Portable balancer “Balanset-4”

USER MANUAL
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CONTENTS

1. Destination

Balancing set “Balanset-4” is portable balancing set used for balancing in one, two, three and four planes of correction of the rotors rotating in own bearings.

Balancing set includes: up to 4 sensors of vibration, phase mark sensor, USB USB interface unit, and also portable computer.

It can be used when carrying out assembly, installation and repair works to decrease the dynamic weightings operating on bearing knots of machines owing to their unbalance. Thus the operation resource of machines and mechanisms raises significantly.

Use of a balancing set allows to exclude in many cases need for special balancing machines as balancing of a rotor is carried out in its own bearings without dismantling of the mechanism

If necessary the Balanset-4 balancing set can be also used as a measuring system of the balancing machine.

All process of balancing, including measurement, calculation and indication information about mass and angle of placing of the correction weight is carried out in the automated mode and doesn't demand from the user of the additional skills and knowledge which are beyond this instruction.

Results of all balancing stored in Archive of balancing and can be printed in the reports.

The balancing set “Balanset-4” can additionally be used as vibrotachometer allowing to carry out measurement on four channels of the RMS of common vibration, RMS of a 1x component of vibration and also to control rotor RPM value.

Besides, this balancing set allows to output the display of wave and spectrum charts that can be useful at an assessment of technical conditions of the balanced machine.

2. TECHNICAL FEATURES

2.1. Number of the correction planes during balancing	1, 2, 3, 4
2.2. Number of channels of the vibration measurement	4
2.3. Number of channels of the rotation frequency measurement	1
2.4. Measurement range of the root-mean-square value (RMS) of the vibration velocity, mm/sec	from 0.2 to 80
2.5. The frequency range of the RMS measurement of the vibration velocity, Hz	from 5 to 200
2.6. The limits of permissible absolute error of vibration RMS measurement on the base frequency (80 Hz) and in the operating band, mm/sec	±(0.1 + 0.1*Vи), V - the measured value of the MS vibration velocity
2.7. Range of the frequency of rotation measurement, rpm	300 - 30000
2.8. Limits of permissible absolute error of the vibration velocity measurement in the operating band, rpm	±(1 + 0.005*RPM),
2.9. Range of the vibration phase shift measurement, angular degrees	from 0 to 360
2.10. Limits of the permissible absolute error of the vibration phase shift measurement, angular degrees	± 1
2.11. Overall dimensions of the measuring unit, mm, max	200*160*65
2.12. Mass of the USB interface unit, kg, max	0.9
2.13. Overall dimensions of the vibrator inverter, mm, max	25*25*20
2.14. Mass of the vibrator sensor, kg, max	0.04
2.15. Overall dimensions of the phase angle sensor, mm, max	120*60*30
2.16. Service conditions:	
▪ air temperature, °C	from 1 to 35
▪ the relative humidity of the air at temperature 25 °C, %	max 80
▪ atmospheric pressure, kPa	from 84 to 106.7

3. BALANCER COMPONENTS AND DELIVERY SET

Basic delivery set of “Balanset-4” BALANCER includes DAQ USB interface unit, two sensors of vibration, phase ensor, the equipment necessary for the user for main measurement, as well as a flash disk with the software.

In addition (at the request of the Customer) the BALANCER can be completed with the portable computer .

Delivery set

Description	Number	Note
USB interface unit	1	
Laser phase reference marker (digital tachometer)	1	
Single-axis accelerometers	4	
Magnetic stand	1	
Digital scales	1	
Hard case for transportation	1	
“Balanset-4”. User’s manual.	1	
Flash-disk with balancing software	1	
Portable PC (notebook)	1	Optionally

4. BALANCER STRUCTURE AND PRINCIPLE OF OPERATION

4.1. Photos of the balancing set “Balanset-4” are shown in fig. 4.1 и 4.2.

Balancing set (fig. 4.1) consists of USB interface unit 6, four sensors of vibration 1, 2, 3, 4, phase sensor 5 and portable computer 7 .

Delivery set also includes equipment required for balancing mechanisms in field conditions. In particular, the magnets used for on-site installation of vibration sensors and the magnetic stand used for setting the phase angle sensor.

The frame of the USB interface unit of the BALANCER is made of ABS plastic of gray color.

On a front wall of the case (see fig. 4.2) the X1, X2 X3, X4 connectors intended for connection of the vibration sensors respectively to 1, 2, 3 and 4 measuring channels of the BALANCER, and also the X5 socket used for connection of the phase corner sensor are disposed.

The cable with the X6 USB socket intended for connection of the USB interface unit to the computer is brought out of a back wall of the sensor.

Through this cable the information is exchanged between the USB interface unit and computer unit. It also provides power +5 V from the computer to the USB interface unit.

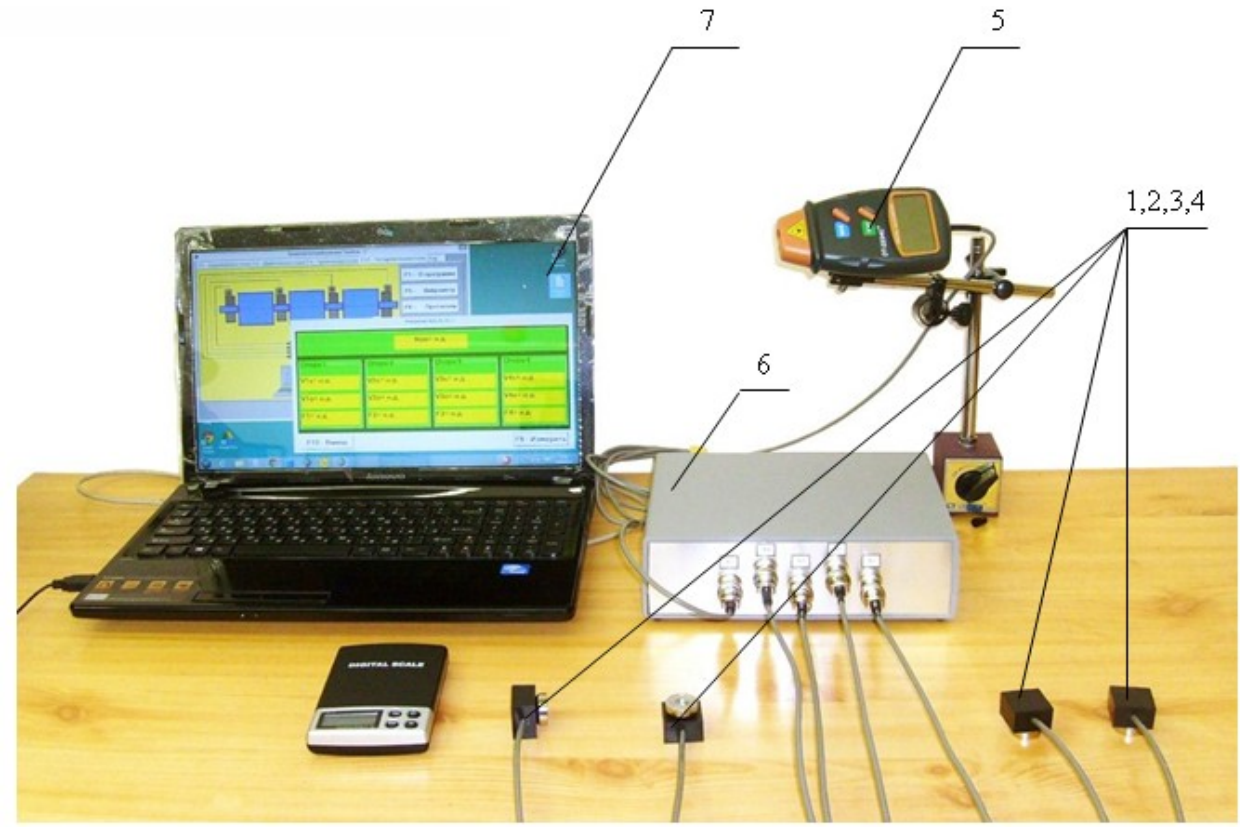


Fig. 4.1. Delivery set of the balancing set “Balanset-4”

4.2. Functional diagram of the BALANCER is shown in Fig. 4.3.

The BALANCER includes the following structural units : USB interface unit 6, vibration sensors 1, 2, 3, 4, phase angle sensor (laser tachometer) 5, portable computer 7. As the diagram shows, in the case of the USB interface unit is mounted module 8 ADC / DAC E154 (or E14-140-M), to which the board 9 with normalizing converters of sensor signals is connected.

The board 9 contains components which ensure the standardization of the signals from sensors, including:

Integrators 10, 11, 12, 13 of the vibration sensor signals on the first, second, third and fourth measuring inputs;

inverter 14 of the phase angle sensor;

power converter 15 + 5V / + 3V;

power converter 16 DC-DC +5V/+12V.

The principle of operation of the BALANCER is based on measurement of mechanical vibrations which take place on cases of machines during their work.

To convert mechanical vibrations into an electrical signal vibration sensors - integrated capacitive accelerometers **2-5** - are used. To determine phase characteristics of a signal the optical laser tachometer **6** working for reflection is used**.**

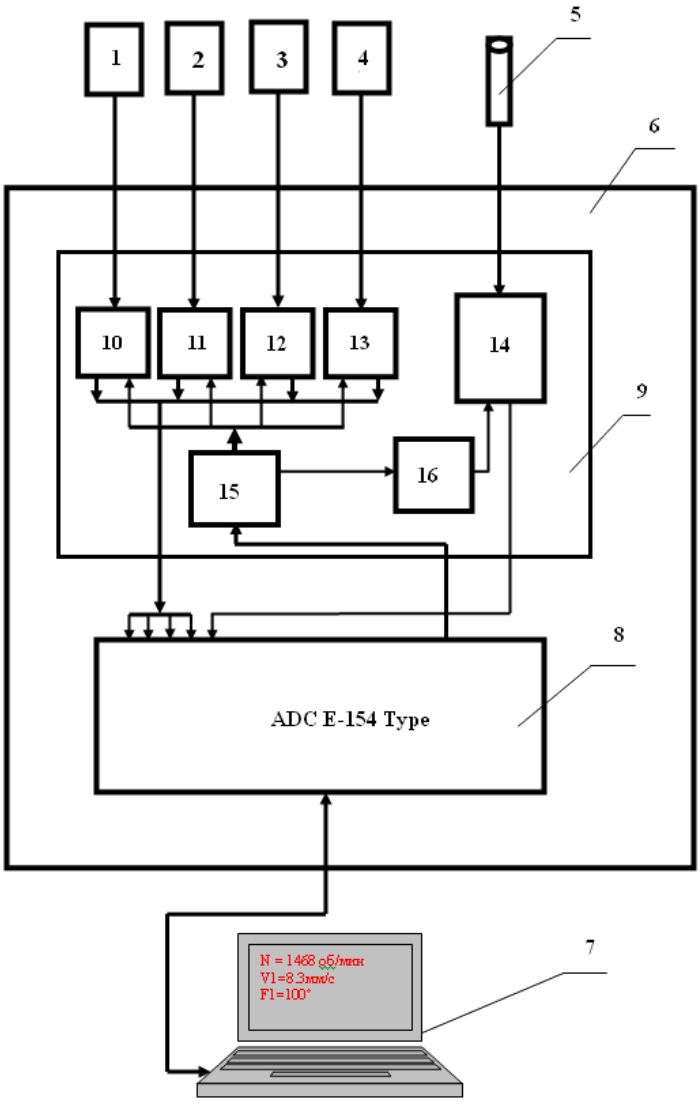


Fig. 4.3. Functional diagram of the BALANCER “Balanset-4”.

Under the influence of mechanical vibrations on the output of the vibration sensor an electrical analog signal proportional to the vibration acceleration is generated applying to the corresponding input of the USB interface unit of the BALANCER.

Next, after converting (integration, bandpass filter) modified vibration signal is supplied to a proportional analog input module 8, the ADC E154, which is converted to digital form.

In case of necessary measurements of rotation frequency and/or phase characteristics of vibration signal the pulse signal formed by the sensor of a phase corner 5 is additionally used which is also provided after rationing on the corresponding analog entrance of the module 8.

Module 8 ADC performs pre-digital processing of analog signals from the sensors. Then, digitized signals are transferred via USB to the portable PC 7, wherein according to the set program further processing of a digital signal is carried out (a filtration, interpolation, Fourier – the analysis, calculation of parameters of balancing, etc.).

The obtained results (the numerical values of the amplitude and phase of vibration, speed, etc.) are displayed and stored in computer memory.

Depending on the chosen balancing mode (one, two, three or four planes of correction) the corresponding number of measurements of vibration of the object in its initial state and after installation of the test weight used for taring of the BALANCER is consistently carried out.

By results of measurements the solution of balancing is carried out in a digital form, after that the computer display provides information about the size and the correction mass setting angle.

The role of the user in this case reduces to the installation of trial and correction weights on the balanced rotor and pressing the appropriate keys when ready to computer keyboard (or virtual keys on the display).

The whole process of balancing, which includes measurement, signal processing and calculation of results is performed in an automated mode according to the programs, located in the computer memory.

6. SETTING-UP PROCEDURES

6.1. Install vibration sensors **1, 2, 3, 4** at the inspected or balanced mechanism (Detailed information about installation of the sensors is given in Annex 1).

Connect vibration sensors to the sockets X1, X2, X3, X4.

6.3. Set phase angle sensor (laser tachometer) 5 so that the nominal clearance between the radial (or face) surface of the balanced rotor and the case of the sensor be in range from 10 to 300 mm.

Stick a mark of light-reflecting tape on the surface of the rotor width of at least 10 to 15 mm.

Connect the phase angle sensor to the socket X5.

6.4. Connect the USB interface unit to the USB-port of the computer.

6.5. Connect the computer to the power mains when using the AC power supply. Connect the power supply to 220 V, 50 Hz.

6.6. Turn on the computer and select a program "Balanset-4."

7. BALANCER OPERATION

7.1. Main operating window. Correct use of the basic action buttons.

When running the program "Balanset-4" the main working window, shown in Fig. 7.1, appears on the computer's display.

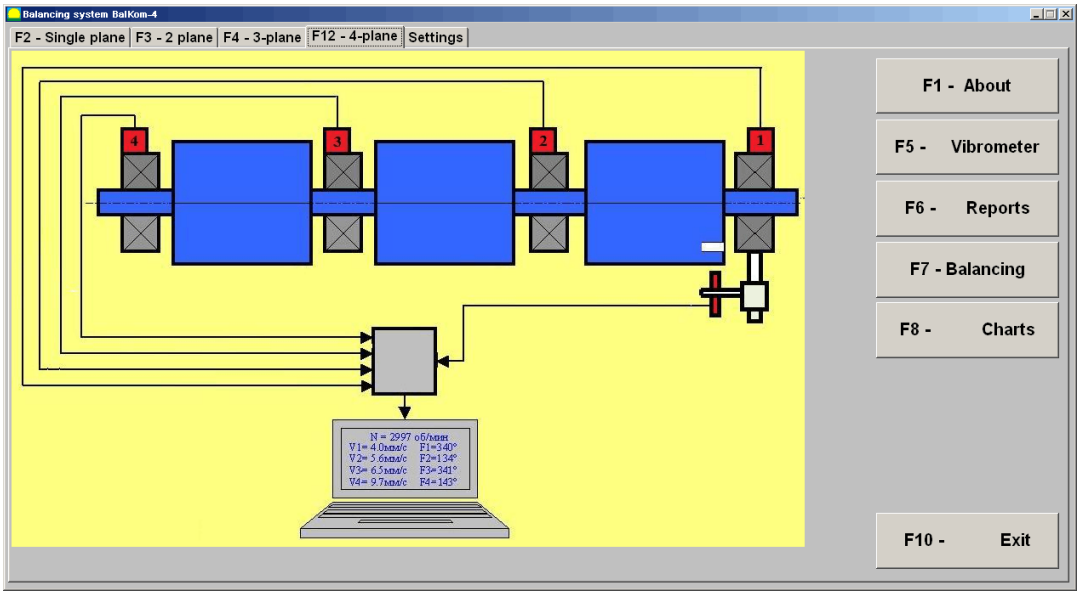


Fig. 7.1. Main operating window of the "Balanset-4" program

For management of work of the program there are 11 virtual buttons in the specified window with the names of the functions realized when pressing on them.

For pressing the chosen button it is necessary to guide the mouse pointer at it and click it, having pressed the left mouse button.

Control of work in the Main window of the program can be also exercised by means of function keys of the keyboard of the computer which designation is also put on the corresponding buttons of a window.

7.1.1. Button «**F1**-About program»**.**

When this button is pressed (or, equivalently, the F1 function key on the computer keyboard) the user can get brief information about the purpose of the program and, if necessary, to get acquainted with the operating manual of the BALANCER «Balanset-4».

7.1.2. Buttons «**F2**-single-plane»**,** «**F3**-two-plane» **,**
«**F4**-three-plane»**,** «**F12**-four-plane»**.**

Pressing "**F2**- single-plane" (or **F2** function key on the computer keyboard) selects the measurement mode on the same plane of vibration using the vibration sensor 1 connected to the input X**1** of the USB interface unit.

After clicking this button, the computer display saves mimic diagram shown in Fig. 7.1 illustrating a process of measuring the vibration only in the first measuring channel (or the balancing process in a single plane).

Pressing the "**F3**-two-plane" (or **F3** function key on the computer keyboard) selects the mode of vibration measurements simultaneously in two planes using vibration sensors **1** and **4**, respectively connected to the inputs X1 and X4 of the USB interface unit.

In this case, on the computer display appears mimic diagram, shown in Fig. 7.2, illustrating a process of measuring the vibration simultaneously on two different channels (or balancing process in two planes).

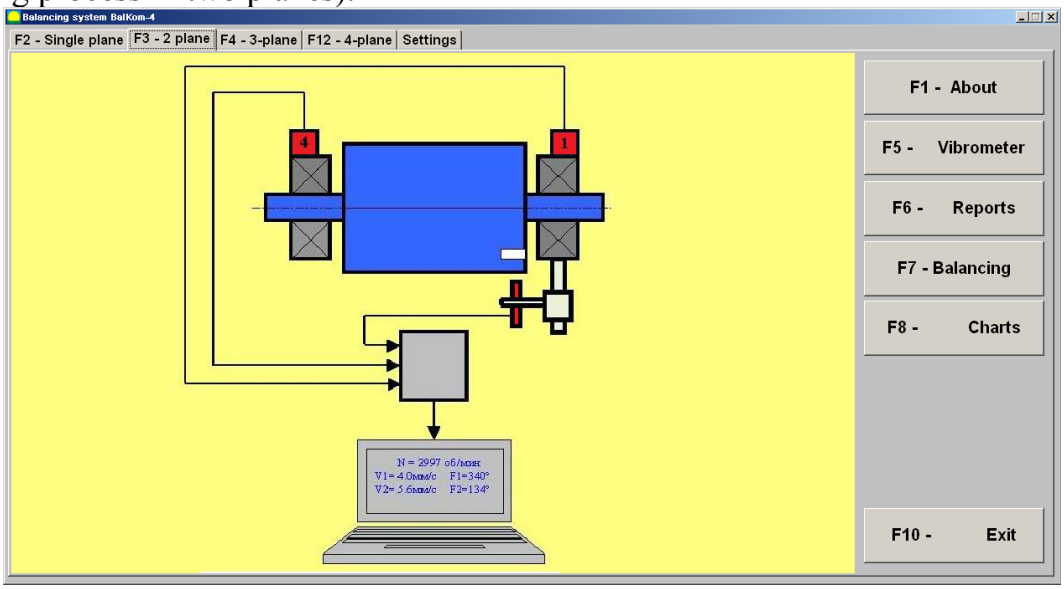


Fig. 7.2. Main operating window of the "Balanset-4" after pressing the button "**F3**-two-plane

Pressing "**F4**-three-plane" (or **F4** function key on the computer keyboard) selects the mode of vibration measurement in three planes simultaneously using vibration sensors **1, 2** and **4**, respectively connected to the inputs X1, X2 and X4 of the USB interface unit.

In this case, on the computer display appears mimic diagram illustrating a process of measuring the vibration simultaneously on three different channels (or balancing process in three planes).

Pressing "**F12**-four-plane" (or function keys **F12** on your keyboard) selects the mode of vibration measurements simultaneously in four planes using vibration sensors **1, 2, 3, 4,** respectively connected to the inputs X1, X2, X3 and X4 of the USB interface unit.

In this case, on the computer display appears mimic diagram shown in Fig. 7.3 illustrating a process of measuring the vibration simultaneously on three different channels (or balancing process in four planes).

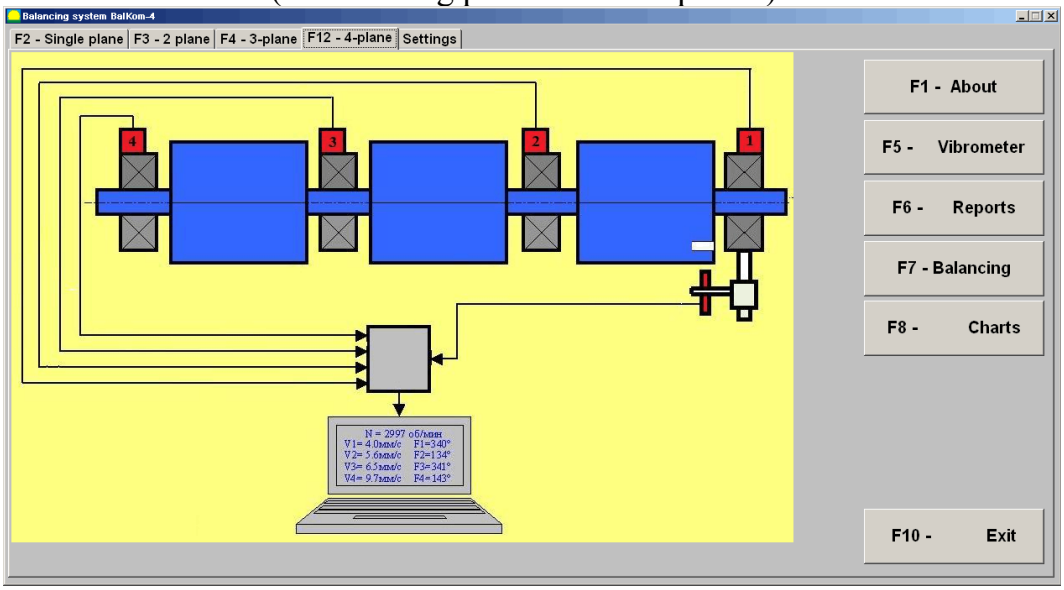


Fig. 7.4. Main operating window of the "Balanset-4" after pressing the button "**F12**-four-plane

7.1.3. Button «**Settings**».

Pressing this button opens the operating window “Sensor conversion coefficients” and the user can, if necessary, make adjustments to these coefficients.

7.1.4. Button «**F5** – Vibrometer».

Pressing of this button (or a function key of **F5** on the computer keyboard) activates the mode of vibration measurement on one, two, three or four measuring channels of virtual vibration depending on which measurement mode is selected by pressing the buttons "**F2**-single-plane", "**F3**-two-plane", "**F4** - three-plane", "**F12** - four-plane".

7.1.5. Button «**F6** – **Reports**».

Pressing this button (or **F6** function key on the computer keyboard) switches on the balancing Archive, from which you can print the report with the results of balancing for a specific mechanism (or rotor).

7.1.6. Button «**F7** – Balancing».

Pressing of this button (or function key F7 on your keyboard) activates balancing mode in one, two, three or four correction planes depending on which measurement mode is selected by pressing the buttons "**F2**-single-plane", "**F3**-two-plane", "**F4** - three-plane", "**F12** - four-plane".

7.1.7. Button «**F8** – Charts».

Pressing this button (or **F8** function key on the computer's keyboard) enables graphic vibrometer, the implementation of which displays on a computer screen simultaneously with the digital values of the amplitude and phase of the vibration graphics of its time function.

7.1.8. Button «**F10** – Exit».

Pressing this button (or **F10** function key on the computer's keyboard) completes the program “Balanset-4”.

7.2. Input or correction of the conversion coefficients of the vibration sensors.

When you click button " **Settings** " in the main operating window on a computer screen appears the operating window "Conversion coefficients" (see. Fig. 7.5).

In this window an adjustment to the conversion coefficients of vibration sensors can be done, the need for which is revealed in the course of their calibration.

To enter coefficients, refined by the results of the calibration values of conversion, it is necessary to put mouse pointer on the appropriate window "Кпр" of the operating window, "click" it and enter the appropriate value of the vibration sensor conversion factor.

Attention!

When you enter a conversion factor its fractional part is separated from the integer part with the decimal point (the sign ",").

In this window, if necessary, it is possible to make adjustments, taking into account the offset value of zero ADC of the USB interface unit.

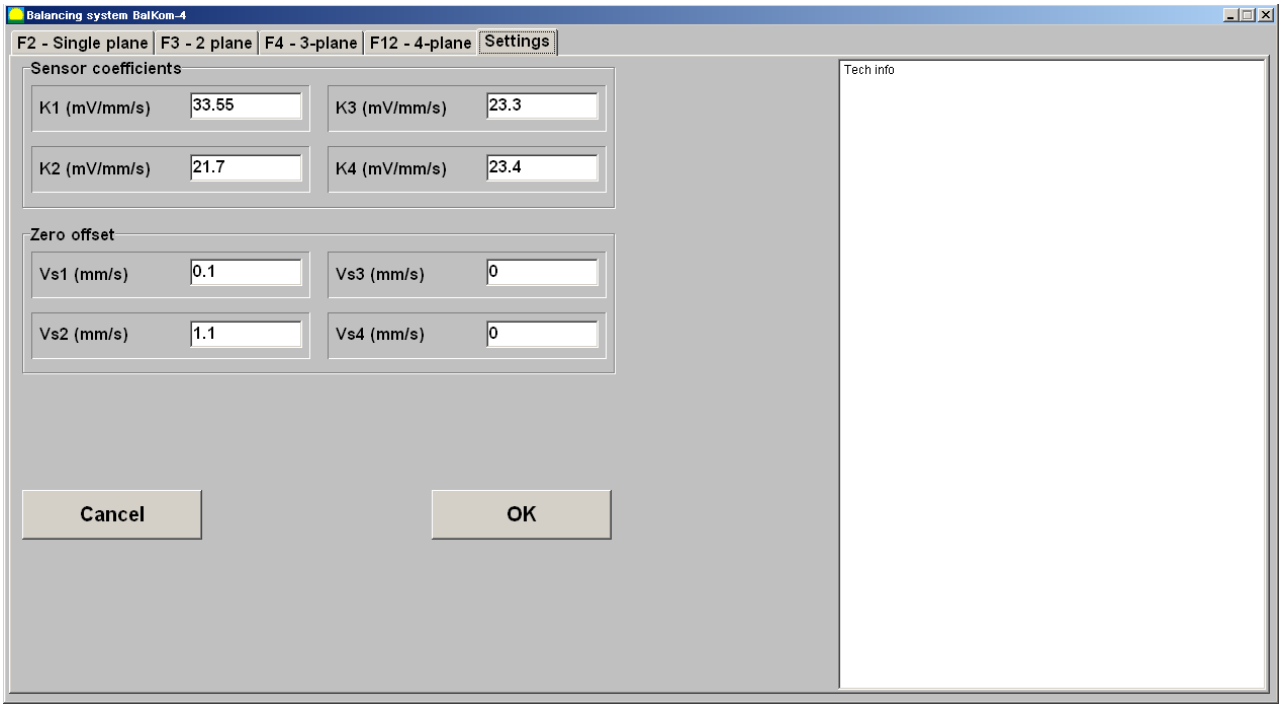


Fig. 7.5. Operating window for entering the coefficients of the vibration sensors.

In the case of faulty input of a conversion factor to correct the error you should click on the "Cancel" button, then you can re-enter this factor.

After completion of the input of the conversion factor sensors on all measurement channels you should click the button "Accept", then the new values of the coefficients will be stored in the program memory.

To continue work with the program click the button "**F10** – Exit" and return to the main operating window.

7.3. Operation of the BALANCER in the "Vibration" mode

Before working in the "Vibration" mode, install vibration sensors on the machine and connect them respectively to the inputs of the USB interface unit.

When using one vibration sensor **(1)** it must be connected to the input X1 of the USB interface unit.

When using two vibration sensors (**1** and **4**) they must be respectively connected to the inputs X1 and X4 of the USB interface unit.

When using the three vibration sensors (**1, 2, 4**) they must be connected respectively to the inputs X1, X2, X4 of the USB interface unit.

When using four vibration sensors (**1, 2, 3, 4**) they must be connected respectively to the inputs X1, X2, X3, X4 of the USB interface unit.

Photoelectric sensor phase angle **5** should be connected to the input X5 of the USB interface unit.

Besides, for use of this sensor it is necessary to apply the special mark having the reflecting ability on an available surface of a rotor of the machine which should be contrasting to the reflecting ability of a surface of a rotor.

Recommendations for the installation and configuration of sensors are given in Appendix 1.

After that for performance of measurement in the Vibration mode you should click on the button "**F5** – Vibration" in the Main operating window of the program (see fig. 7.1).

At the same time the operating window appears on a computer screen (see. Fig.7.6), which periodically displays the results of measurement, including: total RMS value of vibration (Vis), RMS values (Vio,) and phase (Fi) 1st harmonic circulating component of the vibration, and the rotor speed (N rev.).

Attention**!**

Before working in this mode, select how many channels (one, two, three or four) will be carried out by measuring of vibration.

In the case of vibration measurements only on the first channel press in the main operating window (see. Fig. 7.1) "**F2**- single-plane" button.

In the case of simultaneous measurement of two channels press "**F3**- two-plane" button.

In case of simultaneous measurements on three channels press "**F4**- three-plane" button.

In case of simultaneous measurements on four channels press "**F12**- four-plane" button.

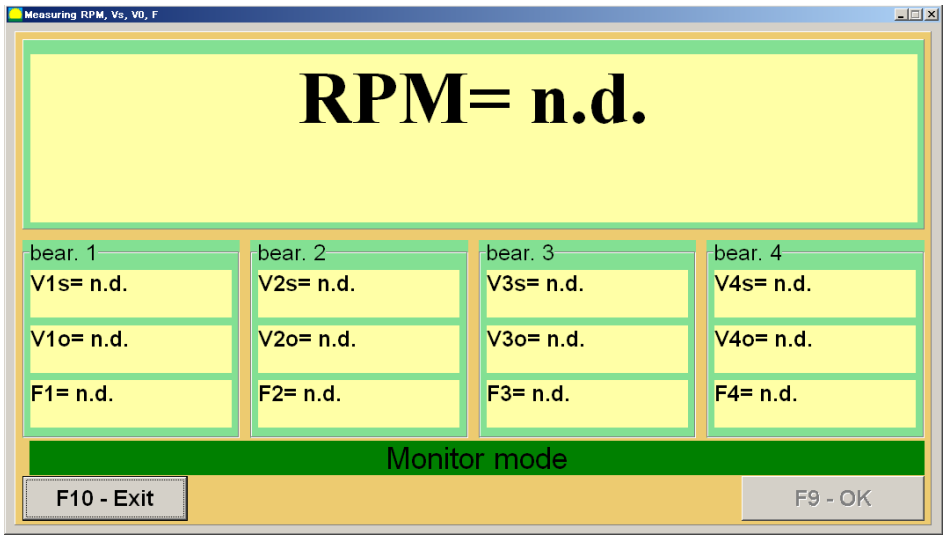


Fig. 7.6. Operating window of the "Vibration" mode.

To start vibration measurements in this window click button "**F9** – Measure" (or press the function key **F9** on your keyboard).

After that, the results of measurements of vibration parameters of the object will be periodically displayed in the respective windows of the operating window.

In the case of the vibration measuring only on a first channel the windows located beneath the words "Support **1**" (bear1) in the left part of the operating window would be filled.

In the case of simultaneous measurement of vibration of the first and second channels, the windows located beneath the words "Support **1**" (bear1) and "Support **2**" (bear2) will be filled, etc.

Vibration measuring in the "Vibration" mode also may be carried out with disconnected phase angle sensor. In the main window of the program (see. Figure 7.6) the value of the total RMS vibration will only be displayed.

To complete the work in the "Vibration" mode click button "**F10** – Exit" and return to the main operating window.

7.4. Balancing in one plane (static).

Before working in the "Balancing in the **1**st plane" mode the vibration sensor **1** must be installed on the machine in the selected measuring point and connected to the input X1 of the USB interface unit.

Optical sensor phase angle 5 should be connected to the input X5 of the USB interface unit. Furthermore, for use of this sensor a special mark having the reflecting ability should be applied on an available surface of a rotor of the machine which should be contrasting to the reflecting ability of a surface of a rotor.

Detailed requirements on site selection of the sensors and their attachment to the object when balancing are set out in Annex 1.

Work on the program in the "Balancing in the 1st plane" starts from the main operating window.

At first click the button «**F2**-one-plane" (or press the **F2** key on your keyboard).

The mimic diagram shown in Fig. 7.1 and illustrating a process of measuring the vibration amplitude and phase only for the first measurement channel confirms that the selected balancing is carried out in one plane.

Further, in the main working window of the program it is necessary to click the button "**F7** – Balancing" and then appears the operating window (see. Fig. 7.7), used for the data input when balancing.

In this window initially select one of the balancing options - "Primary" or "Serial balancing".

"Primary" is typically performed for balancing rotors of machines which previously were not balanced and which archival information necessary for "Serial balancing " (numerical values of balancing and mass of the test weight) is absent.

"Primary" balancing in the 1st plane requires two starts of the machine required for tare of the measuring system of the BALANCER.

Simultaneously during the initial start-up the initial vibration of the machine is determined. Second start of the machine is carried out after installing test weight on the rotor, with the help of which tare of the instrument is performed.

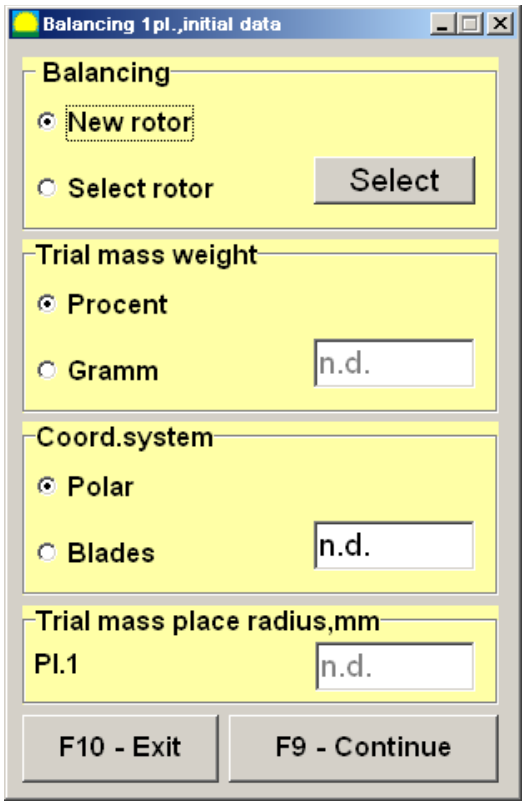


Fig. 7.7. Operating window for entering the initial data when balancing in a single plane

"Serial balancing" is performed only for previously balanced machine for which the mass of the test weight and balancing coefficients are defined and stored in the memory. In this case, to determine the mass and the place of installation of corrective weight, required to compensate the imbalance, only one start of the balanced machine rotor is required.

7.4.1. Primary balance in **1** Plane**.**

7.4.1.1. Setting the measuring system (input initial data).

Input of initial data for primary balancing starts at the operating window "Balancing in 1 Pl. Initial data"(see. Fig. 7.7.).

In the section "Type of Balancing" use mouse to put a label in the "Primary".

Next, in the "Mass of the test weight" select unit of the test weight in the column "Grams" and "Percent".

If you select a unit of measure "Interest" all further calculations of the correction weight mass will be carried out as a percentage by weight of the test weight.

If you select a unit of measurement "Grams" all further calculations of the correction weight mass will be performed in grams. Then enter in the window located to the right of "grams" mass of the test weight, which will be installed on the rotor.

ATTENTION**!**
If you require further work mode "Serial balancing" in the primary balancing mass of the test weight must necessarily be entered in grams.

Next, in the "Coordinate System" choose one of possible options of placement of the correction weights on the balanced rotor – in "Polar" or "Bladed" coordinate system. Use the mouse to put the check mark next to the appropriate caption.

If you select placing weights on blades of the driving wheel of the balanced car it is necessary to enter rotor blades number in the corresponding window close to an inscription "Bladed".

Moreover, in the next section of the operating window, it is desirable to enter the installation radius of trial weight, allowing to obtain additional information about the magnitude of the residual unbalance of the rotor "g * mm".

After completion of the input data click on the button "**F9** – Continue" (or press **F9** on your keyboard).

After that, the computer displays the operating window (see. Fig. 7.8) used to perform a complete cycle of measurements when balancing.

7.4.1.2. Measurements during balancing.

As already mentioned above, the "Primary" balancing requires two calibration starts and at least one test start of a balancing machine.

Measurement of vibrations at the first start-up of the machine is carried out in the operating window "Balancing in the 1st plane" (see. Fig. 7.8) in "Start no trial mass".

ATTENTION**!**
Before starting the measurement it is necessary to include the balanced machine rotor (first start) and make sure it started operation.

The readiness of the program to work in this section is indicated by a dark green background color section and button illumination "**F8** – Return" and "**F9** – perform" located in the right-hand side.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous operating window.

For the measurement of vibration parameters in section “Start no trial mass” click button “**F9** – Run” (or press **F9** on your keyboard) and then start vibration measurement and analysis of measurements, which, depending on the frequency of the rotor rotation can last from 2 to 10 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1**) and phase (**F1**) of the vibration, which manifests itself on the speed of the balancing rotor.

Fig. 7.8. Operating window used for balancing measurements in one plane.

Attention**!**

In the case where there is no signal during the measurement of the phase angle sensor (sensor is not connected to the instrument or damaged), or when the rotational speed of the rotor is less than **300** rev / min, the warning banner (see. Fig. **7.9**) is displayed on the computer display, indicating that the actual speed of the rotor is outside measurements.

After fixing the problem press (click) "OK" button on the banner to continue work on the program.

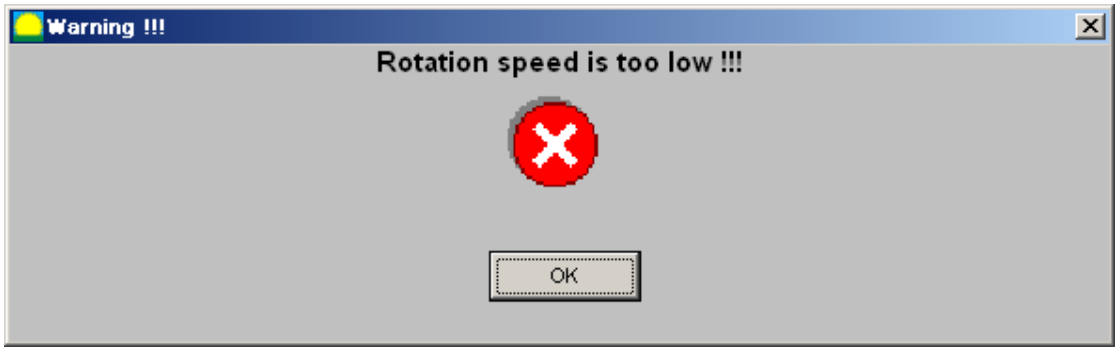


Fig. 7.9. Banner warning of abnormal operation of the phase angle sensor.

Thus color of a background of the section "Mass in the Plane **1**" also changes (with salad on dark green) and illumination of the "**F8**-Return" and "**F9**-Run" buttons switches on that points to readiness of the BALANCER for work on the second start.

Button "**F8** – Return" (or function key **F8**) is used to return to the section "Start no trial mass" and, if necessary, to the re-measurement of vibration parameters in this mode.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should stop the rotation of the rotor of the balanced machine and install it on the test weight. The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **1** Pl. Initial data" (see. Fig. 7.7), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

Attention**!**

1. The choice of the mass of the test weight and installation position on the balanced machine rotor is particularly discussed in Annex **1**.

2. If you require further work with the "Serial balancing" mode the place of installation test weight must necessarily coincide with the plane set of the mark used for the phase angle reference.

For the measurement of vibration parameters in the "Weight in Plane **1**" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 2 to 10 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1**) and phase (**F1**) of the reverse component of the vibration.

At the same time over the operating window "Balancing in the 1st plane" appears operating window "Balancing weights" (see. Fig. 7.10), which shows the results of calculating the parameters of the adjustment cost, which should be installed on the rotor to compensate its imbalance.

Moreover, in case of using the polar coordinate system the display shows the value of the mass (M**1**) and the angle of installation (f**1**) of the corrector weight.

In case of the expansion of correction weights on the blades display shows the number of blades (Z1i, Z1j) of the balanced rotor and weight of weights that need to be installed at them.

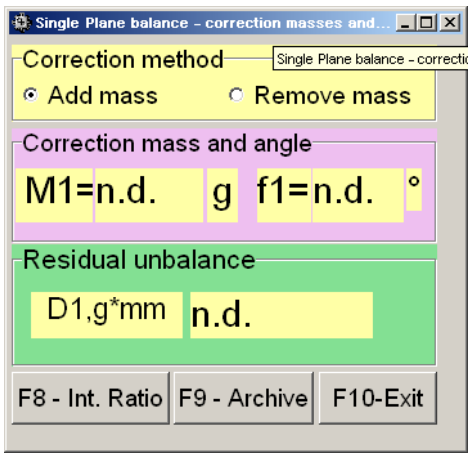


Fig. 7.10. Operating window with the results of the calculation of the correction weight parameters

Attention!:
1. After completion of the measurement process on the second start of the balanced machine stop the rotation of its rotor and remove the previously set test weight. Only then you can begin to install (or remove) correction weight on the rotor.
2. Counting the angular position of the place of adding (or removing) of the correction weight from the rotor is carried out on the installation site of trial weight in the polar coordinate system. Counting direction coincides with the direction of the angle of rotor rotation.
3. In the case of balancing on the blades - the balanced rotor blade, conditionally accepted for the 1st, coincides with the place of the test weight installation. Reference number direction of the blade shown on the computer display is performed in the direction of the rotor rotation.
4. In this version of the program it is accepted by default that, correction weight will be added on the rotor. The tag established in the field "Addition" testifies to it.
In case of correction of an imbalance by removal of weight (for example drilling) it is necessary to establish with a mouse a tag in the field I "Removal" then the angular provision of the correction weight will change automatically on 180 º.

Once installed on the balanced rotor correction weight press the button, “Exit -F10” (or function key F10 on the keyboard), return to the previous active window "Balancing in the 1st plane" and assess the effectiveness of the balancing operation implementation. In this case, the operating window of the "Balancing in the 1st plane" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the button “F9-Run”, which indicates the readiness of the BALANCER to work on the third (test) start.

Attention**!**
Before you begin measuring on the third start enable rotor rotation of the machine and make sure that it has entered the operating mode.

After the completion of the test start measurements of rotor speed (Nrev) and RMS values (V1o) and reverse-phase component of the vibration (**F1**) obtained after balancing, are displayed on a computer screen in the appropriate windows in this section.

At the same time over the operating window "Balancing in **1** plane" appears operating window "Balancing weights" (see. Fig. 7.10), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Also the same window shows the residual unbalance of the rotor reached after balancing.

If the value of the residual vibration and / or the residual unbalance of the balanced rotor meets the tolerances specified in the technical specifications, the balancing process can be completed.

Otherwise, the balancing process can be continued. This allows using the method of successive approximations to correct any errors that may occur during the installation (removal) of the correction weight on the balanced rotor.

At continuation of the balancing process on the balanced rotor it is necessary to install (remove) additional corrective weight, the parameters of which are shown in the operating window "Balancing weights".

After that you need to click the button "Exit - **F10**» (or a function key **F10** on your keyboard) and return to the previous active window to continue.

As it can be seen from Fig. 7.10, with an operating window "Balancing weights" in addition to the button “Exit -**F10**” two other control buttons can be used – “Coefficients - **F8**”, «Archive - **F9**».

Button “Coefficients - **F8**” (or function key **F8**on the computer keyboard) is used for viewing and storing in memory rotor balancing coefficients, calculated from the results of the two calibration starts.

When it is pressed on a computer screen appears the operating window "Balancing coefficients in 1 Plane" (see. Fig. 7.11), showing balancing coefficients, calculated from the first two calibration starts.

If a subsequent balancing of the machine will be used with the mode "Serial balancing", these coefficients must be stored in a computer memory.

For this purpose it is necessary to press the button “Save-**F9”** and to go to the second page the " Balancing coefficients in 1 Plane" windows (see Fig. 7.12).

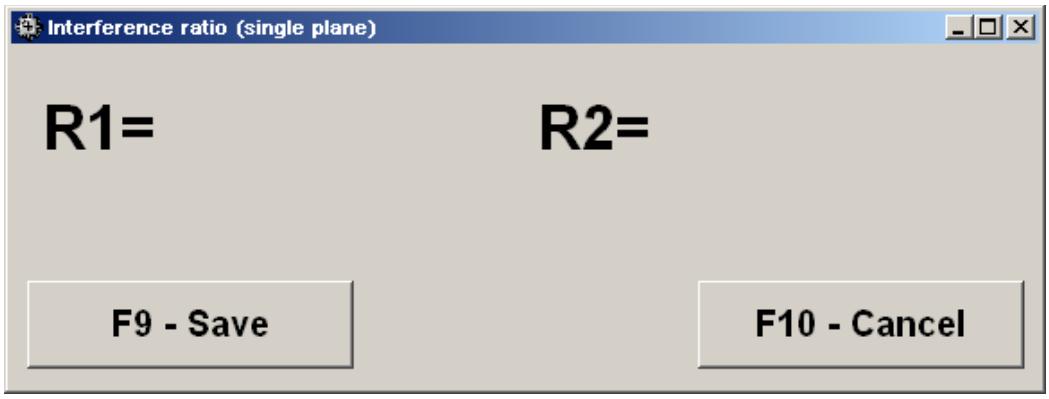


Fig. 7.11. “Balancing coefficients in 1 Plane” operating window

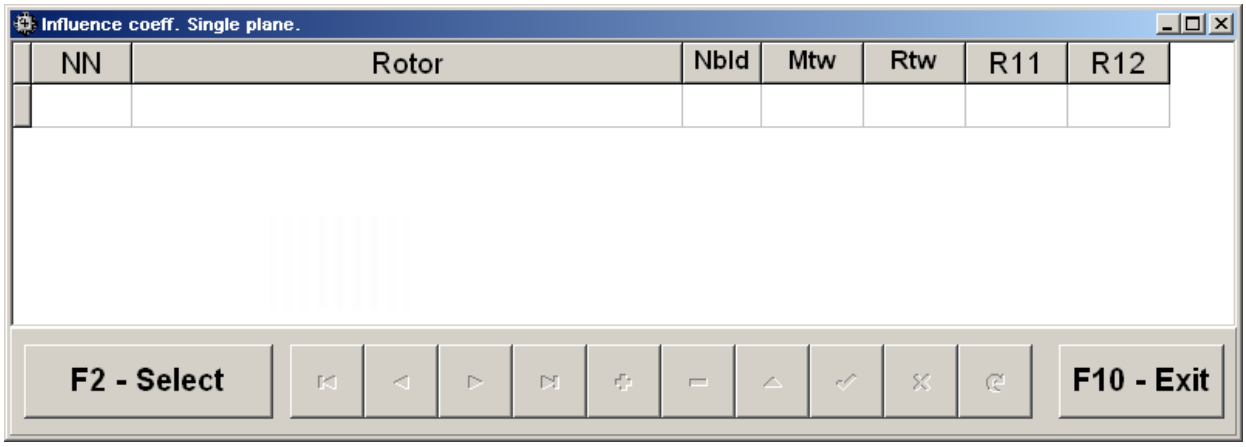


Fig. 7.12. Second page of the operating window « Balancing coefficients in 1 Plane».

Then enter the symbol of this machine in the window "Machine" in the last significant row of the table and press (click) button «√» to store indicated computer data.

Then you can return to the previous window by pushing the button “Exit - **F10**” (or function key **F10** on your keyboard).

The button “Archive - F9” in the operating window "Balancing in 1 Pl. Installation of weights and imbalance" (see. Fig. 7.10.) is used for viewing and editing of archival data that is stored in the computer's memory and, if necessary, is used as reference documents or balancing protocols for print.

When it is pressed on a computer screen appears the operating window "Archive of the balancing in 1 Plane" (see. Fig. 7.13), which contains the source and destination of a current balancing, as well as a table with the results of all previous balancing.

Final results of balancing are prepared for archiving and subsequent printout during the work in this window.

Preparation includes:

Input of a name (or symbol) of the balanced mechanism that is run in the window "Machine Name";

Input of the installation location of the balanced mechanism that is run in the window " Installation location ";

Input of the tolerances specified by the regulations on vibration and residual unbalance of the balanced mechanism that is run in the appropriate box "Tolerances".

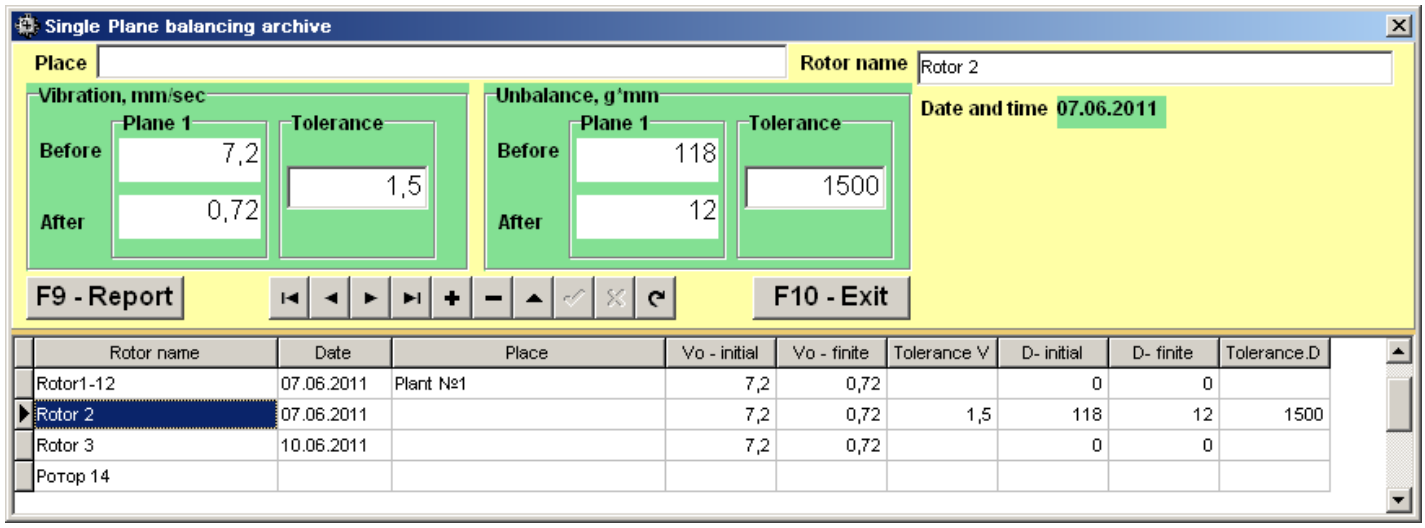
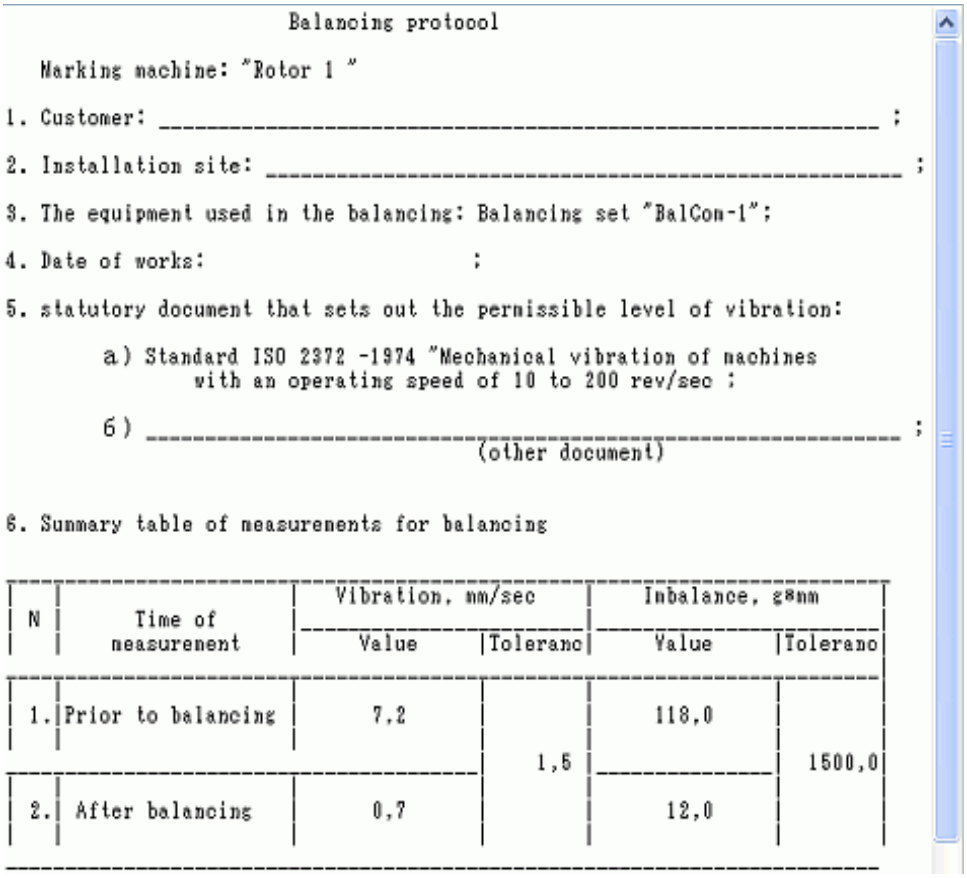


Fig. 7.13. Operating window «Archive of the balancing in **1** Plane»

After input of the specified data for its storing in memory of the computer it is necessary to press (to click) the button « √ » located among the operating buttons of the working window "Archive of Balancing in **1** Plane".

After that, having pressed (clicked) the button “Protocol-**F9**”, it is possible to bring the draft of the check protocol (fig. 7.14) to the computer display to edit it and, if necessary, to print or keep in memory of the computer as the text document.

To complete the work in this window to press (click) the button “**F10** – Exit”.



Balancing protoool

Marking machine: "Rotor 1 "

1. Customer: _____ ;

2. Installation site: _____ ;

3. The equipment used in the balancing: Balancing set "BalCon-1";

4. Date of works: ;

5. statutory document that sets out the permissible level of vibration:

a) Standard ISO 2372 -1974 "Mechanical vibration of machines with an operating speed of 10 to 200 rev/sec ;

6) _____ ; (other document)

6. Summary table of measurements for balancing

N	Time of measurement	Vibration, mm/sec		Inbalance, g*mm	
		Value	Tolerance	Value	Tolerance
1.	Prior to balancing	7,2	1,5	118,0	1500,0
2.	After balancing	0,7		12,0	

Fig. 7.14. Balancing report.

7.4.2. **Serial balancing** (in one plane **)**

7.4.2.1. Setting the measuring system (input initial data).

Serial balancing can be performed on the machine the same type for which balancing coefficients have already been saved in the computer.

Attention**!**

During the Serial balancing the vibration sensor and the phase angle sensor must be installed in the same way as during the initial balancing.

Input of the initial data for the Serial balancing (as in the case of the initial balancing) starts in the operating window "Balancing in 1 Pl. Initial data" (see. Fig. 7.7.).

In the section "Type of Balancing" use the mouse to put a label in the "Serial balancing" and click to the right of it button "Select".

In this case, the computer shows the second page of the operating window " Balancing coefficients in 1 Plane" (see. Fig. 7.12), in which the archive of the earlier specifed balancing coefficients is stored.

Moving on the archive table via the control buttons «►» or «◄» you can select the desired entry with coefficients of the balancing machine of interest. In case this data is used in the current measurements click "**F2** – Select" and return to the previous operating window "Balancing in 1 Pl. Initial data" (see. Fig. 7.7.) by pressing «**F10** - Exit ".

The contents of all other windows of the operating window "Balancing in 1 Pl. Initial data" are filled in automatically.

Attention**!**

If necessary, the original data stored in the sections of the windows "Coordinate system" and "Test weight installation radius" can be changed.

After completion of input of initial data click on the button “**F9**-Continue” (or press the **F9** key on the computer keyboard).

Then on the display appears an operating window (see fig. 7.8) used for performance of a cycle of measurements at Serial balancing.

7.4.2.2. Measurements during the Serial balancing.

"Serial balancing" demands carrying out only one adjusting start and, at least, one test start of the balanced car.

Measurement of vibration on the first - adjusting start-up of the car is carried out in the operating window "Balancing in **1** Plane" (see fig. 7.8) in the section "Start no trial mass".

Attention**!**

Before you begin measuring enable rotor rotation of the machine (first start) and make sure that it has entered the operating mode.

Readiness of the program for work in this section is indicated by dark green color of a background of the section and illumination of the “**F8**-Return” and “**F9**-Run” buttons located in the right.

Button “**F8** – Return” (or function key **F8**) can be used to return to the previous active window.

For the measurement of vibration parameters in section “Start no trial mass” click button “**F9** – Run” (or press **F9** on your keyboard) and then start vibration measurement and analysis of measurements, which, depending on the frequency of the rotor rotation can last from 2 to 10 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (Vo1) and phase (**F1**) of the vibration, which manifests itself on the speed of the balancing rotor.

At the same time over the operating window "Balancing in **1** plane" appears operating window "Balancing weights" (see. Fig. 7.10), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass (M**1**) and the angle of installation (f**1**) of the corrector weight.

In the case of the expansion of corrector weights on the blades display shows the number of blades of the balanced rotor and weight of weights that need to be installed at them.

Further, the balancing process is carried out in accordance with the recommendations set forth in section 7.4.1.2. Primary balancing.

7.5. Balancing in two planes (dynamic balancing).

Before working in the "Balancing in **2** planes" mode install vibration sensors **1** and **4** on the machine in the selected measurement points and connect respectively to the inputs X1 and X4 of the USB interface unit.

Photoelectric sensor phase angle **5** should be connected to the input X5 of the USB interface unit. Besides, for use of this sensor it is necessary to apply the special tag having the reflecting ability on an available surface of a rotor of the machine which should be contrasting to the reflecting ability of a surface of a rotor.

Detailed requirements on site selection of the sensors and their attachment to the object when balancing set out in Annex 1.

As in the case of balancing in the 1 plane, work on the program in the "Balancing in **2** planes" mode starts from the main operating window.

For this purpose click on the "**F3**-two-plane" button (or press the **F3** key on the computer keyboard).

Mimic diagram shown in Fig. 7.2 confirms the selection "Balancing in one plane" mode and illustrates the process of measuring of the vibration amplitude and phase on the first and second measurement channels.

Further in the Main operating window of the program click on the "**F7**-Balancing" button, then on the display appears an operating window (see fig. 7.15) used for input of initial data when balancing.

Select in this window one of the balancing options - "Primary" or "Serial balancing".

"Primary" is usually performed for the rotors of the balancing machines that have not been balance and for which there is no computer information in the archival memory needed to perform "Serial balancing" (numerical values of balancing coefficients and mass of the test weight).

"Primary" balancing in 2 planes demands three starts of the machine required for calibration of the measuring system of the BALANCER.

During the initial start the initial vibration of the machine is determined. The second start of the machine is carried out after installing test weight on the rotor in the first balancing plane.

The third machine start is carried out after installing test weight on the rotor in the second balancing plane.

"Serial balancing" is performed only for previously balanced machine for which mass of the test weight and balancing coefficients are defined and stored in the memory. In this case, only one start of the balanced machine rotor is required to determine the mass and siting of corrector weights needed to compensate for the imbalance.

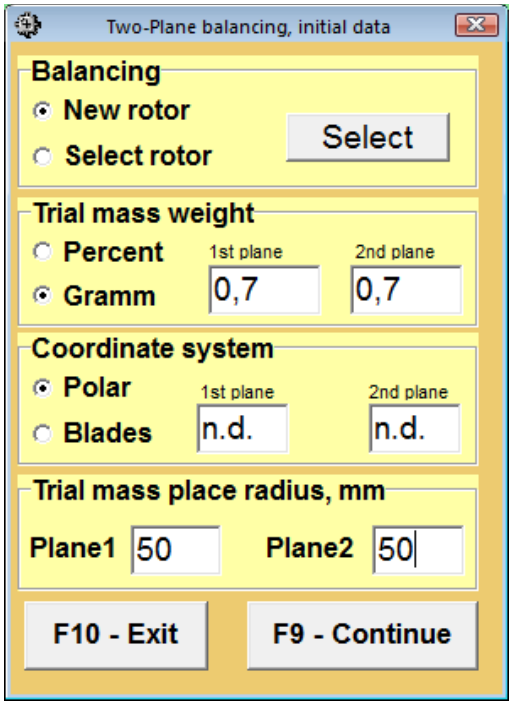


Fig. 7.15. Operating window for initial data input when balancing in two planes.

7.5.1. Initial balancing in **2** Planes.

7.5.1.1. Setting the measuring system (input initial data).

Input of initial data for primary balancing starts at the operating window "Balancing in 2 Pl. Initial data"(see. Fig. 7.15.).

In the section "Type of Balancing" you should use mouse to put a label in the "Primary".

Next, in the "Mass of the test weight" you should select weight unit of the test weight, put a label respectively in the column "Grams" and "Percent".

If you select a unit of measure "Percent" all further calculations of the correction weight mass will be carried out as a percentage by weight of the test weight.

If you select a unit of measurement "Grams" all further calculations of the correction weight mass will be performed in grams. Then enter in the window located to the right of "grams" mass of the test weight, which will be installed on the rotor.

ATTENTIO
N**!**
If you require further work in the "Serial balancing" mode in the primary balancing masses of the test weight must necessarily be entered in grams.

Next, in the "Coordinate System" it is necessary to choose one of possible options of placement of the correction weights on the balanced rotor – in "Polar" or "Bladed" coordinate system. Use the mouse to put the check mark next to the appropriate caption.

If you select placing weights on blades of the driving wheel of the balanced car it is necessary to enter rotor blades number in the corresponding window close to an inscription "Bladed".

Moreover, in the next section of the operating window, it is desirable to enter the installation radius of trial weight, allowing to obtain additional information about the magnitude of the residual unbalance of the rotor "g * mm".

After completion of the input of the initial data click on the button "**F9** – Continue" (or press **F9** on your keyboard).

After that, the computer displays the operating window (see. Fig. 7.16) used to perform a complete cycle of measurements when balancing.

7.5.1.2. Measurements during balancing..

Carrying out balancing in two planes in the "Primary" balancing mode requires three calibration starts and at least one test start of a balancing machine.

Measurement of vibrations at the first start-up of the machine is carried out in the operating window "Balancing in **2** planes" (see. Fig. 7.16) in "Start no trial mass".

Attention**!**

Before starting the measurement it is necessary to include the balanced machine rotor (first start) and make sure it started operation.

The readiness of the program to work in this section is indicated by a dark green background color section and button illumination "**F8** – Return" and "**F9** – perform" located in the right-hand side.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous operating window.

For the measurement of vibration parameters in section "Start no trial mass" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V**o**1**,**V**o**2**) and phase (**F1, F2**) of the vibration, which manifests itself on the speed of the balancing rotor.

Thus color of a background of the section "Weight in the Plane **1**" also changes (from salad on dark green) and illumination of the "**F8**-Return" and "**F9**-Run" buttons switches on that points to readiness of the BALANCER for work on the second start.

Attention**!**

In the case where there is no signal during the measurement of the phase angle sensor (sensor is not connected to the instrument or damaged), or when the rotational speed of the rotor is less than **300** rev / min, the warning banner (see. Fig. **7.9**) is displayed on the computer display, indicating that the actual speed of the rotor is outside measurements.

After fixing the problem press (click) "OK" button on the banner to continue work on the program.

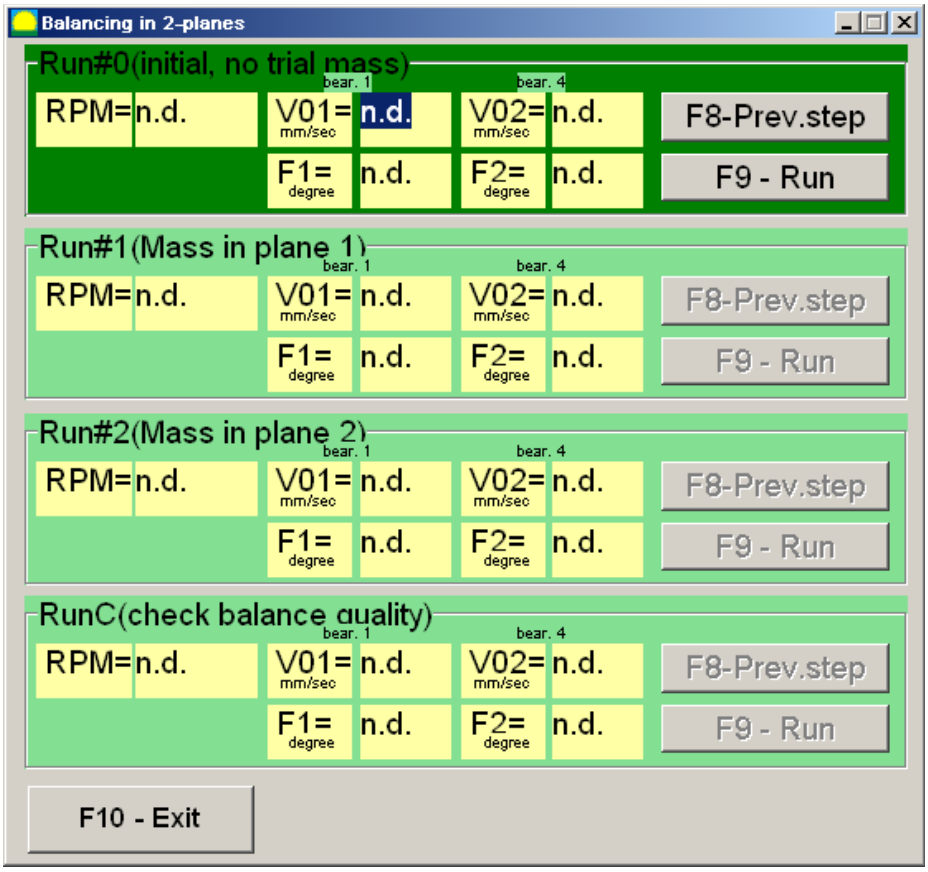


Fig. 7.8. Operating window used for balancing measurements in two planes.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should stop the rotation of the rotor of the balanced machine and install the test weight on it in the first plane. The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **2** planes. Initial data" (see. Fig. 7.15), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

Attention**!**

1. The choice of the mass of the test weight and installation position on the balanced machine rotor is particularly discussed in Annex **1**.

2. If you require further work with the "Serial balancing" mode the place of installation test weight must necessarily coincide with the plane set of the mark used for the phase angle reference.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should click the button “F9-Run” (or press F9 function key on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process during the second start in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2**) and phase (**F1,F2**) of the reverse component of the vibration.

Also the operating window of the "Balancing in 2 Planes" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the

buttons “**F8**-Return” and “**F9**-Run”, which indicates the readiness of the BALANCER to work on the second start.

Before starting the measurement of vibration parameters in the "Weight in the plane **2**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 1;
- set the test weight in the plane 2.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **2** Planes. Initial data" (see. Fig. 7.15), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **2**" click button “**F9** – Run” (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V**o**1, V**o**2**) and phase (**F1, F2**) of the reverse component of the vibration.

At the same time over the operating window "Balancing in the 1st plane" appears operating window "Balancing weights" (see. Fig. 7.10), which shows the results of calculating the parameters of the adjustment cost, which should be installed on the rotor to compensate its imbalance.

Also the operating window of the "Balancing in the 1st plane" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the buttons “**F8**-Return” and “**F9**-Run”, which indicates the readiness of the BALANCER to work on the second start.

second start.

At the same time over the operating window "Balancing in **2** Planes" appears operating window "Balancing weights" (see. Fig. 7.17), which shows the results of calculating the parameters of the adjustment cost, which should be installed on the rotor in the first and the second planes to compensate its imbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass (M**1,** M**2**) and the angle of installation (**f1, f2**) of the correction weights.

In the case of the expansion of correction weights on the blades display shows the number of blades (**Z1i, Z1j** and **Z2i, Z2j**) of the balanced rotor and weight of weights that need to be installed at them.

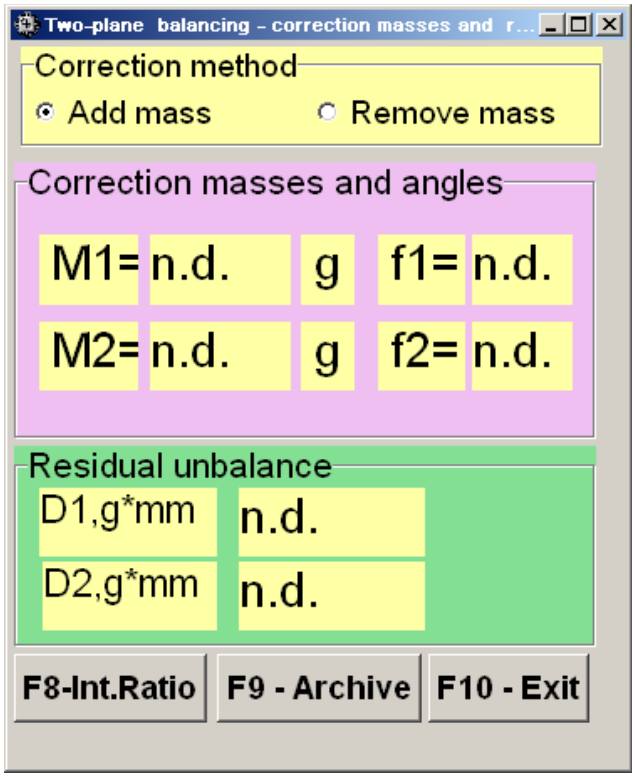


Fig. 7.17. Operating window with the results of the calculation of the correction weight parameters

Attention!:
1. After completion of the measurement process on the third start of the balanced machine stop the rotation of its rotor and remove the previously set test weight. Only then you can begin to install (or remove) correction weights on the rotor.
2. Counting the angular position of the place of adding (or removing) of the correction weight from the rotor is carried out on the installation site of trial weight in the polar coordinate system. Angle direction counting coincides with the direction of the of rotor rotation.
3. In the case of balancing on the blades - the balanced rotor blade, conditionally accepted for the 1st, coincides with the place of the test weight installation. Reference number direction of the blade shown on the computer display is performed in the direction of the rotor rotation.
4. In this version of the program it is accepted by default that correction weight will be added on the rotor. The tag established in the field "Addition" testifies to it.

In case of correction of an imbalance by removal of weight (for example by drilling) it is necessary to establish with a mouse a tag in the field I "Removal" then the angular provision of the correction weight will change automatically on 180 º.

Once installed on the balanced rotor correction weight press the button, “Exit -**F10**” (or function key **F10** on the keyboard), return to the previous active window "Balancing in **2** Planes" and assess the effectiveness of the balancing operation implementation.

In this case, the operating window of the " Balancing in **2** Planes" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the button “**F9**-Run”, which indicates the readiness of the BALANCER to work on the fourth (test) start.

Attention**!**
Before you begin measuring on the fourth start enable rotor rotation of the machine and make sure that it has entered the operating mode.

After the completion of the test start measurements of rotor speed (Nrev) and RMS values (**Vo1, Vo2**) and reverse-phase component of the vibration (**F1, F2**) obtained after balancing, are displayed on a computer screen in the appropriate windows in this section.

At the same time over the operating window "Balancing in **2** planes" appears operating window "Balancing weights" (see. Fig. 7.17), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Also the same window shows the residual unbalance of the rotor reached after balancing.

If the value of the residual vibration and / or the residual unbalance of the balanced rotor meet the tolerances specified in the technical specifications, the balancing process can be completed.

Otherwise, the balancing process can be continued. This allows using the method of successive approximations to correct any errors that may occur during the installation (removal) of the correction weight on the balanced rotor.

At continuation of the balancing process on the balanced rotor it is necessary to install (remove) additional correction weight, the parameters of which are shown in the operating window "Balancing weights".

After that you need to click the button "Exit - **F10**» (or a function key **F10** on your keyboard) and return to the previous active window to continue.

As it can be seen from Fig. 7.17, with an operating window "Balancing weights" in addition to the button “Exit -**F10**” two other control buttons can be used – “Coefficients - **F8**”, «Archive - **F9**».

Button “Coefficients - **F8**” (or function key **F8**on the computer keyboard) is used for viewing and storing in memory rotor balancing coefficients, calculated from the results of three calibration starts.

When it is pressed on a computer screen appears the operating window "Balancing coefficients in **2** Planes" (see. Fig. 7.18), showing balancing coefficients, calculated from three calibration starts.

If a subsequent balancing of the machine will be used with the mode "Serial balancing", these coefficients must be stored in a computer memory.

For this purpose it is necessary to press the button “Save-**F9”** and to go to

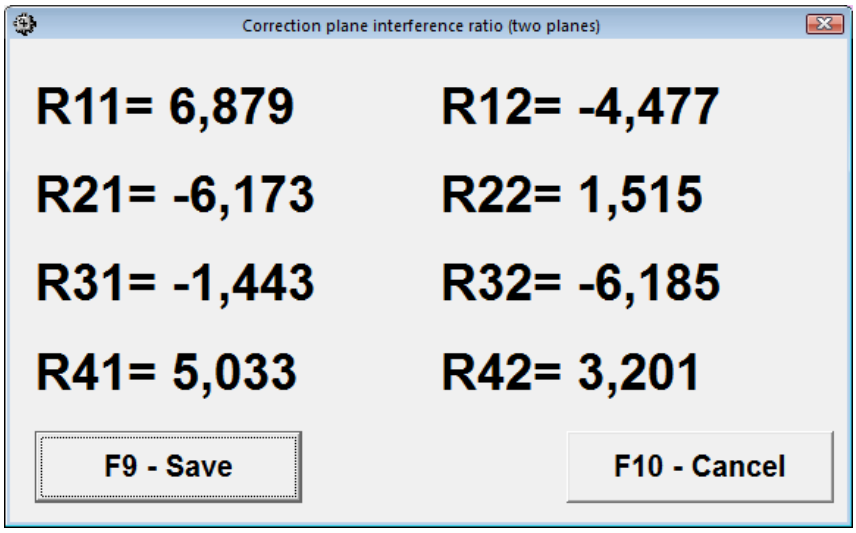


Fig. 7.18. Operating window "Balancing coefficients in **2** Planes"

If a subsequent balancing of the machine will be used with the mode "Serial balancing", these coefficients must be stored in a computer memory.

For this purpose it is necessary to press the button “Save-**F9”** and to go to the second page " Balancing coefficients in **2** Planes" (see Fig. 7.19).

Then enter the symbol of this machine in the window "Machine" in the last significant row of the table and press (click) button «√» to store indicated computer data.

Then you can return to the previous window by pushing the button “Exit - **F10**” (or function key **F10** on your keyboard).

The button “Archive - **F9**” in the operating window "Balancing in **2** Pl. Installation of weights and imbalance" (see. Fig. 7.17.) is used for opening the archives, where the results of previous balancing are automatically saved.

When it is pressed on a computer screen appears the operating window "Archive of the balancing in **2** Plane" (see. Fig. 7.20), which contains initial and finite data of a current balancing, as well as a table with the results of all previous balancing.

During the work in this window (see Fig. 7.20) preparation of results of the last balancing is carried out for archival storage and the subsequent print-out.

Preparation includes:

Input of a name (or symbol) of the balanced mechanism that is run in the window "Machine Name";

Input of the installation location of the balanced mechanism that is run in the window "Installation location";

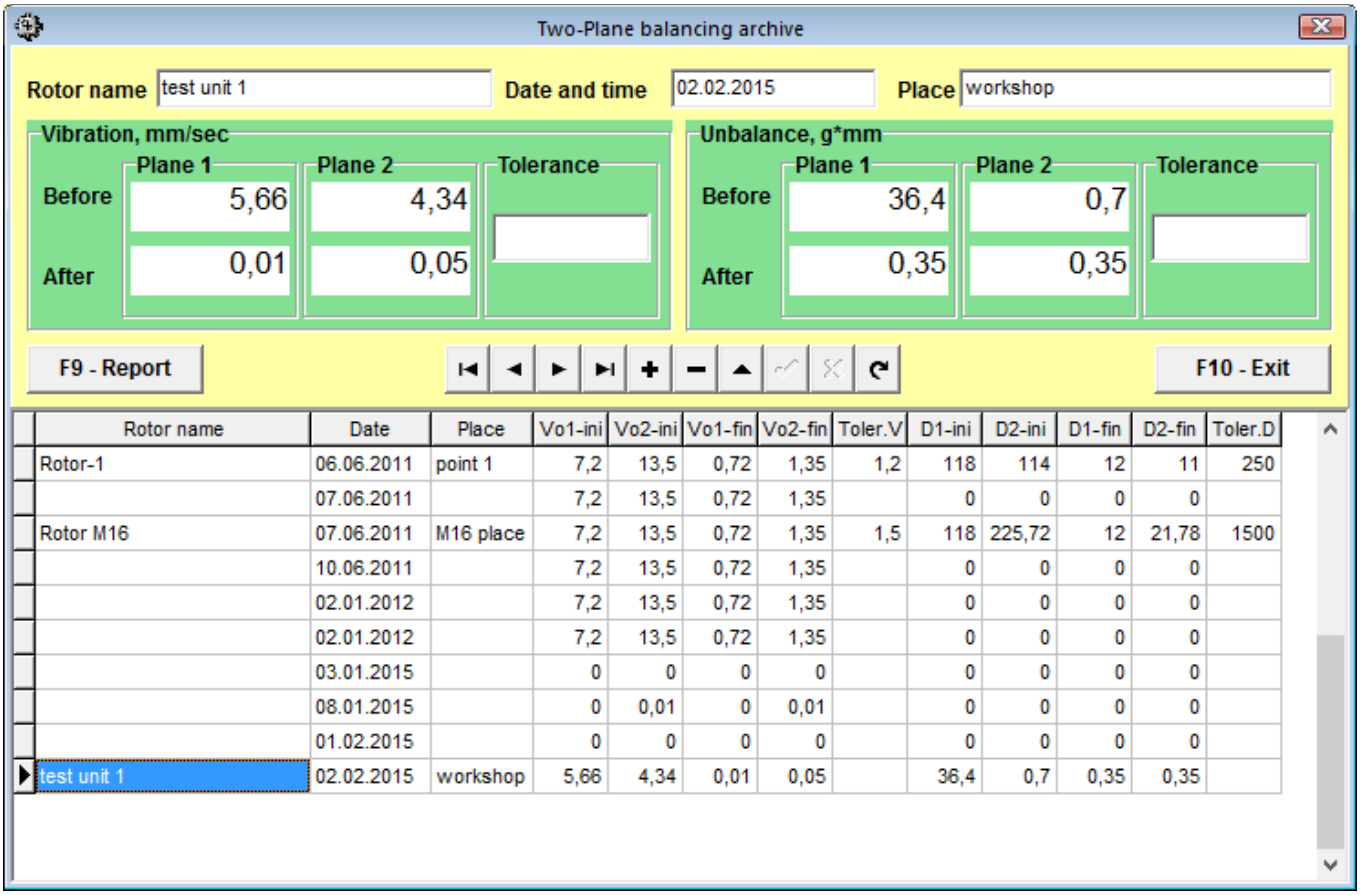
Input of the tolerances specified by the regulations on vibration and residual unbalance of the balanced mechanism that is run in the appropriate box "Tolerances".

After input of the specified data for its storing in memory of the computer it is necessary to press (to click) the button « √ » located among the operating buttons of the working window "Archive of Balancing in **2** Planes".

After that, having pressed (clicked) the button “Protocol-**F9**”, it is possible to bring the draft of the check protocol (fig. 7.14) to the computer display to edit it and, if necessary, to print or keep in memory of the computer as the text document.

The specified document is similar to the protocol of balancing in one plane, given above in fig. 7.14.

To complete the work in this window press (click) the button “**F10** – Exit”.



Rotor name	Date	Place	Vo1-ini	Vo2-ini	Vo1-fin	Vo2-fin	Toler.V	D1-ini	D2-ini	D1-fin	D2-fin	Toler.D
Rotor-1	06.06.2011	point 1	7,2	13,5	0,72	1,35	1,2	118	114	12	11	250
	07.06.2011		7,2	13,5	0,72	1,35		0	0	0	0	
Rotor M16	07.06.2011	M16 place	7,2	13,5	0,72	1,35	1,5	118	225,72	12	21,78	1500
	10.06.2011		7,2	13,5	0,72	1,35		0	0	0	0	
	02.01.2012		7,2	13,5	0,72	1,35		0	0	0	0	
	02.01.2012		7,2	13,5	0,72	1,35		0	0	0	0	
	03.01.2015		0	0	0	0		0	0	0	0	
	08.01.2015		0	0,01	0	0,01		0	0	0	0	
	01.02.2015		0	0	0	0		0	0	0	0	
test unit 1	02.02.2015	workshop	5,66	4,34	0,01	0,05		36,4	0,7	0,35	0,35	

Fig. 7.20. Operating window «Archive of the balancing in **2** Planes»

7.5.2. Serial balancing in **2** Planes**.**

7.5.2.1. Setting the measuring system (input initial data).

Serial balancing can be performed on the machine for which balancing coefficients have already been identified and recorded in the computer memory.

Attention**!**

During the Serial balancing the vibration sensor and the phase angle sensor must be installed in the same way as during the Primary balancing.

Input of the initial data for the Serial balancing (as in the case of the Primary balancing) starts in the operating window "Balancing in **2** Pl. Initial data" (see. Fig. 7.15.).

In the section "Type of Balancing" use the mouse to put a label in the "Serial balancing" and click to the right of it button "Select".

In this case, the computer shows the second page of the operating window "Balancing coefficients in **2** Planes" (see. Fig. 7.19), in which the archive of the earlier specifed balancing coefficients is stored.

Moving on the archive table via the control buttons «►» or «◄» you can select the desired entry with coefficients of the balancing machine of interest. In case this data is used in the current measurements click "**F2** – Select" and return to the previous operating window "Balancing in **2** Pl. Initial data" (see. Fig. 7.13.) by pressing «**F10** - Exit ".

After that the contents of all other windows of the operating window "Balancing in **2** Pl. Initial data" are filled in automatically.

Attention**!**
If necessary, the original data stored in the sections of the windows "Coordinate system" and "Test weight installation radius" can be changed.

After completion of input of initial data click on the button "**F9**-Continue" (or press the **F9** key on the computer keyboard).

Then on the display appears an operating window (see fig. 7.16) used for performance of a cycle of measurements at Serial balancing.

7.5.2.2. Measurements during the Serial balancing.

"Serial balancing" demands carrying out only one adjusting start and, at least, one test start of the balanced car.

Measurement of vibration on the first - adjusting start-up of the car is carried out in the operating window "Balancing in **2** Planes" (see fig. 7.16) in the section "Start no trial mass".

Attention**!**
Before you begin measuring enable rotor rotation of the machine (first start) and make sure that it has entered the operating mode.

Readiness of the program for work in this section is indicated by dark green color of a background of the section and illumination of the "**F8**-Return" and "**F9**-Run" buttons located in the right.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous active window.

For the measurement of vibration parameters in section "Start no trial mass" click button "**F9** – Run" (or press **F9** on your keyboard) and then start vibration measurement and analysis of measurements, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V1o, V2o**) and reverse phase (**F1, F2**) of the vibration component.

At the same time over the operating window "Balancing in **2** planes" appears operating window "Balancing weights" (see. Fig. 7.17), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass and the angle of installation of the correction weight.

In the case of the expansion of corrector weights on the blades display shows the number of blades of the balanced rotor and weight of weights that need to be installed at them.

Further, the balancing process is carried out in accordance with the recommendations set forth in section 7.5.1.2. Primary balancing.

7.6. Balancing in three planes (dynamic balancing).

Before working in the "Balancing in **3** planes" mode install vibration sensors **1, 2** and **4** on the machine in the selected measurement points and connect respectively to the inputs X1, X2 and X4 of the USB interface unit.

Photoelectric sensor phase angle **5** should be connected to the input X5 of the USB interface unit. Besides, for use of this sensor it is necessary to apply the special tag having the

reflecting ability on an available surface of a rotor of the machine which should be contrasting to the reflecting ability of a surface of a rotor.

Detailed requirements on site selection of the sensors and their attachment to the object when balancing set out in Annex 1.

Work on the program in the "Balancing in **3** planes" mode starts from the Main operating window.

For this purpose click on the "**F4**-three-plane" button (or press the **F4** key on the computer keyboard).

Mimic diagram shown in Fig. 7.3 confirms the selection "Balancing in one plane" mode and illustrates the process of measuring of the vibration amplitude and phase on the first, second and third measurement channels.

Further in the Main operating window of the program click on the "**F7**-Balancing" button, then on the display appears an operating window (see fig. 7.21) used for input of initial data when balancing.

Select in this window one of the balancing options - "Primary" or "Serial balancing".

"Primary" is usually performed for the rotors of the balancing machines that have not been balance and for which there is no computer information in the archival memory needed to perform "Serial balancing" (numerical values of balancing coefficients and mass of the test weight).

"Primary" balancing in 3 planes demands four starts of the machine required for calibration of the measuring system of the BALANCER.

During the initial start the initial vibration of the machine is determined. The second start of the machine is carried out after installing test weight on the rotor in the first balancing plane. The third machine start is carried out after installing test weight on the rotor in the second balancing plane. The fourth machine start is carried out after installing test weight on the rotor in the third balancing plane.

"Serial balancing" is performed only for previously balanced machine for which mass of the test weight and balancing coefficients are defined and stored in the memory. In this case, only one start of the balanced machine rotor is required to determine the mass and siting of corrector weights needed to compensate for the imbalance.

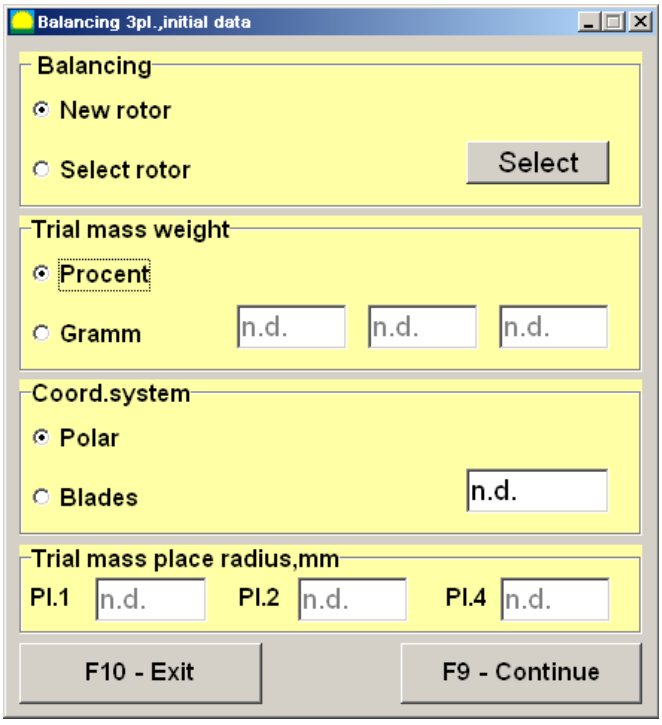


Fig. 7.21. Operating window for initial data input when balancing in three planes.

7.6.1. Primary balancing in **3** Planes**.**

7.6.1.1. Setting the measuring system (input initial data).

Input of initial data for primary balancing starts at the operating window "Balancing in **3** Pl. Initial data"(see. Fig. 7.21.).

In the section "Type of Balancing" you should use mouse to put a label in the "Primary".

Next, in the "Mass of the test weight" you should select weight unit of the test weight, put a label respectively in the column "Grams" and "Percent".

If you select a unit of measure "Percent" all further calculations of the correction weight mass will be carried out as a percentage by weight of the test weight.

If you select a unit of measurement "Grams" all further calculations of the correction weight mass will be performed in grams. Then enter in the window located to the right of "grams" mass of the test weight, which will be installed on the rotor respectively in the first, second and fourth planes of correction.

Attention**!**
If you require further work in the "Serial balancing" mode in the primary balancing masses of the test weight must necessarily be entered in grams.

Next, in the "Coordinate System" it is necessary to choose one of possible options of placement of the correction weights on the balanced rotor – in "Polar" or "Bladed" coordinate system. Use the mouse to put the check mark next to the appropriate caption.

If you select placing weights on blades of the driving wheel of the balanced car it is necessary to enter rotor blades number in the corresponding window close to an inscription "Bladed".

Moreover, in the next section of the operating window, it is desirable to enter the installation radius of test weight respectively in the first, second and fourth planes of correction, which allows to obtain additional information about the magnitude of the residual unbalance of the rotor "g * mm".

After completion of the input of the initial data click on the button "**F9** – Continue" (or press **F9** on your keyboard).

After that, the computer displays the operating window (see. Fig. 7.22) used to perform a complete cycle of measurements when balancing.

7.6.1.2. Measurements during balancing**.**

Measurement of vibrations at the first start-up of the machine is carried out in the operating window "Balancing in **2** planes" (see. Fig. 7.16) in "Start no trial mass".

Carrying out balancing in three planes in the "Primary" balancing mode requires four calibration starts and at least one test start of a balancing machine.

Measurement of vibrations at the first start-up of the machine is carried out in the operating window "Balancing in **3** Planes" (see. Fig. 7.22) in "Start no trial mass".

Attention**!**
Before starting the measurement it is necessary to include the balanced machine rotor (first start) and make sure it started operation.

The readiness of the program to work in this section is indicated by a dark green background color section and button illumination "**F8** – Return" and "**F9** – perform" located in the right-hand side.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous operating window.

For the measurement of vibration parameters in section "Start no trial mass" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3**) and phase (**F1, F2, F3**) of the vibration, which manifests itself on the speed of the balancing rotor.

Thus color of a background of the section "Weight in the Plane **1**" also changes (from salad on dark green) and illumination of the "**F8**-Return" and "**F9**-Run" buttons switches on that points to readiness of the BALANCER for work on the second start

Attention**!**

In the case where there is no signal during the measurement of the phase angle sensor (sensor is not connected to the instrument or damaged), or when the rotational speed of the rotor is less than **300** rev / min, the warning banner (see. Fig. **7.9**) is displayed on the computer display, indicating that the actual speed of the rotor is outside measurements.

After fixing the problem press (click) "OK" button on the banner to continue work on the program.

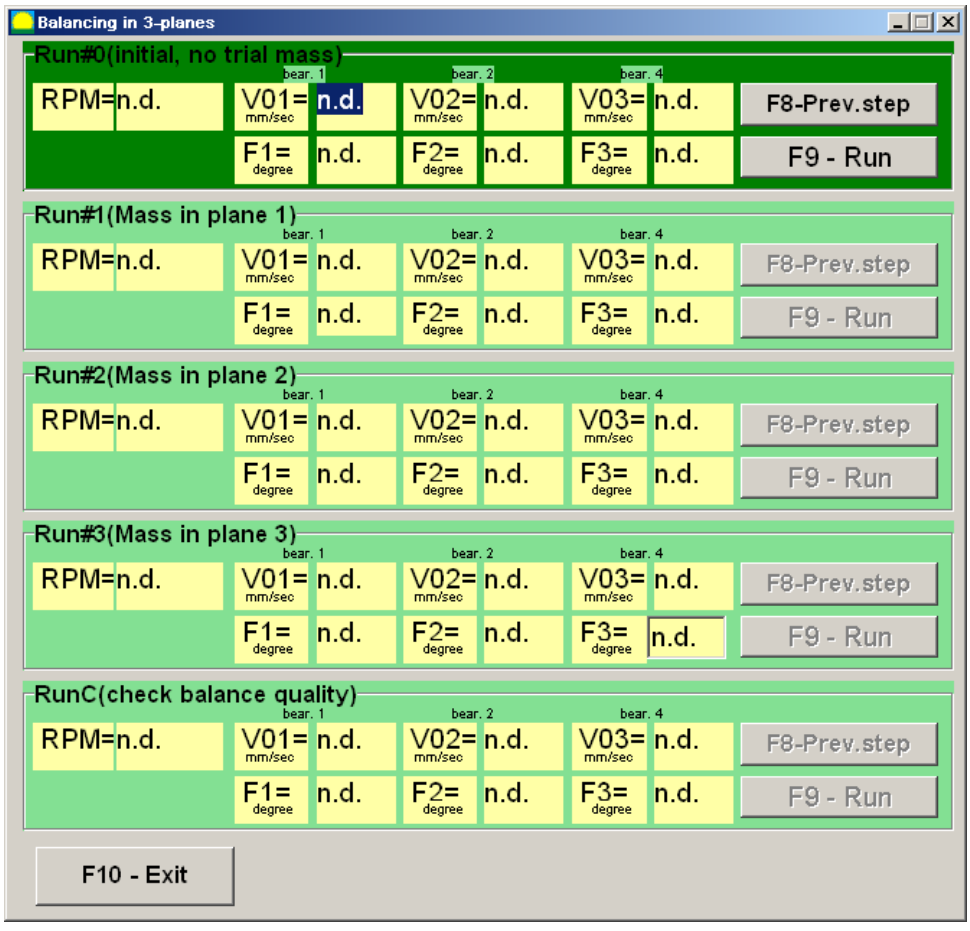


Fig. 7.22. Operating window used for balancing measurements in three planes.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should stop the rotation of the rotor of the balanced machine and install the test weight on it in the first plane. The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **3** planes. Initial data" (see. Fig. 7.21), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

Attention**!**

1. The choice of the mass of the test weight and installation position on the balanced machine rotor is particularly discussed in Annex **1**.

2. If you require further work with the "Serial balancing" mode the place of installation test weight must necessarily coincide with the plane set of the mark used for the phase angle reference.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should click the button “F9-Run” (or press F9 function key on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process during the second start in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3**) and phase (**F1, F2, F3**) of the reverse component of the vibration.

Also the operating window of the " Weight in the plane **2**" changes the background color (salad to dark green) and switches on the backlight of the buttons “**F8**-Return” and “**F9**-Run”, which indicates the readiness of the BALANCER to work on the second start.

Before starting the measurement of vibration parameters in the "Weight in the plane **2**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 1;
- set the test weight in the plane 2.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **3** Planes. Initial data" (see. Fig. 7.21), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **2**" click button “**F9** – Run” (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3**) and phase (**F1, F2, F3**) of the reverse component of the vibration.

Also the operating window of the " Weight in the plane **3**" changes the background color (salad to dark green) and switches on the backlight of the buttons “**F8**-Return” and “**F9**-Run”, which indicates the readiness of the BALANCER to work on the second start.
Before starting the measurement of vibration parameters in the "Weight in the plane **3**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 2;
- set the test weight in the plane 3.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **3** Planes. Initial data" (see. Fig. 7.21), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **3**" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3**) and phase (**F1, F2, F3**) of the reverse component of the vibration.

At the same time over the operating window "Balancing in the 1st plane" appears operating window "Balancing weights" (see. Fig. 7.10), which shows the results of calculating the parameters of the adjustment cost, which should be installed on the rotor to compensate its imbalance.

Also the operating window "Checking" changes the background color (salad to dark green) and switches on the backlight of the buttons "**F8**-Return" and "**F9**-Run", which indicates the readiness of the BALANCER to work on the second start.

At the same time over the operating window "Balancing in **3** Planes" appears operating window "Balancing weights" (see. Fig. 7.23), which shows the results of calculating the parameters of the correction weights, which should be installed on the rotor to compensate its imbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass (M**1,** M**2,** M**3**) and the angle of installation (**f1, f2, f3**) of the correction weights.

In the case of the expansion of correction weights on the blades display shows the number of blades (**Z1i, Z1j, Z2i, Z2j, Z3i, Z3j**) of the balanced rotor and weight of weights that need to be installed at them.

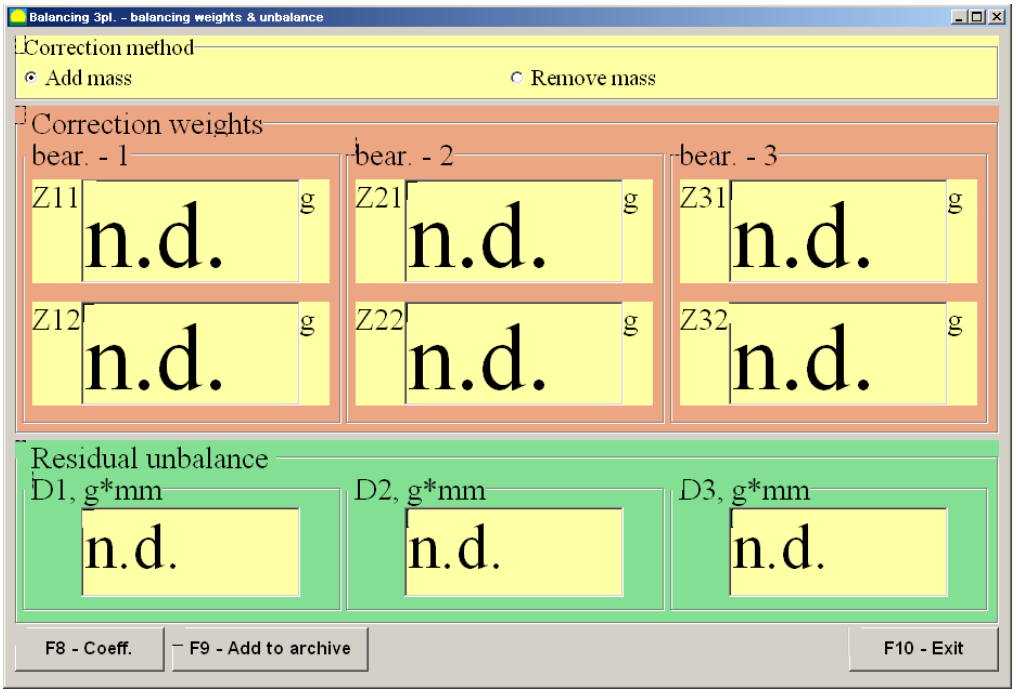


Fig. 7.23. Operating window with the results of the calculation of the correction weight parameters in three planes

Attention**!:**

1. After completion of the measurement process on the fourth start of the balanced machine stop the rotation of its rotor and remove the previously set test weight. Only then you can begin to install (or remove) correction weights on the rotor

2. Counting the angular position of the place of adding (or removing) of the correction weight from the rotor is carried out on the installation site of trial weight in the polar coordinate system. Angle direction counting coincides with the direction of the of rotor rotation.
3. In the case of balancing on the blades - the balanced rotor blade, conditionally accepted for the 1st, coincides with the place of the test weight installation. Reference number direction of the blade shown on the computer display is performed in the direction of the rotor rotation.
4. In this version of the program it is accepted by default that correction weight will be added on the rotor. The tag established in the field "Addition" testifies to it.

In case of correction of an imbalance by removal of weight (for example by drilling) it is necessary to establish with a mouse a tag in the field I "Removal" then the angular provision of the correction weight will change automatically on 180 º.

Once installed on the balanced rotor correction weight press the button, “Exit -**F10**” (or function key **F10** on the keyboard), return to the previous active window "Balancing in **3** Planes" and assess the effectiveness of the balancing operation implementation.

In this case, the operating window of the " Balancing in **3** Planes" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the button “**F9**-Run”, which indicates the readiness of the BALANCER to work on the fifth (test) start.

Attention**!**

Before you begin measuring on the fourth start enable rotor rotation of the machine and make sure that it has entered the operating mode.

After the completion of the test start measurements of rotor speed (Nrev) and RMS values (**V**o**1, V**o**2, V**o**3**) and reverse-phase component of the vibration (**F1, F2, F3**) obtained after balancing, are displayed on a computer screen in the appropriate windows in this section.

At the same time over the operating window "Balancing in **3** planes" appears operating window "Balancing weights" (see. Fig. 7.23), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Also the same window shows the residual unbalance of the rotor reached after balancing.

If the value of the residual vibration and / or the residual unbalance of the balanced rotor meet the tolerances specified in the technical specifications, the balancing process can be completed.

Otherwise, the balancing process can be continued. This allows using the method of successive approximations to correct any errors that may occur during the installation (removal) of the correction weight on the balanced rotor.

At continuation of the balancing process on the balanced rotor it is necessary to install (remove) additional correction weight, the parameters of which are shown in the operating window "Balancing weights".

After that you need to click the button "Exit - **F10**» (or a function key **F10** on your keyboard) and return to the previous active window to continue.

As it can be seen from Fig. 7.23, with an operating window "Balancing weights" in addition to the button “Exit -**F10**” two other control buttons can be used – “Coefficients - **F8**”, «Archive - **F9**».

Button “Coefficients - **F8**” (or function key **F8**on the computer keyboard) is used for viewing and storing in memory rotor balancing coefficients, calculated from the results of four calibration starts.

If a subsequent balancing of the machine will be used with the mode "Serial balancing", these coefficients must be stored in a computer memory.

For this purpose it is necessary to press the button “Save-**F9”** and to go to the second page " Balancing coefficients in **3** Planes" (see Fig. 7.25).

Then enter the symbol of this machine in the window "Machine" in the last significant row of the table and press (click) button «√» to store indicated computer data.

Then you can return to the previous window by pushing the button “Exit - **F10**” (or function key **F10** on your keyboard).

The button “Archive - **F9**” in the operating window "Balancing in **3** Pl. Installation of weights and imbalance" (see. Fig. 7.23.) is used for opening the archives, where the results of previous balancing are automatically saved.

When it is pressed on a computer screen appears the operating window "Archive of the balancing in **3** Plane" (see. Fig. 7.26), which contains initial and finite data of a current balancing, as well as a table with the results of all previous balancing.

During the work in this window (see Fig. 7.26) preparation of results of the last balancing is carried out for archival storage and subsequent print-out.

Preparation includes:

Input of a name (or symbol) of the balanced mechanism that is run in the window "Machine Name";

Input of the installation location of the balanced mechanism that is run in the window "Installation location";

Input of the tolerances specified by the regulations on vibration and residual unbalance of the balanced mechanism that is run in the appropriate box "Tolerances".

After input of the specified data for its storing in memory of the computer it is necessary to press (to click) the button « √ » located among the operating buttons of the working window "Archive of Balancing in **3** Planes".

After that, having pressed (clicked) the button "Protocol-**F9**", it is possible to bring the draft of the check protocol to the computer display to edit it and, if necessary, to print or keep in memory of the computer as the text document.

The specified document is similar to the protocol of balancing in one plane, given above in fig. 7.14.

To complete the work in this window press (click) the button "**F10** – Exit".

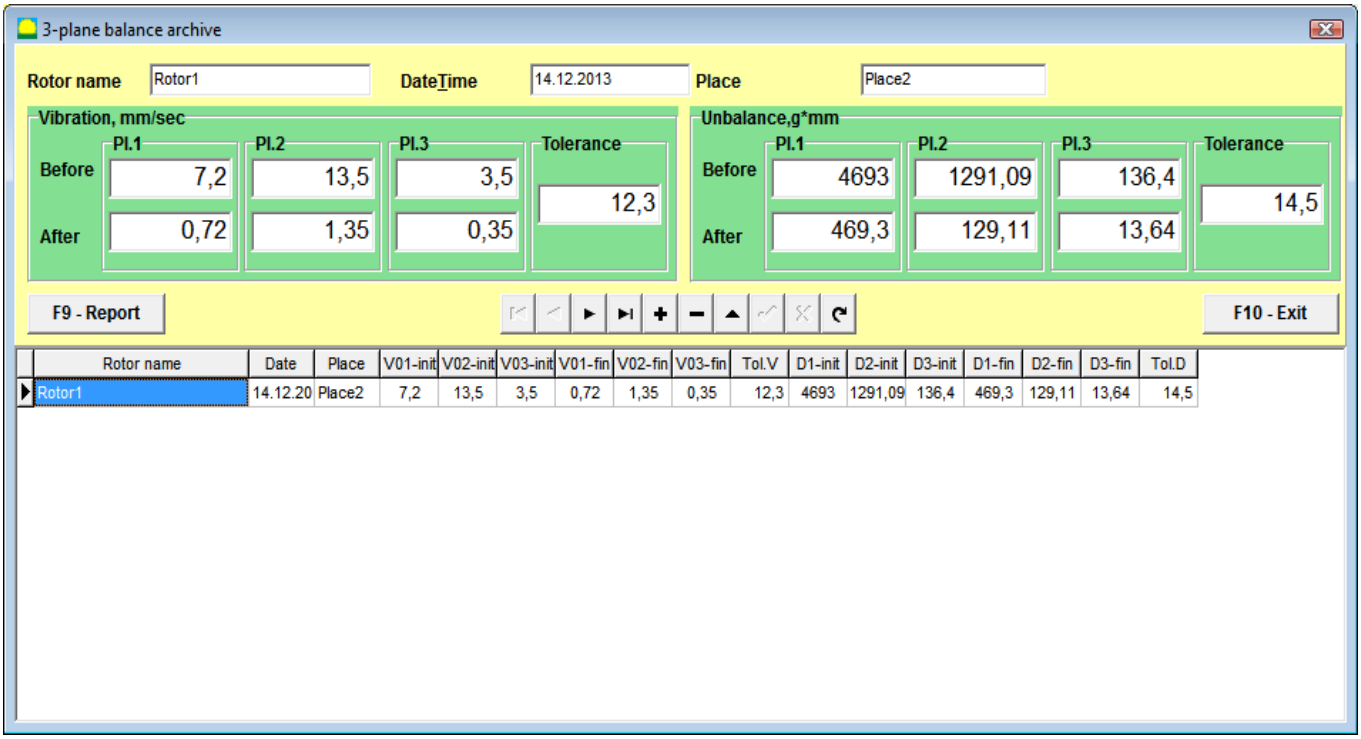


Fig. 7.26. Operating window «Archive of the balancing in **3** Planes»

7.6.2. Serial balancing in **3** Planes**.**

7.6.2.1. Setting the measuring system (input initial data).

Serial balancing can be performed on the machine for which balancing coefficients have already been identified and recorded in the computer memory.

Attention**!**

During the Serial balancing the vibration sensor and the phase angle sensor must be installed in the same way as during the Primary balancing.

Input of the initial data for the Serial balancing (as in the case of the Primary balancing) starts in the operating window "Balancing in **3** Pl. Initial data" (see. Fig. 7.21.).

In the section "Type of Balancing" use the mouse to put a label in the "Serial balancing" and click to the right of it button "Select".

In this case, the computer shows the second page of the operating window "Balancing coefficients in **3** Planes" (see. Fig. 7.25), in which the archive of the earlier specifed balancing coefficients is stored.

Moving on the archive table via the control buttons «►» or «◄» you can select the desired entry with coefficients of the balancing machine of interest. In case this data is used in the current measurements click "**F2** – Select" and return to the previous operating window "Balancing in **3** Pl. Initial data" (see. Fig. 7.21.) by pressing «**F10** - Exit ".

After that the contents of all other windows of the operating window "Balancing in **3** Pl. Initial data" are filled in automatically.

Attention**!**
If necessary, the original data stored in the sections of the windows "Coordinate system" and "Test weight installation radius" can be changed.

After completion of input of initial data click on the button "**F9**-Continue" (or press the **F9** key on the computer keyboard).

Then on the display appears an operating window (see fig. 7.22) used for performance of a cycle of measurements at Serial balancing.

7.6.2.2. Measurements during the Serial balancing.

"Serial balancing" demands carrying out only one adjusting start and, at least, one test start of the balanced car.

Measurement of vibration on the first - adjusting start-up of the car is carried out in the operating window "Balancing in **3** Planes" (see fig. 7.22) in the section "Start no trial mass".

Attention**!**
Before you begin measuring enable rotor rotation of the machine (first start) and make sure that it has entered the operating mode.

Readiness of the program for work in this section is indicated by dark green color of a background of the section and illumination of the "**F8**-Return" and "**F9**-Run" buttons located in the right.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous active window.

For the measurement of vibration parameters in section "Start no trial mass" click button "**F9** – Run" (or press **F9** on your keyboard) and then start vibration measurement and analysis of measurements, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V1o, V2o, V3o**) and reverse phase (**F1, F2, F3**) of the vibration component.

At the same time over the operating window "Balancing in **3** planes" appears operating window "Balancing weights" (see. Fig. 7.23), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass and the angle of installation of the correction weight.

In the case of the expansion of corrector weights on the blades display shows the number of blades of the balanced rotor and weight of weights that need to be installed at them.

Further, the balancing process is carried out in accordance with the recommendations set forth in section 7.6.1.2. Primary balancing.

7.7. Balancing in four planes (dynamic balancing).

Before working in the "Balancing in **4** Planes" mode install vibration sensors **1, 2, 3** and **4** on the machine in the selected measurement points and connect respectively to the inputs X1, X2, X3 and X4 of the USB interface unit.

Photoelectric sensor phase angle **5** should be connected to the input X5 of the USB interface unit. Besides, for use of this sensor it is necessary to apply the special tag having the reflecting ability on an available surface of a rotor of the machine which should be contrasting to the reflecting ability of a surface of a rotor.

Detailed requirements on site selection of the sensors and their attachment to the object when balancing set out in Annex 1.

Work on the program in the "Balancing in **4** planes" mode starts from the Main operating window.

For this purpose click on the "**F12**-4-plane" button (or press the **F12** key on the computer keyboard).

Mimic diagram shown in Fig. 7.4 confirms the selection "Balancing in one plane" mode and illustrates the process of measuring of the vibration amplitude and phase on the first, second, third and fourth measurement channels.

Further in the Main operating window of the program click on the "**F7**-Balancing" button, then on the display appears an operating window (see fig. 7.27) used for input of initial data when balancing.

Select in this window one of the balancing options - "Primary" or "Serial balancing".

"Primary" is usually performed for the rotors of the balancing machines that have not been balance and for which there is no computer information in the archival memory needed to perform "Serial balancing" (numerical values of balancing coefficients and mass of the test weight).

"Primary" balancing in 3 planes demands four starts of the machine required for calibration of the measuring system of the BALANCER.

During the initial start the initial vibration of the machine is determined. The second start of the machine is carried out after installing test weight on the rotor in the first balancing plane. The third machine start is carried out after installing test weight on the rotor in the second balancing plane. The fourth machine start is carried out after installing test weight on the rotor in the third balancing plane.

"Serial balancing" is performed only for previously balanced machine for which mass of the test weight and balancing coefficients are defined and stored in the memory. In this case, only one start of the balanced machine rotor is required to determine the mass and siting of correction weights needed to compensate for the imbalance.

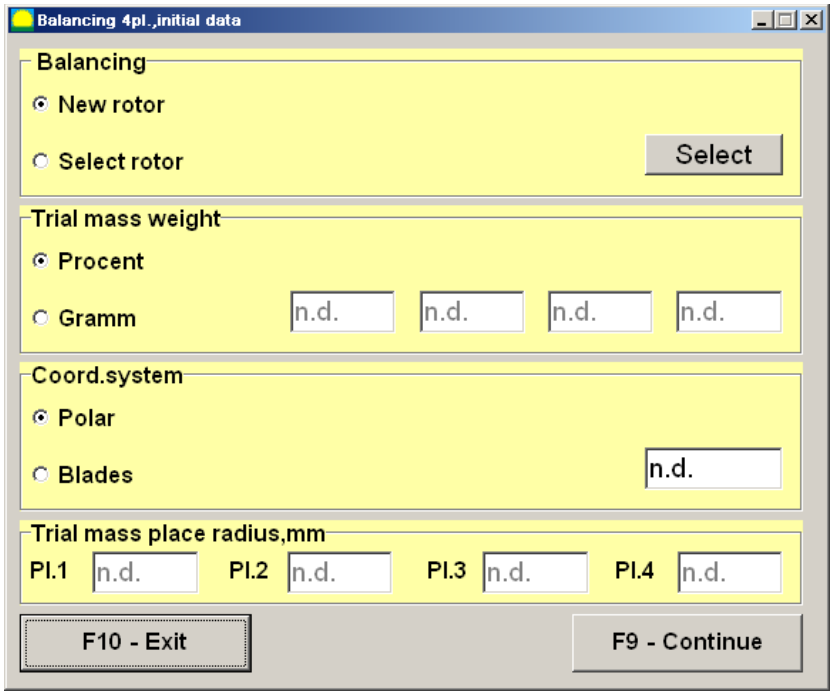


Fig. 7.27. Operating window for initial data input when balancing in four planes.

7.7.1. Primary balancing in **4** Planes**.**

7.7.1.1. Setting the measuring system (input initial data).

Input of initial data for primary balancing starts at the operating window "Balancing in **4** Pl. Initial data"(see. Fig. 7.27.).

In the section "Type of Balancing" you should use mouse to put a label in the "Primary".

Next, in the "Mass of the test weight" you should select weight unit of the test weight, put a label respectively in the column "Grams" and "Percent".

If you select a unit of measure "Percent" all further calculations of the correction weight mass will be carried out as a percentage by weight of the test weight.

If you select a unit of measurement "Grams" all further calculations of the correction weight mass will be performed in grams. Then enter in the window located to the right of "grams" mass of the test weight, which will be installed on the rotor respectively in the first, second, third and fourth planes of correction.

Attention**!**

If you require further work in the "Serial balancing" mode in the primary balancing masses of the test weight must necessarily be entered in grams

Next, in the "Coordinate System" it is necessary to choose one of possible options of placement of the correction weights on the balanced rotor – in "Polar" or "Bladed" coordinate system. Use the mouse to put the check mark next to the appropriate caption.

If you select placing weights on blades of the driving wheel of the balanced car it is necessary to enter rotor blades number in the corresponding window close to an inscription "Bladed".

Moreover, in the next section of the operating window, it is desirable to enter the installation radius of test weight respectively in the first, second and fourth planes of correction, which allows to obtain additional information about the magnitude of the residual unbalance of the rotor "g * mm".

After completion of the input of the initial data click on the button “**F9** – Continue” (or press **F9** on your keyboard).

After that, the computer displays the operating window (see. Fig. 7.28) used to perform a complete cycle of measurements when balancing.

7.7.1.2. Measurements during balancing**.**

Carrying out balancing in three planes in the "Primary" balancing mode requires five calibration starts and at least one test start of a balancing machine.

Measurement of vibrations at the first start-up of the machine is carried out in the operating window "Balancing in **4** Planes" (see. Fig. 7.28) in "Start no trial mass".

Attention**!**

Before starting the measurement it is necessary to include the balanced machine rotor (first start) and make sure it started operation.

The readiness of the program to work in this section is indicated by a dark green background color section and button illumination “**F8** – Return” and “**F9** – perform” located in the right-hand side.

Button “**F8** – Return” (or function key **F8**) can be used to return to the previous operating window.

For the measurement of vibration parameters in section “Start no trial mass” click button “**F9** – Run” (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V**o**1, V**o**2, V**o**3, V**o**4**) and phase (**F1, F2, F3, F4**) of the vibration, which manifests itself on the speed of the balancing rotor.

Thus color of a background of the section "Weight in the Plane **1**" also changes (from salad on dark green) and illumination of the “**F8**-Return” and “**F9**-Run” buttons switches on which points to readiness of the BALANCER for work on the second start.

Attention**!**

In the case where there is no signal during the measurement of the phase angle sensor (sensor is not connected to the instrument or damaged), or when the rotational speed of the rotor is less than **300** rev / min, the warning banner (see. Fig. **7.9**) is displayed on the computer display, indicating that the actual speed of the rotor is outside measurements.

After fixing the problem press (click) "OK" button on the banner to continue work on the program.

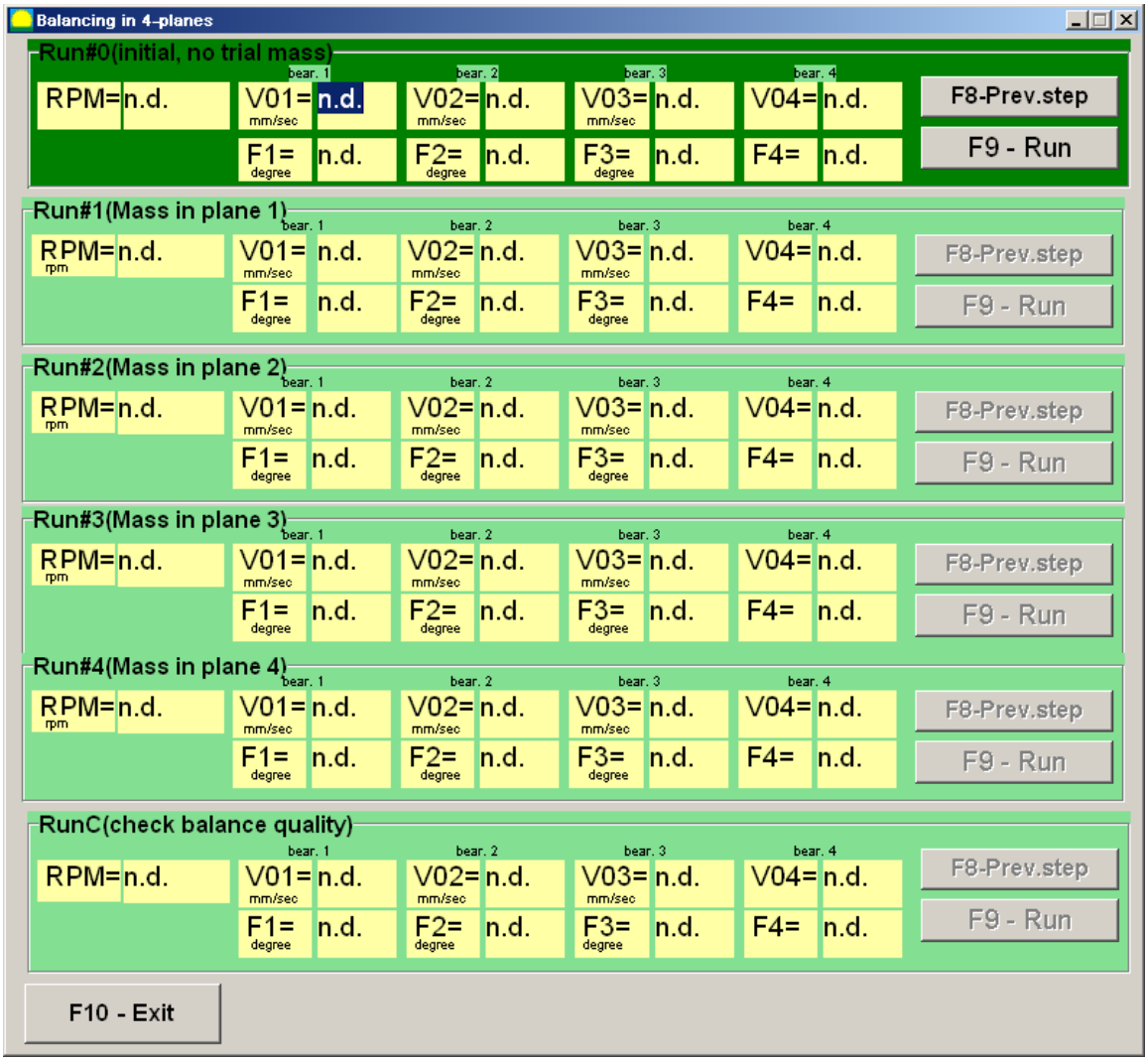


Fig. 7.28. Operating window used for balancing measurements in four planes.

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should stop the rotation of the rotor of the balanced machine and install the test weight on it in the first plane. The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **4** planes. Initial data" (see. Fig. 7.27), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

Attention**!**

1. The choice of the mass of the test weight and installation position on the balanced machine rotor is particularly discussed in Annex **1**.

2. If you require further work with the "Serial balancing" mode the place of installation test weight must necessarily coincide with the plane set of the mark used for the phase angle reference**.**

Before starting the measurement of vibration parameters in the "Weight in the Plane **1**" you should click the button “F9-Run” (or press F9 function key on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process during the second start in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3, Vo4**) and phase (**F1, F2, F3, F4**) of the reverse component of the vibration.

Also the operating window of the " Weight in the plane **2**" changes the background color (salad to dark green) and switches on the backlight of the buttons "**F8**-Return" and "**F9**-Run", which indicates the readiness of the BALANCER to work on the second start.

Before starting the measurement of vibration parameters in the "Weight in the plane **2**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 1;
- set the test weight in the plane 2.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **3** Planes. Initial data" (see. Fig. 7.21), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **2**" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3**) and phase (**F1, F2, F3**) of the rotation speed of the rotor.

Also the operating window of the " Weight in the plane **2**" changes the background color (salad to dark green) and switches on the backlight of the buttons "**F8**-Return" and "**F9**-Run", which indicates the readiness of the BALANCER to work on the second start.

Before starting the measurement of vibration parameters in the "Weight in the plane **2**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 1;
- set the test weight in the plane 2.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **4** Planes. Initial data" (see. Fig. 7.27), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **2**" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows of "Weight in Plane **3**" section appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3, Vo4**) and phase (**F1, F2, F3, F4**) of the rotation speed of the rotor.

Also the operating window of the " Weight in the plane **3**" changes the background color (salad to dark green) and switches on the backlight of the buttons "**F8**-Return" and "**F9**-Run", which indicates the readiness of the BALANCER to work on the second start.

Before starting the measurement of vibration parameters in the "Weight in the plane **3**" it is necessary to:

- stop the rotation of the rotor of the balanced machine;
- remove the test weight previously installed in the plane 2;
- set the test weight in the plane 3.

The mass of this weight, is either already set in preparation for the measurements in the memory of the BALANCER in the operating window "Balancing in **4** Planes. Initial data" (see. Fig. 7.27), or conditionally admitted to the further calculations as 100%.

You must then re-enable the balanced machine rotors and make sure that the machine has entered the operating mode.

For the measurement of vibration parameters in the "Weight in the Plane **4**" click button "**F9** – Run" (or press **F9** on your keyboard) and then vibration measurement and analysis of measurements start, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**Vo1, Vo2, Vo3, Vo4**) and phase (**F1, F2, F3, F4**) of the rotation speed of the rotor.

Also the operating window "Checking" changes the background color (salad to dark green) and switches on the backlight of the buttons "**F8**-Return" and "**F9**-Run", which indicates the readiness of the BALANCER to work on the second start.

At the same time over the operating window "Balancing in four Planes" appears operating window "Balancing weights" (see. Fig. 7.29), which shows the results of calculating the parameters of the correction weight, which should be installed on the rotor to compensate its imbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass (M**1,** M**2,** M**3, M4**) and the angle of installation (**f1, f2, f3, f4**) of the correction weights.

In the case of the expansion of correction weights on the blades display shows the number of blades ((**Z1i, Z1j, Z2i, Z2j, Z3i, Z3j, Z4i, Z4j**) of the balanced rotor and weight of weights that need to be installed at them.

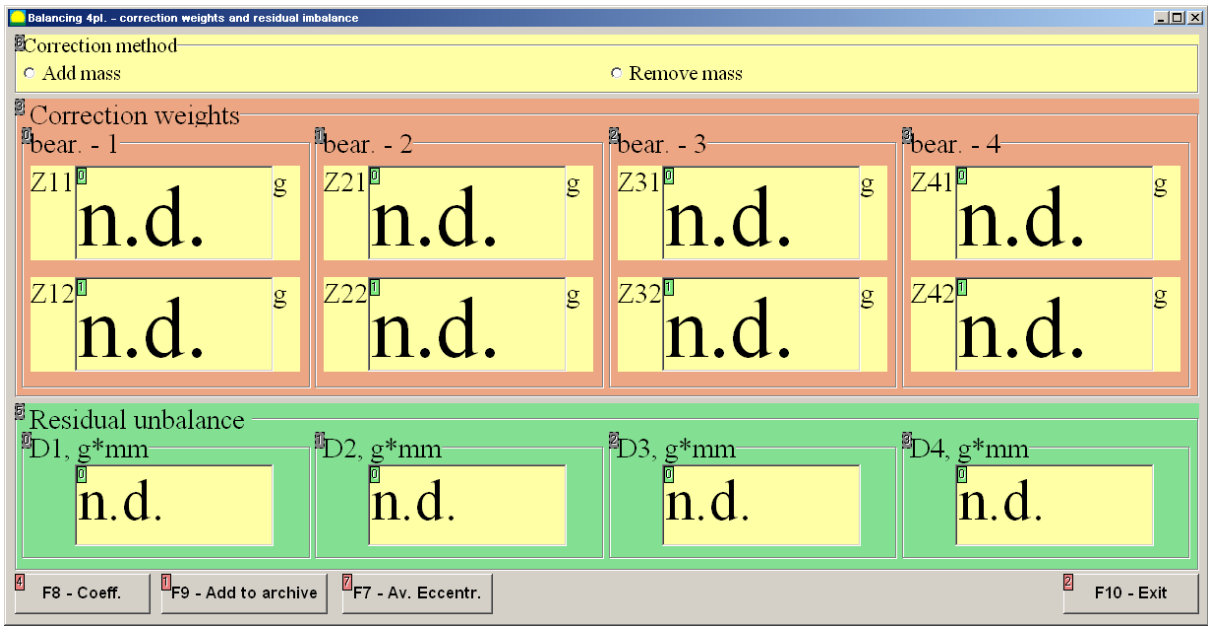


Fig. 7.29. Operating window with the results of the calculation of the correction weight parameters in four planes.

Attention**!:**

1. After completion of the measurement process on the fourth start of the balanced machine stop the rotation of its rotor and remove the previously set test weight. Only then you can begin to install (or remove) correction weights on the rotor.

2. Counting the angular position of the place of adding (or removing) of the correction weight from the rotor is carried out on the installation site of trial weight in the polar coordinate system. Angle direction counting coincides with the direction of the of rotor rotation.

3. In the case of balancing on the blades - the balanced rotor blade, conditionally accepted for the 1st, coincides with the place of the test weight installation. Reference number direction of the blade shown on the computer display is performed in the direction of the rotor rotation.

4. In this version of the program it is accepted by default that correction weight will be added on the rotor. The tag established in the field "Addition" testifies to it.

In case of correction of an imbalance by removal of weight (for example by drilling) it is necessary to establish with a mouse a tag in the field I "Removal" then the angular provision of the correction weight will change automatically on 180 º.

Once installed correction weight on the balanced rotor press the button, "Exit **-F10**" (or function key **F10** on the keyboard), return to the previous active window "Balancing in **4** Planes" and assess the effectiveness of the balancing operation implementation.

In this case, the operating window of the " Balancing in **4** Planes" changes the background color of the section "Checking" (salad to dark green) and switches on the backlight of the button "**F9**-Run", which indicates the readiness of the BALANCER to work on the fifth (test) start.

Attention**!**

Before you begin measuring on the fourth start enable rotor rotation of the machine and make sure that it has entered the operating mode.

After the completion of the test start measurements of rotor speed (Nrev) and RMS values (**V**o**1, V**o**2, V**o**3, V**o**4**) and vibration phase (**F1, F2, F3, F4**) obtained after balancing, are displayed on a computer screen in the appropriate windows in this section.

At the same time over the operating window "Balancing in **4** Planes" appears operating window "Balancing weights" (see. Fig. 7.29), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Also the same window shows the residual unbalance of the rotor reached after balancing.

If the value of the residual vibration and / or the residual unbalance of the balanced rotor meet the tolerances specified in the technical specifications, the balancing process can be completed.

Otherwise, the balancing process can be continued. This allows using the method of successive approximations to correct any errors that may occur during the installation (removal) of the correction weight on the balanced rotor.

At continuation of the balancing process on the balanced rotor it is necessary to install (remove) additional correction weight, the parameters of which are shown in the operating window "Balancing weights".

After that you need to click the button "Exit - **F10**» (or a function key **F10** on your keyboard) and return to the previous active window to continue.

As it can be seen from Fig. 7.29, with an operating window "Balancing weights" in addition to the button “Exit -**F10**” two other control buttons can be used – “Coefficients - **F8**”, «Archive - **F9**».

Button “Coefficients - **F8**” (or function key **F8**on the computer keyboard) is used for viewing and storing in memory rotor balancing coefficients, calculated from the results of five calibration starts.

When it is pressed on a computer screen appears the operating window "Balancing coefficients in **4** Planes" (see. Fig. 7.30), showing balancing coefficients, calculated from four calibration starts.

If a subsequent balancing of the machine will be used with the mode "Serial balancing", these coefficients must be stored in a computer memory.

For this purpose it is necessary to press the button “Save-**F9”** and to go to the second page " Balancing coefficients in **4** Planes" (see Fig. 7.31).

Then enter the symbol of this machine in the window "Machine" in the last significant row of the table and press (click) button «√» to store indicated computer data.

Then you can return to the previous window by pushing the button “Exit - **F10**” (or function key **F10** on your keyboard).

The button “Archive - **F9**” in the operating window "Balancing in **4** Pl. Installation of weights and imbalance" (see. Fig. 7.29.) is used for opening the archives, where the results of previous balancing are automatically saved.

When it is pressed on a computer screen appears the operating window "Archive of the balancing in **4** Plane" (see. Fig. 7.32), which contains initial and finite data of a current balancing, as well as a table with the results of all previous balancing.

During the work in this window (see Fig. 7.32) preparation of results of the last balancing is carried out for archival storage and subsequent print-out.

Preparation includes:

Input of a name (or symbol) of the balanced mechanism that is run in the window "Machine Name";

Input of the installation location of the balanced mechanism that is run in the window "Installation location";

Input of the tolerances specified by the regulations on vibration and residual unbalance of the balanced mechanism that is run in the appropriate box "Tolerances".

After input of the specified data for its storing in memory of the computer it is necessary to press (to click) the button « √ » located among the operating buttons of the working window "Archive of Balancing in **4** Planes".

After that, having pressed (clicked) the button “Protocol-**F9**”, it is possible to bring the draft of the check protocol to the computer display to edit it and, if necessary, to print or keep in memory of the computer as the text document.

The specified document is similar to the protocol of balancing in one plane, given above in fig. 7.14.

To complete the work in this window press (click) the button “**F10** – Exit”.

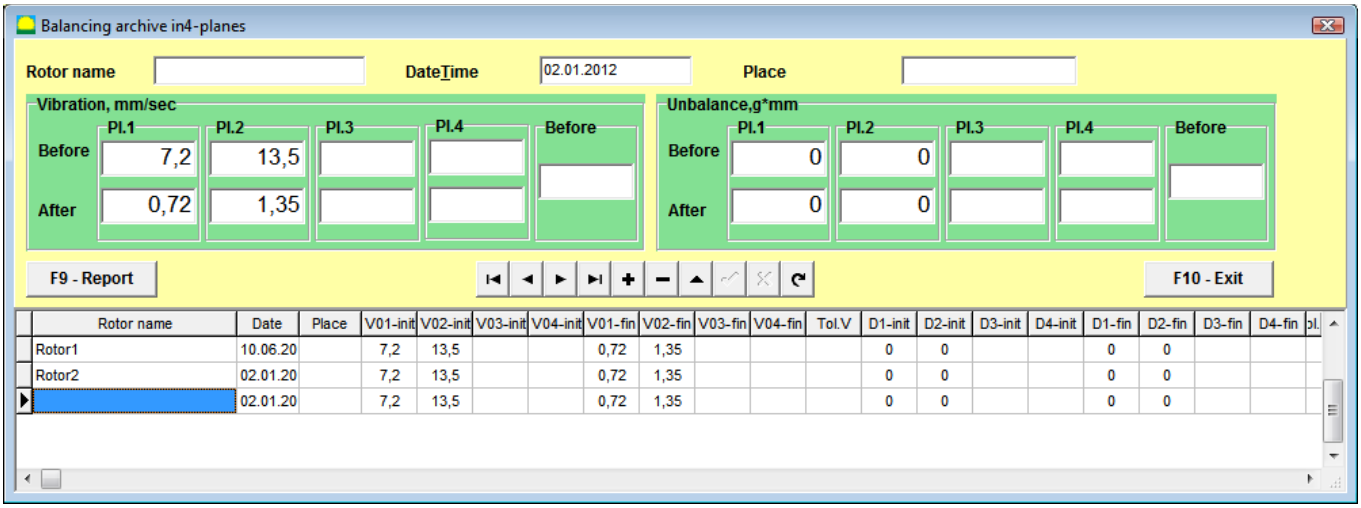


Fig. 7.32. Operating window «Archive of the balancing in **4** Planes»

7.7.2. Serial balancing in 4 Planes**.**

7.7.2.1. Setting the measuring system (input initial data).

Serial balancing can be performed on the machine for which balancing coefficients have already been identified and recorded in the computer memory.

Attention**!**

During the Serial balancing the vibration sensor and the phase angle sensor must be installed in the same way as during the Primary balancing.

Input of the initial data for the Serial balancing (as in the case of the Primary balancing) starts in the operating window "Balancing in **4** Pl. Initial data" (see. Fig. 7.27.).

In the section "Type of Balancing" use the mouse to put a label in the "Serial balancing" and click to the right of it button "Select".

In this case, the computer shows the second page of the operating window "Balancing coefficients in **4** Planes" (see. Fig. 7.31), in which the archive of the earlier specifed balancing coefficients is stored.

Moving on the archive table via the control buttons «►» or «◄» you can select the desired entry with coefficients of the balancing machine of interest. In case this data is used in the current measurements click "**F2** – Select" and return to the previous operating window "Balancing in **4** Pl. Initial data" (see. Fig. 7.27.) by pressing «**F10** - Exit ".

After that the contents of all other windows of the operating window "Balancing in **4** Pl. Initial data" are filled in automatically.

Attention**!**

If necessary, the original data stored in the sections of the windows "Coordinate system" and "Test weight installation radius" can be changed.

After completion of input of initial data click on the button "**F9**-Continue" (or press the **F9** key on the computer keyboard).

Then on the display appears an operating window (see fig. 7.28) used for performance of a cycle of measurements at Serial balancing.

7.7.2.2. Measurements during the Serial balancing.

"Serial balancing" demands carrying out only one adjusting start and, at least, one test start of the balanced car.

Measurement of vibration on the first - adjusting start-up of the car is carried out in the operating window "Balancing in **4** Planes" (see fig. 7.28) in the section "Start no trial mass".

Attention**!**

Before you begin measuring enable rotor rotation of the machine (first start) and make sure that it has entered the operating mode.

Readiness of the program for work in this section is indicated by dark green color of a background of the section and illumination of the "**F8**-Return" and "**F9**-Run" buttons located in the right.

Button "**F8** – Return" (or function key **F8**) can be used to return to the previous active window.

For the measurement of vibration parameters in section "Start no trial mass" click button "**F9** – Run" (or press **F9** on your keyboard) and then start vibration measurement and analysis of measurements, which, depending on the frequency of the rotor rotation can last from 4 to 15 seconds.

Upon successful completion of the measurement process in the appropriate windows under "Start no trial mass" appear the results of measurement of rotor speed (Nrev), as well as the RMS value of the component (**V1o, V2o, V3o, V4o**) and reverse phase (**F1, F2, F3, F4**) of the vibration component.

At the same time over the operating window "Balancing in **4** planes" appears operating window "Balancing weights" (see. Fig. 7.29), which shows the results of calculation the parameters of additional corrective weight that must be installed (deleted) on the rotor to compensate its residual unbalance.

Moreover, in the case of using the polar coordinate system the display shows the value of the mass and the angle of installation of the correction weight.

In the case of the expansion of corrector weights on the blades display shows the number of blades of the balanced rotor and weight of weights that need to be installed at them.

Further, the balancing process is carried out in accordance with the recommendations set forth in section 7.7.1.2. Primary balancing.

7.8. Charts mode

Working in the "Charts" mode begins from the Main operating window (see. Fig. 7.1) by pressing "**F8** – Charts". Then opens a window "Measurement of vibration on two channels. Charts" (see. Fig. 7.33).

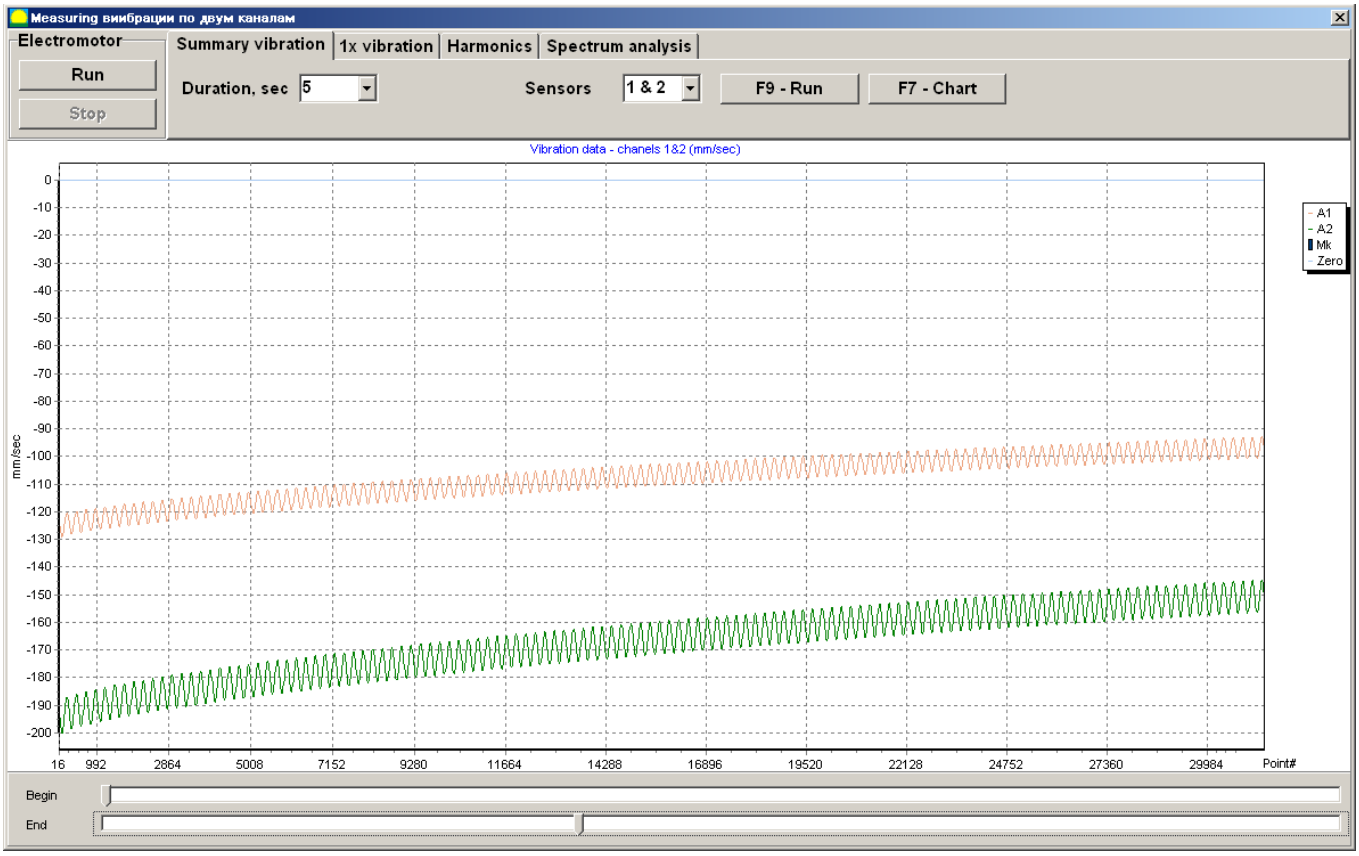


Fig. 7.33. Operating window «Measurement of vibration on two channels. Charts».

While working in this mode it is possible to plot four versions of vibration chart.

The first version allows you to get a timeline function of the total vibration (of vibration speed) on the first and second or third and fourth measuring channels.

The second version allows you to get graphs of vibration (of vibration speed), which occurs on rotation frequency and its higher harmonical components.

These graphs are obtained as a result of the synchronous filtering of the total vibration time function.

The third version provides vibration charts with the results of the harmonical analysis.

The fourth version allows to get a vibration chart with the results of the spectrum analysis.

7.8.1. Charts of total vibration**.**

To plot a total vibration chart in the operating window "Measurement of vibration on two channels. Charts" it is necessary to:

- select the operating mode "total vibration" by clicking the appropriate button;
- To set the measurement of vibration in the box "Duration, in seconds," by clicking on the button «▼» and select from the dropdown list the desired duration of the measurement process, which may be equal to 1, 5, 10, 15 or 20 seconds;
- select in the window "Sensors" channel pair 1+2 or 3+4, for which the measurement will be taken.

Upon readiness press (click) the "**F9**-Measure" button then the vibration measurement process begins simultaneously on two channels.

After completion of the measurement process in the operating window appear charts of time function of the total vibration of both selected channels (see. Fig. 7.34).

In this case, a chart for the channel with the lowest number (1 or 3) is depicted in red and with a higher number (2 or 4) in green.

On these charts time is plotted on X-axis and the amplitude of the vibration speed (mm/sec) is plotted on Y-axis.

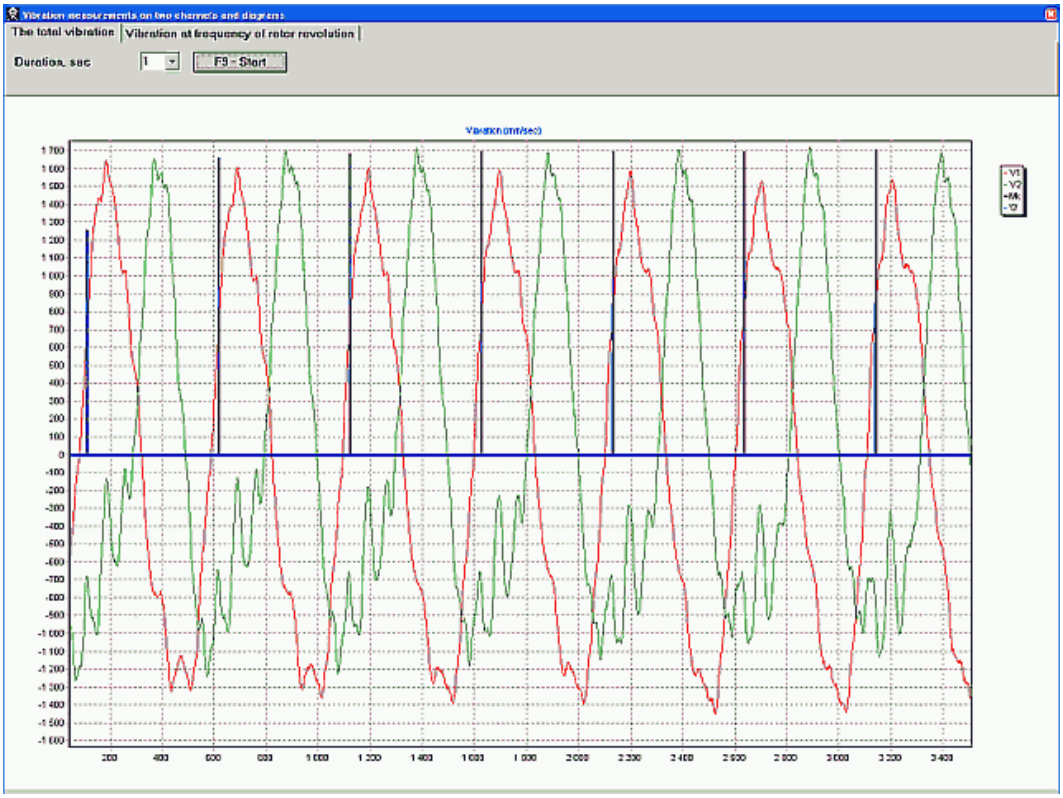


Fig. 7.34. Operating window for the output of the time function of the total vibration charts

There are also marks (blue-coloured) in these graphs connecting charts of total vibration with the rotation frequency of the rotor. In addition, each mark indicates beginning (end) of the next revolution of the rotor.

In need of the scale change of the chart on X-axis the slider, pointed by an arrow on fig. 7.34, can be used.

7.8.2. Charts of **1x** vibration**.**

To plot a reverse vibration chart in the operating window "Measurement of vibration on two channels. Charts" (see Fig. 7.33) it is necessary to select the operating mode "Reverse vibration" by clicking the appropriate button.

Then select in the arisen operating window “Reverse vibration” in a box "Sensors" channel pair 1+2 or 3+4, for which the measurement will be taken.

Upon readiness press (click) the “**F9**-Measure” button then the vibration measurement process begins simultaneously on two channels.

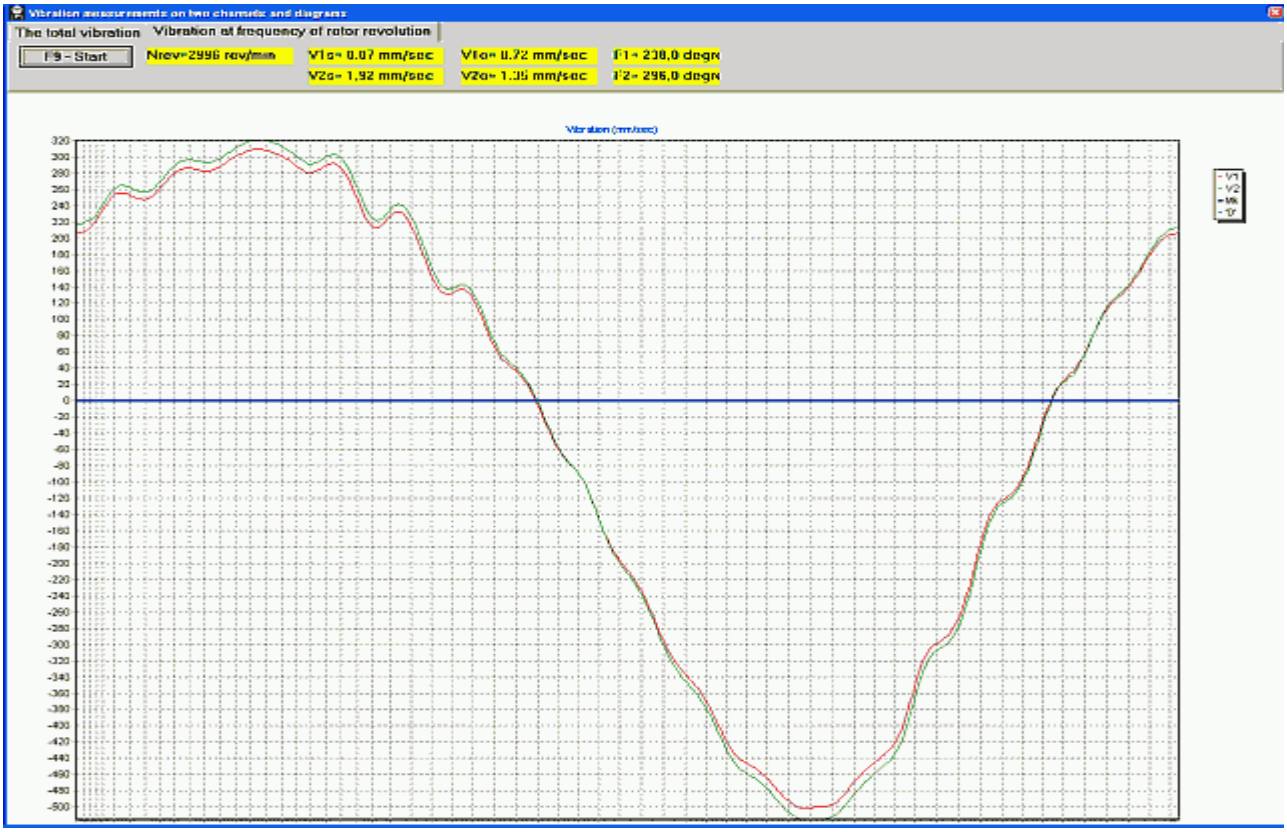


Fig. 7.35. Operating window for the output of the 1x vibration charts

After completion of the measurement process and mathematical calculation of results (synchronous filtering of the time function of the total vibration) on display in the main window on a period equal to one revolution of the rotor appear charts of the reverse vibration on two channels (see Fig. 7.35).

In this case, a chart for the channel with the lowest number (1 or 3) is depicted in red and with a higher number (2 or 4) in green.

On these charts angle of the rotor revolution is plotted (from mark to mark) on X-axis and the amplitude of the vibration speed (mm/sec) is plotted on Y-axis.

In addition, in the upper part of the working window (to the right of the button "**F9** – Measure") numerical values of vibration measurements of both channels, similar to those we get in the "Vibration" mode, are displayed.

In particular: RMS value of the total vibration (**Vis, Vjs**), the magnitude of RMS (**Vio, Vjo**) and phase (**Fi, Fj**) of the 1st harmonical component of the reverse vibration and rotor speed (Nrev).

Attention**!** When operating in this mode it is necessary to use the phase angle sensor**.**

7.8.3. Vibration charts with the results of harmonical analysis.

To plot a chart with the results of harmonical analysis in the operating window "Measurement of vibration on two channels. Charts" (see Fig. 7.33) it is necessary to select the operating mode "Harmonical analysis" by clicking the appropriate button:

Then select in the arisen operating window "Harmonical analysis" in a box "Sensors" channel pair 1+2 or 3+4, for which the measurement will be taken.

Then set the revolution number on which the measurement will be taken. Click the button «▼» and select from the dropdown list desirable rotor revolution number, which may be equal to 1, 2, 4 or 8 rotor revolutions.

Upon readiness press (click) the "**F9**-Measure" button then the vibration measurement process begins simultaneously on two channels.

After completion of the measurement process in operating window (see Fig. 7.36) appear charts of time function (higher chart) and specrum of vibration harmonical aspects (lower chart).

The number of harmonic components is plotted on X-axis and RMS of the vibration speed (mm/sec) is plotted on Y-axis.

In this case, a chart for the channel with the lowest number (1 or 3) is depicted in red and with a higher number (2 or 4) in green.

Attention**!** When operating in this mode it is necessary to use the phase angle sensor**.**

Fig. 7.36. Operating window for the output of the specrum of vibration harmonical aspects.

7.8.4. Charts of vibration with the results of spectral.

To plot a chart with the results of narrow-band spectral in the operating window "Measurement of vibration on two channels. Charts" (see Fig. 7.33) it is necessary to select the operating mode "Spectral" by clicking the appropriate button:

Then select in the arisen operating window "Spectral" frequency range in which the measurement will be taken.

Click the button «▼» and select from the dropdown list desirable rotor revolution number, which may be equal to 64, 128, 320 or 640 Hz.

When selecting the frequency range remember that in the range of 64 Hz band analysis is 0.5 Hz, in the range of 128 Hz - 1 Hz, in the range of 320 Hz - 2.5 Hz and in the range of 640 Hz - 5 Hz.

Then select in the operating window "Sensors" channel pair 1+2 or 3+4, for which the measurement will be taken.

Upon readiness press (click) the "**F9**-Measure" button then the vibration measurement process begins simultaneously on two channels.

After completion of the measurement process in operating window (see Fig. 7.37) appear charts of time function (higher chart) and specrum of vibration (lower chart).

The vibration frequency is plotted on X-axis and RMS of the vibration speed (mm/sec) is plotted on Y-axis.

In this case, a chart for the channel with the lowest number (1 or 3) is depicted in red and with a higher number (2 or 4) in green.

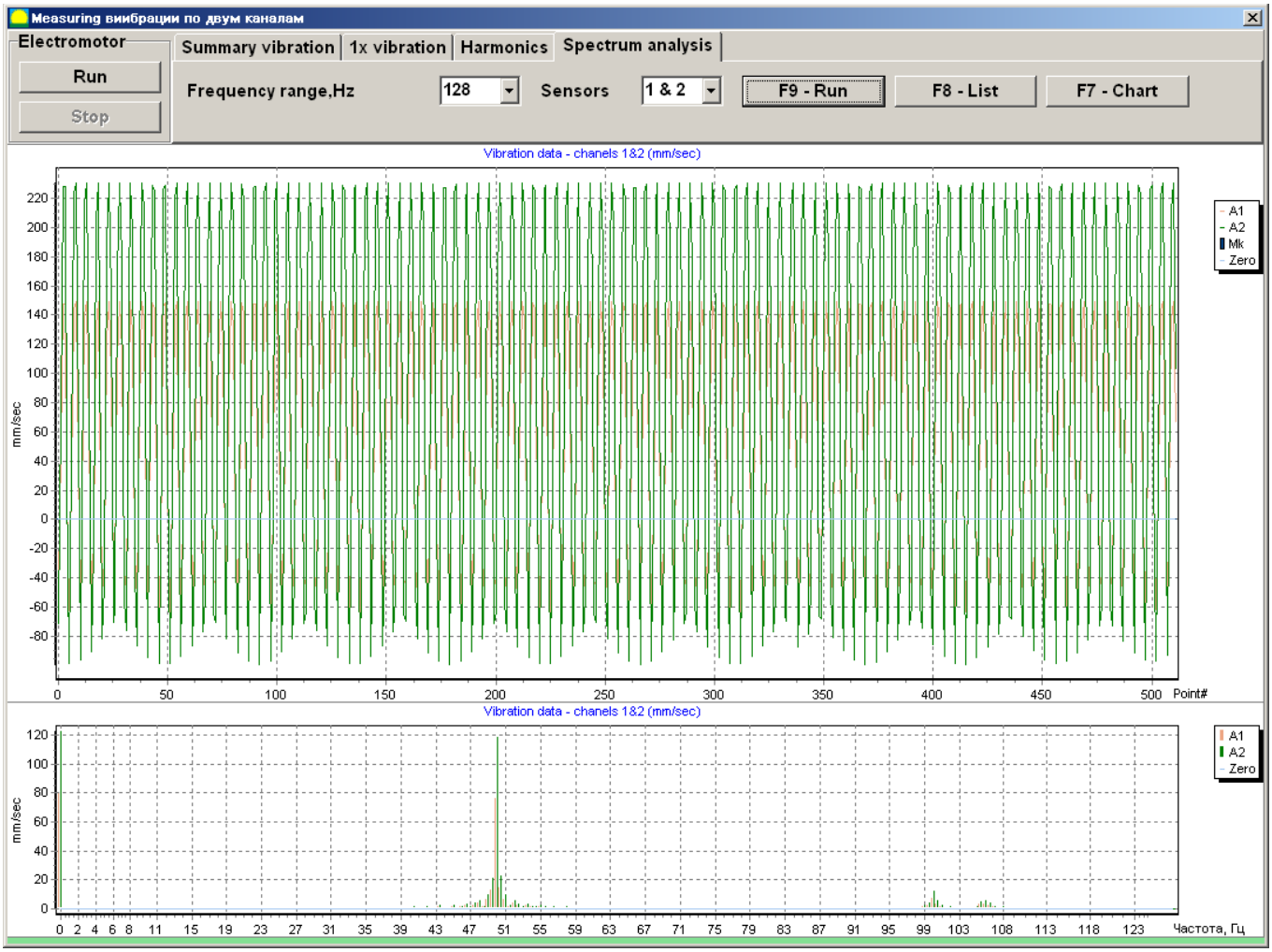


Fig. 7.37. Operating window for the output of narrow-band vibration spectrum.

8. GENERAL INSTRUCTIONS ON OPERATION AND MAINTENANCE OF THE BALANCER

8.1. Before work, perform an external inspection of the BALANCER: it is necessary to check:

- Configuration of the BALANCER in accordance with Section 3 "BALANCER components and delivery set";
- Absence of mechanical damage to the housing of USB interface unit, computer, cables, sensors and other components;

8.2. At operation of the BALANCER it is not recommended to turn it on in the production power supply network in which unpredictable sharp electric shocks and power surge can lead to failures in operation of the BALANCER, especially the computer.

In case of inability to ensure power supply of high quality it is recommended to use self-contained power supply from the computer's battery.

8.3. Climatic conditions of operation and storage of the BALANCER must meet the requirements stated in par. 2.17 and par. 9.4 of this manual.

8.4. In operation, in order to ensure the normal performance of the BALANCER and keep it in good condition routine maintenance work should be carried out.

8.4.1. Routine maintenance work includes:

- External inspection of all units of the BALANCER;
- Removing dust and dirt from vibration sensors, connecting cables, connectors, USB interface unit and computer;

- Flushing connectors and optical components (LED-photodiode) of the phase angle sensor (cleaning and washing are carried out with soaked in ethyl alcohol gauze);
- Rubbing cables (rubbing is performed with soaked in gasoline gauze);

9. RULES OF TRANSPORTATION AND STORAGE

9.1. For convenient transportation of the BALANCER, keep components and documentation within a special bag or a suitcase.

9.2. When transporting by mail the bag (suitcase) with the BALANCER, components and documentation has to be packed into a rigid box. the packing list has to be placed on a box from above. Warning signs have to be put on two sidewalls of a box.

9.3. It is necessary to store the BALANCER on a rack in a specially allotted place protected from moisture and dust. Avoid putting other products on it or impact of mechanical weights.

9.4. Storage air temperature is allowed ranging from +4 to +45 °C, max relative humidity 90% at a temperature of 30 °C.

9.5. The BALANCER being on long storage is recommended to include at least once in three months for component preageing and recharge of accumulators.

10. BALANCER CHECKING

Checking of the BALANCER is made according to requirements of the Technique of checking of the balancing set "Balanset-4" KIN 040.00.00.000 MP.
Periodic checking of the BALANCER has to be carried out at least once a year by representatives of Federal agency for technical regulation and metrology.

11. Acceptance certificate

Balancing set «Balanset-4» № manufactured in accordance with the technical requirements of KIN040.00.000TU and by results of acceptance tests it is recognized suitable for operation.

Release date _____

Representative of manufacturer:

(Signature)

12. PACKING CERTIFICATE

Balancing set «Balanset-4» №
is packed by the manufacturer according to the technical specifications KIN040.00.000TU.

Package date _____

Packaging made:

(Signature)

Accepted a product after packing:

(Signature)

13. MANUFACTURER'S GARANTUES

13.1. The manufacturer guarantees compliance of the balancing set "Balanset-4" to requirements of specifications at observance by the consumer of the conditions and rules established by operational (technical) documentation.

13.2. Warranty period of operation - 12 months from the date of acquisition of the BALANCER by the Consumer.

13.3. In case of failure of the BALANCER by manufacturer's fault within the warranty period, the warranty period is extended by the time taken to eliminate the identified defects, with recording in the logbook.

13.4. Warranty repairs performed at: Vibromera OU
Estonia,Kreenholmi 39v, Narva linn, Ida-Viru maakond, 20303 tel.+372 8801884
E-mail: info@vibromera.eu

ANNEX **1**

BALANCING IN OPERATIONAL CONDITIONS
(Help)

П**.1.1**. Rotor balancing in one and two planes of correction.

The quantity of balancing planes is defined with design features of a rotor of the balanced car.

Balancing in one plane ("static") is usually carried out for the narrow disk-shaped rotors with no essential axial beats.

Typical examples of rotors of this class are:

narrow grinding wheels;
pulleys of belt drives;
disk flywheels;
cogwheels;
couplings;
tightening cartridges of lathes;
narrow fans, etc.

Balancing in two planes ("dynamic") is carried out for long (arched) double-bearing rotors.

Typical examples of rotors of this class are:

rotors of electric motors and generators;
rotors for compressors and pumps;
turbine wheel and fans;
wide wheels;
spindles;
shafts of flour machines with whips, etc.

П**.1.2.** Features of the balanced machine installation.

As a rule, balancing of the machine is carried out directly on a place of its installation.

The exception takes place when the speed of a rotor gets to one of car resonance ranges. A sign of it is the difference (more than for 10-20%) of results of amplitude and/or a phase measurements from start to start. In case of a resonance identification it is necessary to change the speed of a rotor rotation and in case it is impossible - to change conditions of car installation on the base (for example, having it temporarily established on elastic support).

П**.1.3.** Choice of speed rotation of a rotor.

Balancing is usually set at operation speed of a rotor rotation. Балансировку обычно проводят на рабочей скорости вращения ротора. In the case when applies an actuator with speed change ability, it is advisable to select the highest operation speed.

Attention**!**
At a choice of rotation speed of a rotor when balancing it is necessary to avoid hit in ranges of resonances of the car (see Ann. Par. 1.2.)

П**.1.4.** Choice of measuring points and planes of correction.
Bearing supports or pole planes are preferably selected as vibration measurement points.
When balancing in a single plane it is sufficient to have one measuring point (see Fig. Ann. 1.1.).

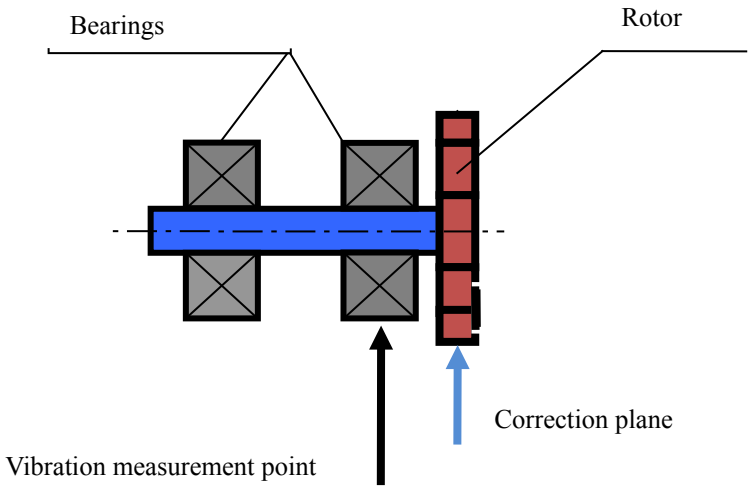


Fig. Ann.**1.1.** Choice of measuring points and planes of correction when balancing in one plane.

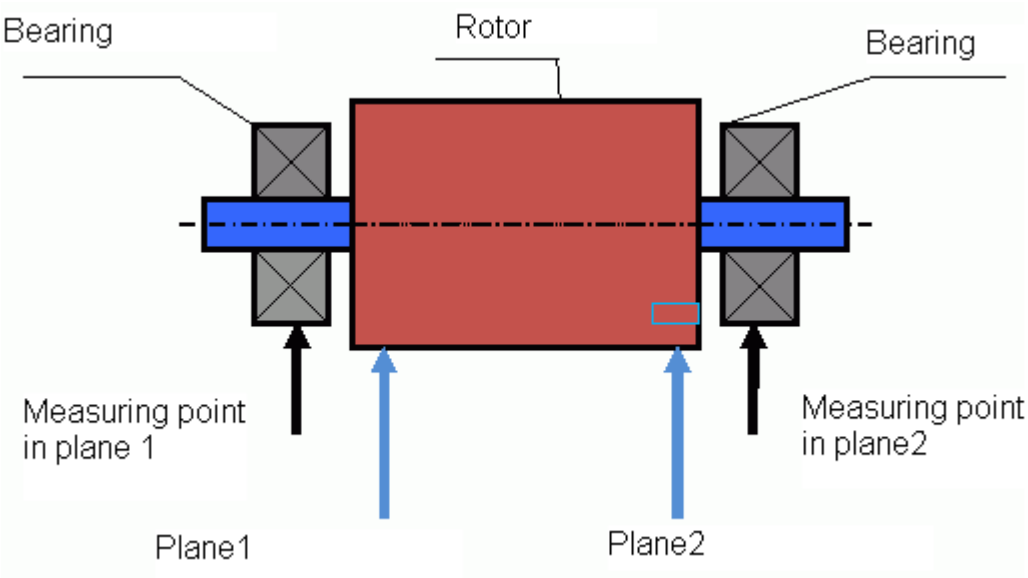


Fig. П**.1.2.** Choice of measurement points and the correction planes when balancing in two planes in the case of a symmetric rotor

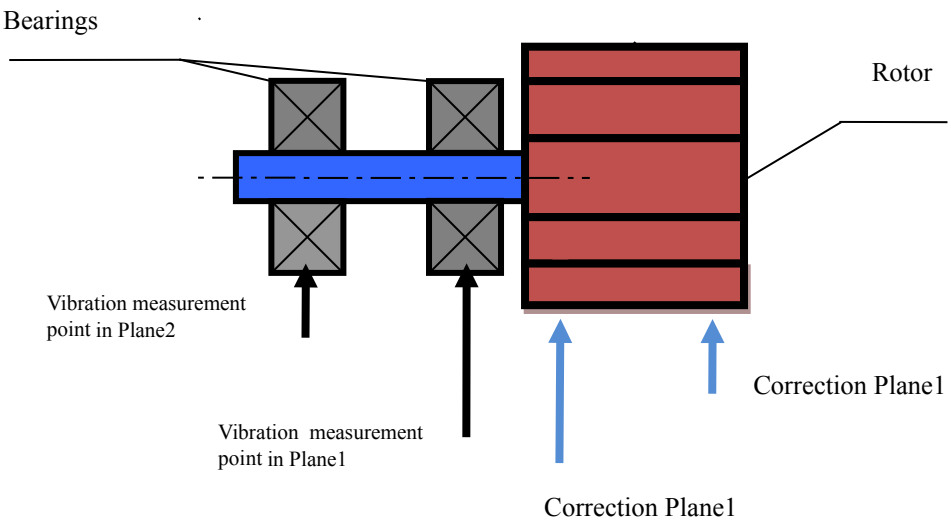


Fig. Ann.**1.3.** The choice of measurement points and the correction planes when balancing in two planes in the case of a outboard rotor.

When balancing in two planes there should be two points of measurement (see. Fig. Ann. 1.2 and Ann. 1.3).

Correction planes, in which occurs the removal (setting) of correction weights on the rotor, should be selected as close as possible to the point of measurement. In case of balancing in two planes distance between the planes should be chosen as large as possible.

Par.**1.5**. Choice of test weight weight.

Weight of the test weight may be approximately determined from the empirical formula:

$$Мп = \frac{К * Mp}{Rп*(N/100)^2} \qquad (Ann.1.1)$$

where: Мп - test weight weight, g
Mp – balanced rotor weight, g
Rп –test weight installation radius, sm
N – rotor speed, rpm
К= from 1 to 5 – coefficient considering conditions of installation of the balanced rotor.

When the weight of test weight is correct its installation on the rotor should lead to noticeable changes in the level of vibration. Otherwise, the weight of the test weight should be increased.

Par.1.7. Criteria of balance according to the state standard ISO 10816-1-97 (ISO 2372).

Limit values for vibration level established for the four classes of machines are listed in **Table A.1.**

*) **The class mechanism**	****Acceptable levels of vibration, mm / sec RMS****			
	Good	**acceptably**	**Еще допустимо**	**unacceptable**
1	**< 0.7**	**0.7-1.8**	**1.8-4.5**	**> 4.5**
2	**<1.1**	**1.1-2.8**	**2.8-7.1**	**>7.1**
3	**<1.8**	**1.8-4.5**	**4.5-11**	**>11**
4	**<2.8**	**2.8-7.1**	**7.1-18**	**>18**

*)Note:

*)Note**:**
- class **1** corresponds to small machines, installed on rigid foundations (analogue - motors up to **15** kW);
- Class **2** corresponds to average machines, installed without separate foundations (analogue - electric power of **15-75**kvt), as well as actuators on detached foundations with individual power up to **300** kW;
- Class **3** corresponds to large machines installed on rigid foundations (analogue - the electrical equipment of more than **300** kW);
- Class **4** corresponds to large machines installed on foundations of facilitated type (analog - electrical equipment more than **300** kW).