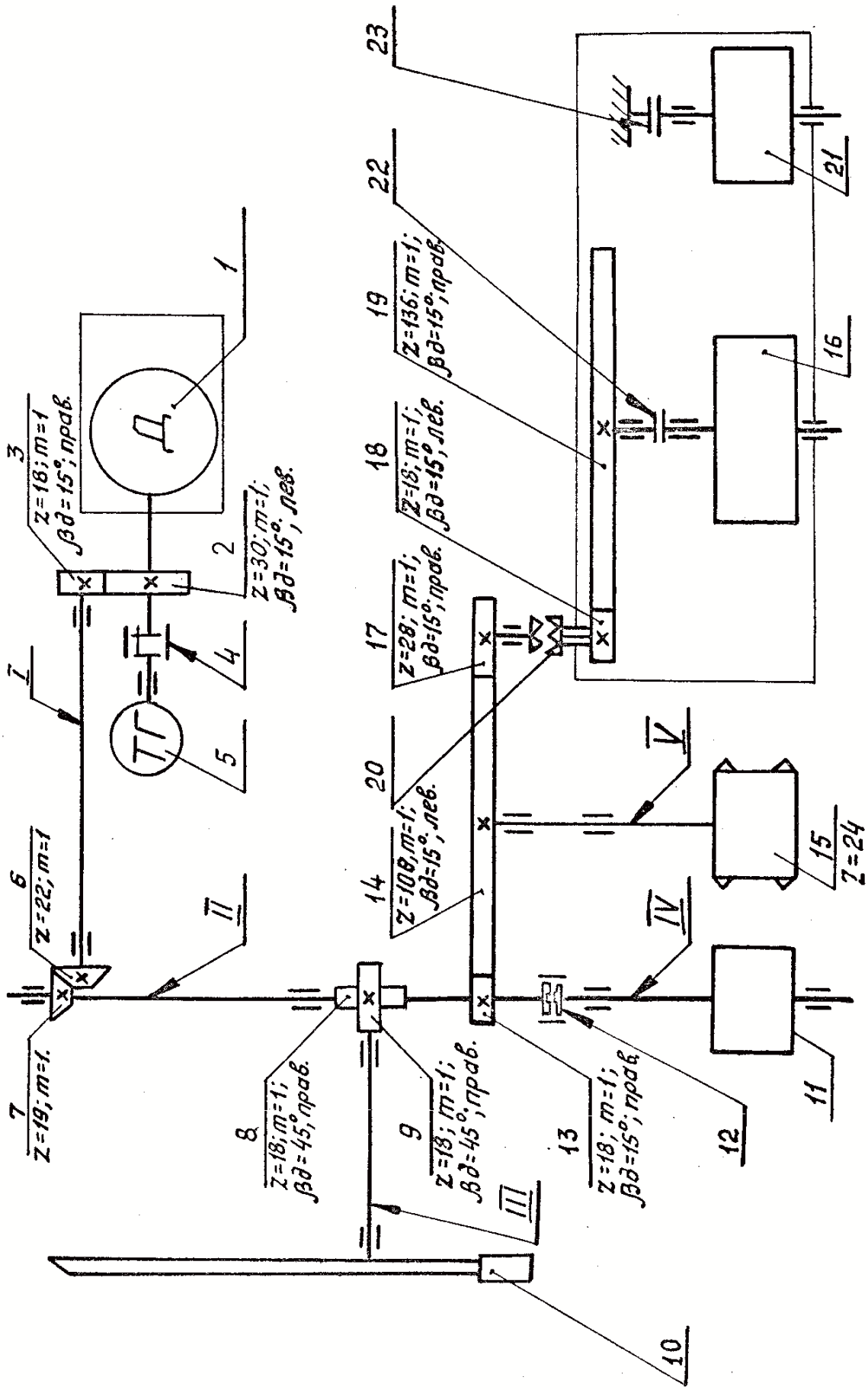

Figure 2. Kinematics

5.4. Optical schematics

5.4.1. Attached viewfinder. Optical schematic

The optical schematic of the attached viewfinder is shown at the Figure 3.
The image produced by a lens in the frame window is observed by operator by means of the viewfinder mounted instead of the claw so that ground glass (30) touch the surface of the front film gate by it's front matted surface. The image is observed by operator with resulting 8x magnification by means of the prisms (31), (32), (33) (AR-90° type), 52.4mm lens (34), prism assembly consisting of the prisms (35, 36, 37), and 15x eyepiece (38). The eyepiece slide (b-B) rotates around the axis (a-b) to change the output pupil position. The eyepiece has dioptric adjustment of ±5 dptr. Linear field of view is 22x16mm. You can turn the image by turn of the prism assembly (35, 36, 37) around the axis (b-B).

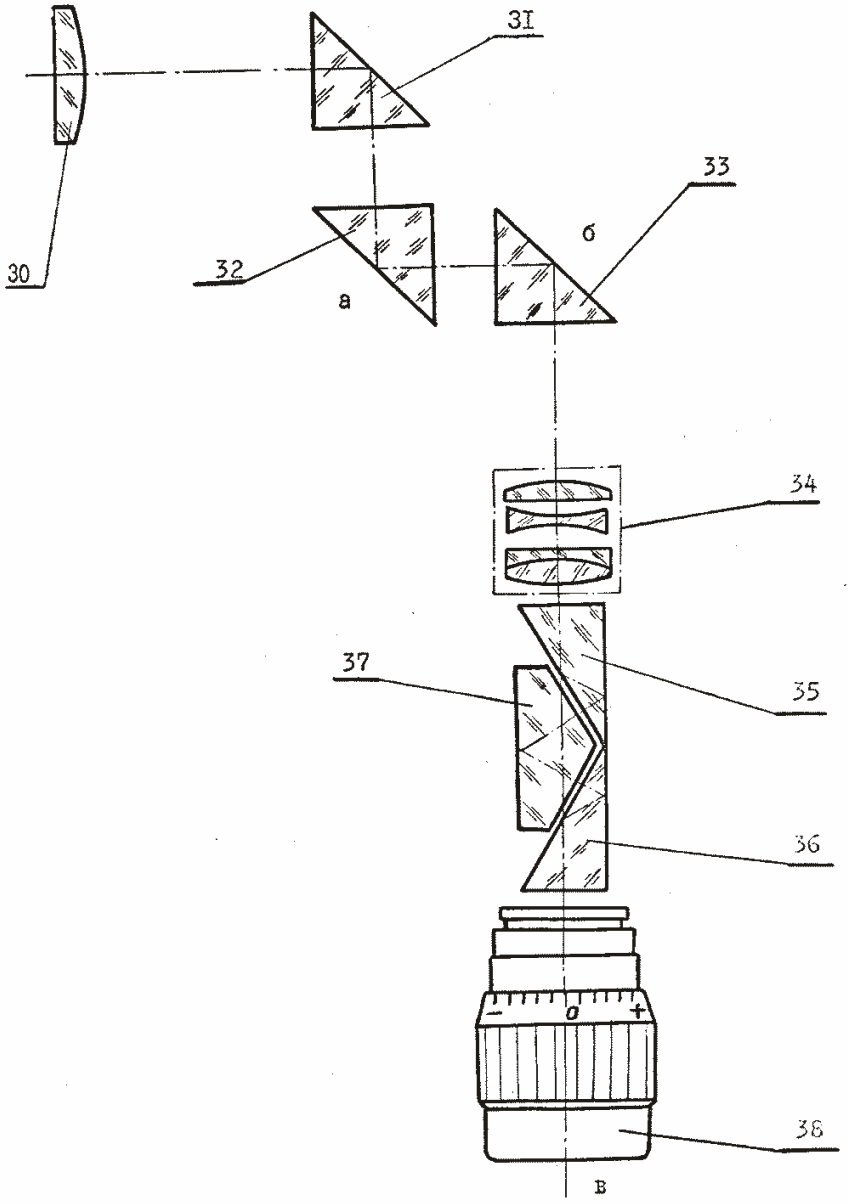

Figure 3. Attached viewfinder. Optical schematic

5.4.2. Collimator sight. Optical schematic

Optical schematic of the collimator sight is shown at the Figure 4.

The optical schematic consists of the grid (40), prism (41) (AR-90°), three-elements lens (42), two-way mirror (43), and dispersive safety glass (44).
The grid (40) contains transparent crosshair and rectangular easels with ‘40’, ‘75’, ‘100’ marks corresponding to the filed of view of the 40mm, 75mm, and 100mm lenses.
The image and the easels are observed through the two-way mirror (43). The image within each easel is identical to the image produced in the frame window by corresponding lens.

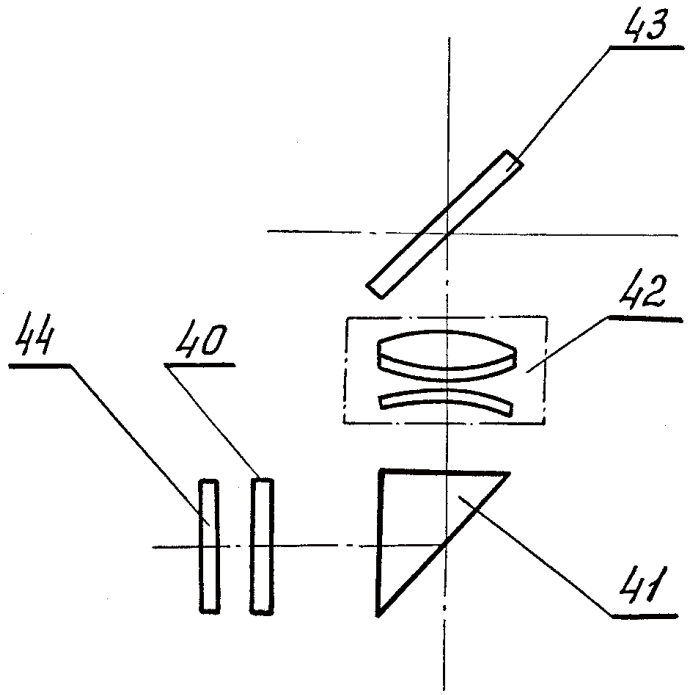

Figure 4. Collimator sight. Optical schematic

5.5. Electric circuits

The electrical part of the camera consists of the following circuits:

1) The camera;
2) Remote control unit;
3) Control unit;
4) Heater;
5) Power source unit;
6) Monitoring unit;
7) Cables to connect the units above.

5.5.1. Electric circuit of the camera

The camera electric circuit is shown on the Figure 5.
The motor M2 actuates all kinematics of the camera. Required power is supplied from the power source unit through the pins 1-6 and 19-24 of the connector Ш1.
The shaft of the motor M2 is cinematically coupled with the tacho-generator M1 which produces a feedback voltage proportional to rotation speed of the motor M2. The feedback voltage goes to the control unit through the pins 112 and 13 of the connector Ш1 to form a governing signal for the motor M2.
Resistor R11 included in line with the tacho-generator adjusts the feedback signal slope.
Photodiode Д2, IR-transmitting diode Д3, and amplifier assembled on transistors T1-T3 form pulses of the film movement during camera’s run. This unit works as described below.
Bridges between perforation holes block a light flow from Д3 to Д2 during film movement. Voltage pulses are passed from the resistor R1 to the amplifier. Amplified pulses are passed from transistor T3 to the pin 7 of the connector Ш1 and to the control unit therefore.
Diodes Д4 and Д5 serve for marking events on the film. Required voltage comes from the control unit through the pin 9 of the connector Ш1.
The button B1 blocks the camera with opened door.
Start-up device is connected through the connector Ш3. The start-up device has buttons B2 and B3 for starting the camera and marking ‘events’ on the film.

Thermo-relay P (RB-5-1.5°C) indicates readiness of the camera for operation in the box.

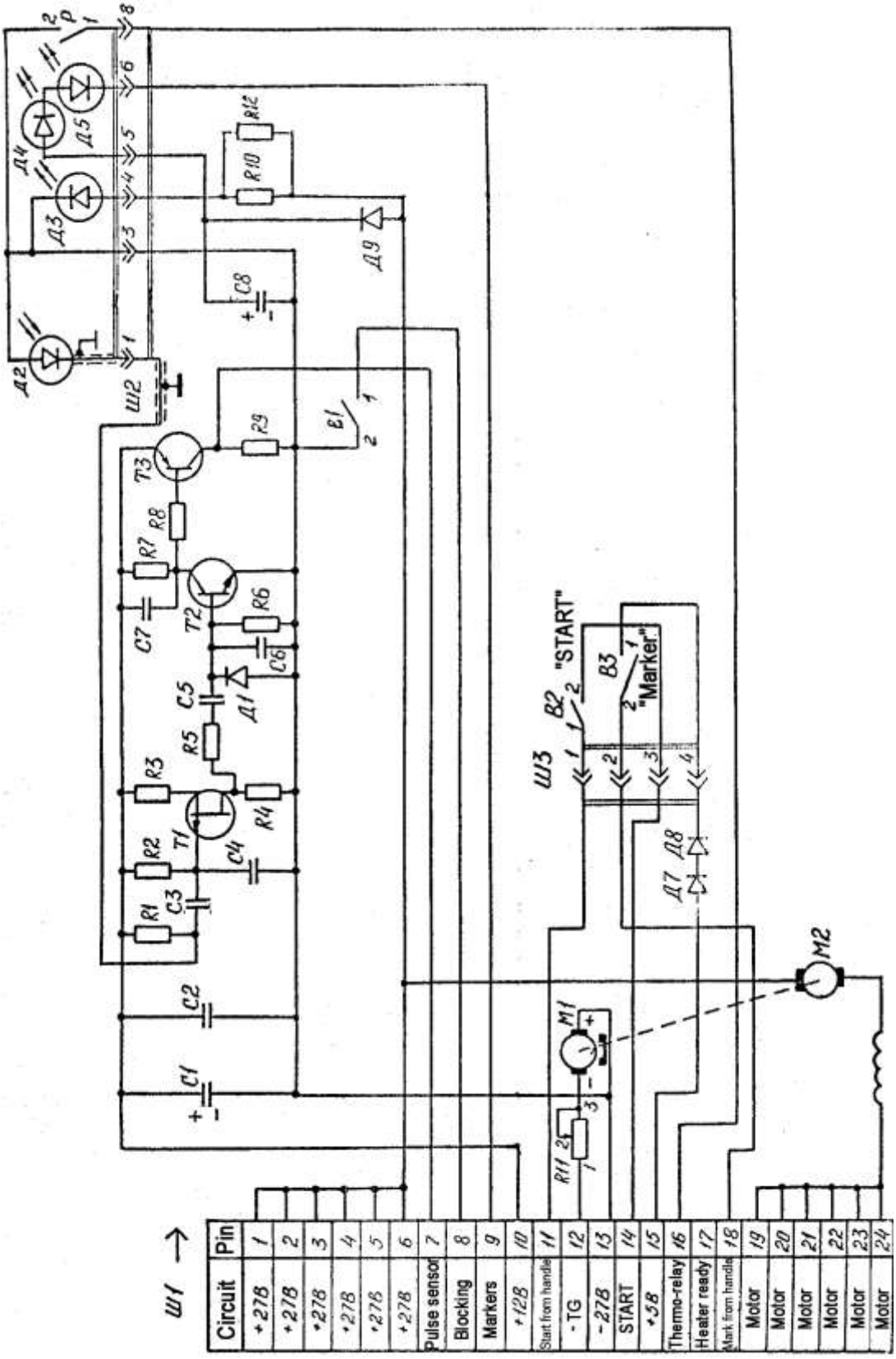

Figure 5. Electric circuit of the camera

5.5.2. Electric circuit of the remote control unit

Electric circuit of the remote control unit is shown on the Figure 6.
The circuit works as described below.

When you turn the switch B3 ON, power supplied to the remote control and indicator lamp L2 ‘POWER’ lights up.
When you press the button B1 ‘START’, lamp L1 ‘WORK’ lights up, and 27V DC supplied to the control unit (for commutating of the camera power) through the button B2 ‘STOP’ and pin 3 of the connector III1. 27V DC supplied to the pin 14 of the connector III1, locks the button B1 ‘START’ through the control unit. Selector B5 is used for setting required shooting speed.
If camera runs correctly, indicator lamp L3 ‘BREAK’ is off. If there is no film in the camera, or film is broken, the lamp L3 ‘BREAK’ lights up in 1-2 seconds after pressing the button B1 ‘START’.
Button B2 ‘STOP’ stops the camera.
Upon appearing an impulse corresponding to every 50th frame on the pin 6 of the connector III1, electro-mechanical counter IP1 advances length of exposed film in meters with 4.5% accuracy.
After mounting other mag onto the camera, it is necessary to reset the counter by means of the button situated on the counter.
If you operate the camera from the remote control unit, set the speed selector into ‘REMOTE’ position.
If power supplied incorrectly, the button B1 ‘START’ will not run the camera, and lamp L2 ‘POWER’ will be off.

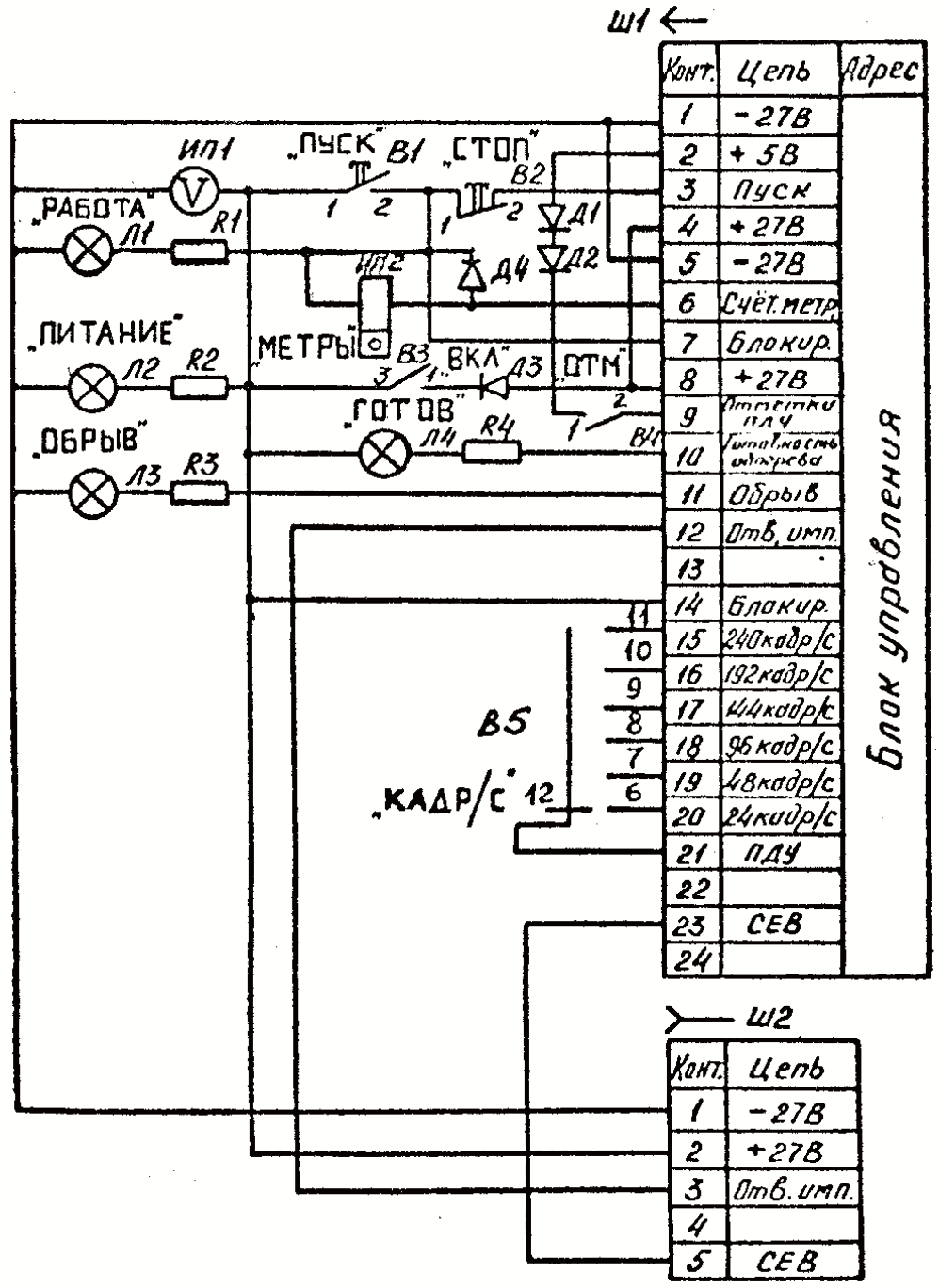

Figure 6. Electric circuit of the remote control unit

5.5.3. Electric circuit of the control unit

Electric circuit of the control unit is shown on the Figure 7.
The control unit is purposed for all necessary connections and stabilizing of the motor rotation speed.
Electric circuit of the control unit consists of several units: rotation speed stabilization unit, voltage converter unit, scalers unit (purposed for film counting), and some other units purposed for controlling of the camera.

5.5.3.1. Board of the voltage converter and stabilizers U1

The board U1 contains voltage stabilizers of 5V and 12.6V; transformer with rectifier; parametrical stabilizers of –27V and –12.6V.
The stabilizer of 5V is built using VR diode D1 (2S168A) and output transistor T1 (2T909A).
Resistor R3 sets a required voltage on the stabilizer output. The 5V voltage is required for powering logic elements of the scaler.
The stabilizer 12.6V is built on the transistor T2 (2T312B), IC Y1 (140UD1B), stabilitrons D2, D3 (D818E, D814A) and transistor T9 (2T909A) mounted off the board.
The IC Y1 is included into feedback chain. Voltage on the inverting input of the operational amplifier is stabilized by stabilitron D2. Required voltage on the output of the stabilizers is set by means of the trimming resistor R5.
Output voltage of the operational amplifier controls operation of the output transistor T9 through transistor T2. Diode D3 matches signal levels of the transistor T2 and IC Y1.
The voltage converter is used to provide –12.6V and –27V using +27V. The converter is built as duple multivibrator on the transistors T4, T5 (MP26B) and transformer Tr. Output secondary voltage is rectified by half-duplex rectifier built on diodes D4-D7 (2D522B). Voltage stabilizer of –12.6V and –27V is built on stabilitronts D8-D10 (D814D).

5.5.3.2. Board of the scalers U2

Scalers board is purposed for producing of the footage reading impulses. Is also produces impulses after every 10^{th} and 100^{th} frame.
The camera sensor impulses are passed from the board U4 to the pin 1 of the connector III5 and further to the IC U1 (134LB1A) for improving of the impulse fronts.
Triggers Y2-1 and Y2-2 (IC 134TB14) form a scaler dividing a frequency by 4. This provides matching of the camera sensor impulses with quantity of exposed frames.
Triggers Y3-1, Y3-2, Y4-1, Y4-2, Y5-1, Y5-2 and Y6-1 extract every 50^{th} impulse to read meters of the exposed film.
A signal from pin 8 of the trigger Y6-1 passes to the NOR gate Y7-4 and further to the differentiating circuit Y12-1, Y12-2. Differentiated signal passes to the IC Y10-2 for improving a fronts, and further to the inflowing currents producer Y11 (IC 146AA2A). The signal for pin 12 of the IC Y11 passes to the film counter of the remote control unit.
Trigger Y6-2 is purposed for extracting every 100^{th} frame. The impulses of every 10^{th} and every 100^{th} frame are passed through the coincidence elements (Y7-Y8 and Y10-3) to the inflowing currents producer Y13, and from the pin 12 of the connector III8 to the remote control unit to register the feedback impulse on the external equipment. ICs Y8, Y10 and Y11 are used to place an ‘events’ mark on the film.
When switch B4 ‘MARK’ is set to ‘MARK’ position, signals form the buttons ‘events’ of the remote control unit and control unit pass to the input of the IC Y9-4, and to the inflowing currents producer Y11 through the matching logic element Y10-1. From the UC Y11 the signal passes to the camera LEDs (through the pin 9 of the connector III2) to mark a film.
It this position of the switch B4 ‘MARK’ a signal also appears on the LEDs at every 10^{th} and 100^{th} frame.
In the position ‘SOWING’ of the switch B4 ‘ MARK’, external signals are supplied to the LEDs.

5.5.3.3. Board of the DC amplifier U3 and Board of connections U4

DC amplifier (board U3) is purposed for providing a master voltage supplied to the power amplifier built on transistors T1-T8. The amplifier works as described below.
When you switch on the switch B1 ‘POWER’ of the control unit, stabilized voltage 12.6V is supplied to the board through pin 11 of the connector III6. Reference voltage from scaler R11-R14 is filtered by capacitor C5 and passed to the inverting input of the operational amplifier (IC Y2, 140UD1B). Then it is amplified and supplied to emitter follower built on transistor T5 (2T608B). Then it is passed to the output stage of the power amplifier.
It the ‘START’ mode, the output stage is open, and provides a power to the camera motor through pins 19-24 of the connector III2. A tachogenerator linked to the motor begin to run together with the motor. The TG voltage is passed to the commutation board U4 of the control unit.
Depending on the selected shooting speed (set by selector B3 ‘FPS’), one of the relays P1-P6 in actuated and passes the feedback voltage from the TG to the operational amplifier (Y1) and transistors T1-T3 of the board U3. Output voltage of the transistor T3 has inverted polarity relatively to reference voltage. Operational amplifier (IC Y2) of the board U3 combines the reference voltage and negative feedback voltage.
The motor will speed up until feedback voltage match the reference voltage. Sustained speed will be maintained automatically.
Board U4 contains also commutation device of the ‘START’ mode.

When you switch on the switch ‘START’ of the control unit, or push the button ‘START’ of the remote control unit, 27V is supplied to the relay P9 of the board U4. This relay links chain R23-C4 to the base of transistor T4. This chain provides actuating of the relay P8 for 1-2 seconds for producing a DC signal fro the impulses coming from the camera.
If there are no impulses from the camera, this can be caused by absence of the film or by its break. So, the camera stops after 1-2 seconds.
If the camera runs correctly, the relay P8 remains in ON state, and feeds 27V to the relay P1 through its pins 22-23 and pin 18 of the connector III7.
Relay P1 feeds the power amplifier through its pins 12-22. To stop the camera, just switch OFF the switch ‘START/STOP’ on the control unit, or release the ‘START’ button on the camera, or press ‘STOP’ button on the remote control unit.
If you operate the camera from the remote control unit, set the speed selector into ‘REMOTE’ position.
You can run the camera without film during adjusting or maintenance. To do this, press the button B6 ‘LOCK OFF’. In all other cases this button should be released.
Blocking diodes D1 and D3 protects the camera from wrong polarity.
If polarity is wrong, indicator lamp L1 is off.
Box is connected to the camera through the connector III3.

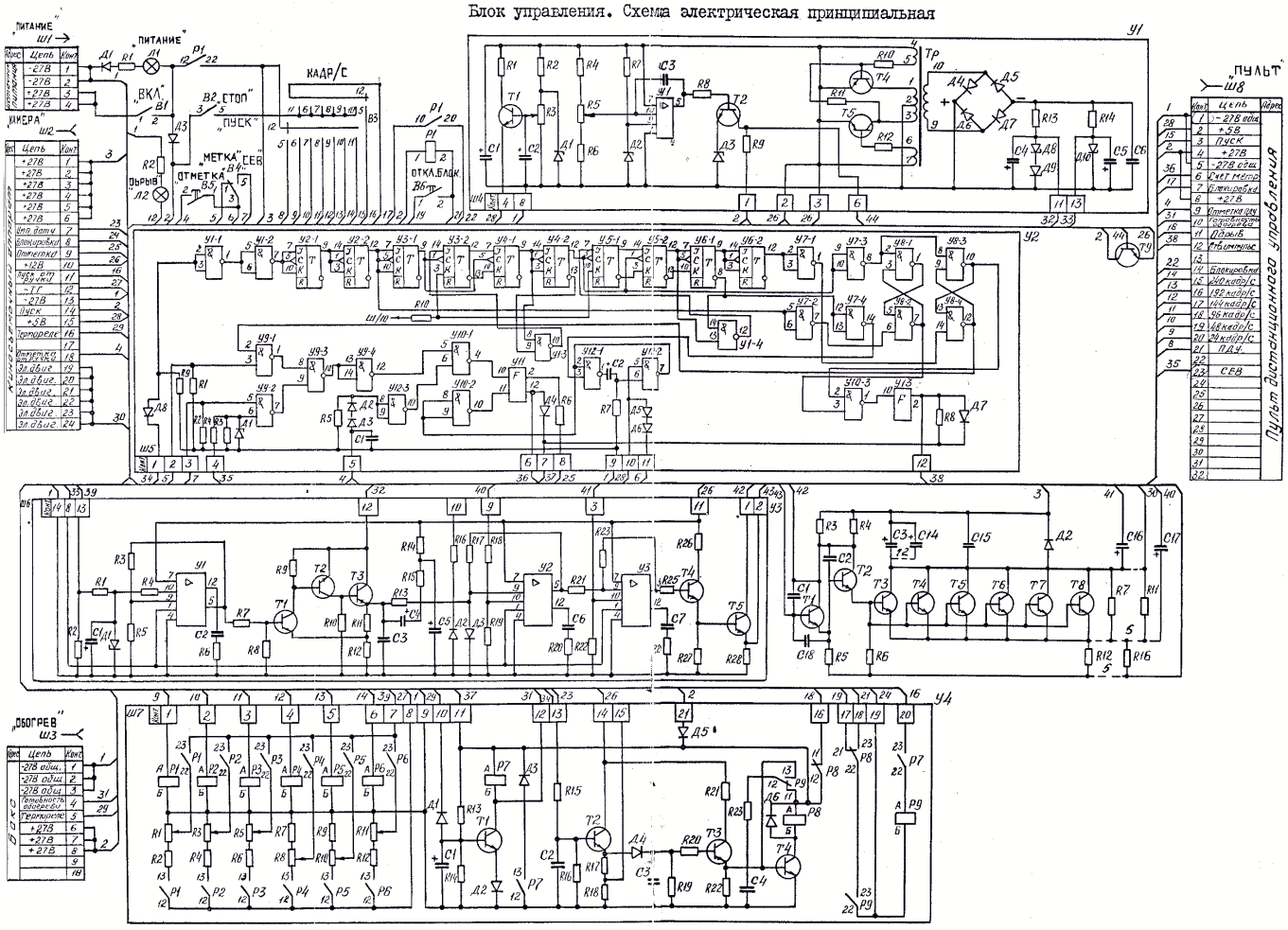

Figure 7. Electric circuit of the control unit

5.5.4. Electric circuit of the power source unit

Electric circuit of the power source unit is shown on the Figure 8. The power source unit is purposed for powering the camera with 27±2.7V DC. The power source unit is connected with the control unit by means of the 4-pins connector. Connector III1 situated on the power source unit.

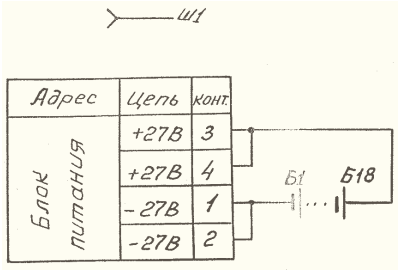

Figure 8. Electric circuit of the power source unit

5.5.5. Electric circuit of the heater

Electric circuit of the heater is shown on the Figure 9. The heater is purposed for maintenance of positive temperature in the box during operation at low temperatures (less than +5°C).

The heater is stand-alone unit mounted onto the box. Powering of the heater is accomplished from separate power source of 27±2.7V DC. Power consumption is not more than 600W.

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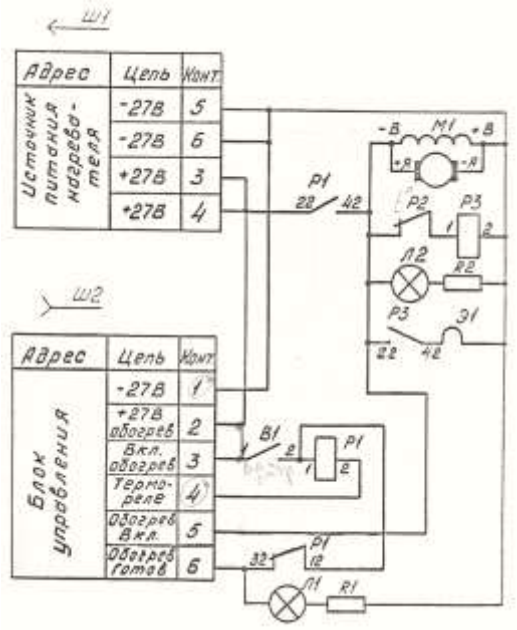

Figure 9. Electric circuit of the heater

5.5.6. Electrical connections

Electrical connections are shown on the Figure 10. The connections are accomplished by means of the cables:

Cable #1 connects the power source unit with the connector Ш1 of the control unit. The cable is purposed for powering the camera.

Note. During maintenance procedure powering is accomplished through the terminal box of the monitoring unit.

Cable #2 connects the camera with the connector Ш2 of the control unit.

Note. During maintenance procedure powering is accomplished through the terminal box of the monitoring unit.

Cable #3 connects connector Ш3 of the control unit with the connector Ш2 of the heater.

Cable #4 connects the remote control unit with the control unit.

Cable #5 is purposed for providing the camera with ‘time’ markers during maintenance procedure.

Cable #6 is used instead of the Cable #1 when the camera is powered from the external power source.

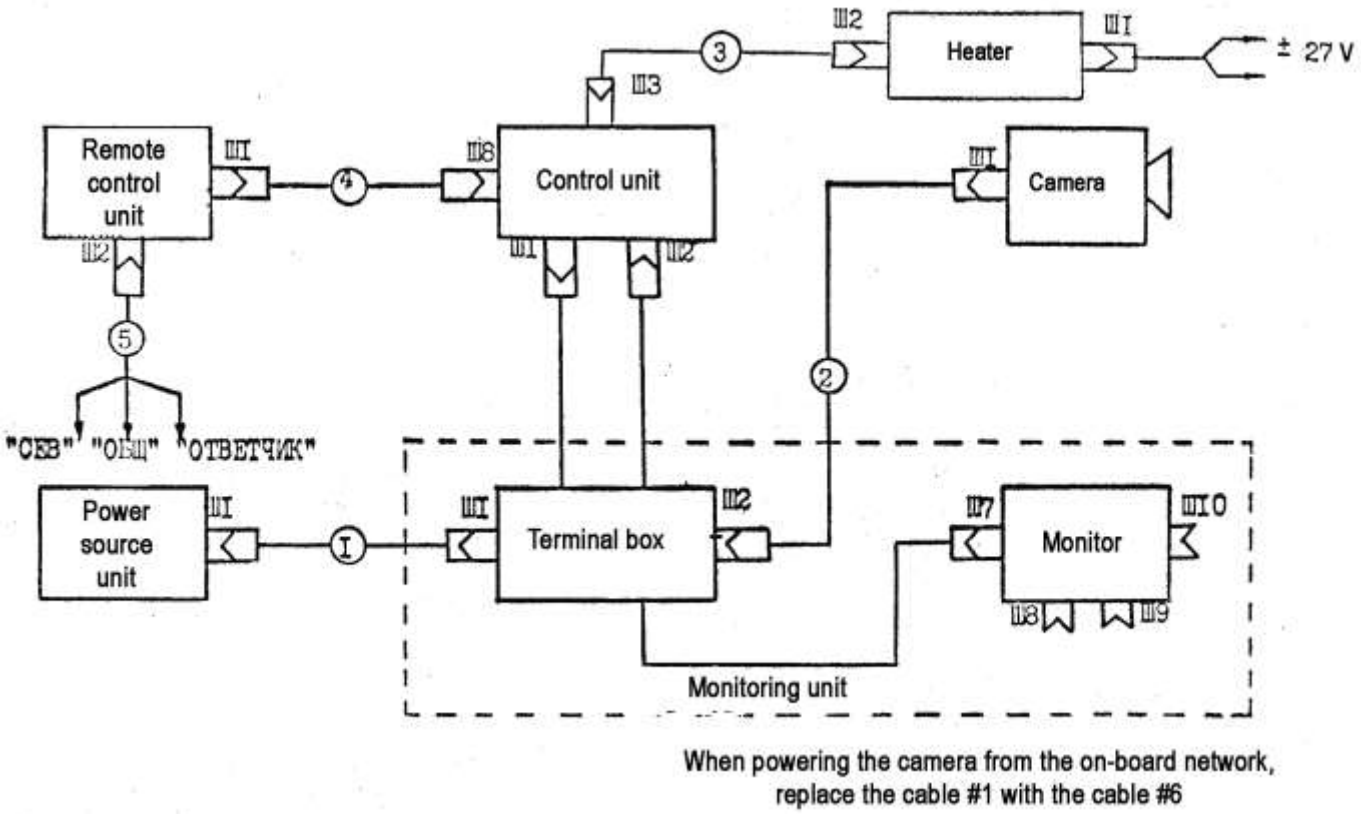

Figure 10. Electric connections

5.6. Electrical circuit of the monitoring unit

Electrical circuit of the monitoring unit is shown on the Figure 11.

The monitoring unit is purposed for measuring powering voltage and consumption current during maintenance procedure. It also measures voltage of the tacho-generator and current of the motor at different speeds.

The monitoring unit consists of the terminal box and monitor.

The terminal box is transit unit with shunts Шн1 and Шн2 purposed for measuring consumption currents on them. Their voltage drop is passed to the monitor through the connector Ш5.

The monitor has the measuring devices ИП1-ИП4 and switches for switching these devices. It has also 2-pin connectors for external indicators (voltmeter, oscilloscope, frequency meter etc.)

The monitor has built-in marker generator assembled on the transistors T1-T4.

Powering of the marker generator is accomplished from the voltage stabilizer assembled on the resistor R7 and stabilitron Д2. Switching the marker generator is accomplished by the B1 switch 'Generator ON'.

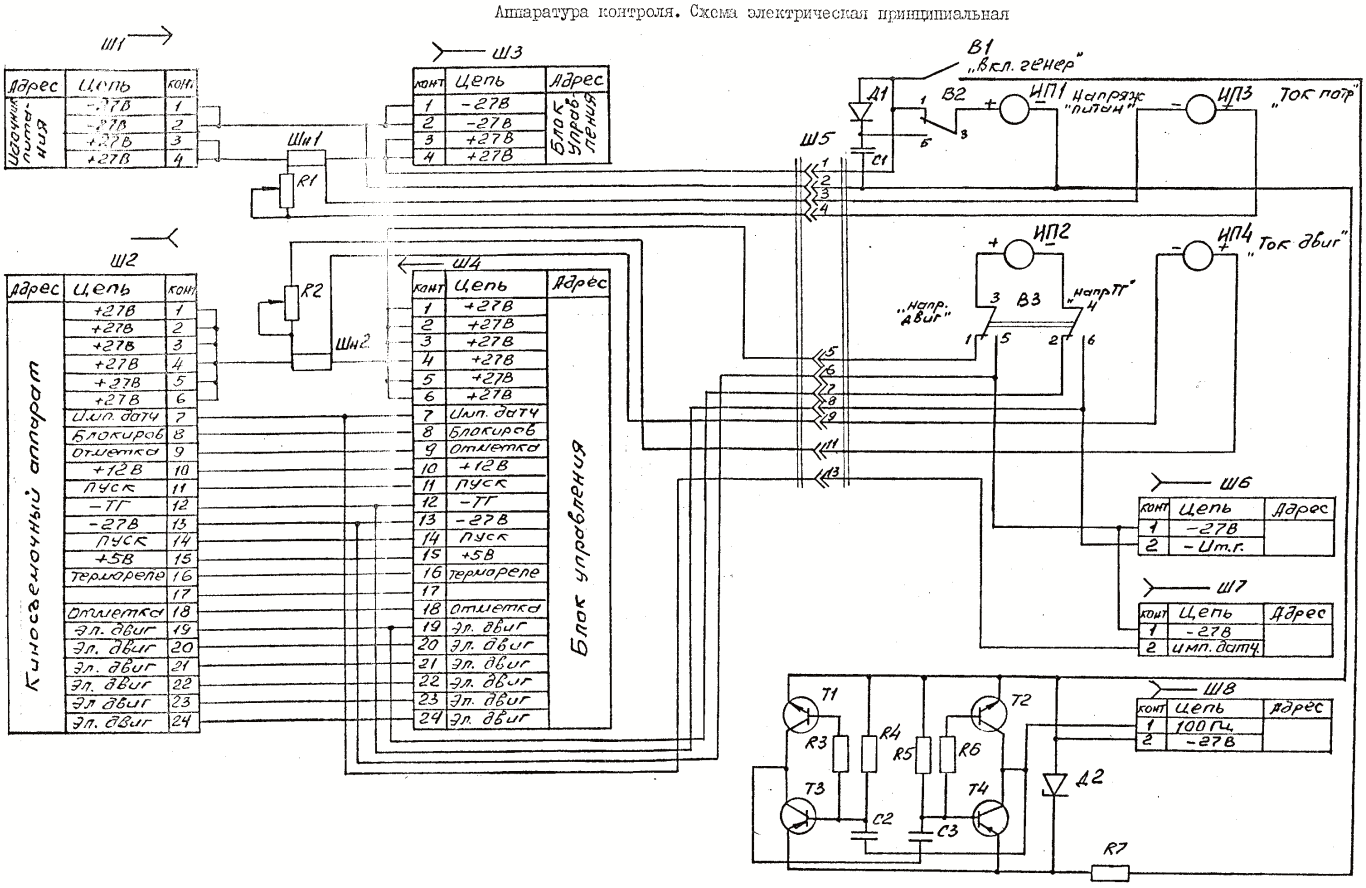

Figure 11. Electric circuit of the monitoring unit

5.7. Construction and operation of the basic parts

5.7.1. The camera

The camera is pictured on the Figures 12, 13. It is the body (51) (Figure 12) with gears inside.

5.7.1.1. The camera body

The body has the frond side (53) (Figure 12) attached to it by means of the screws (52). The front side has lens mount. A lens body has the ring (54) to attach a bracket for heavy lens support. The ring and body are fastened to the brackets by means of the screws (55). The housing (56) covers the motor. The cap (57) can be taken off for manual turn of the camera gears.

There are two bearing sleeves for the brackets (59) on the camera body to the right of the lens mount. The bracket (the small bracket is pictured) is fastened to the bearing sleeves by means of the screws (58). Third bearing sleeve situated at the front side of the camera, and the bracket is fastened to it by means of the screw (60).

Rear right part of the camera contains the motor unit. The motor unit consists of motor (1) (Figure 13) which flange is fastened to the body by means of the screws (61). Console part of the motor is supported by the brackets (62) (one bracket is pictured). The tacho-generator is coupled with the motor shaft and secured by means of the screw situated in the “A” hole.

Bottom slope of the camera has the connector (63) for connecting the camera with the control button of the hand support.

The bracket (62) has the connector (64) connection the control unit and the camera. Bottom part of the camera has the plate (65) with tripod nuts in it.

The lens mount has the bayonet ring (66) with locking ring (67).

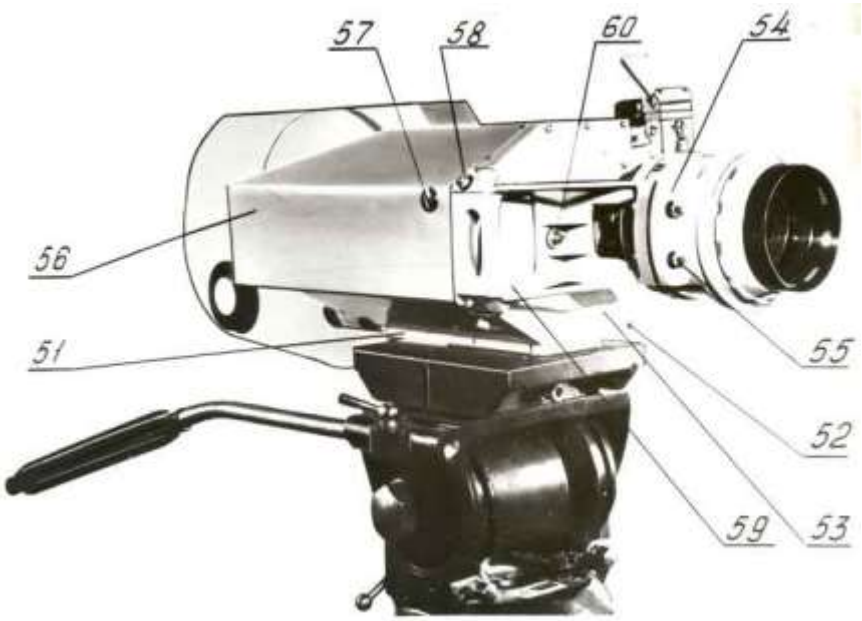

Figure 12. View from the lens brackets side.

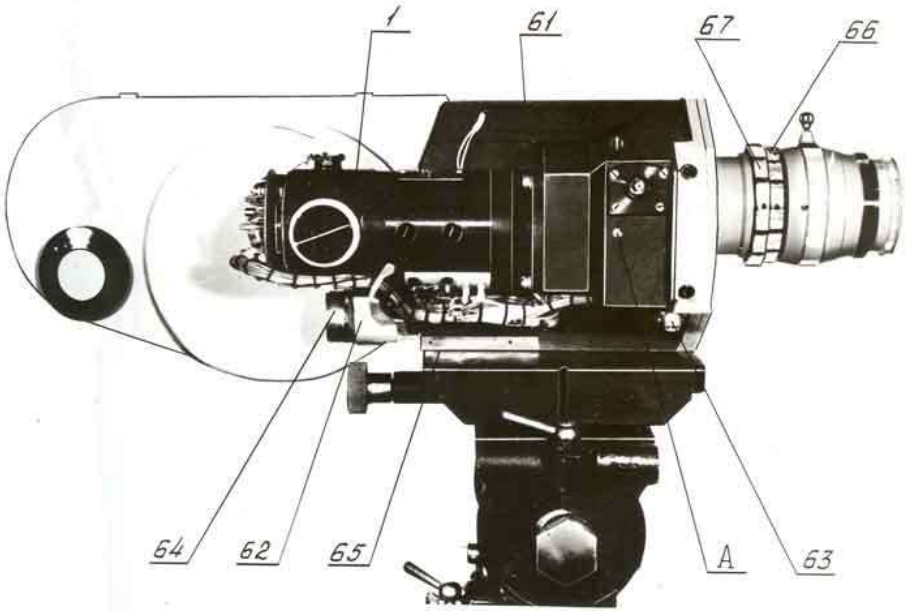

Figure 13. View from the motor side. Housing is removed.

5.7.1.2. Camera mechanism

Board (84) (Figure 14) holds the film movement mechanism consisting of:

1) claw mechanism (11);
2) sprocket (15) wit top (85) and bottom (86) carriages;
3) marker (87) of time pulses;
4) damping rollers (88), (89), (90);
5) guider (91);
6) film stripper (92);
7) sensor (93);
8) thermo switch (94);
9) tooth-type coupling of the mag coupling.

The transporting mechanism is fastened to the body (51) by means of the screws (95) and covers by a cover.

The claw mechanism moves a film through the film channel. The claw mechanism consists of the body (96) (Figure 15) which contains quadric-crank mechanism consisting of the crankshaft (97), the con-rod (98), and the cross-beam (99).

4-teeth reg pin moves along two guiders (100) and along rear gland guider attached to the body by means of screws. Movement from claw forks is transmitted to the reg pins by means of the lever (101). Both crankshafts are installed in the busing (102) which outer diameter is eccentric regarding to the crankshafts axes.
Front gate (103) is secured by means of the lock (104). Rear gate consists of two parts (105) and (106).
To ensure reliable work of the mechanism at speed of 24 to 216-240 fps special adjustment is used to change a distance between claw mechanism pins and reg pins. This adjustment is accomplished by turn of the bushing (102) accordingly to engraving of the mechanism body, and secures by means of the screw (107) (Figure 16). The coupling (108) (Figure 15) links the mechanism to the camera gears. The claw mechanism is aligned in the camera by means of the protruding part of the bushing (102) and secures by means of the screw (109) (Figure 16).
Front film gate is mounted on the pin (110) (Figure 14) and secures by means of the latch (104).

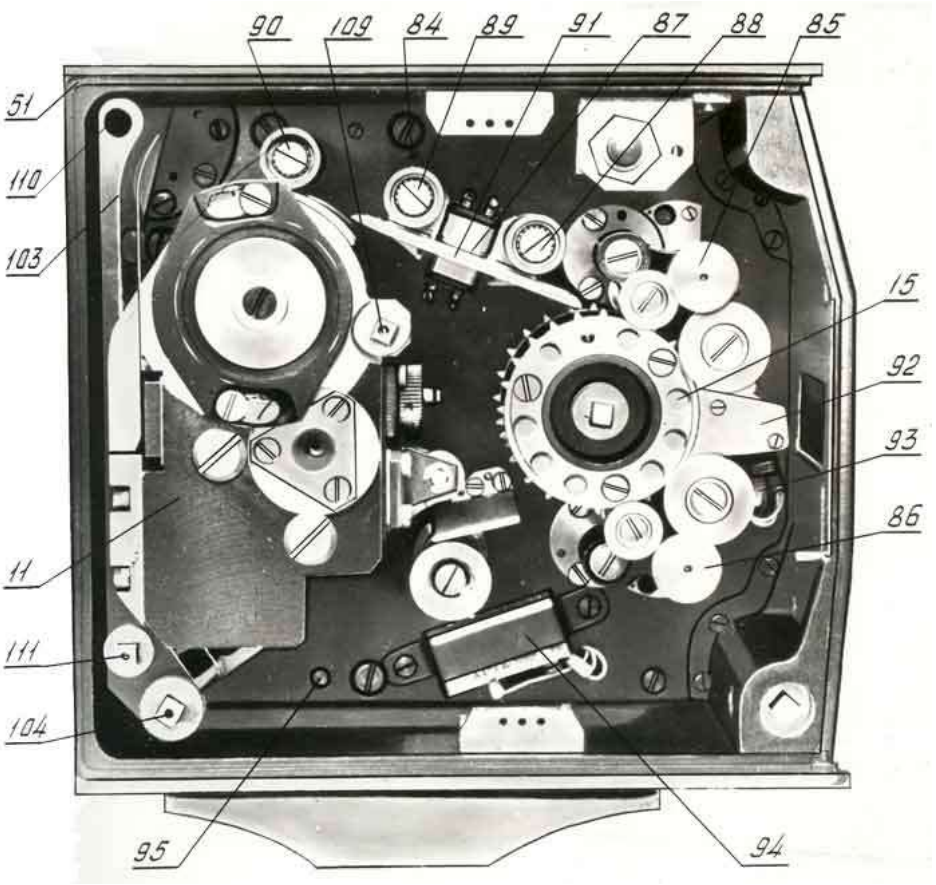

Figure 14. The camera gears

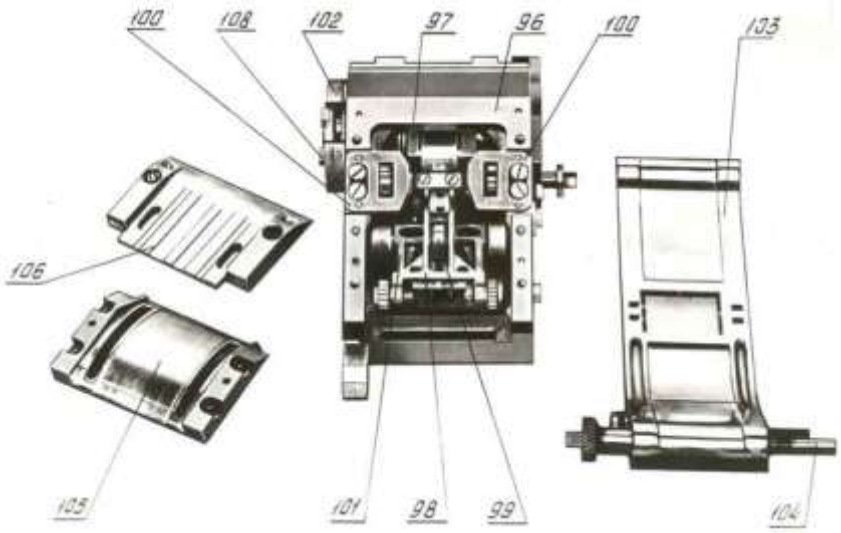

Figure 15. Claw mechanism. Front and rear gates are removed.

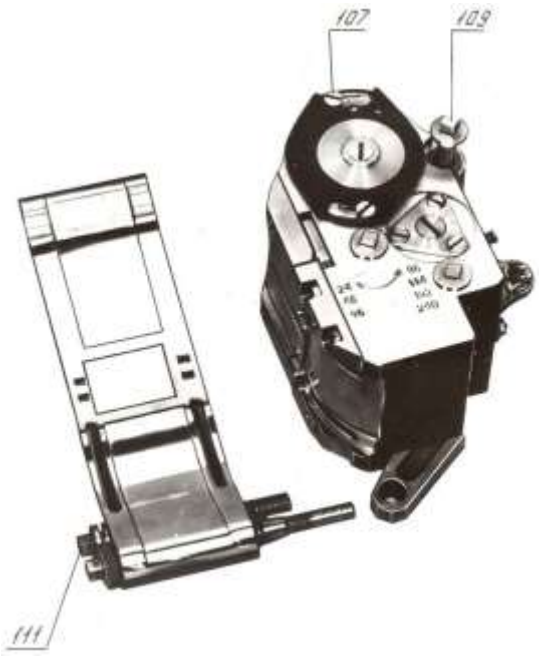

Figure 16. Claw mechanism

5.7.2. Mags

The mags are shown at Figures 17 and 18.
The camera is supplied with two types of the mags – 60m and 120m.
All the mags are detachable, common chamber. They are installed into the camera onto two alignment pins and secured by means of the thread lock (120) (Figure 17).
All main gears of the mag are mounted onto it's body (121): feeding clutch (122), take-up clutch (123), exposed film counter (124), guiding rollers (125), (126), and opening parts (127).
Levered counter shows length of the exposed film in meters. It touches the film roll in working position.
Film cores are standard ones: feeding core has 50mm diameter, take-up one – 75mm.
The mag lid has two devices for film winding (128), (129) (Figure 18).
The lid is secured by means of the lock (130) and clamp wedges (131), (132).
60m mag has similar construction.

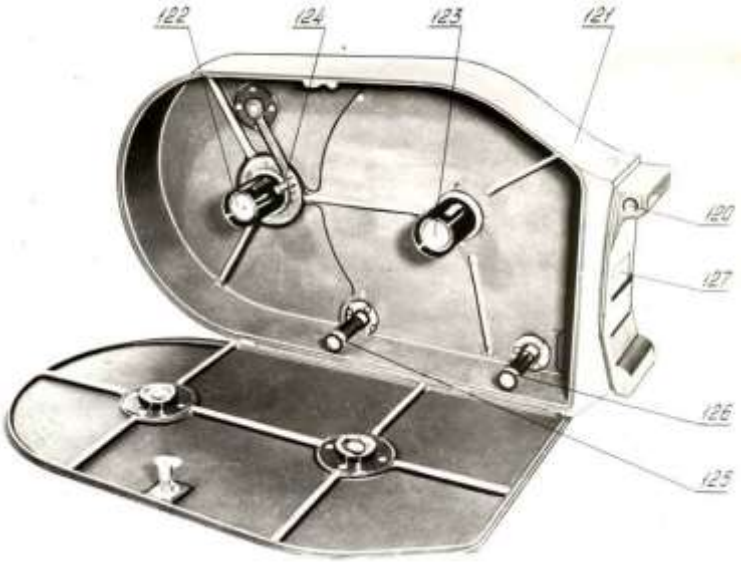

Figure 17. Mag with opened cover

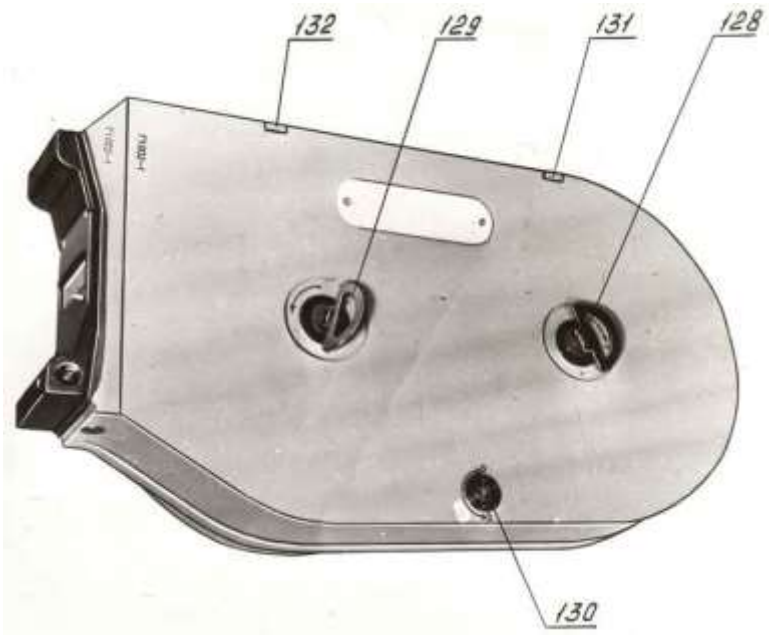

Figure 18. 120m mag

5.7.3. Lenses

The lenses are shown at the Figure 19. They are complex optical systems purposed for projecting of the geometrically correct image to the film.
18mm and 28mm lenses are used to shoot a tool and wide objects, landscapes, indoor shots etc.
40mm lens has a general purpose.
75mm, 150mm, 300mm lenses are used for nature shooting of distant objects, hard-to-reach objects, indoors, macro shootings, and if it is impossible to get close to an object.
The lenses consist of the optical units in focusing mounts. The mount consists of the focusing mechanism (moving the optical unit along it's axis) and aperture control. Both focusing ring (140) and aperture ring (141) have stopping devices.
Stopping device of the aperture ring is spring-loaded metal ball stopping the ring in selected position.
Stopping device of the focusing ring is special screw pushing the movable ring by means of the friction element.
The focusing mechanism of 75mm, 150mm, 300mm lenses is spiral groove with dowel moving in it.
The lenses has the light filters YB-17, OB-12, and RB-11. Specifications of the lenses are listed in the Table 8.

Table 8

Parameter	Focal lengths, mm					
	18	28	40	75	150	300
Allowed error in focus distance, %	±2	±2	±2	±2	±3	±3
Relative aperture	1:2.8	1:2.5	1:2.5	1:2	1:2.8	1:3.5
View angle, °	76	53.4	40	20.6	10	5.7
Aperture range	1:2.8–1:16	1:2.5–1:16	1:2.5–1:16	1:2–1:16	1:2.8–1:16	1:3.5–1:16
Light transmission factor	0.75	0.80	0.75	0.75	0.72	0.90
Flange focal length, mm	$57^{+0.01}$					
Lens mount	4-ears bayonet					

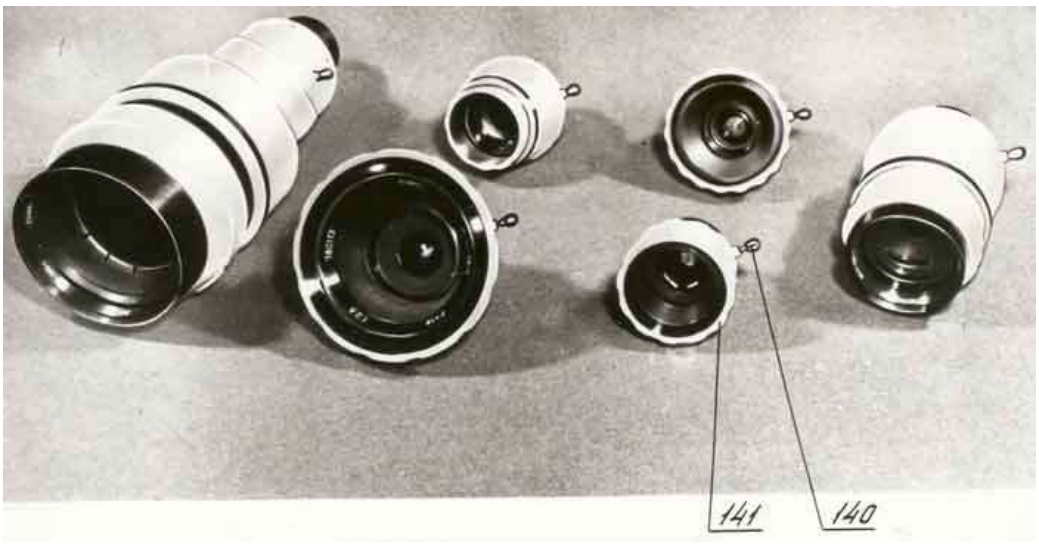

Figure 19. Lenses

5.7.4. Viewfinders

The viewfinders are: attached viewfinder, monocular, collimator sight, prismatic sight.

5.7.4.1. Attached viewfinder

The attached viewfinder is shown on the Figure 20. It is purposed for focusing and keyframing. The viewfinder's construction allows to orient it in any direction within a free hemisphere. Turn of the image is possible by means of the ring (145) after loosening of it's lock. The viewfinder is fastened to the camera by means of screws.
The ring (146) allows to adjust diopters in ±5dptr range. The viewfinder magnification is 6x. The viewfinder is mounted in place of the claw mechanism.

Figure 20. Attached viewfinder

5.7.4.2. Monocular

The monocular is pictured on the Figure 21.
It is purposed for focusing the camera on a distant object.
The monocular consists of lenses and reversal prisms inside the body, and eyepiece (148).
Mounting of the monocular onto the camera is accomplished by means of the bracket (149).
Dioptric adjustment is possible by means of the ring (150) in ±5dptr range. The monocular magnification is 8x.

Figure 21. Monocular

5.7.4.3. Collimator sight

The collimator sight is pictured on the Figure 22.
It is purposed for focusing and keyframing with 40, 75, 150, 300mm lenses.
The collimator sight is mounted onto the camera for work with objects at 200-250m from the camera. The sight consists of the body (153) with two-way mirror (43) on it. There are lenses, prism, and targeting frame inside of the body. The sight is mounted to the camera by means of the plate (154) with ground glass in it. The bracket can be moved on the lid for an operator's convenience. A long bracket supposed to be used when operator wears a pressure helmet.
Adjusting of the collimator sight is accomplished by means of adjustment washers at the mounting places.

Figure 22. Collimator sight

5.7.4.4. Prismatic sight

The prismatic sight is pictured on the Figure 23.
The prismatic sight (cold zeroing tube) is purposed aiming of the camera axis onto an object. The sight magnification is 3x. It's construction allows to turn an eyepiece part in the plane perpendicular to the optical axis of the camera.
Focusing is accomplished by means of the ring (156). Dioptric adjustment is possible by means of the ring (156) in ±5dptr range.

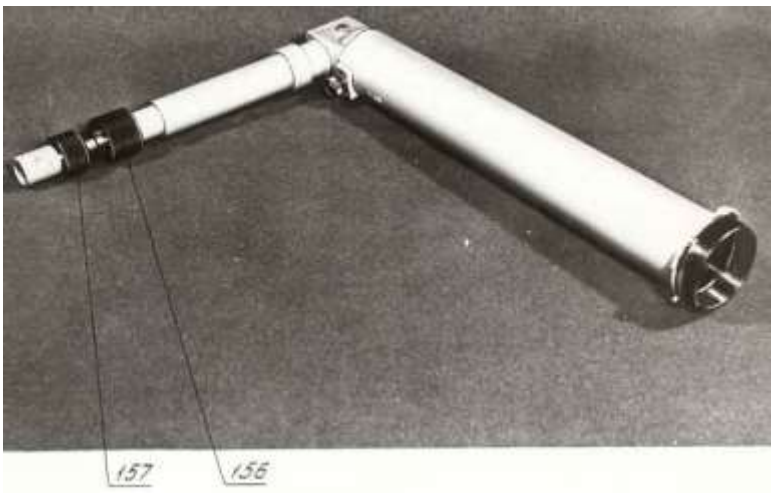

Figure 23. Prismatic sight

5.7.5. Hand support

The hand support (Figure 24) is purposed for the convenience of the operator when he is shooting form hands.
The hand support is handle (160) with tube rod (161) attached to it by means of tooth-type coupling. The handle can be fastened at different angles. The handle has the button (162) to start the camera. When the button is pressed, it's shift toward operator triggers 'events' marks.
The handle can be attached to the camera by means of the screw (163). Connector (164) links the handle with the camera circuit.

Figure 24. Hand support

5.7.6. Tripod

Description of the tripod is in the document 5ShKS.00.000PS

5.7.7. Remote control unit

The remote control unit is purposed for operating and monitoring the camera from up to 30m. The unit is shown on the Figure 25.
It is rectangular metal box. Side walls are prolonged and serve as handles. Most of the elements are situated on the front panel (167) and on the board inside the body. The front panel contains following control and monitor devices:

1) switch (168) 'POWER' to powering the control unit;
2) voltmeter (169) indicating the input voltage;
3) button (170) 'START' powering the camera;
4) button (171) 'STOP' switching off the camera;
5) button (172) 'Marker' for marking 'events';
6) lamp (173) 'POWER' indicating the input power presence;
7) lamp (174) 'WORK' indicating operation mode of the camera;
8) lamp (175) 'BREAK' indicating break of the film;
9) lamp (176) 'READY' indicating readiness of the camera to operate in the box;

10) counter (177) counting amount of exposed film;
11) switch (178) ‘FPS’ for setting the shooting speed.

Side wall of the unit has a connectors for connecting cables. Rear and bottom sides have a rubber dampers. Bottom side has also a metal folding bracket for setting the unit into convenient position.

Figure 25. Remote control unit

5.7.8. Control unit

The control unit is purposed for providing an operational modes of the camera, stabilizing a shooting speed and safety provision in abnormal operation conditions. The unit is shown on the Figures 26 and 27.

It is rectangular metal box. Side walls are prolonged and serve as handles. There six boards inside the body (including four printed circuits).

Top part holds a radiator with output power transistors on it. Necessary outlets are situated on the front and rear sides. The front side contains following control and monitor devices:

1) switch (180) ‘ON/OFF’ powering the unit
2) switch ‘(181) SOWING/MARK’ setting the time marker mode;
3) button (182) ‘Marker’ for marking an ‘event’;
4) switch (183) ‘START/STOP’ controlling the camera;
5) lamp (184) ‘POEWR’ indicating the power presence;
12) lamp (185) ‘BREAK’ indicating break of the film;
13) switch (186) ‘FPS’ for setting the shooting speed.

Rear side hold four connectors for cables:

1) connector (187) (Figure 27) for the remote control unit;
2) connector (188) for the camera;
3) connector (189) for the heater;
4) connector (190) for the power source.

There is also button (191) on rear side for powering the camera without film during technological tests.

The control unit has detachable shoulder strap.

Figure 26. Control unit, front side

Figure 27. Control unit, rear side

5.7.9. Power source

The power source is purposed for powering the camera with 27V DC. It is pictured on the Figure 28.
The unit is metal box (195) with swinging cover (196). It holds 18 rechargeable batteries SCS-25 linked in-line.
The box and cover are connected by means of four locks (197). The power source has a connector to link it to the control unit.
The power source has also carrying handle.
The power source is delivered in dry state (not filled with electrolyte). It should be used in accordance with technical description and manual FshO.358.009TO.

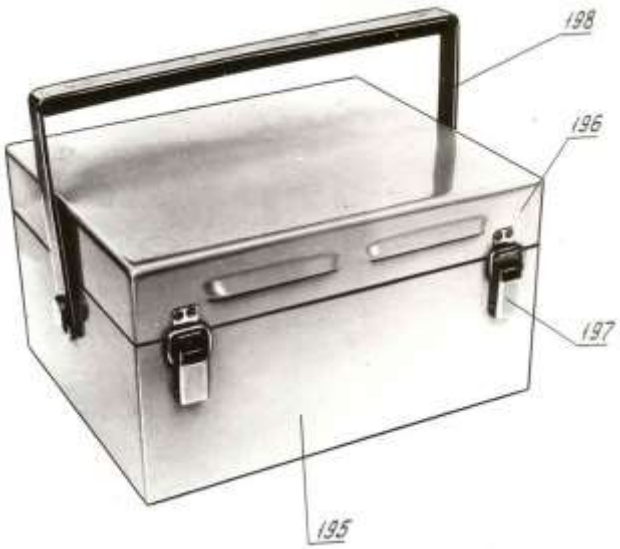

Figure 28. Power source unit

5.7.10. Box

The camera should be placed into the box during operation at high dust loading, high relative humidity, and low air temperature (+5 to –40°C).

The box consists of the body (200) and housing (201) attached to each other by means of the locks (202) using a rubber padding. There is base (203) (Figure 30) with screws (205) for the camera fastening inside the box. Dove-tail guiders of the base (203) hold the support (206) (Figure 31) secured by means of two screws (207).

5.7.10.1. Body of the box

Body of the box is load-carrying part with the cap (211) for a lens. Front side of the cap has a coated glass. There is cellular ring (212) (Figure 30) with silica gel inside the cap. The cap is fastened to the body by means of four screws (213) (Figure 29). There is carrying handle on the box.

5.7.10.2. Housing of the box

The housing has two heater flanges covered with the caps (218) (Figure 30) and window “Б” with two inserts (219) (providing a containment) and the nut (220).

Rear side of the housing has the cup (221) (Figure 31) with silica gel covered with glass for observing the silica gel color.

5.7.10.3. Base

The base (203) (Figure 30) is intermediate part between the camera and tripod. It is also linking part between the box body and housing. The base holds plate (222) (Figure 31) with tripod nuts, and two stoppers (223) limiting screws (207) of the support (206).

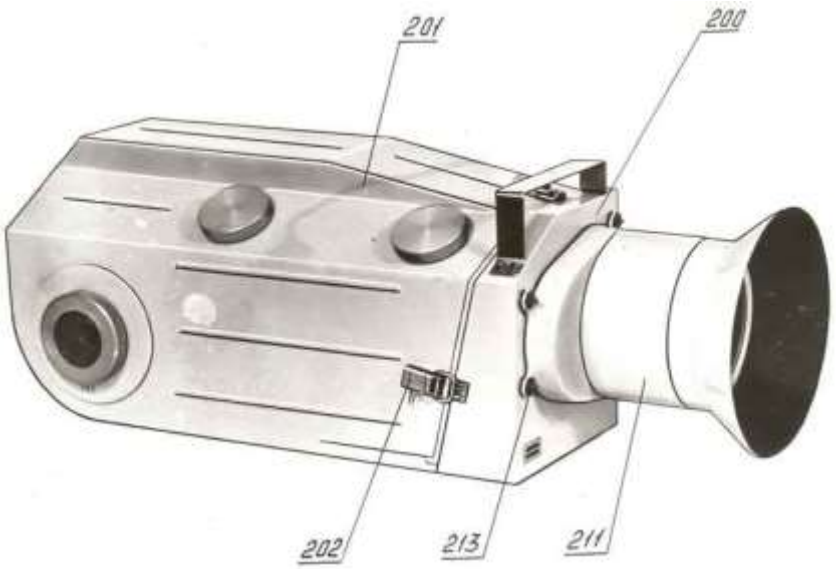

Figure 29. Assembled box

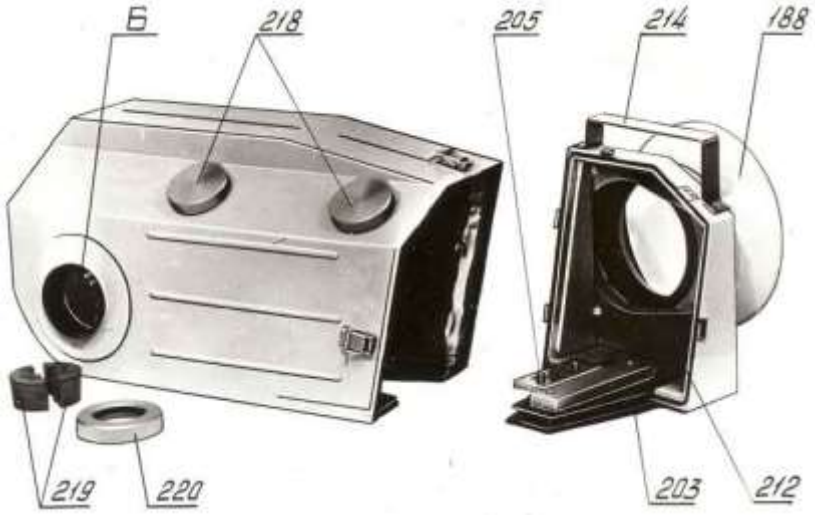

Figure 30. The box before inserting the camera

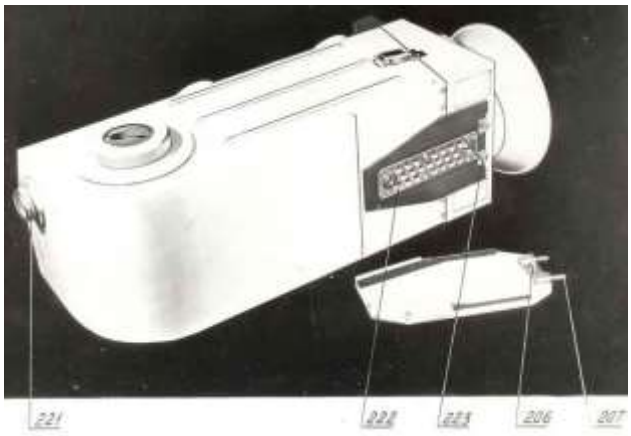

Figure 31. Bottom part of the box

5.7.11. Heater

The heater (Figure 32) is purposed for warming the camera in the box.
The heater is detachable unit mounted by means of two nuts (228). The heater mechanism is covered with safety housing (229).
Front side of the heater contains following control and monitor devices:

1) switch (230) ‘ON/OFF’ for the heater powering;
2) red lamp (231) ‘HEATER IS ON’
3) green lamp (232) ‘HEATER READY’

There are two connectors Ш1 (233) and Ш2 (234) on the front side for controlling and powering.
The heater has the carrying handle (235).

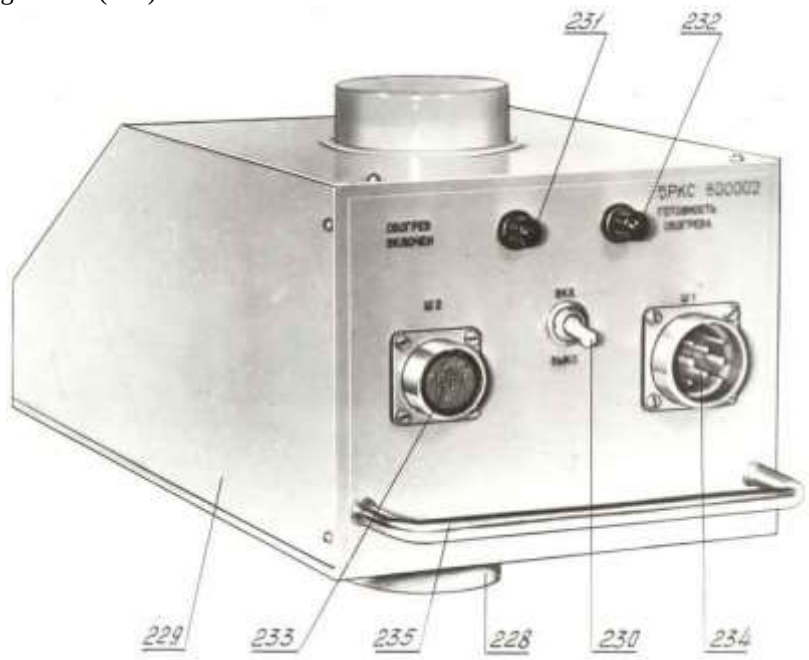

Figure 32. Heater

5.7.12. Monitoring units

The monitoring units consist of the monitor and terminal box.

5.7.12.1. Monitor

The monitor is shown on the Figure 33.
It is metal body (240) with different element on it’s top:

1) voltmeter (241) for monitoring the power;
2) ammeter (242) for monitoring overall consumption current;
3) voltmeter (243) for monitoring a motor and tacho-generator voltage;
4) ammeter (244) measuring the motor current;
5) switch (245) ‘Voltage Monitor’;
6) switch (246) ‘Generator ON’ for built-in 100Hz generator;
7) switch (247) ‘POWER’ for measuring a motor and tacho-generator voltage.

The panel has following sockets:

1) socket (249) ‘U_{TG}’ for output the tacho-generator signal to an oscilloscope;
2) socket (250) ‘Pulse sensor’ for output the sensor signal to an oscilloscope;
3) socket (251) ‘100Hz’ for output the generator signal to a frequency meter.

Other elements are mounted inside the body.
Rear side of the monitor has the connector for the terminal box. Bottom side has four dampers. The monitor has the carrying handle.

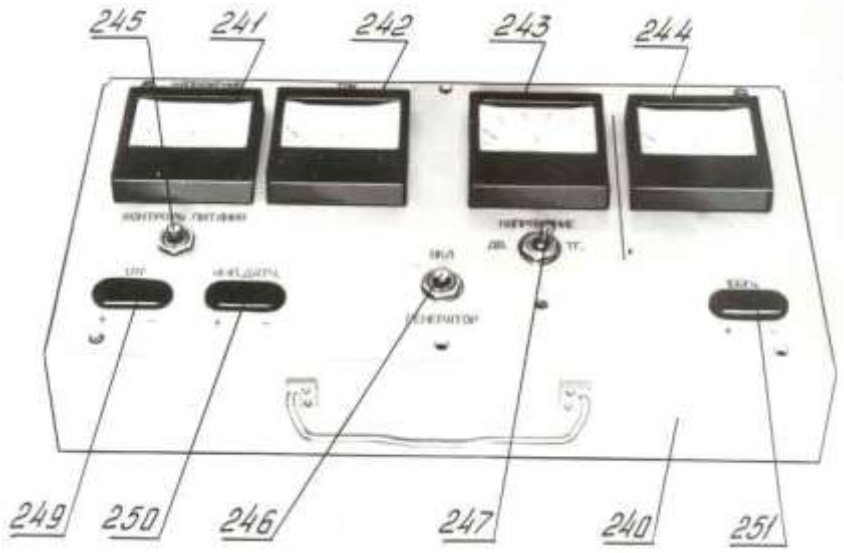

Figure 33. Monitor

5.7.12.2. Terminal box

The terminal box pictured on the Figure 34 is purposed for linking the monitor with the control unit. The box has following items:

1) connector (258) and cable (259) for the camera;
2) connector (260) and cable (261) for powering.

Cable (262) built into side wall is purposed for connecting the monitor. Bottom side has four dampers. The monitor has the carrying handle.

Figure 34. Terminal box

6. TOOLS AND ACCESSORIES

The tools and accessories set is shown on the Figure 35. It consists of:

1) lens mount cap (265);
2) case (266) with screw-driver, scissors, brush;
3) spanner (267) for the camera;
4) spanner (268) for the heavy lens brackets;
5) spanner (269) for tightening of the lens mount rings.
6) spanner (270) for the mags adjustments;
7) case (271) with tubes with oil VNIINP-271;
8) oiler (272) with oil VNIINP-6;
9) syringe (273);
10) can with oil VNIINP-6;
11) napkin (275);
12) ZIP parts (276).

Figure 35. Tools and accessories

7. MARKING AND SEALING

The camera has a plate with:

1) camera code;
2) factory code and year of production;
3) serial number of the camera.

The control unit, remote control unit, power source, monitor unit, box, tripod, mags, mag lids, lenses, brackets, adapter rings have marking with code and serial number of the camera.

Each box has plate with:

1) word “case” and number of the case;
2) list of included items.

Inner side of the box lid has schematic layout.

The code and serial number of the camera is marked on the lid , front wall and one of side walls of each box.

The boxes are locked, sealed with two seals, and wrapped into brown paper.

Transporting boxes has main and additional markings ‘Fragile’, ‘Top’, ‘Protect from moisture’.

8. PACKAGE AND CONTAINERS

Do following before packing:

1) check the set of delivery;
2) preserve the boxes (Section 15).

All parts of the outfit should be laid into the boxes purposed for storing and transporting of the outfit.

All boxes have similar design. They have locks, limiting hinges, and carrying handles. There is frame inside each box to put the parts into it. The walls are covered with soft material.

Operational manuals are put into the box #1.

Sealed and wrapped into brown paper boxes are put into polyethylene bags (if carried by water transport) with silica gel accordingly to GOST 3956-76. The bag is compressed and pressurized.

All boxes are put into nonseparable wooden boxes with water-proof material.

9. OPERATION INSTRUCTIONS

Use following as general guidelines:

1) use a film with shrinkage of –0.1 to +0.2%;
2) don’t bend a film during mag loading;
3) load the camera in accordance with the Figure 36;
4) don’t close the camera door with not secure film gates, non-operational position of the carriages, or with pulled reg pins;
5) do care about film tension at 192-240 fps – underwind the film during intermediate pauses;
6) do not run the camera longer than 13 seconds at 240 fps.

10. SAFETY MEASURES

1) Provide protection against short-circuit using external power source;
2) Don’t make any work (repair, test, adjustment) with power ON and rotating gears;
3) Don’t change any connections and don’t switch any modes during shooting;

4) Connect the units with power OFF only.

11. PREPARATION FOR WORK

Do following before using the camera:

1) check the delivery set by logbook;
2) unpack all boxes;
3) wipe the film channel carefully with clean napkin.

Check and clean all outfit before using. Blow out any dust by means of syringe, especially from film channel.
Make electric connections in accordance with the Figure 10.

11.1. Preparation for shooting from hands

1) Attach the hand support (Figure 24) by means of screws (163);
2) Connect the hand support cable (164) to the camera;
3) Connect the camera to the control unit;
4) Connect the control unit to the power source.

11.2. Preparation for shooting from tripod

1) Mount the camera onto tripod by means of screw;
2) Connect the camera to the control unit;
3) Connect the power source and remote control unit to the control unit.

11.3. Preparation for operation in the box

1) Install the camera into the box;
2) Mount the box onto tripod;
3) Connect the camera to the control unit;
4) Connect the power source and remote control unit (if necessary) to the control unit.

Note. For operation at low temperature, mount the heater onto the box preliminary, and connect the heater to the control unit and power source.

11.4. Preparation of the control unit

1) Remove a caps from connectors to be used;
2) Connect necessary cables;
3) Set the control unit in convenient place;
4) Connect the camera to the control unit and remote control unit as shown on Figure 10;
5) Switch OFF switches (180) ‘ON/OFF’ (Figure 26) of the control unit, and switch (168) ‘POWER’ (Figure 25) of the remote control unit.
6) Press the catch of the film counter on the remote control unit to reset it;
7) Switch the power source ON (if external power source used);
8) Set switch (186) ‘FPS’ (Figure 26) of the control unit and switch (178) ‘FPS’ (Figure 25) of the remote control unit into desired positions.

Note. When operate the camera from the remote control unit, set the control unit switch to the ‘Console’ position;

9) Switch ON switches (180) ‘ON/OFF’ (Figure 26) of the control unit, and switch (168) ‘POWER’ (Figure 25) of the remote control unit. Red lamps ‘POWER’ should light on the control unit (184) and remote control unit (173) (Figure 25).

Note. Switch ON the remote control ‘POWER’ switch only if you operate the camera from it.

11.5. Mag loading

Load the mag in dark room in accordance with Figure 36:

1) remove the mag cover turning the lock (130) (Figure 18) by means of special spanner into ‘O’ position;
2) pull aside the film counter lever (124) (Figure 17) and hold it by your hand;
3) set a film roll onto feeding lug (122) and release the film counter lever;

Note. The reel should be wound emulsion outside, and it should be set so that it rotates counter-clockwise during unwinding. Don’t bend the take-up core end of film more than once;

4) pass free end of the film through the guiding rollers. Fast the end to the take-up core, and turn it at least twice. Put the core onto take-up lug;
5) push a movable part of the mag outlet and pass the film between the two rollers in the outlet;
6) place the cover and lock it into the ‘3’ position by the spanner.

11.6. Camera loading

1) Turn the camera cover locks into ‘O’ position by means of special spanner;
2) Turn the sprocket (15) (Figure 14) by means of the same spanner so that reg pins came out of the film channel; the film register’s tail should maximally came out of the guider;
3) Loose the screw (111) securing the film gate (103) and unscrew the holder (104) and screw (109) by means of the same spanner;
4) Take out the holder; after the screw (109) came out of the camera board, screw it on 0.5-2 turns into the claw mechanism body;
5) Turn the claw mechanism counterclockwise to make a gap in the film channel enough for loading;

Note. Take care to not drop the claw mechanism out of the camera. It the camera is tilted, it is better to take the claw mechanism out of the camera.

6) Unscrew holders of the carriages (85), (86) and pull them from the sprocket;
7) Mount a mag onto guiding rods of the camera passing the film loop through the film channel and along the film track as shown on the Figure 36;
8) Secure the mag by means of the lock (120) (Figure 17);
9) Put the film’s perforations onto the reg pins and turn the claw mechanism into original position;
10) Set and screw in the holder (104) (Figure 14), and screws (109) and (111);
11) Push the carriages toward the sprocket and tight their holders;
12) Check the film loops length, turning the sprocket counter-clockwise by means of the spanner. The loops should not touch body of the camera or claw mechanism. Adjust the loops size by changing length of the film between the sprocket and claw mechanism. This may cause a loose piece of film in front of the mag outlet – turn the take-up lug of the mag to wind it into the mag. To do this, press the device (129) (Figure 18) and turn it clockwise until film if tight.
13) Check the speed range setup (24, 48, 96) or (96, 144, 192, 240).

Note. If you need to change the speed range, loose two screws (107) (Figure 16) on 0.5-1 turn by mean of screw-driver, and turn the bushing (102) (Figure 15) into required direction until stop.

14) Put the camera cover back and turn it’s locks into ‘3’ position.

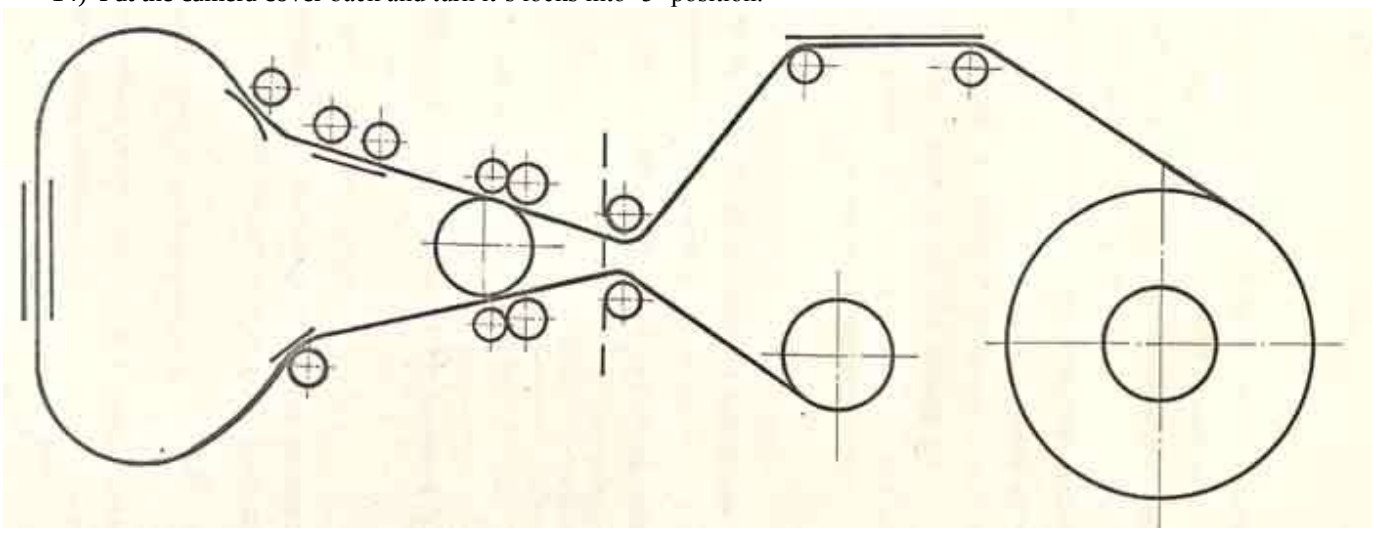

Figure 36. Camera loading

11.7. Mounting lenses

1) Remove rear cap from a lens;
2) Remove the lens cap out of the camera;
3) Turn the bayonet ring counter-clockwise until stop and place the lens into the mount, aligning the mount pin with the lens groove;
4) Secure the lens turning the bayonet ring (66) (Figure 13) counter-clockwise and tight the locking ring (67).

If vibration supposed during operation, mount a brackets onto 75, 150, 300mm lenses and fast them to the camera.

11.8. Installing viewfinder

1) Remove the viewfinder port cap;
2) Install the viewfinder into the mount instead of the claw mechanism, aligning it’s locking screw with the thread in the board, and secure the viewfinder by this screw.

11.9. Installing collimator sight

1) Place the sight onto bracket;

2) Mount the sight with the bracket onto the camera top and secure it by screws.

11.10. Installing prismatic sight

Install it like lens.

11.11. Placing the camera into the box

1) Remove the nut (220) (Figure 30) and inserts (219);
2) Remove the housing (201) (Figure 29) opening the locks (202);
3) Remove the support (206) (Figure 31) from the dove-tail, having the screw (207) loosed preliminary;
4) Unscrew two screws (204), remove the base (204) (Figure 30), and attach it to the camera by screws (205);
5) Mount the camera onto the base (204);
6) Mount the camera with the base onto tripod;
7) Point the camera onto a shooting object, and immobilize the support;
8) Focus the lens;
9) Remove viewfinder, put the cap;
10) Put the body (200) (Figure 29) until stop;
11) Put the housing, passing cables through the hole 'Б' (Figure 30);
12) Close the locks (202) (Figure 29);
13) Put the inserts into the hole 'Б', embracing the cables;
14) Pass the cable through the nut (220) and tight the inserts;
15) To change the lens, unscrew the cap (211) and refer to the paragraph 11.7.

Note. Use an intermediate ring or longer cap when mounting 150 or 300mm lesn.

11.12. Mounting the heater

Put the camera into the box and mount the heater then:

1) remove the caps (218) (Figure 3) from the box;
2) mount the heater onto the box as shown on the Figure 37, and tight the buts (228) (Figure 32);
3) set the switch (230) into OFF position.

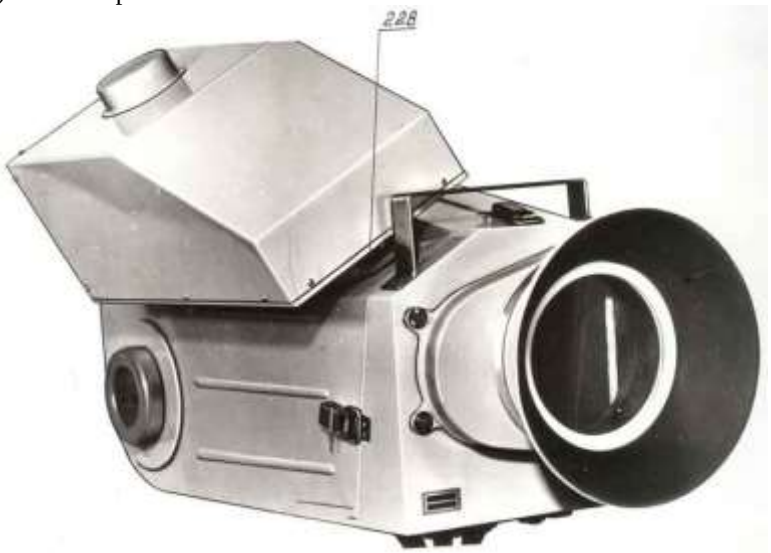

Figure 37. Box with the heater

11.13. Checking of the technical condition of the camera

Load the camera, press the 'door' micro-switch, and do following:

1) turn the camera ON;
2) check the film tension;
3) create artificial problems to check work of the 'break' and 'salad' blockers – the camera should stop;
4) release the 'door' micro-switch – the camera should stop.

12. OPERATING THE CAMERA

1) Make sure that the camera runs smoothly, without jerks and stuck, at 24 fps;
2) Using the collimator sight or monocular at distance less than 100m, keep in mind a parallax of the optical axes of the camera and a sight;

3) Don't turn ON the camera by means of the power source unless control unit and remote control unit are set into operational state;
4) Turn OFF the 'POWER' switch of the control unit after finishing your job.

12.1. Start and stop of the camera

The camera can be run from remote control unit – button (170) (Figure 25), from control unit – switch (183) (Figure 26), from hand support – button (162) (Figure 14). During test without film, the camera can be run from remote control unit or from hand support if the button (191) (Figure 27) on the rear side of the control unit is pressed. Stop the camera by setting a switch to OFF position or by releasing a button.

12.2. Controlling lenses

Focus a lens by rotating the ring (140) (Figure 19). Set an aperture by means of the ring (141). The diaphragm scale is marked in effective relative apertures.

12.3. Using the heater

Connect a cables to the mounted heater accordingly to the Figure 10. Refer to the paragraph 5.5.5. Moreover, you can turn the heater ON by means of the switch (230) (Figure 32) of the front side of the heater.
When the camera is ready for use, the heater is going OFF automatically. Since this moment and on, the hater maintains operational temperature in the box automatically.

13. GENERAL MALFUNCTIONS AND THEIR SOLUTIONS

It is forbidden to:
1) alternate the factory circuitry;
2) replace broken parts with not approved ones;
3) use an acid instead colophony during soldering.

If malfunction occurred that can't be solved without special tools and specialists, the camera should be sent to a specialized workshop for repair. Such malfunctions are:
1) worn teeth of the camera kinematics;
2) mechanical damages of the film channel parts;
3) break of the claw mechanism;

Here is list of possible minor malfunctions.

Table 9.

Malfunction	Possible cause	Solution	Note
1. Film is too tight or too weak	Wrong friction adjustment	Unscrew a locking nut of the friction, take out a control bushing, and turn a friction tension nut. Check the friction operation.	Use the friction checking tool (paragraph 14.1)
2. Friction lines and scratches on the film during shooting	1. Scale on the work surfaces of the film channel	1. Remove the scale by means of soft cloth wet with 40-60% spirit solution	
	2. Rollers of the film movement tract don't rotate	2. Remove the rollers unscrewing their screws. Wash the ball-bearings in gasoline and lubricate them with oil VNIINP-6.	
3. 'Salad'	Loose mag frictions	Tight the frictions by special spanner	
4. Bridges between perforation holes are crushed at bottom part from side of take-up core at 24, 48, 96 fps	Eccentric bushing of the claw mechanism isn't set into '24,48,96' position	Turn the bushing clockwise into '24,48,96' position	
5. Unable to mount a film reel onto feeding lug	Film counter lever isn't pulled away	Pull away the lever before mounting the film reel	
6. The motor runs 1-2 second only	The lamp 'BREAK' is light on the control unit and remote control unit	Reload the camera	
7. The camera doesn't run, the lamp 'POWER' isn't light	No power	Charge batteries. Connect a power source to the camera.	
	Wrong polarity of the feeding power	Change the polarity	
8. The camera doesn't run when 'START' button	The door of the camera isn't closed tightly	Close the door tightly	

pressed			
9. There are not light marks ‘events’ or ‘time’ on the film	Dirt un the LED channel	Clean and wash with spirit the LED channel	

14. MAINTENANCE

The movie camera is precise device consisting of complex mechanical, electrical and optical systems. Be especially careful handling optics and claw mechanism. Only operators and techs with special skills can service and repair the camera. The maintenance includes following procedures:

1) servicing before operation;
2) routine maintenance;
3) repair.

14.1. Servicing before operation

Do following before using the camera:

1) clean the film transporting channel. To do this:
   - blow out any dust from the camera by means of syringe;
   - remove front gate, clean it with soft cloth moistured in spirit (do not remove a scale by hard tools);
   - remove the claw mechanism and clean the rear gate as described above;
     Note: Do not disassemble the claw mechanism.
   - pull the clamping rollers and LED plate, and clean them with soft cloth moistured in spirit;
   - clean a support surfaces of the sprockets.
     ATTENTION! Make sure that spirit isn’t get to the reg pins guider.
   - set the front gate and claw mechanism back.
2) clean necessary optics:
   - remove a lens from the camera;
   - use a syringe of sift brush to remove a dust from optical surfaces of the lens and viewfinder;
   - remove any oil or fingerprints by means of soft napkin moistured in spirit;
   - place the lens and viewfinder back onto the camera.

Lubricate a cone gears after 5-6 shootings. To do this, remove the camera side lid, remove old lube from the cone gears by soft napkin, clean them by napkin moistured in gasoline, and put a thin layer of lube VNIINP-271 TU38-102603-76.
Lubricate the reg pins fork finger with same time pattern with lube VNIINP-271.
Always check the film tension. If the film is too weak or too tight on the take-up spool, check and adjust it’s friction clutch. Use the tool AGD5.178.011091 from the ZIP set.
Place the lube VNIINP-271 into the grooves of the brass cross-piece and cog wheels of the shutter.
Take care of the electric connectors condition.
Check the film counter and mag opening regularly.
Do not operate the camera with defective control devices. Tight securing screws or replace a control handles if necessary.

14.2. Routine maintenance

The routine maintenance is essential for providing long and reliable work of the camera. The maintenance should be done after 5000, 15000, 30000, 50000, 70000 and 90000m of the film passed through the camera.
Over 90000m, the maintenance should be done each 15000m. Make a visual check of film movement after each maintenance procedure. Refer to the table 10 to learn what is necessary to do.

Table 10

Maintenance procedures	Length of the film passed through the camera, m										
	5000	15000	30000	50000	70000	90000	105000	120000	135000	150000	165000
1. Cleaning and lubricating of the camera mechanism	+	+	+	+	+	+	+	+	+	+	+
2. Cleaning and lubricating of the mags	+	+	+	+	+	+	+	+	+	+	+
3. Check of the electrical parts of the camera			+		+		+		+		+
4. Check and adjust of the shooting speeds		+		+		+	+	+	+	+	+
5. Check of the image stability					+	+	+	+	+	+	+

Notes: 1) Routine maintenance of the electrical parts means cleaning of the electrical contacts of the connectors with spirit, and checking of the shooting speed selector.
2) If checked parameters are differ form listed in the Table 12, do not use the camera until cause of this deviance if found and fixed.

14.2.1. Cleaning and lubricating the camera

To clean the camera mechanism, it is necessary to remove it from the body. To do this:

1) remove the camera lid;
2) unscrew the screws of the mechanism plate;
3) remove the mechanism with the plate out of the camera body.

Clean a ball-bearings with A76 gasoline to remove old oil, and put in a new oil VNIINP-6 TU38-001168-74 (two drops into each ball-bearing).
Then cover the ball-bearing with thin layer of the VNIINP-271 lube.
Clean with gasoline and cover with same lube all cog wheels.

14.2.1.1. Cleaning and lubricating the claw mechanism

Remove the front film gate. Remove old lube and foreign particles with gasoline and soft napkin. Lubricate each ball-bearing and wear face with 2 drops of the VNIINP-6 oil. Oiling places are shown at the Figure 38.
Clean inner sides of the bottom part of the rear film gate with napkin and lubricate it with VNIINP-271 lube. Install the claw mechanism back into the camera. Switch the blocking OFF on the control unit, and run the camera without film on 48fps for 20-30 seconds. Remove extra oil from the film movement channel by means of soft napkin.

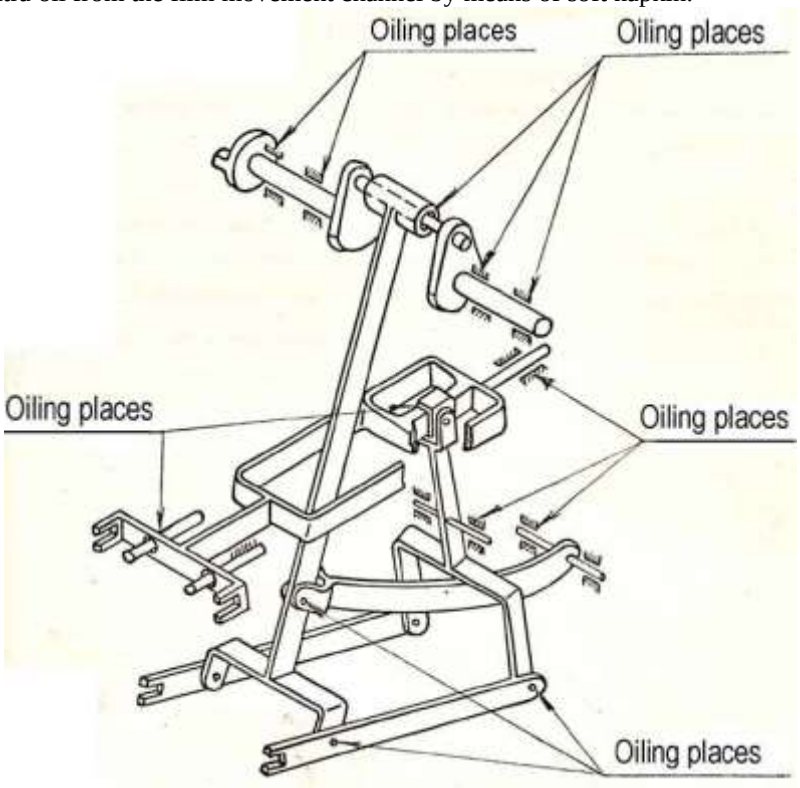

Figure 38. Oiling places of the claw mechanism

14.2.2. Cleaning, lubricating, and adjusting of the mags

Remove the mag ling and cog-wheel cover of the take-up clutch. Inspect and clean and lubricate it if necessary. Check the film counter and mag opening. Disassemble the friction clutches. Clean outer and inner surfaces of the clutches. Clean and lubricate ball-bearings of the take-up clutch from both sides, removing the cog-wheel preliminary.
Put 2 drops of the VNIINP-6 oil into each ball-bearing. Use same oil quantity for each rollers ball-bearing.
Assemble the friction clutches, screw the roller back, and tight the friction clutches using a torque device.
Torques of the frictions are listed in the Table 11.

Table 11

Name	Torque, kg	
	Feeding friction clutch	Take-up friction clutch
60m mag	1.8±0.8	2.5±0.8
120m mag	3.5±0.8	4.0±0.8

After the mag is assembled, test it on the camera without the claw mechanism, passing a film from the feeding clutch to the take-up one.
After this test run, remove all extra oil from the mag.

14.2.3. Testing electric part

Measure total consumption current by means of the ammeter of the monitoring unit.
Check the shooting speeds using the control unit, remote control unit, and monitoring unit.
The test should be done with 60m and 120m film reels at least three times (start, middle, and end of the reel).
The camera should be loaded with one of the reels, and run. Measure consumption current. It should not exceed values listed in the Table 12 (in normal climatic conditions).

Table 12

Shooting frequency, fps	Cymometer indications, Hz	Consumption current, A, no more than
24	96	10
48	192	13
96	384	17
144	576	19
192	768	26
216-240	864-960	32

14.2.4. Testing the image deviance

1) load the camera with 60m reel of the unexposed negative film;
2) put the camera onto tripod;
3) shoot evenly lighted white field at all shooting speeds;
4) process the film up to γ=0.65;
5) use a microscope to measure sizes 'a' and 'b' (Appendix 2, Figure 3) with not less than ±0.005mm accuracy. Measure a film at the part where speed was stable. Difference between average value of three maximum and three minimum values of 'a' and 'b' will be the image deviance in horizontal and vertical direction. It should not exceed:
   0.02mm at 24, 48, 96 fps
   0.04mm at 144, 192, 216-240 fps.

14.2.5. Testing of the shooting speeds

Test the speeds on camera loaded with 120m film reel.
Measure the speed by means of the cymometer connected to the connector III9 of the monitoring unit at least three times – at the start, middle, and end of the film reel. The cymometer indications should be within 5% of the values listed in the Table 12.
If the frequencies differ more, it is necessary to adjust them by means of the resistors R1, R3, R5, R7, R9, R11 (Figure 9) of the control unit. These resistors correspond to the shooting frequencies of 24, 48, 96, 144, 192, 216-240fps.

14.3. Repair

The repair should be done by highly skilled tech only.
Repair of the claw mechanism, stabilizing and blocking mechanisms, and optical parts can be done at the factory or specialized workshops only.
Reassembly of the ball-bearings can be done by skilled tech observing following conditions:

1) adjustment washers can't be replaced without precise preliminary measuring;
2) replacing of the ball-bearing with similar ones is not allowed. The ball-bearings can be used in the camera only after de-preserving and precise measuring of diameter of their inner and outer rings. Tightness of the outer ring should be not less than 0.01-0.005mm. Gap of the inner ring should be not more than 0.005-0.008mm. Pressing force should be applied to the outer ring only;
3) screws can be replaced with same type, dimensions, and galvanic covering screws;
4) replace of the cog wheels is allowed if new cog wheel has a preciseness degree not less that replaced one;
5) change of the materials and coverings of the replacement parts isn't allowed, since this may cause break of the electrical contacts.

14.3.1. Using ZIP

The ZIP set is purposed for replacing broken parts. Replace of the electrical parts should be done by skilled circuit installer. To replace a LEDs units:

1) unscrew the LEDs unit from the plate;
2) seal off the wires from the LEDs;
3) replace the LEDs.

To replace the helical of the shutter:

1) remove the camera front lid;
2) remove the shutter unscrewing the central screw;
3) unscrew the screw fastening the shutter unit to the body;

4) remover the film transporting mechanism plate;
5) unscrew the screw near the helical;
6) remove the shutter unit out of the body;
7) replace the helical.

14.4. Test shot

Take the test shoot after the routine maintenance. Use a test pattern or some object with highly contrast parts. This object should be shot first time after de-preserving the camera with all lenses. Shooting place and light conditions should be written down. This first shoot will be the etalon for further test shots.

15. PRESERVATION

To preserve the open metal parts of the camera from oxidation during transportation or long storage, it is necessary to preserve it in accordance with OST3-2824-75.
The preservation should be done in special room at temperature not less than 15°C and relative humidity not more than 70%. There is not allowed a moisture condensation in the preservation room.
The camera should be preserved in working condition. The metal parts should have no any mechanical defects or oxidation.

1) clean outer surfaces to remove any fat, oil or dirt;
2) clean optical surfaces with wad of cotton wool moistured with spirit;
3) clean all metal parts with cotton napkins moistured with spirit. It is forbidden to clean a wear faces, cog wheels etc. with solvent. Left old oil on this surfaces;
4) wrap optical parts into cigarette paper;
5) place all parts into the boxes;
6) wrap the sealed boxes into brown paper, then into paraffined paper, and put them into polyethylene bags with thickness of not less than 0.15mm. Put a silica gel into the bags, and pressurize them.

16. STORAGE RULES

The outfit should be stored at 5-40°C in any climatic regions. Relative humidity should nit exceed 65% at 20°C. It is allowed a temporary increase of the humidify up to 80% at 25°C (not longer that 1 month total within a year).
Daily temperature change should not exceed 5°C. Store the boxes in the position determined by ‘Top’ marks.
Do not sore the camera near heaters or acids and alkali.
Presence of aggressive vapors in the storage rooms isn’t allowed.
The batteries should be stored accordingly to their maual.

17. TRANSPORTATION

The camera can be transported at temperatures of –60 to +60°C, and relative humidity of 90% at 20°C.
Power source can be transported at temperatures of –40 to +40°C.
The camera can be transported by any means with observing of corresponding transportation rules.

APPENDIX 1

Expense of spirit for routine maintenance. Useless big table.

APENDIX 2

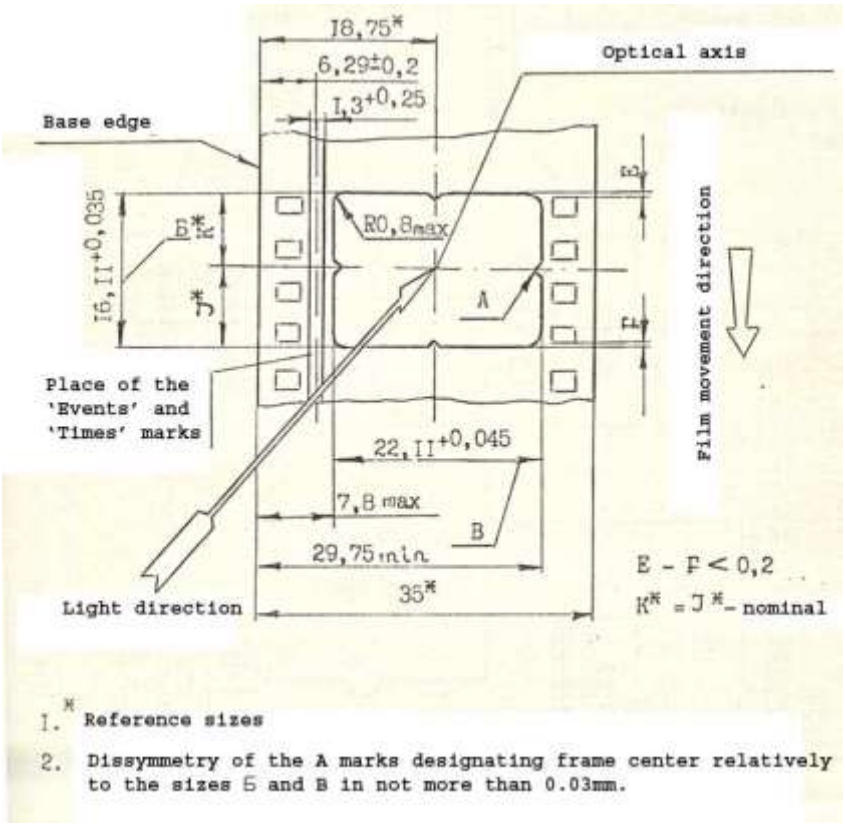

Figure 1. Sizes and positions of the exposed field, and position of the 'Events' and 'Times' marks

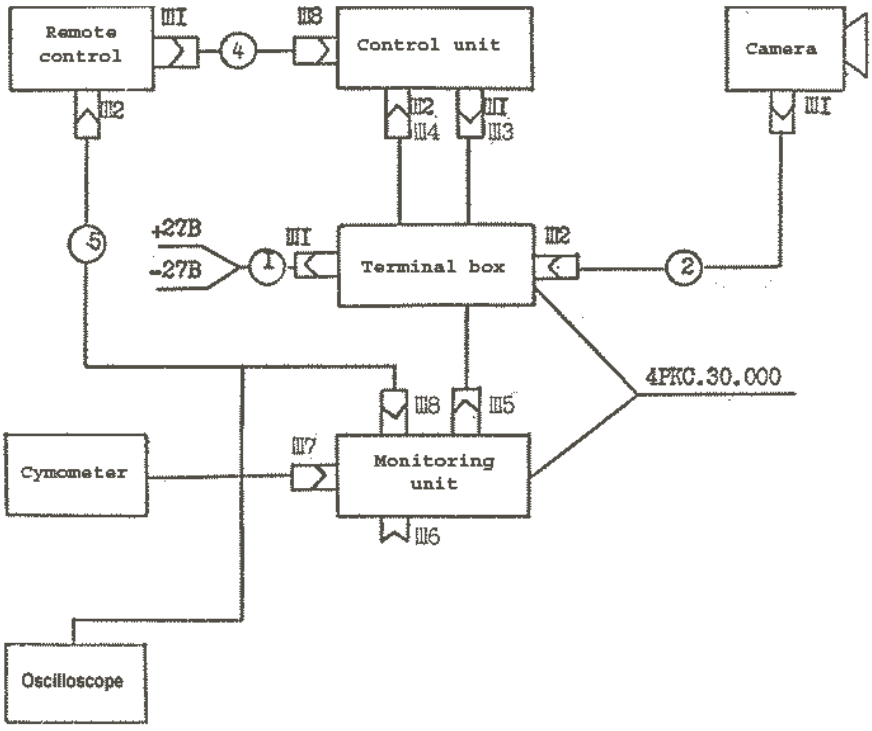

Figure 2. Electrical connections for measuring of the consumption current

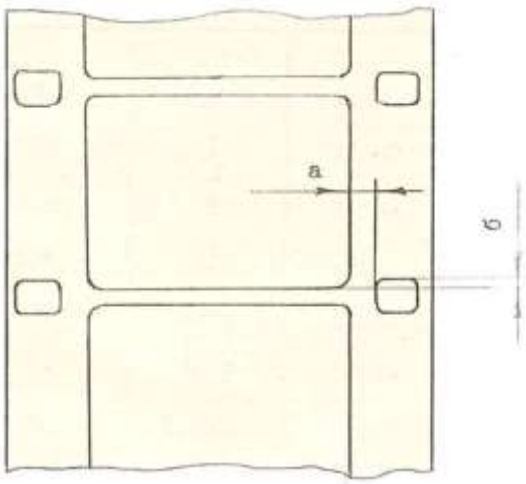

Figure 3. Dimensions used for measuring of the image deviation

APPENDIX 3

Exposure time depending on the shutter opening angle and film speed

Shooting speed, fps	Shutter opening angle, degrees				
	145	120	90	60	30
	Exposure time, seconds				
24	1/59.6	1/72	1/96	1/144	1/288
48	1/119	1/144	1/192	1/288	1/576
96	1/238	1/288	1/384	1/576	1/1152
144	1/358	1/430	1/575	1/864	1/1760
196	1/486	1/576	1/768	1/1152	1/2304
216	1/536	1/648	1/864	1/1286	1/2592
240	1/596	1/720	1/960	1/1440	1/2880

APPENDIX 4

Continuous shooting time depending on the shooting speed and mag capacity

Mag capacity, m	Shooting speed, fps					
	24	48	96	144	192	216-240
	Shooting time, seconds					
60	132	66	32.8	21.9	16.4	14.6-13.1
120	264	132	66	43.8	32.8	–