ANALYTICAL EQUIPMENT FOR
VZOR
ECOLOGY AND POWER INDUSTRY

МАРК-509
DISSOLVED
HYDROGEN
METER

Operation Manual

ВР50.00.000РЭ

АЯ 74

Nizhny Novgorod

2009

VZOR would be grateful for any proposals and criticisms aimed at improvement of the product.

In the event of any apparatus operating trouble you are welcome to report us in writing or by phone.

Postal address	603106 Nizhny Novgorod, P.O.B. 253
Telephone / fax	(831) 229-65-30, 229-65-50
	412-29-40, 412-39-53
E-mail:	market@vzor.nnov.ru
http:	//www.vzornn.com
Chief Executive	Yevgeny Valentinovich Kiseliov
Chief Designer	Alexei Konstantinovich Rodionov
Deputy Chief Designer	Konstantin Evgenievich Kriukov
Deputy Director for Marketing	Alexander Vladimirovich Oleshko
Marketing Division Manager	Olga Valentinovna Puchkova

The product may have minor modifications in design which are not mentioned in this document and have no effect on technical data and operating rules.

CONTENTS

1 DESCRIPTION AND OPERATION

1.1 Purpose

1.1.1 Product name and identification

Panel analyzer with a converter unit

MAPK-509 dissolved hydrogen analyzer

TU 4215-030-39232169-2008 Specifications.

Wall-mounted analyzer with a converter unit:

MAPK-509/1 dissolved hydrogen analyzer

ТУ 4215-030-39232169-2008 Specifications.

1.1.2 The analyzer is used to measure mass concentration of water-dissolved hydrogen and temperature of aqueous media.

1.1.3 Applications: control of dissolved hydrogen concentrations on heat engineering facilities and where continuous dissolved hydrogen control is required.

Type of analyzer:

- amperometric;
- with external reference voltage;
- with two measurement channels;
- with digital liquid crystal display;
- continuously operated;
- with automated temperature compensation;
- with flow submersible probe;
- with automatic atmospheric pressure correction on calibration;
- with integral atmospheric pressure probe;
- with measurement results given in terms of analog current output and RS-485 serial port.

1.2 Basic characteristics

1.2.1 By resistance to climatic load, the analyzer version meets GOST 12997-84 − B4.

1.2.2 By resistance to mechanical action, the analyzer version meets GOST 12997-84 − L1.

1.2.3 By resistance to environmental impact, the analyzer version meets GOST 14254-96:

- with panel converter unit − IP30;
- with wall-mounted converter unit – IP65.

1.2.4 By resistance to atmospheric pressure, the analyzer version meets GOST 12997-84 − P1 (atmospheric pressure from 84 to 106.7 kPa).

1.2.5 Parameters of analyzable medium

1.2.5.1 Temperature, °C ………………………………….. 0 to plus 70.
1.2.5.2 Pressure, MPa ……………………………………..……… 0.
1.2.5.3 pH ....………………………………….........…..... 4 to 12.
1.2.6 Operating conditions
1.2.6.1 Ambient air temperature, °C ..….. plus 5 to plus 50.
1.2.6.2 Ambient air relative humidity at temperature of + 35 °C and below without moisture condensation, %, maximum …………………… 80.
1.2.6.3 Atmospheric pressure, kPa (mm of Hg) ……….. 84,0 to 106,7 (630 to 800).
1.2.7 Analyzer is calibrated against reference hydrogen medium.
1.2.8 The analyzer power requirements: 220V AC, frequency – 50±1 Hz.
Allowable voltage deviation – minus 15 to plus 10 %.
1.2.9 Power consumption at rated power supply, V·A, maximum.………. 10.
1.2.10 Time of heat-up and thermal equilibrium establishment, h, maximum……………………………………………………………….. 0.5.
1.2.11 The analyzer retains in-spec characteristics after installation of spare parts from the SPTA kit and calibration.
1.2.12 Dimensions and weight of analyzer components are given in Table 1.1.

Table 1.1

Analyzer version identification	Identification of components	Maximum dimensions, mm	Maximum weight, kg
МАРК-509	Converter unit ВР50.01.000	252×146×100	2,60
МАРК К-509/1	Converter unit ВР50.01.000-01	266×170×95	2,60
МАРК-509, МАРК -509/1	DHP-509 hydrogen probe ВР50.02.000 (cable not included)	∅30×135	0,10
	DHP-509 hydrogen probe ВР50.02.000-01 (cable not included)	∅30×135	0,10

1.2.13 Conditions of transportation in shipping crates meet GOST 12997-84.

1.2.13.1 Sinusoidal vibration of 5-35 Hz frequency, shift amplitude of 0,35 mm in direction shown by the "TOP. HANDLE WITH CARE" sign on a crate.

1.2.13.2 Temperature, °C ……………............... minus 20 to plus 55.

1.2.13.3 Air relative humidity at 35°C, %, maximum …………….95.

1.2.14 Safety requirements

1.2.14.1 Average time between failures, h, minimum…..…….. 20 000.

1.2.14.2 Mean recovery time, h, maximum……………………..……… 2.

1.2.14.3 Analyzer average life span, years, minimum ………….. 10.

1.2.15 Insulation between the converter unit power circuits and casing thereof resists under normal operating conditions for 1 minute without breakdown and breakover the test AC voltage of 1 500V root-mean-square value and of 50±1Hz frequency.

1.2.16 Electrical impedance of analyzer power circuit insulation between the plug pin and ground, MΩ, minimum:

- at ambient air temperature (20±5)°C …………………..... 40;
- at ambient air temperature 50°C……………….…… 10;
- at ambient air temperature 35°C and relative humidity 80 %....……… 2.

1.2.17 Electrical impedance between external terminal (contact) of block protective grounding and casing thereof, maximum ………. 0,1 Ω.

1.3 Technical data

1.3.1 Analyzer measuring range for dissolved hydrogen mass concentration (hereafter DHC), ppb ……………………………….... 0 to 2 000.

1.3.2 The function of transducing of DHC value to be measured in ppb into the analyzer output current I_{out}, mA, is expressed by:

- for current output from 4 to 20 mA at load that does not exceed 500 Ω:

$$I_{вых} = 4 + 16 \cdot \frac{C}{C_{диап}}; \tag{1.1}$$

- for current output from 0 to 5 mA at load that does not exceed 2 kΩ:

$$I_{вых} = 5 \cdot \frac{C}{C_{диап}}, \tag{1.2}$$

where C – here and underneath − DHC value measured in ppb;
C_{range} – here and underneath − programmed DHC measurement range in terms of current output (hereafter − DHC measurement range in terms of current output), ppb.

1.3.3 The range of analyzer allowable basic absolute accuracy when measuring DHC at analyzable medium temperature of (20,0 ± 0,2)°C and ambient air temperature of (20 ± 5)°C, ppb:

– by indicator ………………….…………………………... ±(3,0+0,04*C*);

– in terms of current output……………… ±[(3,0+0,002C_{range}) +0,04*C*].

1.3.4 The range of analyzer allowable complementary absolute accuracy when measuring DHC governed by changes in analyzable medium temperature per each ± 5°C of normal (20,0 ± 0,2)°C within the operating temperature range from 0 to plus 70°C, ppb:

– by indicator ………………….………………………. ±(0,3+0,015*C*);

– in terms of current output …………….... ±[(0,3+0.002C_{range})+0.015*C*].

1.3.5 The range of analyzer allowable complementary absolute accuracy on measuring DHC governed by changes in ambient air temperature per each ± 10°C of normal (20 ± 5)°C within the operating temperature range from plus 5 to plus 50 °C, ppb:

– by indicator ………………….………………………. ±(0,4+0,002*C*);

– in terms of current output…………….... ±[(0,4+0,002C_{range})+0,002*C*].

1.3.6 Measuring range of analyzable medium temperature, °C ………. 0 to plus 70.

1.3.7 The range of analyzer allowable basic absolute accuracy on measuring analyzable medium temperature at ambient air temperature of (20 ± 5)°C, °C ……………………………………………………………….. ± 0,3.

1.3.8 The range of analyzer allowable complementary absolute accuracy on measuring analyzable medium temperature governed by changes in ambient air temperature per each ± 10°C of normal (20 ± 5)°C within the operating range from + 5 to + 50 °C, °C ..…………………… ±0,1.

1.3.9 Allowable setting time on measuring DHC $t_{0.9}$, min, maximum …….. 2.

1.3.10 Allowable analyzer setting time on measuring DHC t_y, min, maximum ………………………..... 40.

1.3.11 Allowable setting time on measuring analyzable medium temperature $t_{0.9}$, min, maximum……………………………………………… 7.

1.3.12 Allowable setting time on measuring analyzable medium temperature t_y, min, maximum…………………………..…………….……… 20.

1.3.13 Instability of analyzer readings for a period of 8 h, ppb, maximum:

– by indicator ………………….…………………………..… ±(1,5+0,02*C*);

– in terms of current output……………… ±[(1,5+0,001C_{range})+0,02*C*].

1.3.14 If measured DHC or temperature value go beyond the measurement range, it activates audible alarm and "**ALARM**" display on the front panel. The display will show "OVERLOAD!" message.

1.3.15 If measured DHC value goes beyond the setting limits the display will show "▼" or "▲" icons and the setting relay operates.

1.3.16 The analyzer will communicate with a PC when connected to it through RS-485 interface.

1.4 Product components

The analyzer is composed of:

– a panel or wall-mounted converter unit according to the analyzer version;

– DHP-509 hydrogen probes with a cable 5 m long;

– DHP-509 hydrogen probes with a cable 5 m long and detachable inserted cable from 5 to 95 m long;

– mounting accessories set;

– tools and accessories set.

1.5 Description and operation

1.5.1 Analyzer general data

The dissolved hydrogen analyzer is a microprocessor double-channel instrument used to continuously measure DHC and temperature using two channels A and B.

Measured DHC and analyzable medium temperature values are shown on a digital liquid crystal display (hereafter display). The least significant digit on measuring temperature is 0,1°C. The least significant digit on measuring DHC is 0,1 ppb.

Measurements may be displayed in three modes: in channel A, channel B and both channels at a time.

In each channel a provision is made for a programmable measurement range from (from 10 to 2 000 ppb) 5 mA for 0-5 mA current output to 20 mA for 4-20 mA current output. It enables one to register values to be measured using current outputs. Uniform output signal (from 0 to 5 mA or from 4 to 20 mA) may be set individually for each channel.

The low measurement range limit is always equal to DHC zero value. The high range limits are shown on the display.

Output currents are limited to 5 mA for 0-5 mA current output and 20 mA for 4-20 mA current output.

Hydrogen probes are of flow submersible type.

Each probe has a non-volatile memory chip with initial heat probe parameters which memorizes inserted cable length values put from the converter unit and calibration parameters.

Analyzer calibration is made semi-automatically against:

– hydrogen-free ("zero") medium;

– reference hydrogen medium of 100 % humidity with consideration given to atmospheric pressure at calibration moment.

To measure atmospheric pressure on analyzer hydrogen medium calibration, a built-in atmospheric pressure probe is used.

In each analyzer channel a provision is made for easily programmed settings. If DHC values go beyond the setting limits, the relay dry contacts close and display shows " ▲ " icon when a value goes beyond the upper setting and " ▼ " icon when it goes beyond the lower limit.

When measured DHC value goes beyond the upper or lower limits of the programmed range, the **"ALARM"** blinking LED indicator comes on and the display shows **"OVERLOAD"** message and blinking **"ppb"** icon. If it outruns the upper limit of the predetermined measurement range, in addition, the audible alarm is activated and the relay dry contacts close.

If a measured temperature value outruns the 0-70°C range, the **"ALARM"** blinking LED indicator comes on, the audible alarm is activated and the relay dry contacts close. The display shows **"OVERLOAD"** message and blinking **"°C"** icon**.**

In addition to uniform DC outputs from 0 to 5 mA or from 4 to 20 mA, the analyzer menu provides for setting of a uniform output from 0 to 20 mA in each channel.

1.5.2 Hydrogen measurement principle

To measure dissolved hydrogen content, the analyzer is furnished with amperometric probe working as a closed polarographic cell.

Electrodes are submerged in electrolyte solution which is isolated from the measurable medium by a membrane permeable for hydrogen and impermeable for liquids and water vapors. Hydrogen from analyzable medium penetrates through a membrane and diffuses through a thin electrolyte layer between the anode and the membrane and undergoes an electrochemical reaction on the anode surface which is polarized by external voltage between electrodes. In this case the probe generates a DC signal which at constant temperature is proportional to concentration of hydrogen dissolved in the measurable medium.

Hydrogen probe sensitivity (proportionality factor) rises with increase of measurable medium temperature. To compensate for this dependence the analyzer is furnished with automatic temperature correction function that involves a temperature probe which shares the same enclosure with the hydrogen probe.

1.5.3 Analyzer components

1.5.3.1 *Converter unit*

The converter unit converts DHC and temperature signals from the probe, measures atmospheric pressure, shows measured DHC and temperature values on the display, generates current output signals, controls relay dry contacts and transmits data to PC.

The analyzer is powered up from the 220 V, 50 Hz AC integral power supply.

As shown in Fig. 1.1 the converter unit front panel carries:

– a display screen to show measured DHC and temperature values, analyzer operating modes and menus;

– "☼" button to switch on and off display screen light;

– "⇓", "⇑" buttons to navigate in the menu bar in the parameter control and change mode and change setting values;

– "**CHANNEL**" button to change display modes (channel A, channel B, or both channels) and accomplish some operations in the **MENU** mode;

– "$\frac{\text{menu}}{\text{enter}}$" button to enter the menu (to activate parameter control and change mode) and acknowledge working values and modes selected on programming;

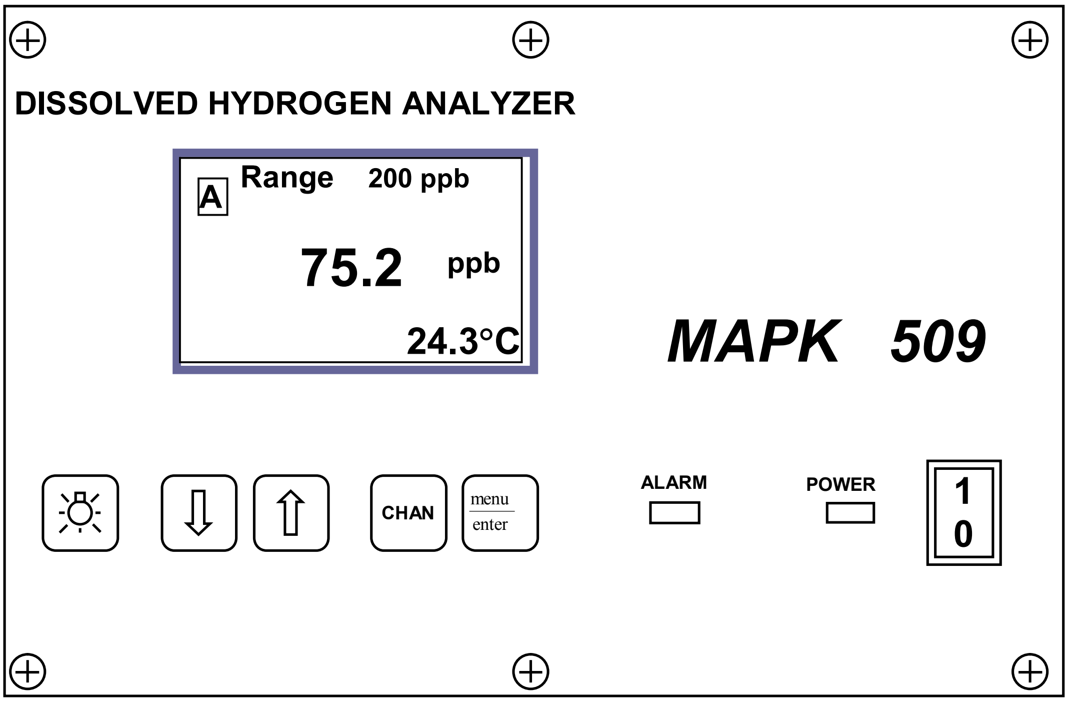


Fig. 1.1 − Layout of controls and indicators on the transuding block front panel

– "**POWER**" switch to energize and de-energize the analyzer;

– "**POWER**" green light to indicate that analyzer is powered up;

– "**ALARM**" red light to indicate overload of the programmed measurement range or that measured temperature value outruns the range (from 0 to plus 70°C).

As shown in Fig. 1.2 and Fig. 1.3, the rear panel of the panel converter unit and the underside of the wall-mounted converter unit carry:

– two "**CHANNEL A**" and "**CHANNEL B**" jacks of A and B channels for connection of hydrogen probes to the converter unit;

– "**CURRENT OUTPUT, ALARM, RS-485**" jack for connection of recorders and actuators and connection of the analyzer to a PC;

– "⏚" terminal for connection of protective grounding to the analyzer case.

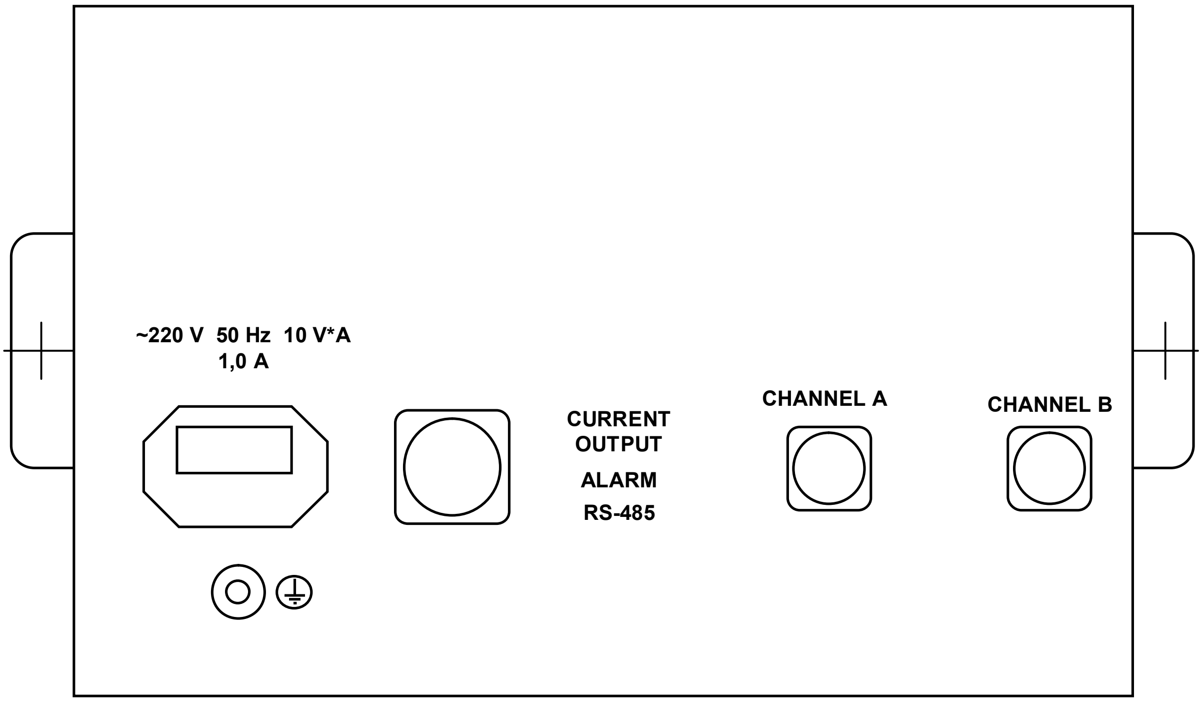


Fig. 1.2 − Layout of jacks and terminals on the panel converter unit rear panel

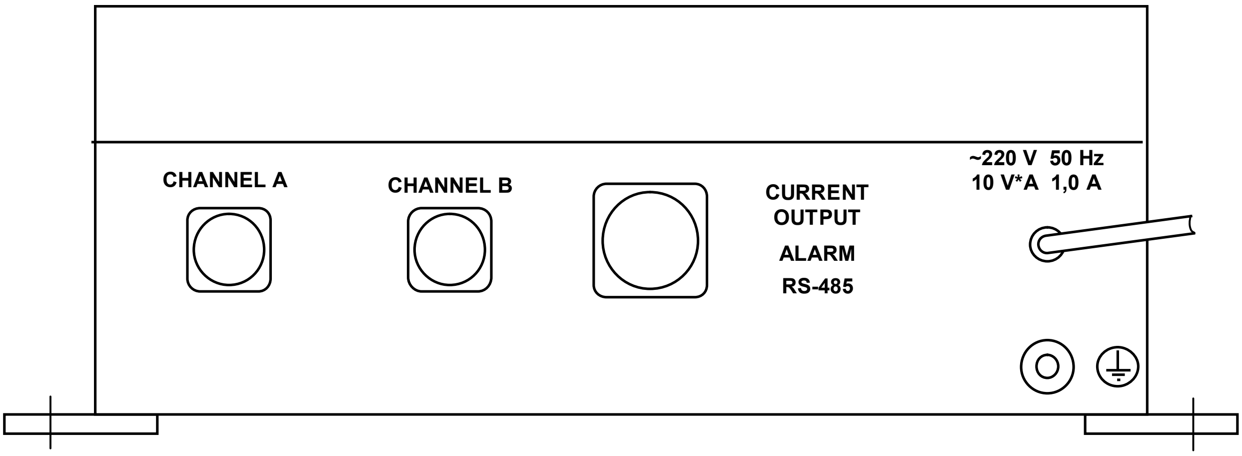


Fig. 1.3 − Layout of jacks and terminals on the underside of the wall-mounted converter unit

The back panel of panel converter unit carries the power supply jack "**~220 V 50 Hz 10 VA 1,0 A**".

The underside of the wall-mounted converter unit carries leak-tight power cable entry "**~220 V 50 Hz 10 VA 1,0 A** ".

1.5.3.2 *Hydrogen probe*

Fig. 1.4 shows main components of the hydrogen probe enclosed in an organic glass casing.

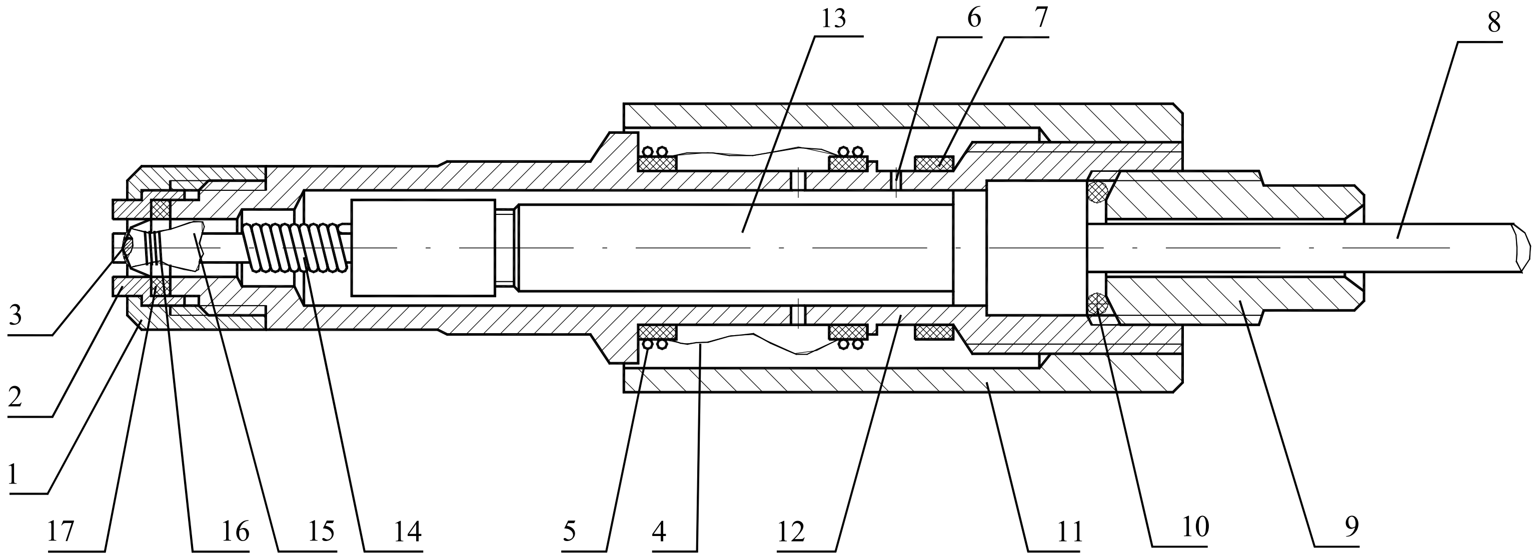
The platinum anode 3 is embedded into the end face of electrode-holding glass tube, while a silver cathode 14 is wound round the tube. The holding tube and a shielded cable 8 are tightly embedded into the inner casing 13 nested in the main casing 12 and secured by a nut 9 with a seal ring 10.

The holding tube bears a Teflon film 15 secured by nylon threads 16. The film ensures a constant gap between the anode and the membrane.

The membrane assembly consists of the castle bushing 2 and the membrane with a rubber ring 17 inserted into the bushing. The membrane assembly is located on the main casing and secured by a coupling nut 1.

The main casing bears a diaphragm 4 used to equalize pressure outside and inside the probe. Thread clamps 5 retain the diaphragm on the main casing and make the probe inner space with electrolyte tight. Electrolyte is poured thru holes 6 in the main casing which are closed with rubber rings 7 in the working position.

A protection cup 11 is used to prevent diaphragm being damaged and also serves as decorative element.



1 – coupling nut, 2 – castle bushing, 3 – platinum anode, 4 – diaphragm, 5 – diaphragm clamp, 6 – orifices for electrolyte filling, 7 – rubber ring, 8 – cable, 9 – nut, 10 – rubber ring, 11 – protective cup, 12 – main casing, 13 – inner casing, 14 – silver cathode, 15 – Teflon film, 16 – nylon thread, 17 – rubber ring and membrane assembly

Fig. 1.4 – Probe design

1.5.4 Measurement displays

The analyzer has the following measurement displays:
- single channel (A or B) measurement display shown in Fig. 1.5;
- double channel (A and B) measurement display shown in Fig 1.6.

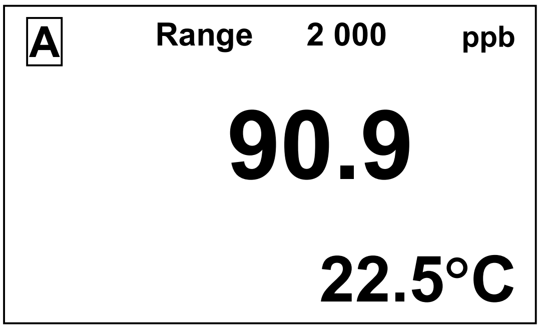


Fig. 1.5

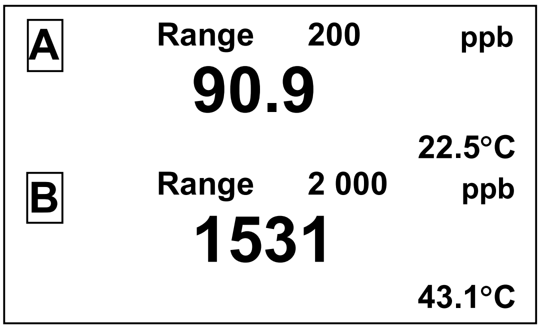


Fig. 1.6

Measurement channel displays are changed by consecutive depressing "**CHANNEL**" button, and the display indicates channel symbols A or B or both.

Displays show channel identification (A and B), upper limits of the programmed measurement ranges and measured DHC and temperature values.

If the probe is connected to one of the channels, measurement mode is set only for this channel.

1.5.5 Displays for setting value control and change (**MENU** mode)

1.5.5.1 *General information on using* **MENU***.*

Analyzer parameters are controlled and changed using display menus.

To enter the **MENU** mode from the measurement mode, button " $\frac{\text{menu}}{\text{enter}}$ " is to be pressed.

The analyzer has three display menus:
- **MENU [A]**;
- **MENU [B]**;
- **MENU [A] [B]**.

To move from one display menu to another, press the "**CHANNEL**" button.

Displays **MENU [A]**, **MENU [B]** show individual channel parameters as demonstrated in Fig. 1.7.

```
A        MENU

► CALIBRATION
  SETUP
  PARAMETERS
  PROBE
  CUR. OUTPUT: 0-5 mA
  EXIT
```

Fig. 1.7

Display **MENU [A] [B]** shows the analyzer parameters common for both measurement channels as demonstrated in Fig. 1.8.

```
A B        MENU

  PASSWORD:            OFF
  NETWORK ADDRESS:     03
  SOUND:   ON

  TEMPERATURE CU:      33°C
► OUTPUT
```

Fig. 1.8

The required line in the menu is selected by the pointer "►". To move the pointer "►" up and down, use "⇓", "⇑" buttons.

When the pointer "►" is moved to the line required, press the " $\frac{\text{menu}}{\text{enter}}$ " button.

To exit from **MENU** displays, highlight the **EXIT** line and press the " $\frac{\text{menu}}{\text{enter}}$ " button.

1.5.5.2 *Procedure for typing numerical values in* **MENU [A]**, **MENU [B]** and **MENU [A] [B]**

The analyzer enables one, if required, to change numerical values in menu lines or enter new ones. This applies, for instance, to selection of the programmable measurement range against current output, entry of setting values and more.

To move along the line to the left, use "**CHANNEL**" button.

To move along the line to the right, use " $\frac{\text{menu}}{\text{enter}}$ " button.

To increment or decrement values, use "⇑", "⇓" buttons.

To enter or change a numerical value, proceed as follows:

- set the pointer "►" against the line required;
- press the " $\frac{\text{menu}}{\text{enter}}$ " button. The first digit will blink;
- using "⇓", "⇑" buttons, set value of the first digit;
- press the " $\frac{\text{menu}}{\text{enter}}$ " button. The second digit will blink;
- using "⇓", "⇑" buttons, set value of the second digit;

- press the " $\frac{\text{menu}}{\text{enter}}$ " button. Set other digits.

After all digits and measurement units have been set (when neither of the digits blinks), using "⇓", "⇑" buttons set the pointer "►" against another line and set the second value, if required.

After all digits and measurement units are set (when neither of the digits blinks), using "⇓", "⇑" buttons set the pointer "►" against **EXIT** line and press the " $\frac{\text{menu}}{\text{enter}}$ " button.

1.5.5.3 *Use of display* **MENU [A]** and **MENU [B]** (*Fig. 1.9)*

A **MENU**

CALIBRATION
SETUP
PARAMETERS
PROBE
CUR. OUTPUT: 0-5 mA
► EXIT

Fig. 1.9

1.5.5.3.1 ► **CALIBRATION** is a line in the menu to go to the **CALIBRATION** sub-menu (refer to 2.3.4, 2.3.5, 2.3.6).

1.5.5.3.2 ► **SETUP** is a line in the menu to view and change the upper limit of the programmable measurement range and view and change minimum and maximum setting values.

The display is shown in Fig. 1.10.

A	**SETUP**
RANGE:	**2 000 ppb**
THRESHOLDS:	
M I N:	**1.0 ppb**
MAX:	**110.0 ppb**
► EXIT	

Fig. 1.10

The upper limit of the programmable measurement range may be set from 10 to 20 000 ppb.

Ranges of thresholds values are as follows:

– **MIN** – from 0 to 1 999 ppb;

– **MAX** – from 1 to 2 000 ppb;

The entered MAX setting value is to be **greater** than the MIN setting value by **at least** 1 ppb.

Once required values are set, press the " $\frac{\text{menu}}{\text{enter}}$ " button.

The analyzer display shows acknowledgement shown in Fig. 1.11.

SAVE?

YES

► **NO**

Fig. 1.11

Using "⇓", "⇑" buttons set "►" pointer to **YES** line and press the " $\frac{\text{menu}}{\text{enter}}$ ".

The analyzer memorizes the set values of the programmable measurement range upper limit and new setting values and goes back to the **MENU** mode.

Note – The analyzer is delivered with preset programmable measurement range upper limit of 2 000 ppb and the following preset setting values:

– **MIN** – 0 ppb;

– **MAX** – 2 000 ppb.

1.5.5.3.3 ► **PARAMETERS** is a line in the menu to view **THERMOCHANNEL** parameters and enter values of the inserted cable length.

The display is shown in Fig. 1.12.

A	PARAMETERS
	►THERMOCHANNEL
	CABLE EXTENSION: 00 m
	CHECK
	EXIT

Fig. 1.12

THERMOCHANNEL is a line in the submenu to view heat probe parameters entered into the non-volatile chip memory including shift, mV, and slope, mV/°C.

The display is shown in Fig. 1.13.

A	THERMOCHANNEL
SHIFT:	621.91 mV
SLOPE:	2.201 mV/°C
► EXIT	

Fig. 1.13

Information about heat probe parameters is **confidential** and is used only during analyzer adjustment at a factory.

"**CABLE EXTENSION**" is a line in the submenu to enter values of the inserted cable length. Connect the inserted cable and enter the value of length thereof in meters (like on setting the programmable measurement range).

Values of connected inserted cable length lie in the range from 5 to 95 m.

Note – If the delivery set includes a cable insert, the analyzer is supplied with the value of the inserted cable length entered into the probe non-volatile memory chip. On connection of the probe to any channel the readings will be based on the inserted cable length entered before. Additional entering of the inserted cable length value into the analyzer memory is not required.

CHECK is an ancillary line in the submenu to view analyzer channel parameters.

The display is shown in Fig. 1.14.

A **CHECK**

H2 : 020.7 ppb
CUR. : 1.33E - 0.1 μA
t : 25.0°C
P : 101.3 kPa
► EXIT

Fig. 1.14

Display shows:
– analyzer readings;
– probe current (in the engineering format);
– measured temperature; and
– measured atmospheric pressure.

1.5.5.3.4 ► **PROBE** is a line in the menu to go to the probe parameters check mode.

The display is shown in Fig. 1.15.

A **PROBE**

CAL. CURRENT : 3.0 μA

SHIFT: 2.3 ppb

► EXIT

Fig. 1.15

The display shows the hydrogen probe parameters entered into the non-volatile memory chip:

– probe current in μA measured on calibration against the reference hydrogen medium reduced to the medium of 100% hydrogen content, 20°C temperature and 101,325 kPa normal atmospheric pressure ("**CAL. CURRENT**");

– analyzer readings in ppb when the probe is in the "zero" medium during calibration ("**SHIFT**").

Parameters of the fault-free probe are to lie in the following ranges:

- "**CAL. CURRENT**" – from 1,4 to 10 μA;
- "**SHIFT**" – from minus 3 to plus 3 ppb.

Control and change of parameters in the channel B are carried out in a similar manner.

1.5.5.4 *Use of display* **MENU [A] [B]**

Display **MENU [A] [B]** shown in Fig. 1.16 makes it possible to change analyzer parameters common to both channels.

AB MENU

PASSWORD: OFF
SYSTEM ADDRESS: 00
SOUND: ON

TEMPERATURE CU: 33°C
► EXIT

Fig. 1.16

Operation of the display menu is similar to operation of the display **MENU [A]**, **MENU [B]**.

1.5.5.4.1 **► PASSWORD: ON** is a menu line used to limit opportunities to change analyzer parameters.

If password is off "**PASSWORD: OFF**", change from measurement mode for **MENU** mode is possible without requesting the password.

If password is on "**PASSWORD: ON**", then on changing from measurement mode for **MENU** mode analyzer will request the user to enter the password (number 12).

The display shown in Fig. 1.17 appears.

ENTER PASSWORD:

00

Fig. 1.17

The first digit to be entered will blink on the display.

Using "⇓", "⇑" buttons, set value of the first password digit "1" and press the "$\frac{\text{menu}}{\text{enter}}$" button. The second digit will start blinking on the display. Using "⇓", "⇑" buttons, set value of the second digit "2" and press the "$\frac{\text{menu}}{\text{enter}}$" button.

If the password is correct, **MENU** display will appear. If the password is wrong, the analyzer will return to the measurement mode.

1.5.5.4.2 ► **SYSTEM ADDRESS: 00** is a **MENU [A] [B]** line used to identify analyzer network address through RS-485 interface when a few instruments are integrated into a network. The network address is used to identify an analyzer in the network and may vary from "**00"** to "**99"**. For non-network operation, a network address is of no importance.

1.5.5.4.3 ► **SOUND:** is a **MENU [A] [B]** line to turn off the analyzer sound alarm, when required.

1.5.5.4.4 ► **TEMPERATURE CU:** is a **MENU [A] [B]** line to indicate temperature inside the transducing casing.

1.5.6 Warning and failure displays

On appearing displays shown in Fig. 1.18-1.21 refer to 2.5 of the Operation Manual.

The display on Fig. 1.18 appears, if the probe is not connected to channel A.

A

WARNING!

PROBE

NOT CONNECTED

Fig. 1.18

The display on Fig. 1.19 appears, if the amplifier board is not responsive.

WARNING!

NO COMMUNICATION WITH

AMPLIFIER BOARD ! ! !

Fig. 1.19

The display on Fig. 1.20 appears in the event of Channel A probe memory trouble.

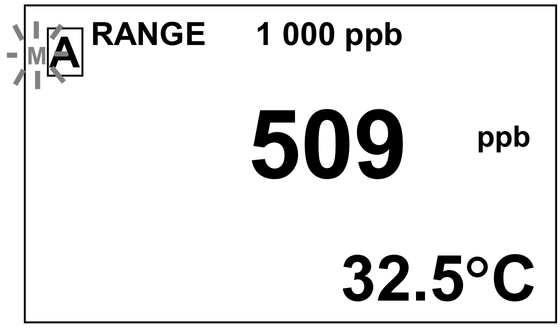


Fig. 1.20

The display on Fig. 1.21 appears in the event of probe memory trouble in Channels A and B.

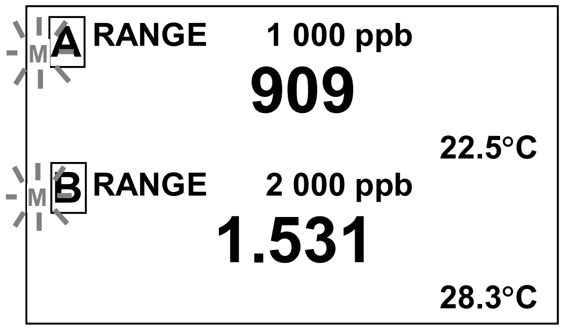


Fig. 1.21

If warning displays shown in Fig. 1.22-1.23 appear during calibration, refer to 2.5 of the Operation Manual.

To change from these displays to the measurement mode, press the "menu/enter" button.

The warning display shown in Fig. 1.22 appears in the event of trouble during calibration against the reference hydrogen medium (probe current at 20°C reduced to the medium of 100% hydrogen content below 1 μA).

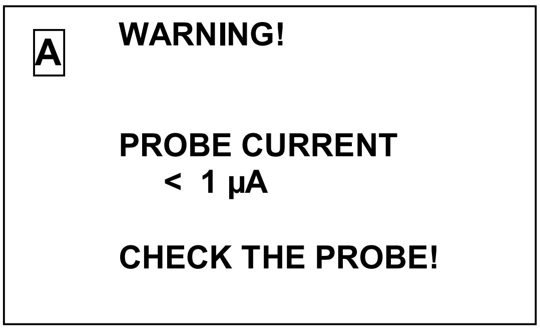


Fig. 1.22

The warning display shown in Fig. 1.23 appears in the event of trouble during calibration against the reference hydrogen medium (probe current at 20°C reduced to the medium of 100% hydrogen content over 10 μA).

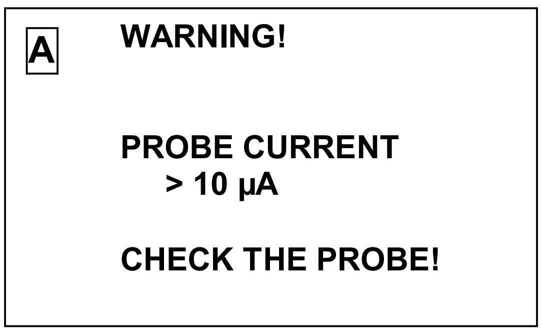


Fig. 1.23

On appearing of warning displays shown in Fig. 1.24-1.25 the "**OVERLOAD!**" message and blinking symbols go out, once parameter overload is released.

The warning display shown in Fig. 1.24 appears when measured DHC value goes beyond the programmed measurement range upper limit. The appropriate limit of the programmable current output limit needs to be set.

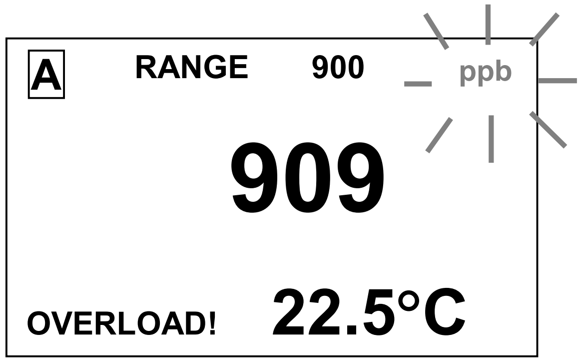


Fig. 1.24

The warning display shown in Fig. 1.25 appears when the measured value of the analyzable medium temperature exceeds 70°C.

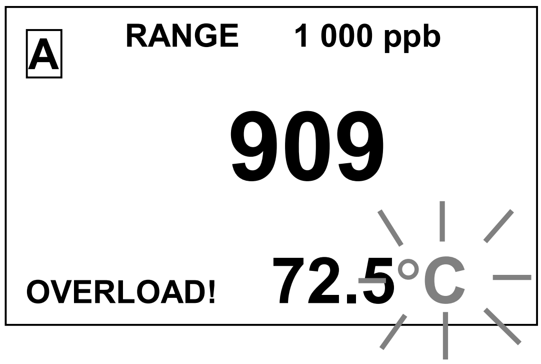


Fig. 1.25

The warning display shown in Fig. 1.26 appears when measured DHC value goes beyond the programmed measurement range upper limit in channel A and measured temperature value exceeds 70°C in channel B.

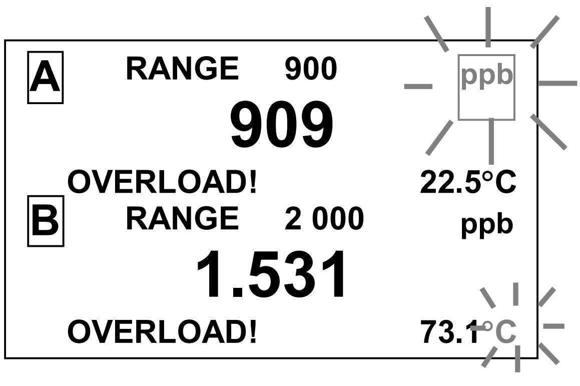


Fig. 1.26

On appearing of warning displays shown in Fig. 1.27-1.29, "" or "" icons disappear, once measured DHC value overrunning the preset limits is remedied.

The warning display shown in Fig. 1.27 appears, when measured DHC value goes beyond the lower preset limit.

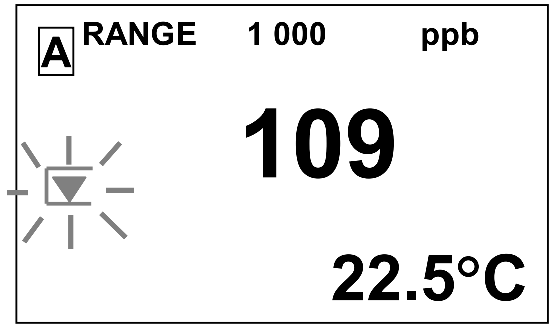


Fig. 1.27

The warning display shown in Fig. 1.28 appears, when measured DHC value goes beyond the upper preset limit.

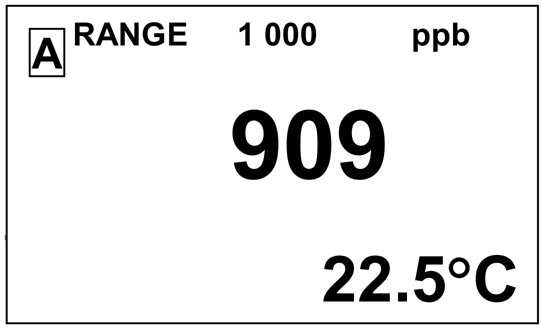


Fig. 1.28

The warning display shown in Fig. 1.29 comes on, when measured DHC value goes beyond the lower preset limit in channel A and beyond the upper preset limit in channel B.

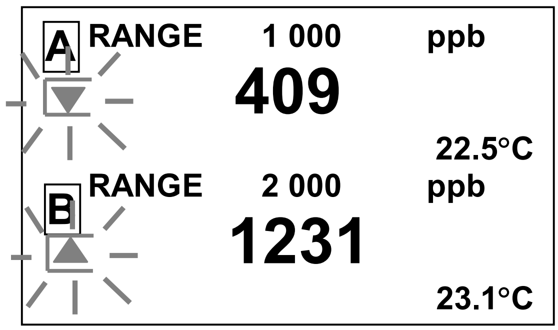


Fig. 1.29

The warning display shown in Fig. 1.30 comes on when voltage of a CR2032 lithium cell on the board inside the converter unit is below 2,2V. Replace the cell.

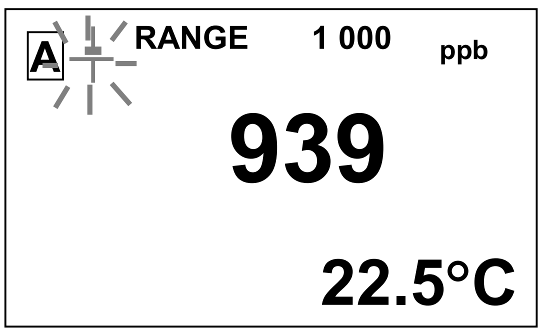


Fig. 1.30

2 INTENDED USE

2.1 *Operating Limitations*

2.1.1 The analyzer should be installed so that water ingress into the converter unit of MAPK-509 analyzer is prevented since it is enclosed in a casing of IP30 protection level.

2.1.2 The probe is to be used in the temperature range from 0 to plus 70°C. For a short time (up to 15 min) it may work at temperature up to 100°C while overheating may cause deformation of the probe casing and failure thereof.

2.1.3 When using the analyzer protect the hydrogen probe from shocks since its components contain glass elements.

2.2 Safety Precautions

2.2.1 The analyzer is to be operated only by people who have acquainted themselves with this manual and chemical solution handling procedures.

2.2.2 In operation the following safety precautions are to be observed:

– when handling reagents − according to GOST 12.1.007-76 and GOST 12.4.021-75;

– when working with electrical installations − according to GOST 12.1.019-79 and GOST 12.2.007.0-75.

2.2.3 The converter unit is to be located so that the analyzer may be easily disconnected from power supply.

2.2.4 **Do not** operate the analyzer with **removed** covers of the converter unit casing and without converter unit **grounding**.

2.2.5 Electrical circuits connected to the "CURRENT OUTPUT, ALARM, RS-485" jack will use shielded cables or wires laid in cable troughs or channels.

Probes are to be connected to the converter unit with a shielded cable.

2.3 Preliminary operations

2.3.1 Analyzer receiving procedure

On receiving the analyzer, unpack it, check completeness of the delivery set and make sure that the packed items are intact.

After holding the analyzer in cold conditions keep it at room temperature for at least 1 h and then make it available for use.

2.3.2 Preparation of the converter unit for use

2.3.2.1 *Converter unit installation*

The converter unit is to be located so that the analyzer may be easily disconnected from power supply.

The panel converter unit mounting holes are shown in Fig. 2.1.

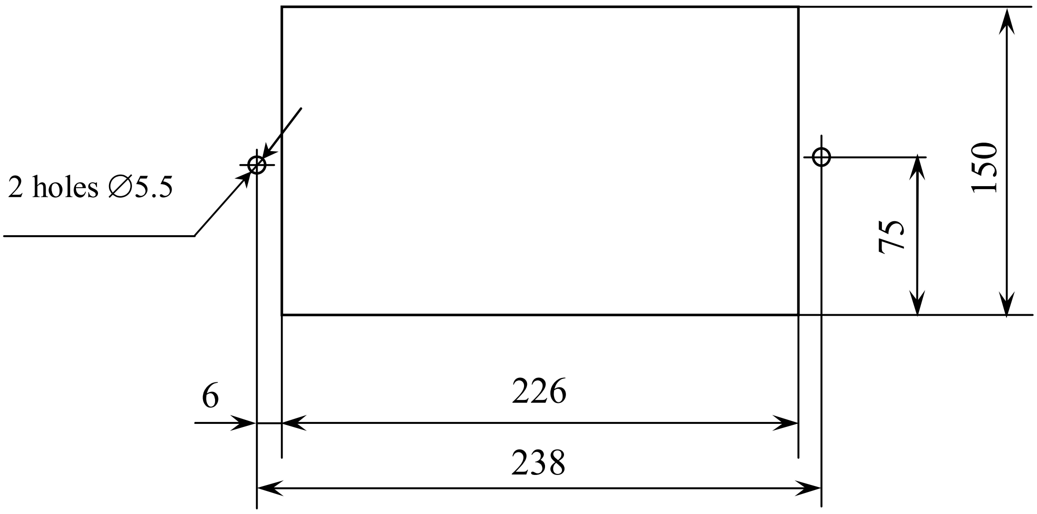


Fig. 2.1 − Layout of mounting holes for the panel converter unit of MAPK-509 analyzer

The panel converter unit is mounted on the inner side of the board. The faceplate in the delivery set of the panel analyzer is mounted on the front side of the board.

Securing is provided by M5 screws with nuts from the delivery set.

Layout of holes for mounting the wall-mounted converter unit on the vertical surface is shown in Fig. 2.2.

Securing is provided by M4 screws with nuts from the delivery set.

Connect 220V, 50Hz power supply.

Ground the converter unit casing using a copper wire of at least 0.35 mm^2 in section which is connected to the casing grounding terminal.

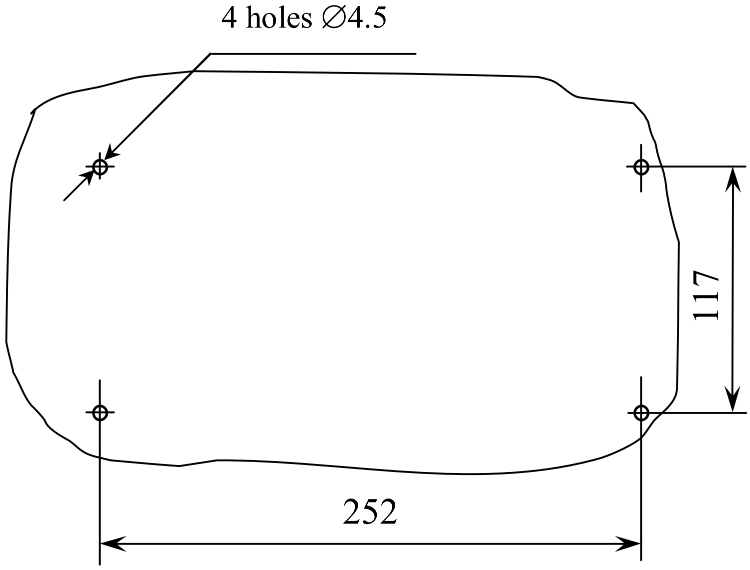


Fig. 2.2 − Layout of holes for mounting the wall-mounted converter unit of MAPK-509/1 analyzer

2.3.2.2 *Converter unit external connections*

External connections to the converter unit are made to the "**CURRENT OUTPUT, ALARM, RS-485**" jack on the rear panel of the panel converter unit and on the underside of the wall-mounted converter unit according to Fig. 1.2 and 1.3 using PC19TB socket from the mounting accessories set.

Layout of PC19TB socket contacts is shown in Fig. 2.3 (as seen from contact soldering side).

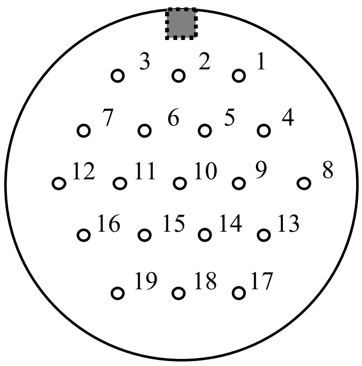


Fig. 2.3

2.3.2.3 *Connection of an external recorder*

Connection of the external recorder to the converter unit is made through contacts of the "**CURRENT OUTPUT, ALARM, RS-485**" jack according to Table 2.1.

Table 2.1

Contact No	5	6	9	10
Circuit	Channel A (+)	Channel A (–)	Channel B (+)	Channel B (−)

Contact 6 and 10 are interconnected.
In 4-20 mA range load shall not exceed 500 Ω.
In 0-5 mA range load shall not exceed 2 kΩ.

2.3.2.4 *Connection of RS-485 interface*

PC RS-485 port is connected to the converter unit through contacts of the "**CURRENT OUTPUT, ALARM, RS-485**" jack according to Table 2.2.

IMPORTANT: Computer is to be connected to the converter unit with both apparatuses being de-energized!

Table 2.2

Contact	Circuit
5	SG (signal ground)
6	DAT + (Data +)
7	DAT – (Data –)

Rate of exchange is 19,200 bit/s.

2.3.2.5 *Connection of external actuators, indicators and alarms*

External actuators, indicators and alarms are connected to the converter unit through contacts of the "**CURRENT OUTPUT, ALARM, RS-485**" jack.

When measured DHC and analyzable medium temperature values fall beyond the preset limits, the "dry" relay contacts complete the circuits between PC19TB socket contacts as shown in Table 2.3.

Table 2.3

Parameter measured	Channel	Value of measured parameter	Numbers of contacts completing circuit
Measured DHC value, ppb	A	fall beyond measurement range limits	1, 2
Measured temperature value, °C		above 70°C	
Measured DHC value, ppb	B	fall beyond measurement range limits	3, 4
Measured temperature value, °C		above 70°C	

Table 2.3 (continued)

Parameter measured	Channel	Value of measured parameter	Numbers of contacts completing circuit
Measured DHC value, ppb	A	below MIN setting value	7, 8
		above MAX setting value	12, 13
	B	below MIN setting value	16, 17
		above MAX setting value	18, 19

Setting values are changed according to 1.5.5.
Maximum switching current is 150 mA at 36V AC.

2.3.3 Preparation of hydrogen probe

2.3.3.1 The hydrogen probes are supplied in the analyzer complete set in "dry" condition and are to be filled with electrolyte from the complete set as prescribed in 2.6.3.

Connect probes to the converter unit.

Submerge probes in distilled water for 24 h with membrane downward. Power may not be applied to the converter unit since polarization voltage will be applied to probes from the internal power supply to stabilize the electrode system.

IMPORTANT: Probes are to be connected to and disconnected from the converter unit with the apparatus being de-energized!

2.3.3.2 Before any calibration probes are to be connected to the analyzer for at least 24 h since with probes disconnected the rate of their reaction to hydrogen appreciably drops.

Calibration is to be carried out with the **cable insert being connected**, if it is included into the delivery set.

After replacement of the membrane or Teflon film the probe prior to calibration is to be held in distilled water for at least **24 h** to stabilize tension of the membrane and Teflon film.

2.3.4 check and calibration against the medium with zero hydrogen content (air)

Air check that makes it possible to know the probe response time and its ability to go to "zero" is the main operational checks.

Air calibration is undertaken:

- after replacement of the membrane assembly;
- after replacement of the Teflon film;
- if analyzer readings seem to be doubtful; and
- after long analyzer downtime.

For air calibration remove the probe from water, shake water drops off the membrane and place it in air at 15-30° angle to the horizontal as shown in Fig. 2.4.

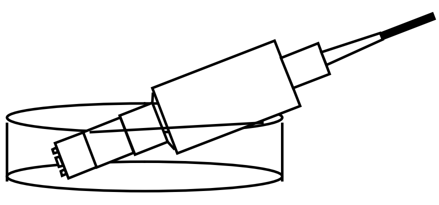


Fig. 2.4

Record analyzer reading in 40 min.

Readings in air within ± 3 ppb are normal. In this case analyzer desired metrological characteristics are ensured. Then proceed with calibration: against GSO CGM with known hydrogen content in % vol. or against the solution with known DHC (2.3.5).

If need be, **additional** air calibration may be carried out (2.3.4.1) which makes it possible to set analyzer zero reading.

If display readings are above ± 3 ppb, refer to 2.5 of the Operation Manual (Troubleshooting) or proceed with air calibration (2.3.4.1).

2.3.4.1 ***Air** calibration procedure*

1 Using " $\frac{\text{menu}}{\text{enter}}$ " button go to **MENU [A]**.

2 Set pointer against **CALIBRATION** line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. The analyzer goes to the **CALIBRATION** menu. Display shown in Fig. 2.5 comes on.

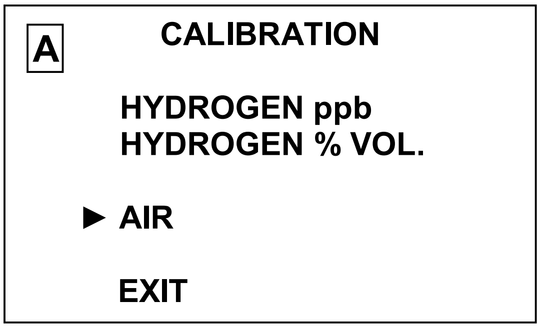


Fig. 2.5

3 With the cursor against AIR line press the " $\frac{\text{menu}}{\text{enter}}$ " button. Display shown in Fig. 2.6 appears.

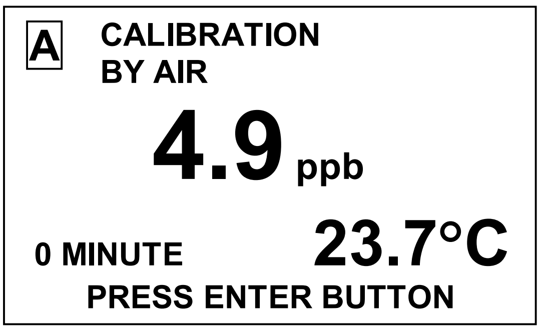


Fig. 2.6

4 Time count from selection of air calibration mode will be displayed in the left lower corner of the screen. Analyzer DHC readings are to go down and in 40 min the value on the Z_0 indicator, μg/dm^3, is not to exceed 3.0 ppb.

Note − If indicator reading exceeds 3 ppb, refer to 2.5 of the Operation Manual (Troubleshooting).

5 At least 40 min press the " $\frac{\text{menu}}{\text{enter}}$ " button and the analyzer will carry out calibration against air. Display shown in Fig. 2.6 appears.

If in 40 min the " $\frac{\text{menu}}{\text{enter}}$ " button is not pressed, in 45 min after calibration beginning the analyzer will exit from the air calibration mode and the display shown in Fig. 2.7 will appear.

A **PROBE**

CAL. CURRENT: 4.7 μA

SHIFT: 2.9 ppb

► EXIT

Fig. 2.7

6 Press the " $\frac{\text{menu}}{\text{enter}}$ " button and display shown in Fig. 2.8 comes on.

SAVE?

YES

►NO

Fig. 2.8

7 Set pointer against YES line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. Display shown in Fig. 2.9 comes on.

If the pointer is set against NO line and the " $\frac{\text{menu}}{\text{enter}}$ " button is pressed, new calibration parameters will not be memorized, and the analyzer will go to the measurement mode.

A

ENTER THE DATE

DD/MM/YY
► 26.03.08

EXIT

Fig. 2.9

8 Enter the calibration date, set the pointer against the EXIT line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. The analyzer will go over to the measurement mode.

Calibration against air results in shift if analyzer readings and on passing to the measurement mode the analyzer display will show DHC value:

- 0.0; if –3.0 ppb ≤ Z_0 ≤ 3.0 ppb;
- Z_0 −3.0; if Z_0 > 3.0 ppb;
- Z_0 +3.0; if Z_0 < –3.0 ppb,

where Z_0 analyzer readings in air in the course of calibration.

2.3.5 Analyzer calibration against GSO CGM with known hydrogen content in % vol. or against a solution with known DHC value (against hydrogen)

Calibration against GSO CGM with known hydrogen content or against a solution with known DHC value is carried out:

- after the probe has been received (after pouring electrolyte and stabilization of the electrode system, 2.3.3.1);
- after replacement of the membrane assembly;
- after replacement of the Teflon film;
- if analyzer readings seem to be doubtful; and
- on a quarterly basis.

To reduce inaccuracy of measurements, analyzer GSO CGM calibration is to be carried out either against a solution with known DHC value or hydrogen content close to the values measured.

To additionally increase analyzer accuracy due to changes in analyzable medium temperature, the probe temperature on hydrogen calibration is to be close to analyzable medium temperature.

Best of all, hydrogen calibration is to be carried out at room temperature against GSO CGM with hydrogen concentration from 40 to 100% vol.

For prompt hydrogen calibration may involve the calibrator from the analyzer SPTA kit.

Select measurement mode of the channel which is connected to the probe (for instance, channel A). Set measurement range against current output of 2,000 ppb.

2.3.5.1 ***For GSO CGM calibration*** assemble the plant in compliance with Fig. 2.10.

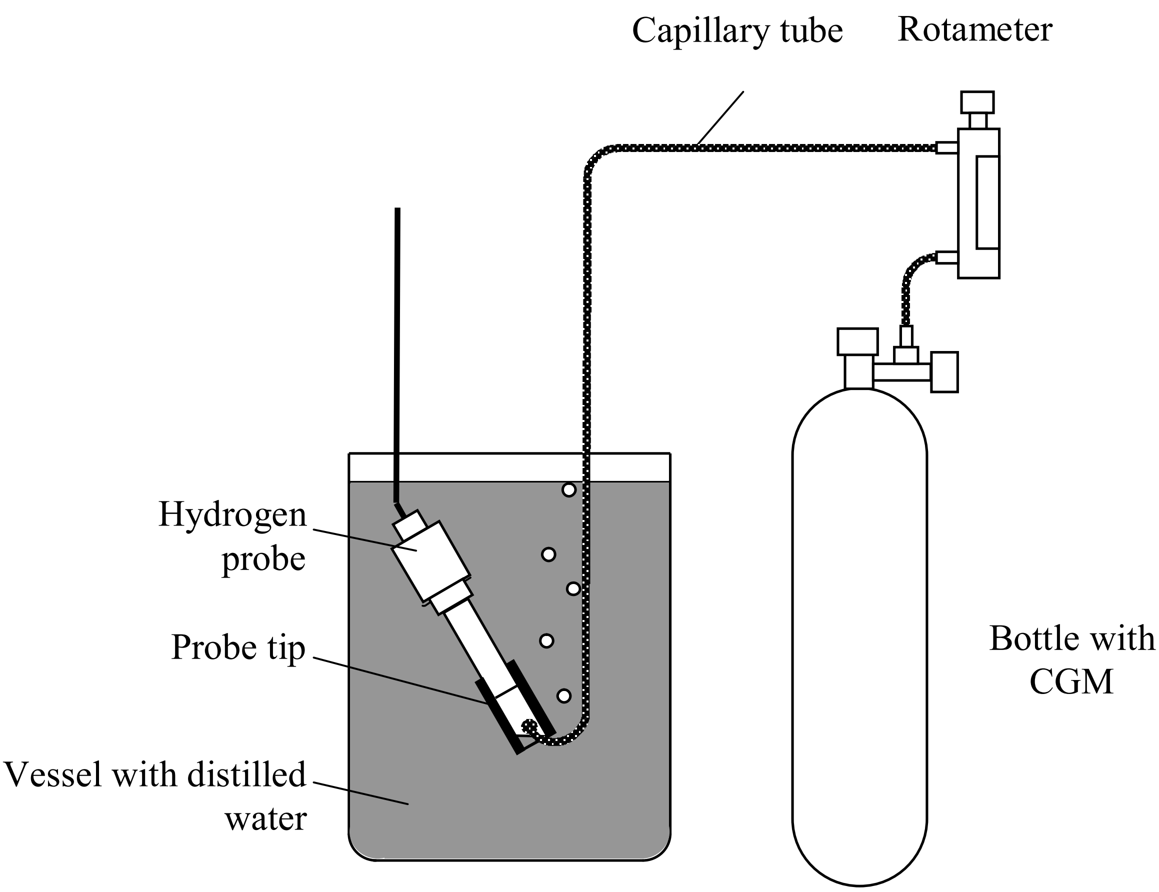


Fig. 2.10 – Analyzer calibration against GSO CGM

Fill the vessel with distilled water of room temperature.

Install the following in the vessel:

– probe with a tip comprising a PVC tube extended 30-35 mm from the probe end. The probe is placed in the vessel at 60-70° angle to the horizontal;

– a bent capillary tube connected to the CGM bottle outlet;

– hold the probe with the tip in the vessel for at least 30 min;

– feed CGM from the bottle to the probe membrane. Using a rotameter, set CGM feed rate so that an air bubble in the cup is changed each 3-5 s. Wait till readings are stable.

2.3.5.2 ***For hydrogen calibration using a calibrator,*** proceed as follows:

– switch on the analyzer;

– loosen nut;

– push analyzer probe into the calibrator socket against stop as shown in Fig. 2.11 and tighten the nut;

– place the calibrator into 0.5-1 dm^3 container;

– fill the container with NaOH solution of 4 ppt concentration so that solution level is at the level of the calibrator upper base;

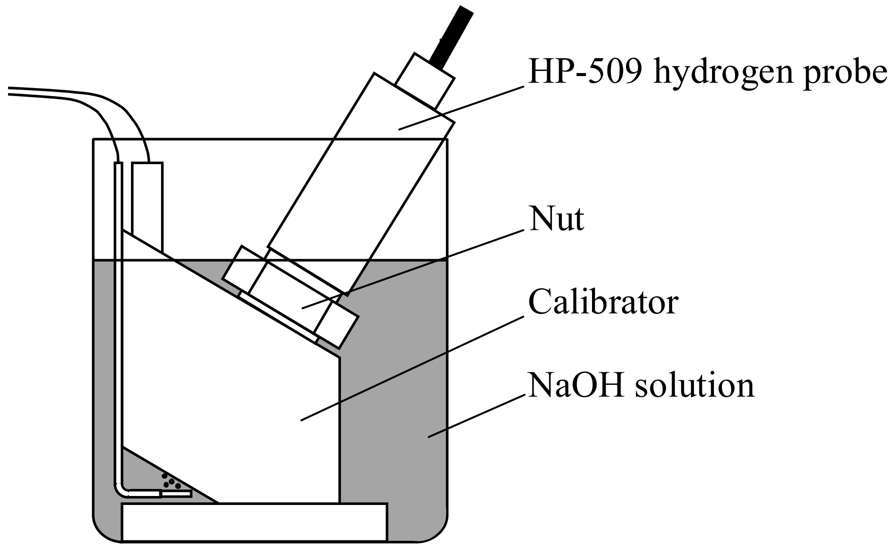


Fig. 2.11 – Analyzer calibration in a calibrator

– connect the calibrator to the power supply socket. Gas is to liberate on the calibrator electrodes;

– in 1 h after placing the probe into the calibrator socket visually check the calibrator socket bottom for a hydrogen bubble and disconnect the calibrator from the power supply.

2.3.5.3 ***Calibration against a solution with known DHC*** requires, for instance, a reference dissolved hydrogen analyzer. In this case DHC of the same solution is to be measured using both the reference analyzer and the working analyzer. Wait for stable readings of both analyzers and carry out calibration.

Hydrogen calibration procedure

1 Using the " menu/enter " button go to **MENU [A]**.

2 Set the pointer against the **CALIBRATION** line and press the " menu/enter " button. The analyzer will go to the **CALIBRATION** menu and display shown in Fig. 2.5 will come on.

3 Move the cursor against "HYDROGEN ppb" (on calibration against a solution with known DHC) or "HYDROGEN % VOL." (on calibration against GSO-CGM or in a calibrator) and press the " menu/enter " button. The display shown in Fig. 2.12 or 2.13 will appear.

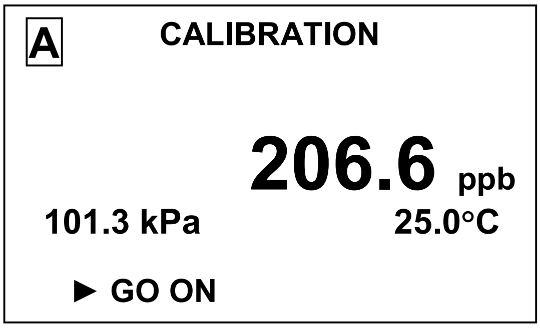


Fig. 2.12

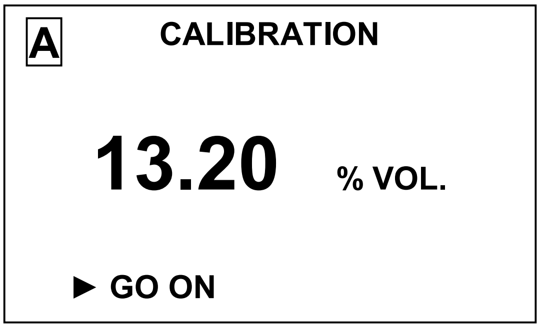
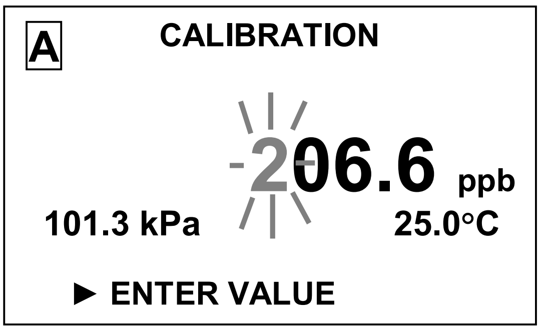


Fig. 2.13

4 Press the " menu/enter " button. The display shown in Fig. 2.14 or 2.15 will appear.



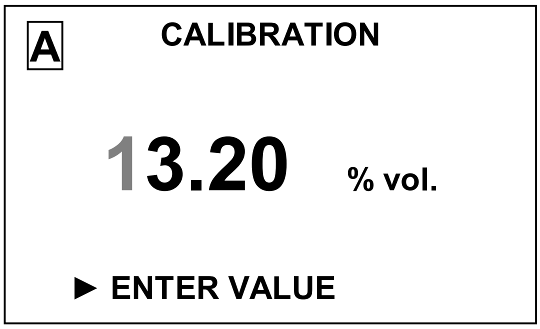


Fig. 2.14 *Fig. 2.15*

5 Enter DHC value digit-by-digit:
- ***on calibration against a solution with known DHC*** enter this value (for instance, readings of the reference analyzer);
- ***on calibration against GSO-CGM*** enter the value of hydrogen concentration in CGM in % vol.;
- ***on calibration in a calibrator*** enter the value "90.00 % vol.".

6 After entering all digit press the " $\frac{\text{menu}}{\text{enter}}$ " button. The display shown in Fig. 2.16 or 2.17 will appear with DHC indicated in ppb or in % vol.

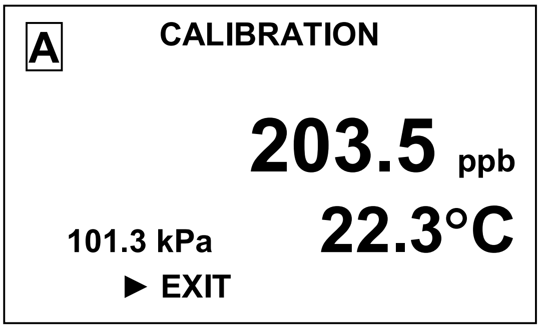


Fig. 2.16

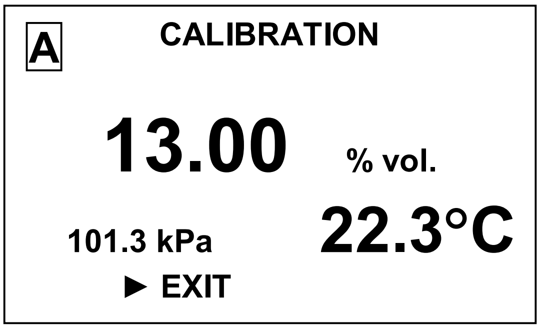


Fig. 2.17

7 Press the " $\frac{\text{menu}}{\text{enter}}$ " button. The analyzer will exit the hydrogen calibration mode to enter into the probe parameters view mode. The display shown in Fig. 2.7 will appear.

8 Press the " $\frac{\text{menu}}{\text{enter}}$ " button once again and the display shown in Fig. 2.8 will appear.

9 Set the pointer against YES line and press the " $\frac{\text{menu}}{\text{enter}}$ " button to enter probe parameters based on hydrogen calibration and new calibration coefficients onto the probe non-volatile chip memory. The display shown in Fig. 2.7 will appear.

10 Enter calibration date, set the pointer against the EXIT line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. The analyzer will go to the measurement mode.

11 If to set the pointer against NO line and press the " $\frac{\text{menu}}{\text{enter}}$ " button, the analyzer will go to the measurement mode with previous calibration coefficients.

The foregoing operations may result in warning displays shown in Fig. 1.23 and 1.24. It may indicate probe failures (refer to 2.5 "Troubleshooting").

When displays shown in Fig. 1.23 and 1.24 come on and the " $\frac{\text{menu}}{\text{enter}}$ " button is depressed, the analyzer goes to the measurement mode with old calibration coefficients.

When on completion of calibration in channel A the calibrated probe is connected to channel B, new calibration is not required since calibration parameters are retained in the probe chip non-volatile memory.

The second probe is to be calibrated against air and hydrogen in a similar manner, if the delivery set includes two probes.

On completion of calibration the analyzer is available for use.

2.3.6 Check of analyzer parameters

Prior to measurements the parameters set in the **MENU [A]**, **MENU [B]**, **MENU [A, B]** are to be checked and corrected, if required, in compliance with 1.5.5.2 by setting in each channel the values of ranges, settings, salinity, current output range, and in compliance with 1.5.5.3 by setting the parameters common to channels A and B.

2.3.7 Pre-measurement operating procedures using the hydraulic panel are undertaken in compliance with ВР37.04.100РЭ Operation Manual.

The hydraulic panel is used at flow rate from 0.40 to 2.7 dm^3/min.

2.3.8 Pre-measurement operating procedures using the SM-402M water flow stabilizing module are undertaken in compliance with ВР13.00.000РЭ Operation Manual.

The water flow stabilizing module is used at flow rate from 0.07 to 5.00 dm^3/min.

2.3.9 Pre-measurement operating procedures using the flow-through cell are undertaken in compliance with ВР11.03.000 document.

The flow-through cell is used at flow rate from 0.07 to 0.60 dm^3/min.

To place the hydrogen probe into the flow-through cell, proceed as follows:

– loosen the nut;

– push the probe into the flow-through cell according to Fig. 2.18 as deep as it goes;

– tighten the nut;

– to remove the probe from the flow-through cell, remove tube from the outlet nozzle and loosen the nut;

– the flow-through cell may be used for storage and transportation of the probe. For this purpose don't drain water from the cell and connect the cell tubes to each other.

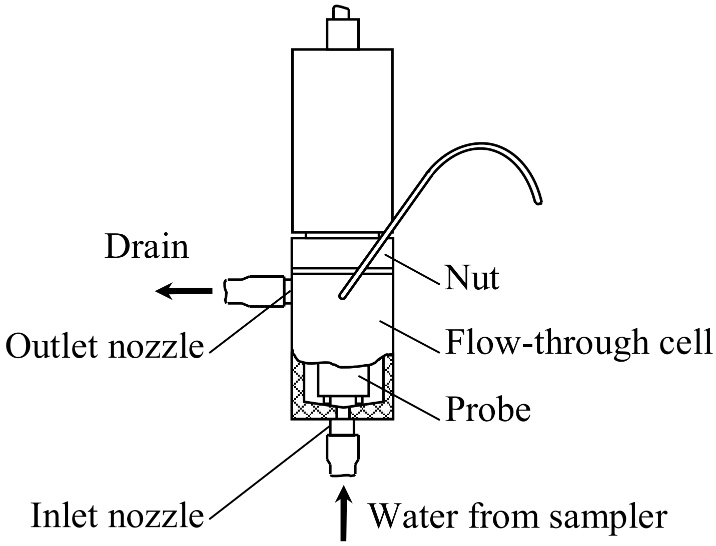


Fig. 2.18 – Position of the probe in the flow-through cell in measurements

2.4 Measurement procedure

2.4.1 Measurement of dissolved hydrogen mass concentration using a flow-through cell

Place the water flow stabilizing module next to the sampling point on a vertical or horizontal surface.

If a flow-through cell is used, place it a fairly vertical position.

Connect the inlet nozzle of SM-402M water flow stabilizing module or the flow-through cell with a probe inside to the line with analyzable water using a flexible hose.

If SM-402M/1 water flow stabilizing module is used, connection to the line with analyzable water involves a metal tube.

Check all connections. The sampling line is to be leak-proof to prevent ingress of outside air.

Feed analyzable water. Make sure that water flow and the probe membrane are both free of air bubbles.

Availability of air bubbles in hose bends, on the probe membrane or in water supply line may produce significantly inaccurate results. One of the symptoms of air bubbles comprises analyzer readings failure to reach stability and their tendency to slowly and continuously drop. Such drop of analyzer readings may last for 1-2 h.

If a flow-through cell is used, to remove bubbles from the membrane shake gently the cell with the probe.

To remove bubbles from the sampler line we recommend that flow be sharply enhanced for 10-20 s and then returned to normal rate.

If a flow-through cell is used, remove the probe from the cell for the period of rapid flow.

If measurements are undertaken continuously, take measures to prevent probe overheat (over 70°C).

Flow rate through the cell is to be maintained within the range from 0.07 to 0.60 dm^3/min. High water flow rate may cause analyzer unstable readings. Too high flow rate may lead to probe membrane damage.

2.4.2 Measurement in a laboratory

To undertake measurements in a laboratory fill analyzable water to an appropriate container and ensure analyzable water flow rate in relation to the probe membrane of at least 5 cm/s. To do so, we recommend that a magnetic stirrer be used.

2.5 Troubleshooting

2.5.1 Typical analyzer troubles and remedies are tabulated in Table 2.4.

In the event of troubles shown in Table 2.4, it is necessary to take corrective actions recommended in the "Remedy" column (refer to paragraphs below and Fig. 1.4, 2.19-2.22).

Table 2.4

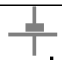
Trouble	Probable cause	Remedy
1 Analyzer does not turn on	Defective power cable.	Check power cable.
	Defective fuses.	Replace fuses (2.5.8) in the panel analyzer. Repair at a factory, if a wall-mounted analyzer is used.
2 Display shows channel **A** (**B**) and **"WARNING! PROBE IS NOT CONNECTED!"** message	The probe is not connected to channel **A** (**B**).	Connect the probe to channel **A** (**B**).
3 Analyzer temperature reading is inconsistent (about 150°C)	Broken temperature probe circuit.	To be remedied at factory.

Table 2.4 (continued)

Trouble	Probable cause	Remedy
4 On air calibration readings do not exceed 3 ppb.	Torn or pierced probe membrane or diaphragm (tightness is impaired), torn Teflon film.	Paragraphs 2.5.4-2.5.7 Replace membrane assembly or diaphragm. Replace Teflon film. Replace electrolyte.
	Broken (cracked) probe electrode glass tube-holder.	To be repaired at factory.
5 On hydrogen calibrating the display shows **"PROBE CURRENT < 1 μA"** message	Probe is in a medium other than hydrogen.	Place the probe in hydrogen medium.
	No electrolyte.	Paragraph 2.5.3. Refill electrolyte.
	Dirty membrane.	Paragraph 2.5.2. Clean membrane.
	Dry membrane.	Keep the probe in distilled water for 1-2 days.
6 On hydrogen calibrating the display shows **"PROBE CURRENT > 10 μA"** message	Torn Teflon film.	Paragraph 2.5.7. Replace Teflon film.
7 Slow response to change in hydrogen concentration	Analyzer has not been used for a long time.	Paragraph 2.3.4.3. Undertake probe cycling.
	Dirty membrane.	Paragraph 2.5.2. Clean membrane.
	Stretched membrane.	Paragraph 2.5.6. Replace membrane assembly.
	Probe overfilled with electrolyte (diaphragm bulging).	Drain excessive electrolyte.
8 In measurements analyzer readings change rapidly and are unstable	Very high water flow rate in the flow-through cell.	Set water flow rate in the flow-through cell from 200 to 600 cm^3/min.

	Unstable water flow.	Ensure flow stability.

Table 2.4 (continued)

Trouble	Probable cause	Remedy
9 Display shows "**WARNING! NO COMMUNICATION WITH AMPLIFIER BOARD!!!**" message	No link between display board and amplifier board.	To be repaired at factory.
10 Display shows "**M**" blinking letter to the left from channel indication (A or B)	Probe memory failure.	Check contact in the connector. Switch off and switch on analyzer again. If "**M**" letter persists, repair is to be made at a factory.
11 Display shows "  " blinking symbol to the right from channel indication (A or B)	Voltage of CR2032 lithium cell on the board inside the converter unit is below 2.2V	Replace the cell.

IMPORTANT: If insulation of the cable connecting the probe to the converter unit is damaged, the cable is to be repaired at the factory since moisture in the cable completely impairs probe operation!

2.5.2 Membrane cleaning

To clean the membrane, use a piece of soft cloth wet with alcohol.

The probe membrane may be submerged in a weak solution (2%) of sulfuric acid for about 1 h and then flushed under running water.

2.5.3 Electrolyte filling up (refilling)

To do so, as shown in Fig 2.19, proceed as follows:

– turn the coupling nut counter clockwise, remove it and moisten the membrane inside and the rubber ring with electrolyte;

– turn the coupling nut clockwise against stop to push membrane to the platinum anode;

– loosen the protective cup;

– shift the protective cup from the probe casing to the connecting cable;

– inject 4 cm^3 of electrolyte through one of the filler orifices in the probe casing using a syringe. To allow electrolyte to reach electrodes, shake the probe a few times;

– displace the rubber ring so that it covers both filler orifices; and

– tighten the protective cup.

1 Important: Electrolyte contains acid! Adhere to safety precautions!

2 Important: Do not overfill the probe with electrolyte (diaphragm bulging)!

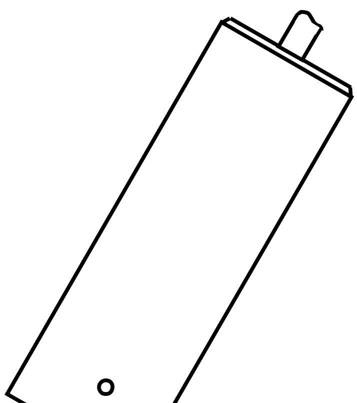
2.5.4 Electrolyte replacement

Electrolyte is to be replaced when it is dirty, or tightness of the membrane or the diaphragm is affected. The symptoms comprise unstable analyzer readings and high readings with the probe in air.

Loosen the protective cup as shown in Fig. 2.20. Displace the rubber ring to uncover two electrolyte filler orifices.

Turn the probe so that the membrane assembly is in the up position, and draw off old electrolyte through one of the filler orifices using a syringe.

Fill up fresh electrolyte as described in 2.5.3.



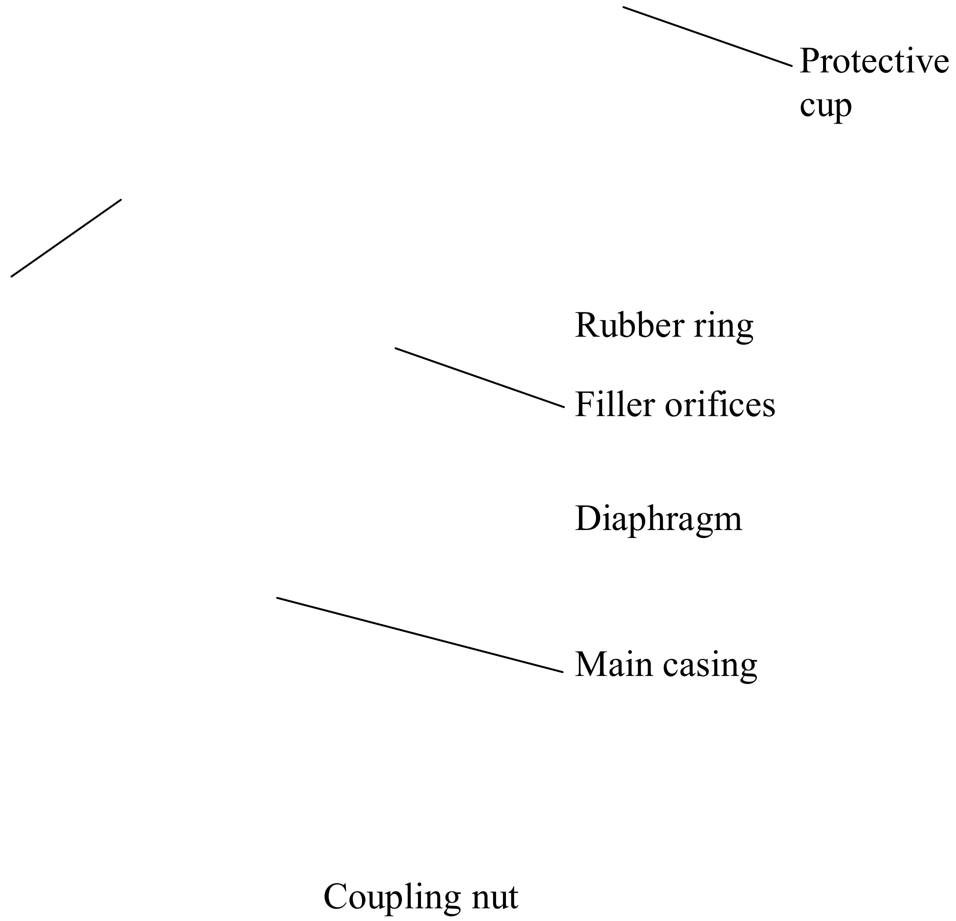
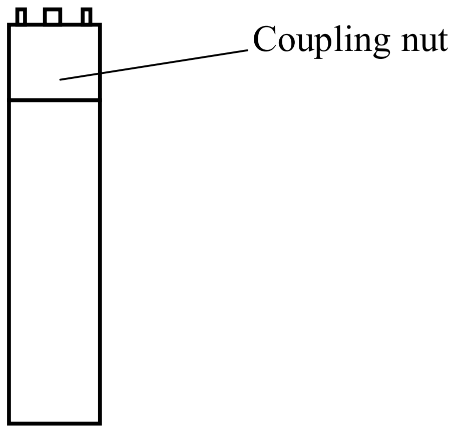


Fig. 2.19 – Filling up (refilling) electrolyte



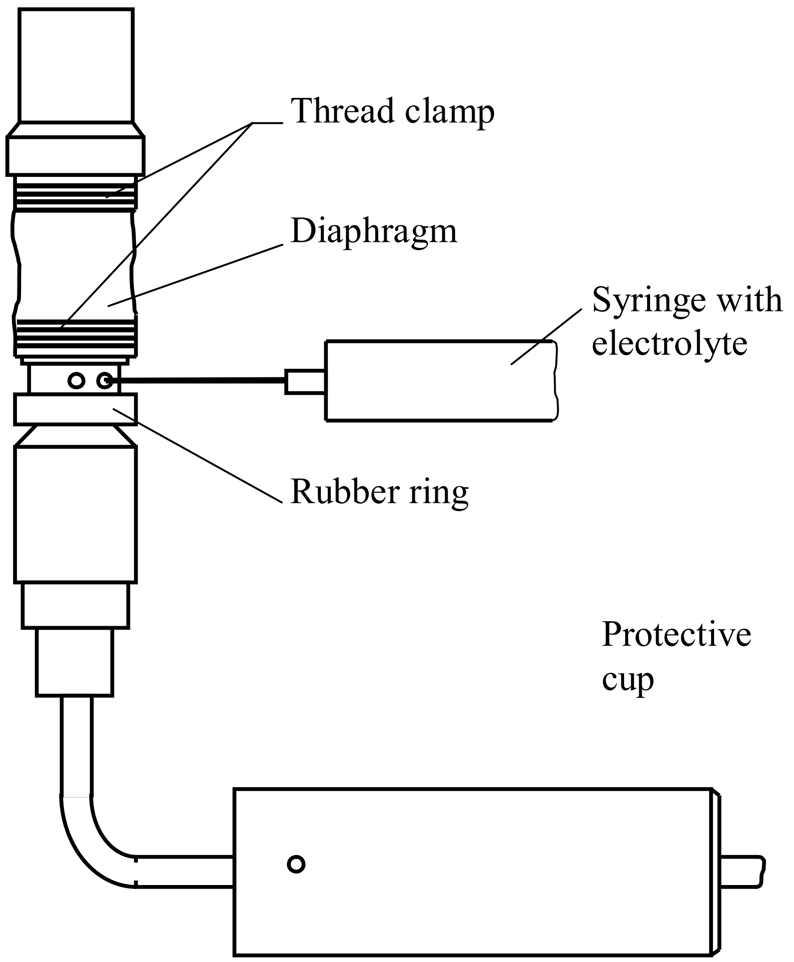


Fig. 2.20 – Replacement of electrolyte and diaphragm

2.5.5 Diaphragm replacement

2.5.5.1 Loss to diaphragm tightness may cause electrolyte outflow or contamination.

Loosen the protective cup as shown in Fig. 2.20 and inspect the diaphragm visually. If visible mechanical damages are detected (cracks, orifices), replace the diaphragm for a new one from the SPTA kit.

After replacement the diaphragm is secured by a thread clamp.

To do so, proceed as follows:

– remove damaged diaphragm;

– install a new diaphragm from the SPTA kit and smooth it out so that the diaphragm tightly fits on rubber sealing rings;

– fold the end of the thread and place it along the diaphragm as shown in Fig. 2.21*a*;

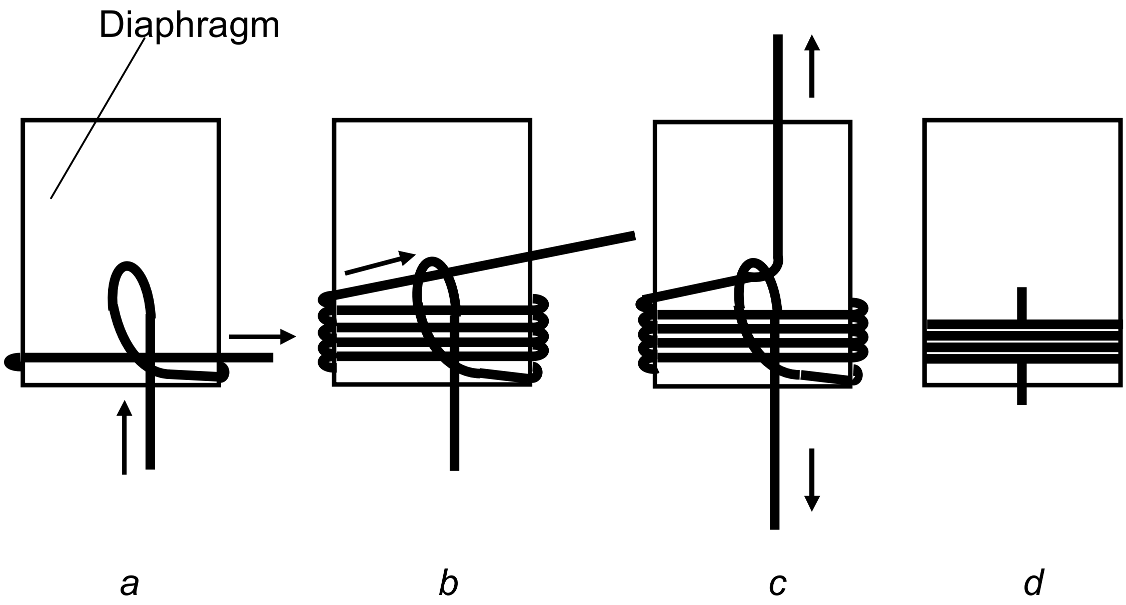


Fig.2.21

– wind 5-6 coils round the loop near to the silicone ring and then insert the thread end through diaphragm loop as shown in Fig. 2.21*b*;

– pull the thread end to shift the resultant knot under diaphragm thread coils as shown in Fig. 2.21*c*;

– cut off excessive length of the diaphragm thread as shown in Fig. 2.21*d*;

– secure the diaphragm in a similar way near the second silicone ring; and tighten the protective cup.

2.5.6 Replacement of membrane

The membrane is replaced in the event of damage (cracks, stretching). The symptoms include: unstable analyzer readings, high readings in air, and slow response in measurements of hydrogen concentration.

Turn the probe so that the membrane assembly is in the up position in order to prevent electrolyte outflow during disassembly thereof. Loosen the coupling nut (Fig. 2.22), remove the old membrane assembly therefrom (castle bushing with a rubber ring and membrane). Make sure that Teflon film is free of mechanical defects (holes, cracks, crumples) and tightly fits on the platinum cathode.

In the event any defect is detected, replace the Teflon film in compliance with 2.5.7.

If film defects are not found, install a new membrane assembly from the SPTA kit in the coupling nut, moisten the membrane and rubber ring inside with electrolyte, and tighten the nut onto the probe casing against stop.

Fill up electrolyte in compliance with 2.5.3, submerge the probe into distilled water for at least 8 h and perform operations as in 2.3.3-2.3.5.

2.5.7 Replacement of Teflon film

The Teflon film is replaced if it has visible defects (tears, holes) or if replacement of the membrane assembly or diaphragm failed to ensure normal operation of the probe.

Loosen the protective cup as shown in Fig. 2.22, screw out the nut with flattened surfaces.

Carefully remove the rubber sealing ring using a pincers. Carefully remove the inner casing out of the main casing and drain electrolyte. Remove old Teflon film. Inspect probe electrodes. The platinum anode embedded into a glass tube is to be of dark (black) color. The silver cathode wound round the tube is to be of grey color.

Take a new Teflon film from the SPTA kit and apply it onto the anode surface. Do not move the film on the electrode since special black coating applied onto the anode may be easily damaged.

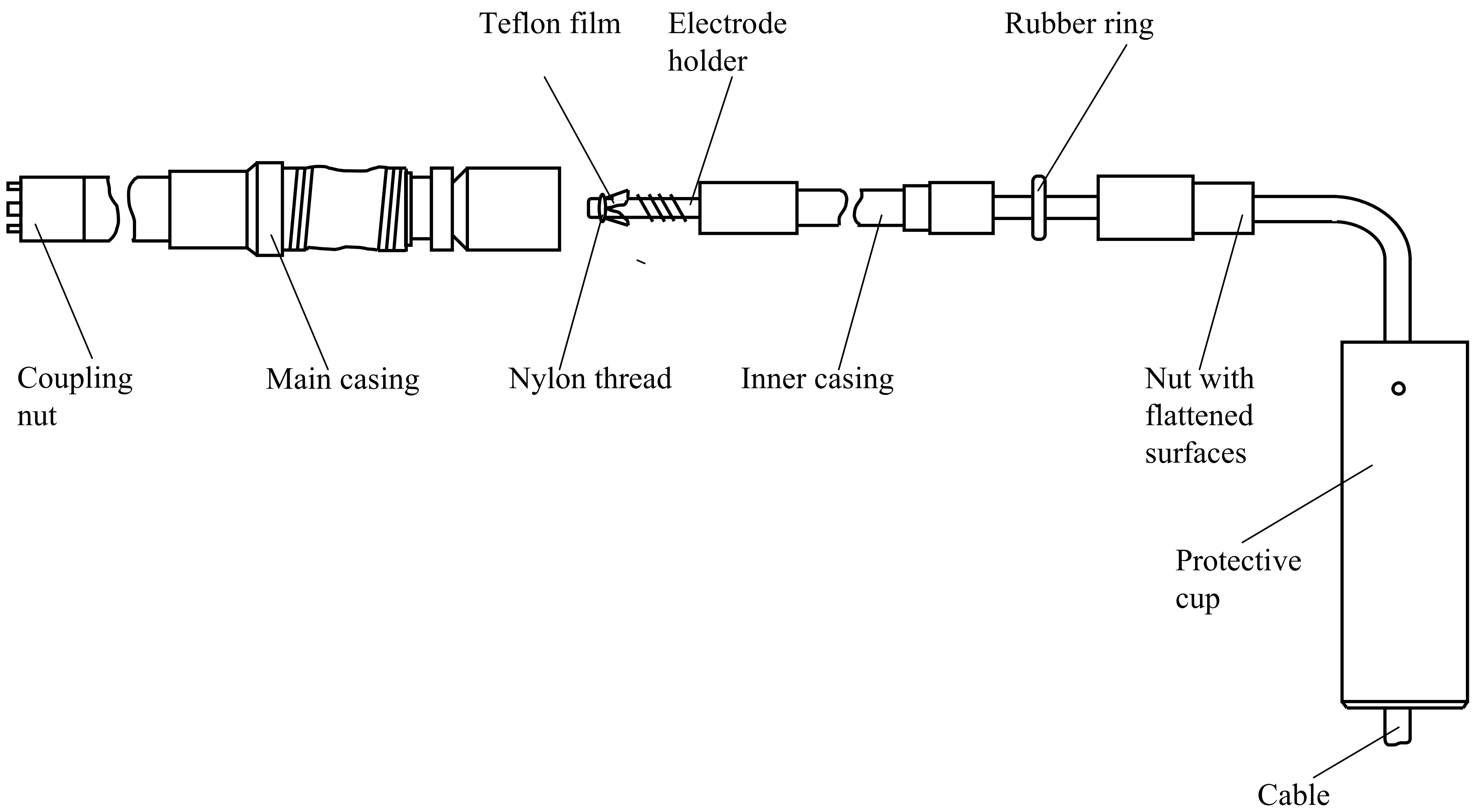


Fig. 2.22 – Sequence of probe assembly operations after replacement of membrane and Teflon film

Press film edges to the glass tube surface and holding them by hand wind up and 5-6 coils of nylon thread and make 2-3 knots. The film will be tightly pressed to the anode.

IMPORTANT: TEFLON FILM MUST BE FREE FROM TEARS AND HOLES!

The probe shall be assembled in the following way.

Insert inner casing into the main casing, mount the rubber ring. Tighten the nut. Refill electrolyte according to 2.5.3 and tighten the protective cup.

After overhaul hold the probe in distilled water with the analyzer ON for at least 24 h and then carry out operations stated in 2.3.3-2.3.5.

2.5.8 Line fuses

Fuses in the panel converter unit are replaced after troubles that caused destruction of fuses are remedied.

The primary winding of the supply transformer includes two (0.5 A/250V) fuses.

The secondary winding of the supply transformer includes four (1A/250V) fuses.

2.5.9 Setting of probe initial parameters

2.5.9.1 Probe initial parameters setting procedure

To go over to the probe initial parameters setting procedure it is necessary to:

– switch on measurement display of the channel required;
– de-energize the analyzer;
– press the "⇓ " button and holding it switch on the analyzer.

Display shown in Fig. 2.23 will come on.

```
A   SET OF INITIAL
    PARAMETERS FOR
    PROBE
    CAL. CURRENT
    SHIFT
    PROBE PROGRAM

  ► EXIT
```

Fig. 2.23

If the pointer "►" is set against the **OUTPUT** line, on depressing the "$\frac{\text{menu}}{\text{enter}}$" button the analyzer goes over to the measurement mode.

A provision is made in the analyzer for the following:

– setting the slope corresponding to the probe initial parameter (**CAL. CURRENT**); and

– zero shift setting (**SHIFT**);

These operations make it possible to start calibration under initial conditions.

They are to be undertaken if **calibration procedures performed by the analyzer seem to be doubtful.**

– Setting of all probe initial parameters including parameters of the temperature channel (**PROBE PROGRAM**). This operation is auxiliary and is **not employed** in use of the analyzer!

2.5.9.2 Initial slope setting

Set the pointer "►" against the **CALIBRATION CURRENT** line and press the "$\frac{\text{menu}}{\text{enter}}$" button. The display shown in Fig. 2.24 will appear.

A **SET CALIBRATION**
CURRENT 4.00 μA

CAL. CURRENT: X.XX μA

PERFORM
► EXIT

Fig. 2.24

Set the pointer "►" against the **PERFORM** line and press the "$\frac{\text{menu}}{\text{enter}}$" button. The display shown in Fig. 2.25 will appear.

A **SET CALIBRATION**
CURRENT 4.00 μA

CAL. CURRENT: 4.00 μA

PERFORM
► EXIT

Fig. 2.25

Press the " $\frac{\text{menu}}{\text{enter}}$ " button. The display shown in Fig. 2.23 will appear. The average slope corresponding to probe current of 4 μA is set.

2.5.9.3 Setting of zero shift

Set the pointer "►" against **SHIFT** line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. The display shown in Fig. 2.26 will come on.

A	**SET SHIFT**	**0.0 μA**
	SHIFT:	**X.X μA**
	PERFORM	
	► EXIT	

Fig. 2.26

Set the pointer "►" against the **PERFORM** line and press the " $\frac{\text{menu}}{\text{enter}}$ " button. The display shown in Fig. 2.27 will come on.

A	**SET SHIFT**	**0.0 μA**
	SHIFT:	**0.0 μA**
	PERFORM	
	► EXIT	

Fig. 2.27

Press the " $\frac{\text{menu}}{\text{enter}}$ " button. The display shown in Fig. 2.23 will come on. Zero shift is set.

3 MAINTENANCE

3.1 "Zero" point check and analyzer air calibration (2.3.4) are to be undertaken:

- after replacement of the membrane assembly;
- after replacement of Teflon film;
- if analyzer readings seem to be doubtful; and
- if the analyzer has not been used for a long time.

3.2 Analyzer hydrogen calibration is undertaken (2.3.5):

- on a quarterly basis;
- after replacement of the membrane assembly;
- after replacement of Teflon film; and
- if analyzer readings seem to be doubtful.

3.3 Converter unit external surfaces are to be cleaned of dirt using soft detergents. Avoid ingress of moisture into the МАРК-509 analyzer converter unit.

3.4 Water flow stabilizing module, flow-through cell, and metal tube are to be cleaned using 10% hydrochloric or sulfuric acid solution and then flushed with water.

3.5 If the display shows the " ⊥ " icon in the left upper corner, replace lithium cell on the amplifier board inside the converter unit.

4 DELIVERY SET

4.1 Delivery set is shown in Table 4.1.

Table 4.1

Description	Identification	Quantity	
		МАРК-509	МАРК-509/1
Converter unit	ВР50.01.000	1	–
	ВР50.01.000-01	–	1
Hydrogen probe	ВР50.02.000	1*	1*
	ВР50.02.000-01	1*	1*
Set of mounting parts	ВР50.03.000	1	1
Tools and appliances kit	ВР50.04.000	1	1
Set of mounting parts	ВР50.08.000	1	–
Operation Manual	ВР50.00.000РЭ	1	1

* Quantity (1 or 2) as agreed to by the customer.

ANNEX A
(reference)

Solubility of hydrogen being in equilibrium with water vapor in distilled water according to temperature

P_{atm}= 101.325 kPa

Table A.1

In ppb

t °C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1,922	1920	1918	1916	1914	1913	1911	1909	1907	1,905
1	1,904	1,902	1,900	1,898	1,896	1,895	1,893	1,891	1,889	1,888
2	1,886	1,884	1,882	1,880	1,879	1,877	1,875	1,873	1,872	1,870
3	1,868	1,866	1,865	1,863	1,861	1,859	1,857	1,856	1,854	1,852
4	1,851	1,849	1,847	1,845	1,844	1,842	1,840	1,838	1,837	1,835
5	1,833	1,831	1,830	1,828	1,826	1,825	1,823	1,821	1,819	1,818
6	1,816	1,814	1,813	1,811	1,809	1,807	1,806	1,804	1,802	1,801
7	1,799	1,797	1,796	1,794	1,792	1,791	1,789	1,787	1,785	1,784
8	1,782	1,780	1,779	1,777	1,775	1,774	1,772	1,771	1,769	1,767
9	1,766	1,764	1,762	1,761	1,759	1,757	1,756	1,754	1,752	1,751
10	1,749	1,748	1,746	1,744	1,743	1,741	1,739	1,738	1,736	1,735
11	1,733	1,731	1,730	1,728	1,727	1,725	1,723	1,722	1,720	1,719
12	1,717	1,716	1,714	1,712	1,711	1,709	1,708	1,706	1,705	1,703
13	1,701	1,700	1,698	1,697	1,695	1,694	1,692	1,691	1,689	1,688
14	1,686	1,685	1,683	1,681	1,680	1,678	1,677	1,675	1,674	1,672
15	1,671	1,669	1,668	1,666	1,665	1,663	1,662	1,660	1,659	1,657
16	1,656	1,654	1,653	1,651	1,650	1,659	1,647	1,646	1,644	1,643
17	1,641	1,640	1,638	1,637	1,635	1,634	1,633	1,631	1,630	1,628
18	1,627	1,625	1,624	1,623	1,621	1,620	1,618	1,617	1,615	1,614
19	1,613	1,611	1,610	1,608	1,607	1,606	1,604	1,603	1,601	1,600
20	1,599	1,597	1,596	1,594	1,593	1,591	1,590	1,588	1,587	1,585
21	1,584	1,582	1,581	1,579	1,578	1,576	1,575	1,573	1,572	1,571
22	1,569	1,568	1,566	1,565	1,563	1,562	1,561	1,559	1,558	1,556
23	1,555	1,554	1,552	1,551	1,550	1,548	1,547	1,545	1,544	1,543
24	1,541	1,540	1,539	1,537	1,536	1,535	1,533	1,532	1,531	1,530
25	1,528	1,527	1,526	1,524	1,523	1,522	1,521	1,519	1,518	1,517
26	1,515	1,514	1,513	1,512	1,511	1,509	1,508	1,507	1,506	1,504
27	1,503	1,502	1,501	1,500	1,498	1,497	1,496	1,495	1,494	1,492
28	1,491	1,490	1,489	1,488	1,486	1,485	1,484	1,483	1,482	1,481
29	1,480	1,478	1,477	1,476	1,475	1,474	1,473	1,472	1,470	1,469
30	1,468	1,467	1,466	1,465	1,464	1,463	1,462	1,460	1,459	1,458
31	1,457	1,456	1,455	1,454	1,453	1,452	1,451	1,450	1,449	1,448
32	1,446	1,445	1,444	1,443	1,442	1,441	1,440	1,439	1,438	1,437
33	1,436	1,435	1,434	1,433	1,432	1,421	1,420	1,419	1,418	1,417
34	1,426	1,425	1,424	1,423	1,422	1,421	1,420	1,419	1,418	1,417
35	1,416	1,415	1,414	1,413	1,412	1,411	1,410	1,409	1,408	1,407
36	1,406	1,405	1,404	1,403	1,402	1,401	1,400	1,399	1,398	1,397
37	1,396	1,395	1,394	1,393	1,392	1,391	1,390	1,389	1,388	1,387
38	1,386	1,385	1,384	1,383	1,382	1,382	1,381	1,380	1,379	1,378
39	1,377	1,376	1,375	1,374	1,373	1,372	1,371	1,370	1,369	1,368

Table A.1 (continued)

t °C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
40	1,367	1,366	1,365	1,364	1,364	1,363	1,362	1,361	1,360	1,359
41	1,358	1,357	1,356	1,355	1,354	1,353	1,352	1,351	1,350	1,349
42	1,349	1,348	1,347	1,346	1,345	1,344	1,343	1,342	1,341	1,340
43	1,339	1,338	1,337	1,336	1,335	1,334	1,333	1,333	1,332	1,331
44	1,330	1,329	1,328	1,327	1,326	1,325	1,324	1,323	1,322	1,321
45	1,320	1,319	1,318	1,317	1,316	1,316	1,315	1,314	1,313	1,312
46	1,311	1,310	1,309	1,308	1,307	1,306	1,305	1,304	1,303	1,302
47	1,301	1,300	1,299	1,298	1,297	1,296	1,295	1,294	1,293	1,292
48	1,291	1,290	1,289	1,288	1,287	1,286	1,285	1,284	1,283	1,282
49	1,281	1,280	1,279	1,278	1,277	1,276	1,275	1,274	1,273	1,272
50	1,271	1,270	1,269	1,268	1,267	1,266	1,265	1,264	1,263	1,262
51	1,261	1,260	1,259	1,258	1,257	1,256	1,255	1,254	1,253	1,252
52	1,251	1,250	1,249	1,247	1,246	1,245	1,244	1,243	1,242	1,241
53	1,240	1,239	1,238	1,237	1,236	1,234	1,233	1,232	1,231	1,230
54	1,229	1,228	1,227	1,226	1,224	1,223	1,222	1,221	1,220	1,219
55	1,218	1,216	1,215	1,214	1,213	1,212	1,211	1,210	1,208	1,207
56	1,206	1,205	1,204	1,202	1,201	1,200	1,199	1,198	1,196	1,195
57	1,194	1,193	1,192	1,190	1,189	1,188	1,187	1,185	1,184	1,183
58	1,182	1,180	1,179	1,178	1,177	1,175	1,174	1,173	1,172	1,170
59	1,169	1,168	1,166	1,165	1,164	1,162	1,161	1,160	1,158	1,157
60	1,156	1,154	1,153	1,152	1,150	1,149	1,148	1,146	1,145	1,144
61	1142	1,141	1,139	1,138	1,137	1,135	1,134	1,132	1,131	1,130
62	1,128	1,127	1,125	1,124	1,122	1,121	1,119	1,118	1,117	1,115
63	1,114	1,112	1,111	1,109	1,108	1,106	1,105	1,103	1,102	1,100
64	1,099	1,097	1,095	1,094	1,092	1,091	1,089	1,088	1,086	1,085
65	1,083	1,081	1,080	1,078	1,077	1,075	1,073	1,072	1,070	1,068
66	1,067	1,065	1,063	1,062	1,060	1,058	1,057	1,055	1,053	1,052
67	1,050	1,048	1,047	1,045	1,043	1,041	1,040	1,038	1,036	1,034
68	1,033	1,031	1,029	1,027	1,025	1,024	1,022	1,020	1,018	1,016
69	1,015	1,013	1,011	1,009	1,007	1,005	1,003	1,001	1,000	998
70	996	994	992	990	988	986	984	982	980	978