ИР-117

ENGINE PRESSURE RATIO INDICATOR

MAINTENANCE MANUAL

ИР-117 РЭ

ИР-117
MAINTENANCE MANUAL

RECORD OF REVISIONS

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INTRODUCTION

The present Maintenance Manual is proposed for study and proper use of the ИР-117 engine pressure ratio indicator (hereinafter referred to as the "indicator").

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ENGINE PRESSURE RATIO INDICATOR – DESCRIPTION AND OPERATION

1. GENERAL

1.1. The indicator is designed for the remote monitoring of the engine power settings of the end items.

The indicator combines the engine pressure ratio indicators, type УР-117, ДВК altitude sensor, ПМ-10МР two pressure probes and П-1 or П-2 temperature bulb.

1.2 The monitoring of the end item engine power is based on the measuring compressor delivery pressure Pc, its conversion to the motion of the side indices of the indicator and comparison with the power settings indicated on the center index, position of which is proportional to the atmospheric pressure and ambient temperature.

Law $Pc = f(P_{amb;}\ t_{amb})$ is determined for each engine power by the following relations:

(a) rated power

$$Pc_{rating} = 3.4 - 0.0068\ t_{amb} + 4.03\ P_{amb}\ (kgf/cm^2);$$

(b) cruising power

$$Pc_{cruise} = Pc_{rating} - 0.45\ (kgf/cm^2);$$

(c) limited takeoff (for the ИР-117М indicator)

$$Pc_{limit\ t/o} = Pc_{rating} + 0.53\ (kgf/cm^2);$$

(d) takeoff power (for the ИР-117В indicator)

$$Pc_{t/o} = Pc_{rating} + 0.98\ (kgf/cm^2),$$

where: Pc_{rating}, Pc_{cruise}, $Pc_{limit\ t/o}$, $Pc_{t/o}$ – compressor delivery pressure at the rated, cruising, limited takeoff and takeoff power, respectively;

P_{amb} – atmospheric pressure, kgf/cm^2 abs.;

t_{amb} – ambient temperature , °C.

1.3. The ИР-117М and ИР-117В indicatorsare identical in design and differ only in the center index of the indicator. On the center index of the УР-117М indicator there are three marks: "О", "Н", "К" corresponding to $Pc_{limit\ t/o}$, Pc_{rating}, Pc_{cruise}, and on the УР-117В indicator, marks "В", "Н", "К" corresponding to $Pc_{t/o}$, Pc_{rating}, Pc_{cruise}.

Compressor delivery pressure at takeoff power $Pc_{t/o}$ exceeds compressor delivery pressure at "limited takeoff " power $Pc_{limit\ t/o}$ by 0.45 kgf/cm^2.

Scale division value of the indicators is 0.5 kgf/cm^2.

Engine pressure ratio indicators ИР-117М and ИР-117В are designed instead of earlier manufactured indicator ИР-117, they differ from the latter in improved visual acceptability: the background of the center index is red with white letters instead of the yellow background with the black letters; the scale division value is 0.5 kgf/cm^2 instead of 0.25 kgf/cm^2; the intermediate marks are shortcut.

2. DESCRIPTION

2.1. Basic Specifications:

(a) the measuring range of excess compressor delivery pressure Pc is within 5 to 10 kgf/cm^2;

(b) the measuring ranges of ambient temperature and pressure altitude are given in Table below;

Altitude, H, km	0	1	3	5
Ambient temperature, $t_{amb,}$ °C	from minus 60 to +30	from minus 60 to +20	from minus 60 to +5	from minus 60 to minus 15
Atmospheric pressure P_{amb}, kgf/cm^2 abs.	1.1	0.91	0.71	0.55

(c) reading error does not exceed ±1.5 % of the upper measuring limit of compressor delivery pressure under the normal conditions at the installation places of the pressure probes, engine pressure ratio indicator and altitude sensor;

(d) the indicator is supplied from the DC mains of 27 V ±10 %. Illumination operates from the DC or AC mains of 5.5 V;

(e) insulation resistance of the electric circuits under the normal conditions is at least 20 megohms;

(f) the indicator is serviceable after cyclic exposure of the ambient temperatures from minus 60 to +80 °C;

(g) the indicator functions properly when subjected to vibrations of the following characteristics: frequency of 10 to 35 Hz and amplitude of 0.5 to 0.8 mm;

(h) the indicator is not adversely affected when subjected to vibrations of the following characteristics: frequency of 18 to 200 Hz, acceleration of 2g, amplitude of 0.8 to 1.8 mm;

(i) the indicator withstands the linear accelerations of up to 4g;

(j) the indicator withstands and functions properly when subjected to impact loads with an acceleration of up to 5.2g at the rate of 40 to 80 impacts per minute in amounts of 10,000 impacts;

(k) the indicator is serviceable at the reduced atmospheric pressure of up to 380 mm Hg at a temperature of +60 °C;

(l) the indicator is still serviceable after staying at relative humidity of 95 to 100 % and ambient temperature of +(40±3) °C for 10 days;

(m) sensors ДВК, pressure probes ПМ-10МР and indicators, type УР-117, are not interchangeable;

(n) mass of the indicator without mounting parts does not exceed 2.5 kg;

(o) service periods, life times, storability and warranty periods are according to Section 4 of Certificate ИР-117 ПС.

2.2. Design of ПМ-10МР Pressure Probe

2.2.1. Design of the pressure probe is shown in Fig. 1.

2.2.2. The pressure probe consists of the following main assemblies:

pressure sensing unit;

casing with a cover;

bellcrank with pushers;

driving element with brush holder;

potentiometer;

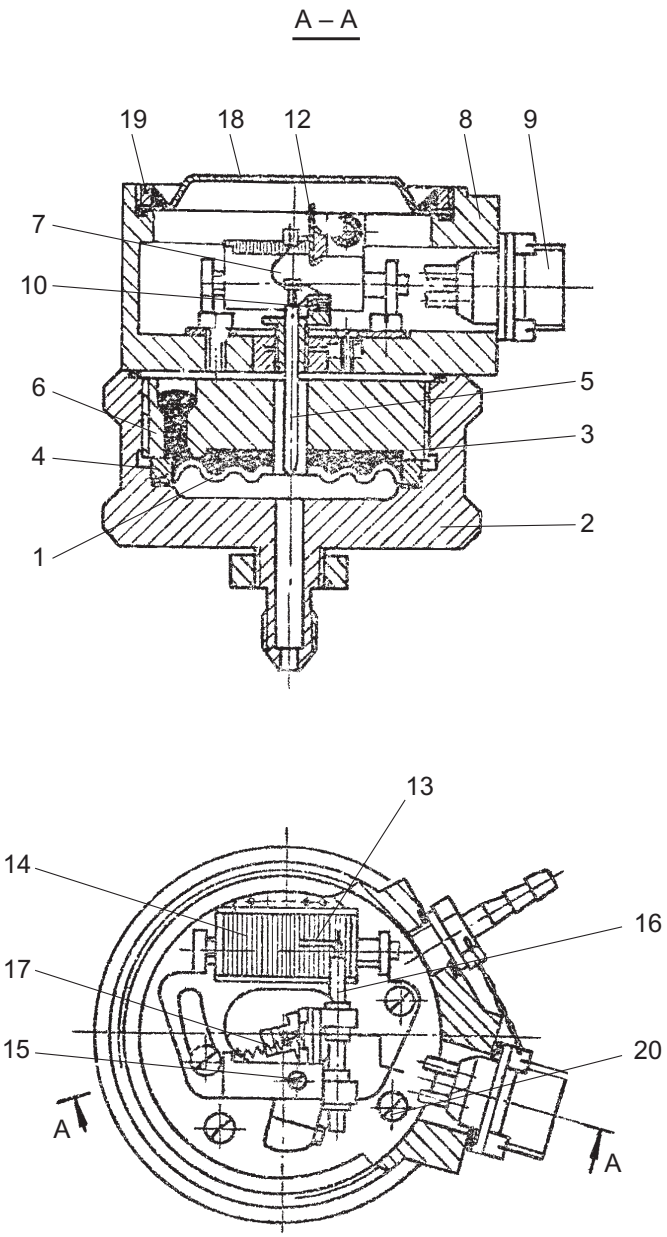
plug.

The sensing element of the pressure probe is membrane (1) fixed in pressure sensing unit (2) by ring (4) and cover (3).

To protect the membrane against damage at pressure overload, provision is made of shaped stop (6) of fusible alloy. The membrane rests against it with the highest points of its corrugations when the pressure exceeds the maximum one.

Under action of the measured pressure the membrane bends and transfers motion to bellcrank (7) with pushers through rod (5).

The bellcrank rotates around axle (10) and displaces driving element (12) with its upper pusher. The driving element is connected to brush holder (16) which rotates around axle (15). In this case, wiper (13) slides along potentiometer (14). Return spring (17) provides reverse motion of the rotating mechanism.



1. Membrane
2. Sensing Unit
3. Cover
4. Ring
5. Rod
6. Stop
7. Bellcrank with Pushers
8. Casing
9. Electrical Connector
10. Axle
12. Driving Element
13. Brush
14. Potentiometer
15. Axle
16. Brush Holder
17. Spring
18. Cover
19. Ring
20. Screw

ПМ-10МР Pressure Probe Design
Figure 1

The transmission-multiplier mechanism is installed inside casing (8) which is attached to the pressure sensing unit by means of screws (20). The casing is closed with cover (18) which secured by threaded ring (19).

2.3. The design of the ДВК sensor and П-1 temperature bulb does not describe because these instruments are manufactured and supplied by the serial plants.

2.4. Design of Engine Pressure Ratio Indicator, Type УР-117

2.4.1. Design of the indicator is shown in Fig. 2.

2.4.2. The indicator consists of the following main assemblies:

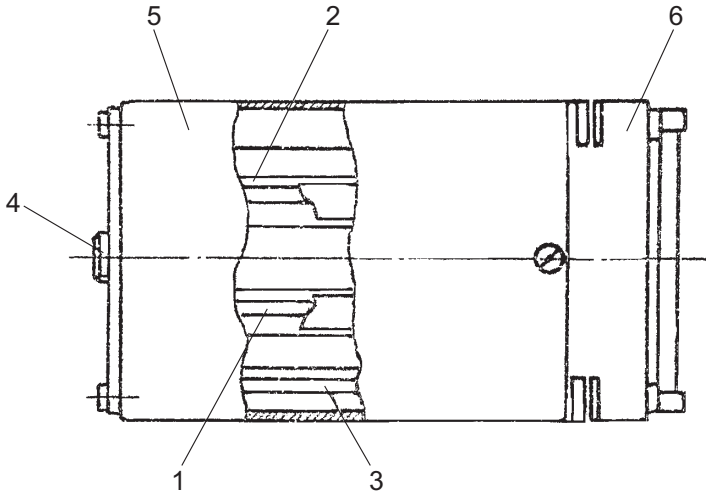
case with glass;

measuring elements;

housing with plugs;

plug.

Measuring elements (1), (2), (3) are secured in case (6) and closed with housing (5).



1, 2, 3. Measuring Elements
4. Plug
5. Housing
6. Case with Glass

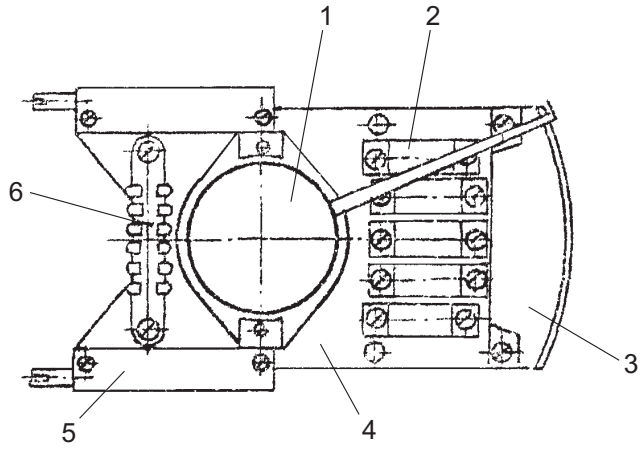
УР-117 Engine Pressure Ratio Indicator Design
Figure 2

2.4.3. Design of the measuring element is shown in Fig. 3.

The measuring element comprises board (4) on which ratiometer (1) is attached, resistance coil (2), adjusting potentiometers (5), plug adapter (6) and illumination unit (3).

The illumination unit consists of the body on which the scale is secured. The scale is illuminated by means of two subminiature red filament lamps mounted in the illumination unit body. The scale is graduated in kgf/cm^2.

The main part of the measuring element is the magnetoelectric ratiometer with the fixed coils arranged at an angle of 90° and moving magnet rigidly connected to a pointer.



1. Ratiometer
2. Resistance Coil
3. Illumination Unit
4. Board
5. Potentiometer
6. Plug Adapter

Measuring Element Design
Figure 3

3. OPERATION

3.1. The schematic circuit diagram of the indicator is given in Fig. 4.

Two extreme measuring elements of the engine pressure ratio indicator complete with two pressure probes ПМ-10МР measure compressor delivery pressure Pc.

The center measuring element complete with the ДВК sensor and П-1 (or П-2Т) temperature bulb measure the atmospheric pressure with temperature correction. Under normal operation the pointer upper edges of the extreme measuring elements should align with the edges of the respective power index of the center measuring element within the indicator error limits.

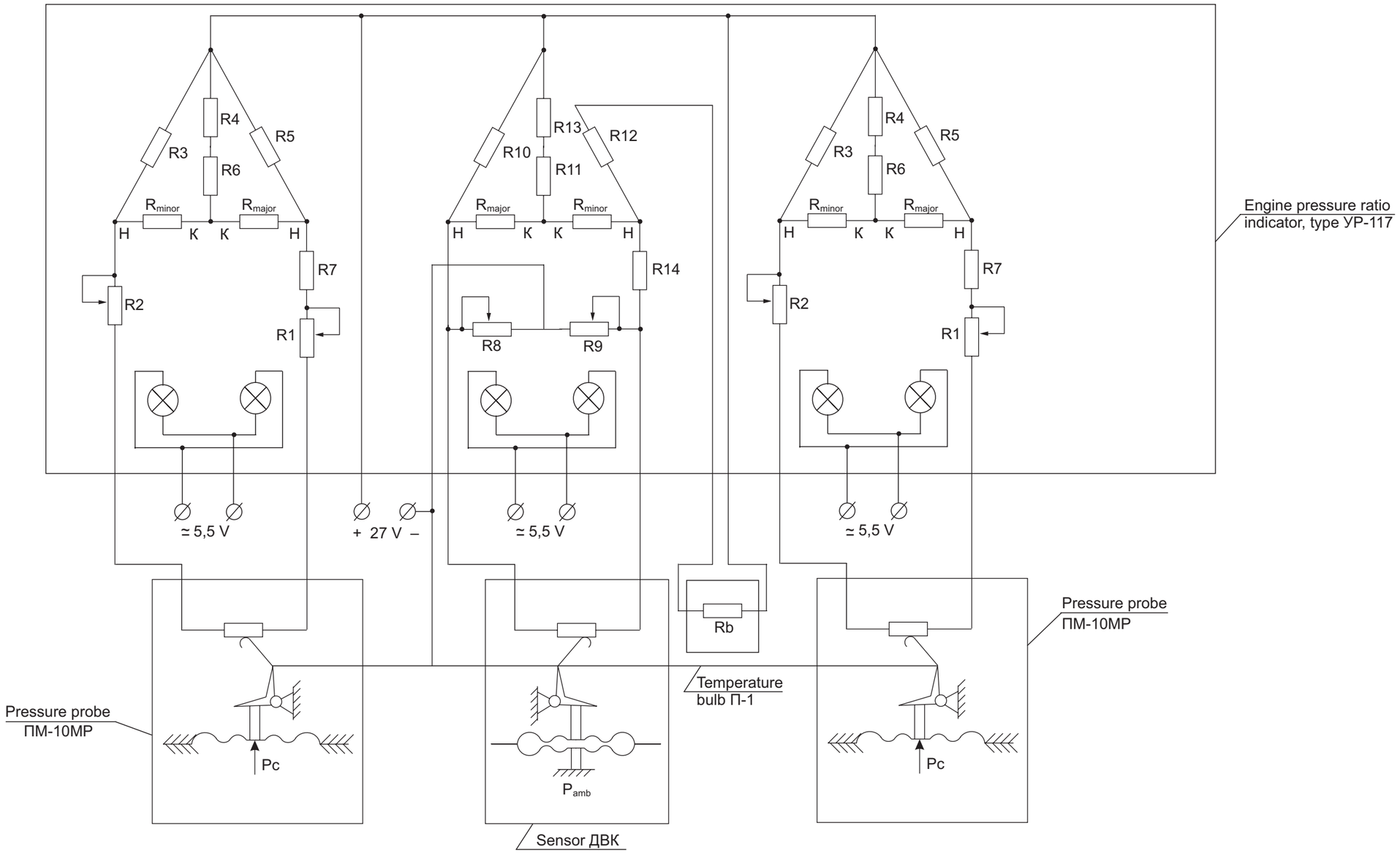
3.2. Compressor delivery pressure is sensed by the membrane of the ПМ-10МР pressure probe and via the transmission-multiplier mechanism is transmitted to the potentiometer wiper. The potentiometer together with the electric circuit of the measuring element form the bridge measuring circuit, across a diagonally opposite pair of junctions of the bridge connected are major ($R_{maior)}$ and minor ($R_{minor)}$ coils of the ratiometer, and the potentiometer arms together with resistors R1, R2, R7 form two arms of the bridge. Change of resistance of the potentiometer arms under action of pressure Pc results in current redistribution in the coils, hence, in change of the pointer position.

To compensate the temperature errors, resistors R6 and R7 are made of copper wire.

Resistors R1 and R2 adjust span and displacement of the pointers.

3.3. Operation of the center measuring element is similar to that described in Item 3.2, difference is only in the fact that the evacuated capsule of the ДВК sensor which responds to change of the atmospheric pressure is used as the sensing element.

The temperature bulb for temperature correction of measured atmospheric pressure P_{amb} is connected to the R_{minor} minor coil arm of the element measuring circuit.



Indicator Schematic Circuit Diagram
Figure 4

Resistance Rb of the temperature bulb changes with the change of the ambient temperature. This changes the resistance of arm R12 + Rb and current in the minor coil, as a result, the pointer position changes as well.

When the temperature decreases, i.e. resistance of the minor coil becomes less, the readings of the center element will go up, and when the temperature increases, they will go down.

Resistors R8 and R9 which adjust span and displacement of the pointer, are connected in parallel to the sensor potentiometer to increase current in the coils and to increase, respectively, the setting moment of the pointer.

Resistors R13 and R14 serve for compensation of the temperature errors.

ENGINE PRESSURE RATION INDICATOR – TROUBLE SHOOTING

In case of the indicator failure, it is necessary to replace it with a sound one, and without opening the failed indicator to send to the manufacturer to reveal the cause of failure (if the warranty period does not expire).

ENGINE PRESSURE RATION INDICATOR – MAINTENANCE PRACTICES

Prior to install on the end item, at performing the scheduled maintenance checks, as well as upon expiration of the warranty period, it is necessary to check the indicator for serviceability and enter the readings in the respective column of the Certificate.

The functional check consists in determination of reading errors of the indicator and insulation resistance under the normal conditions.

NOTE: Necessity and scope of the preliminary, preflight and postflight checks are dictated by the Maintenance Schedule for the end item on which the indicator is installed, and performed in compliance with the documentation for the end item.

The scheduled maintenance checks are performed in the following scope:

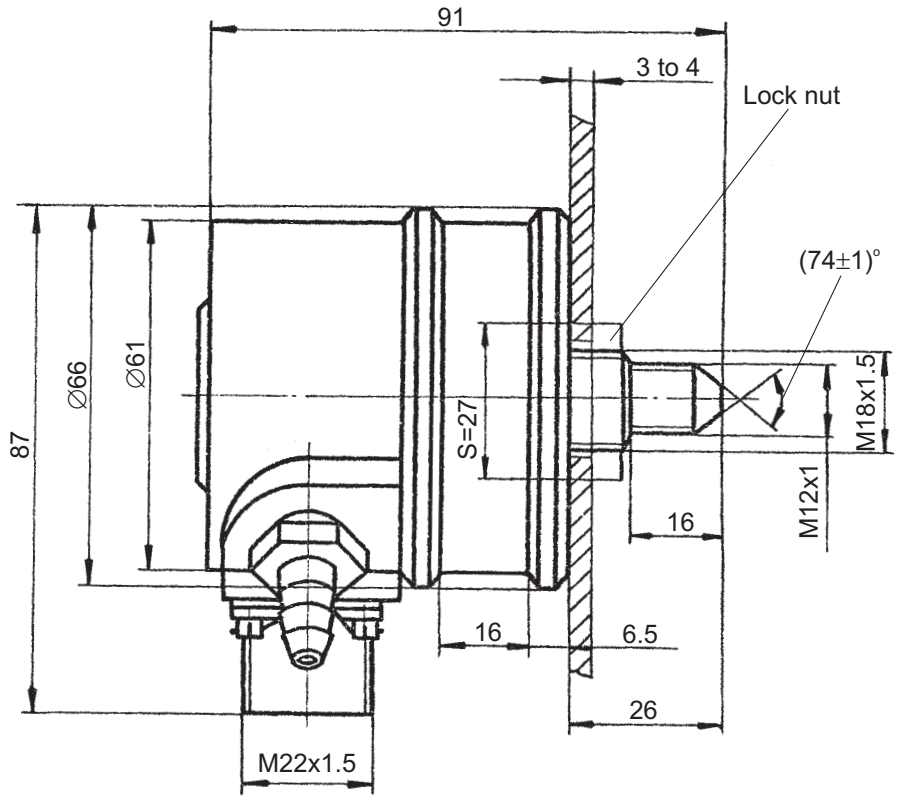
(a) removal from the end item and check of appearance;

(b) functional check;

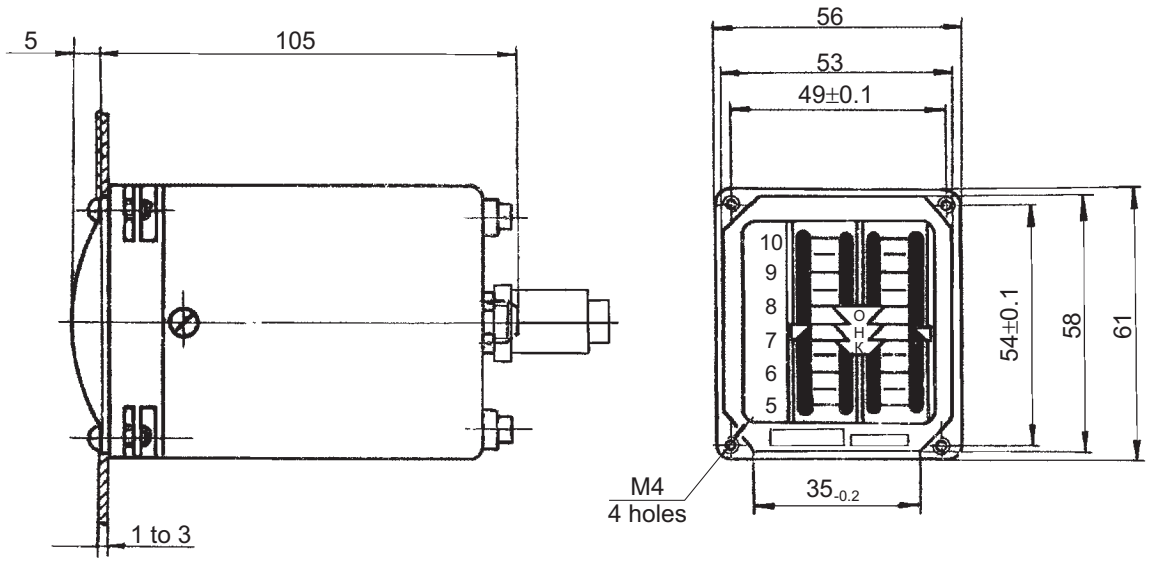
(c) check of appearance and installation on the end item.

The maintenance procedures are given in the Task Cards.

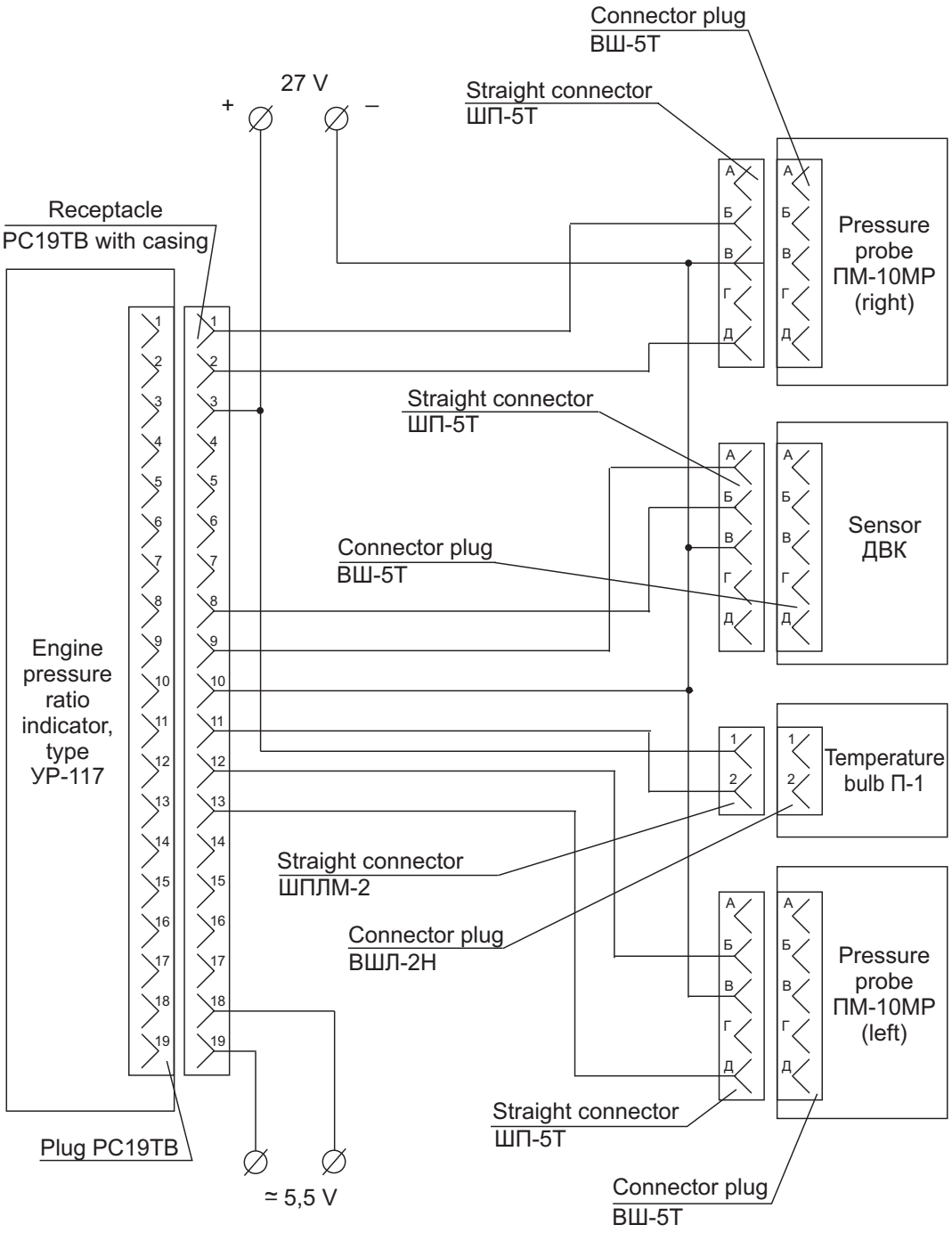
	TASK CARD No. 201	Page(s) 203–207	
	INSTALLATION		
Operations and Technical Requirements (TR)		Corrective Actions	Checked by
1. On the panels secure the following: (a) pressure probes ПМ-10МР by means of the lock nuts as shown in Fig. 201 and lock them; (b) engine pressure ratio indicator, type УР-117 with four screws 3171A-4-12 as shown in Fig. 202. **NOTE:** Installation of the ДВК sensor is given in Maintenance Manual for the altitude sensor. 2. Carry out the wiring in compliance with the interconnection diagram (Fig. 203): (a) with wire of 0.35 to 0.5-mm^2 cross section and not more than 50 m long for the ПМ-10МР pressure probe, УР-117 engine pressure ratio indicator and ДВК sensor; (b) with wire of 0.75-mm^2 cross section and not more than 40 m long or of 0.5-mm^2 cross section and not more than 15 m long for the П-1 temperature bulb. 3. Connect the following connector plugs: ВШ-5Т of the ПМ-10МР pressure probe and ДВК sensor; РС19ТВ of the УР-117 engine pressure ratio indicator;			

Operations and Technical Requirements (TR)	Corrective Actions	Checked by
 ПМ-10МР Pressure Probe Installation Diagram Figure 201		

Operations and Technical Requirements (TR)	Corrective Actions	Checked by



УР-117 Engine Pressure Ratio Indicator Installation Diagram
Figure 202



Indicator Interconnection Diagram
Figure 203

Operations and Technical Requirements (TR)	Corrective Actions	Checked by
ВШЛ-2Н of the temperature bulb in compliance with the interconnection diagram (Fig. 203). 4. Tighten and lock the coupling nuts of the connector plugs. 5. Check the indicator for proper function: (a) energize the indicator. The pointers of extreme measuring elements should be below the mark of 5 kgf/cm^2. The center index indicates what compressor delivery pressure Pc should be at the respective power setting at given atmospheric pressure P_{amb} and ambient temperature $t_{amb.}$ (b) increase pressure in the ПМ-10МР pressure probes from 5 to 10 kgf/cm^2 at the engine running. The pointers of extreme measuring elements should move toward the direction of reading going-up. 6. Check the indicator scale for illumination connecting the indicator in compliance with the diagram shown in Fig. 203. The scale should illuminate uniformly.	See Section "Trouble Shooting" See Section "Trouble Shooting"	

Test Equipment	Tools and Fixtures	Materials
–	–	–

	TASK CARD No. 202	Page(s) 209
	REMOVAL	

Operations and Technical Requirements (TR)	Corrective Actions	Checked by
1. Remove the locking devices from the coupling nuts of the connector plugs of the ПМ-10МР pressure probes, УР-117 engine pressure ratio indicator and ДВК sensor. 2. Undo the coupling nuts of the connector plugs and detach the connectors. 3. Remove the locking devices (a) from the mounting screws of the ДВК sensor; (b) from the mounting nuts of the ПМ-10МР pressure probes. 4. Unscrew (a) four screws attaching the УР-117 engine pressure ratio indicator to the panel; (b) three screws attaching the ДВК sensor to the panel, (c) the lock nuts attaching the ПМ-10МР pressure probes to the panel. 5. Remove the engine pressure ratio indicator and sensors from the end item. 6. Visually inspect the engine pressure ratio indicator and sensors for condition.		

Test Equipment	Tools and Fixtures	Materials
–	–	–

	TASK CARD No. 203	Page(s) 211–216
	ADJUSTMENT AND TESTING	

Operations and Technical Requirements (TR)	Corrective Actions	Checked by

1. Check the reading errors of the indicator:
   (a) connect the indicator in compliance with the diagram given in Fig. 204;
   (b) on the temperature bulb simulator set resistance Rb = 85 ohms;
   (c) energize the indicator and keep it alive for 10 minutes;
   (d) using the vacuum gauge or МЧР-3 pressure gauge set pressure P_{amb}, and using the temperature bulb simulator set resistance Rb corresponding to the checked points indicated in the Table given below:

Checked points P_c, kgf/cm^2	5.75	6.5	7.5	7.25	7.0	7.75
Resistance Rb, ohms	85			101	71	
Pressure P_{amb} in ДВК sensor, kgf/cm^2 abs.	0.558	0.744	0.992	1.006	0.792	0.978

   (e) apply pressure P_c to the pressure probes until the pointer upper edges of the extreme measuring elements of the indicator align with the upper edge of the center index corresponding to the rated power ("H");

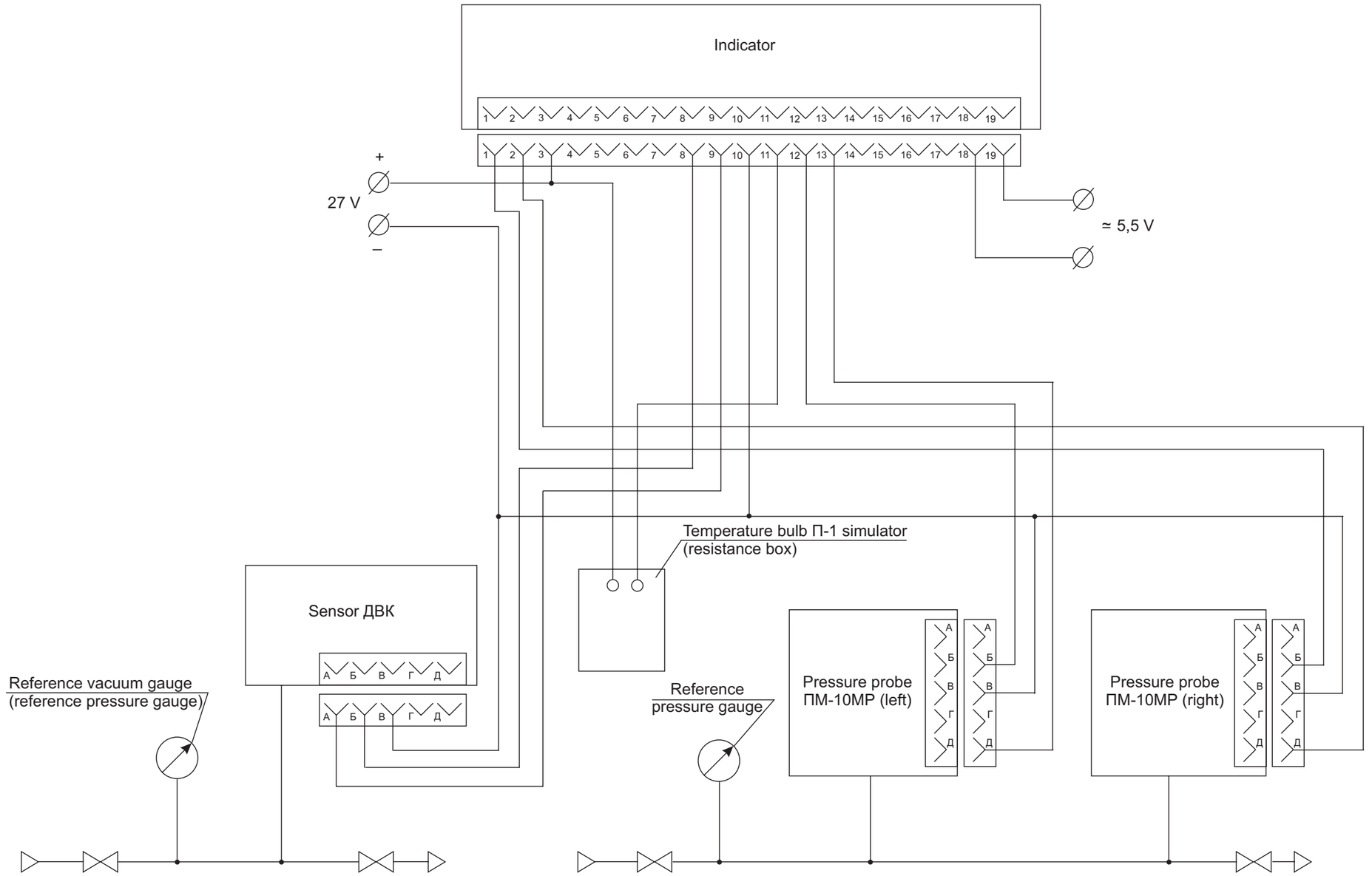
See Section "Trouble Shooting"

Operations and Technical Requirements (TR)	Corrective Actions	Checked by
(f) determine the reading error at each checked point as follows: $\delta = \frac{P_{actual} - P_{check}}{10} \times 100\ (\%)$, where: P_{check} – pressure corresponding to the point under check; P_{actual} – actual pressure indicated by the pressure gauge. The error should not exceed ±1.5 %. (g) calculate readings of the vacuum gauge as follows: $P_{vacuum} = P_{sensor} - P_{day,}$ where: P_{vacuum} – readings of the vacuum gauge in kgf/cm^2; P_{sensor} – pressure in the ДВК sensor in kgf/cm^2; P_{day} – pressure of the day in kgf/cm^2. $P_{day} = \frac{P_{1day}\ Hg mm}{738.3} = \frac{P_{2day}\ Hg mm}{735.5}$ (kgf/cm^2), where: P_{1day} – pressure of the day against the mercury pressure gauge at a mercury temperature of +20 °C; P_{2day} – pressure of the day against the mercury pressure gauge at a mercury temperature of 0 °C; (h) if the P_{vacuum} value is positive, check pressure in the ДВК sensor against the reference pressure gauge of 0.25 class or better with upper limit of the range of 1 kgf/cm^2; (i) perform check by slightly tapping over the cases of the indicator and sensors.		

Operations and Technical Requirements (TR)	Corrective Actions	Checked by
2. Check the insulation resistance of the electric circuits of the indicator under the normal conditions using the megohmmeter rated at 100 V: (a) check the insulation resistance of the electric circuits of the ПМ-10МР pressure probes. For this purpose, connect one terminal of the megohmmeter to the short-circuited pins of the connector plug, and the other terminal, to the pressure sensing unit case; (b) check the insulation resistance of the electric circuits of the engine pressure ratio indicator. For this purpose, connect one terminal of the megohmmeter to the short-circuited pins of the connector plug, and the other terminal, to the mounting screw driven into the indicator case; (c) check the insulation resistance of the electric circuits of the ДВК altitude sensor. For this purpose, connect one terminal of the megohmmeter to the short-circuited pins of the connector plug, and the other terminal, to one of the screws attaching the housing to the sensor case. The insulation resistance of the electric circuits should be at least 20 megohms. 3. Visually inspect the pressure probes, engine pressure ratio indicator and sensor for damage.	See Section "Trouble Shooting"	

Operations and Technical Requirements (TR)	Corrective Actions	Checked by

Test Equipment	Tools and Fixtures	Materials
Resistance box of 0.1 accuracy class or better DC power source of 27 V ±10 % AC or DC power source of 5.5 V for checking illumination Megohmmeter rated at 100 V Reference pressure gauge of 0.25 accuracy class or better rated at 10 kgf/cm^2 Mercury pressure gauge МЧР-3 or vacuum gauge of 0.4 accuracy class or better Reference pressure gauge of 0.25 accuracy class or better rated at 1 kgf/cm^2 Pressure source – bottle with compressed air and reducing valve up to 10 kgf/cm^2 Vacuum gauge of 0.4 accuracy class or better	Temporary cable Temporary pipeline Wrenches S = 27; S = 17 Combination pliers	Wire 0,5-T-12X18H9T



Indicator Testing Diagram
Figure 204

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ENGINE PRESSURE RATIO INDICATOR – STORAGE INSTRUCTIONS

The indicator packed in the corrugate box should be stored in the heated and well-ventilated storehouses at a temperature of + 5 to +35 °C and relative humidity of up to 85 %.

The packed indicators should be placed on the special racks. The racks should be arranged at a distance of at least 40 cm from the foundation wall and protected against dirt and sun rays with the curtains.

Gases of different kind (chlorine, ammoniac steam, smoke, etc.) should not penetrate into the storehouses. Storage of acids, alkalies and other chemicals is not allowed.

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ENGINE PRESSURE RATIO INDICATOR – SHIPMENT

The indicators should transported in the containers manufactured in compliance with the requirements of State Standard.

The boxes with indicators should be placed into the containers densely to preclude their displacement at the shipping. The space between the walls of the container and the boxes should be filled with carton.

The packed indicators can be transported by any kind of transport at any distance and any speed.