

SPINNER MAGNETOMETER

JR5A / JR5

User's Manual

Instrument for measuring
remanent magnetization

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Contens

Warranty	4
GENERAL SAFETY SUMMARY	5
Convention.....	5
Injury Precautions	5
Product Damage Precautions	6
1. INTRODUCTION.....	7
1.1 Unpacking Instructions	8
1.2 Storage and Transportation.....	8
2. JR-5A / JR-5 SPECIFICATIONS	9
3. DESCRIPTION	11
3.1 Measuring Principle.....	11
3.2 Pick-up Unit	11
3.2.1 Specimen holder.....	11
3.2.2 Mechanical set-up JR-5A.....	13
3.3 Measuring Unit	18
3.3.1 Description of controls.....	19
3.3.2 Display	19
4. INSTALLATION PROCEDURES.....	20
4.1 Choosing the Place.....	20
4.2 Interconnection of Units	21
4.3 Magnetometer Switching On	21
5. OPERATION.....	22
5.1 Local Mode (control from the front panel).....	22
5.2 Remote Mode (control by computer program)	22
5.2 Remote Mode - automatic holder	24
5.3 Set Mode	24
5.3.1 Setting the type of specimen	25
5.3.2 Setting the type of holder and the last measuring position	26

5.3.3 Setting the type of displayed units	27
5.3.4 Setting the RS-232C serial channel baud rate	27
5.3.5 Saving the nominal value of the calibration standard and gain into EEPROM memory	27

6. MEASUREMENT 28

6.1 Calibration	28
6.2 Correction for the Holder.....	30
6.3 Measurement in Local Mode	31
6.3.1 Shape and size of the specimen.....	31
6.3.2 Marking of specimens	31
6.3.3 Measurement in six positions	31
6.3.4 Measurement in four positions	32
6.3.5 Measurement with automatic holder	34
6.4 Measurement in Remote Mode	35

7. ADDITIONAL INFORMATION 36

7.1 The RS-232C Serial Interface.....	36
7.2 Maintenance and Repairs.....	36
7.4 Accessories	37
7.5 Orientation Parameter (file REMA5.FAC).....	38

8. APPENDICES 40

8.1 List of Errors.....	40
8.2 Magnetometer Messages - Examples.....	41
8.3 Program for Testing the Communication with a Computer.....	42

Warranty

AGICO warrants that this product will be free from defects in materials and workmanship for a period of 1 (one) year from date of installation. However, if the installation is performed later than 3 (three) months after the date of shipment due to causes on side of Customer, the warranty period begins three months after the date of shipment. If any such product proves defective during this warranty period, AGICO, at its option, either will repair the defective product without charge for parts and labour, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify AGICO of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. AGICO will decide if the repair is to be performed by AGICO technician or AGICO delegated serviceman in customers laboratory, or product shall be sent for repair to the manufacturer. In latter case, customer shall be responsible for packaging and shipping the defective product to the AGICO service centre. In both cases, all the costs related to a warranty repair shall be at expenses of AGICO.

The warranty becomes invalid if the Customer modifies the instrument or fails to follow the operating instructions, in case of failure caused by improper use or improper or inadequate maintenance and care, or if the Customer attempts to install the instrument without explicit written permission of AGICO company. AGICO shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than AGICO representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification increases the time or difficulty of servicing the product.

This warranty is given by AGICO with respect to this product in lieu of any other warranties, expressed or implied. AGICO and its vendors disclaim any implied warranties of merchantability or fitness for a particular purpose. AGICO's responsibility to repair or replace defective products is the sole and exclusive remedy provided to the Customer for breach of this warranty. AGICO and its vendors will not be liable for any indirect, special, incidental, or consequential damages irrespective of whether AGICO or vendor has advance notice of the possibility of such damages.

General Safety Summary

Review the following safety precautions to avoid and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

Convention



Symbol **Attention** is used to draw attention to a particular information.



Symbol **Prohibition** is used to accent important instruction, omission of which may cause loss of properties, damage or injury.

Injury Precautions

Use Proper Power Cord. To avoid fire hazard, use only the power cord specified for this product.

Do Not Operate Without Covers. To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Fasten Connectors. Do not operate the instrument if all connectors are not properly plugged and fixed by screws.

Do Not Operate in Wet / Damp Conditions. To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere. To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Disconnect Power Source. To avoid risk of electric shock unplug the instrument from mains before reinstalling or removing unit.

Product Damage Precautions

Use Proper Power Source. Do not operate this product from a power source that applies more than the voltage specified.

Use Proper Fuses only. Do not use fuses which are not specified by the manufacturer. If a fuse with a different characteristics or value is used, the protection is not effective.

Operator's Training. Operator should be familiar with operation of the instrument and Safety Regulations.

Use Manufacturer's Cables Only. Other devices can be connected to the instrument via the appropriate cables only.

Do Not Disconnect Connectors. To avoid damage of the instrument never disconnect any connector while device is on.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

1. Introduction

The JR-5A / JR-5 spinner magnetometer is a laboratory instrument for measurements of remanent magnetization (RM) of rock specimens in studies of magnetic properties of rocks.

All functions are microprocessor-controlled. The microprocessor controls measurements, carries out digital filtration of the signal, and controls and tests the speed of specimen rotation. The magnetometer is usually controlled by an external computer, but can also be operated stand alone and connected on-line with a printer.

The spinner magnetometer JR-5A with automatic specimen holder is an innovated version of the spinner magnetometer JR-5. All features of the JR-5 are retained, including the possibility of using standard specimen holders for four or six positions.

New features of the instrument JR-5A:

- Automatic measuring of all components of RM vector.
- Repeat mode for each position of the specimen.
- Measurement time for one specimen is three or four times shorter.

Limitation to the automatic style of operation (JR-5A option) :

- Specimens with considerable deviations in size and shape cannot be measured in the automatic specimen holder. This condition is more restrictive than in the case of standard manual holder, which can still be used with this instrument.
- It is necessary to centre the specimen precisely in the holder, the high speed of revolution requires specimens carefully balanced.
- Periodic fine-tuning of mechanical components may be needed.

1.1 Unpacking Instructions

Remove carefully the instrument and its accessories from the box and packing material, referring to the packing list included to confirm that everything has been delivered. Briefly inspect each item for shipping damage. If anything is missing or damaged, contact the manufacturer or your dealer immediately. You may want to retain the box and other packing material in case later you need to ship the instrument.

1.2 Storage and Transportation

The properly wrapped instrument can be stored and transported at a temperature -20°C to $+55^{\circ}\text{C}$ and relative humidity up to 80 %. In both cases the instrument should be stored in suitable premises, free of dust and chemical evaporation.

Note 1

Standard error of measurement of any RM component, pick-up unit without specimen holder, the most sensitive range.

Note 2

Standard error of measurement of any RM vector component. Specimen of the absolute value of RM less than 100 $\mu\text{A}/\text{m}$, the measuring method according to 6.3.3 (i.e. standard measurement in six positions, each component is measured 4 times).

Note 3

Specimen of nominal size and shape. Deviations in size and shape will cause errors in position and thus decreased precision of measurement.

3. Description

The JR-5A / JR-5 spinner magnetometer consists of a pick-up unit and a measuring unit.

3.1 Measuring Principle

Rock specimen of defined size and shape rotates at a constant angular speed in the pick-up unit inside a pair of coils. An AC voltage is induced in the coils whose amplitude and phase depend on the magnitude and direction of the RM vector of the specimen. The voltage is amplified, filtered and digitized. By Fourier analysis the computer calculates two rectangular components of the projection of RM vector into the plane perpendicular to the axis of rotation.

3.2 Pick-up Unit

The pick-up unit (Figs 3 and 4), consists of a base plate, a trapezoidal plate on which the motor and the bearing of the drive shaft is mounted, two circular plates with spinner system and a square plate with pick-up coils and permalloy shield.

The three adjustable screws (columns) on the base plate carry the circular plate on springs with a spring-cushioned block bearing the body of the spinner system. Attached to the shaft, mounted on sliding bearings, is a screen with 100+1 notches interrupting a light beam that falls from two infra red LEDs onto two phototransistors. The phototransistors produce the reference signals used to control the speed of specimen rotation and for digital processing of the signal.

Four columns with springs support the square plate bearing the pick-up coils fixed by three screws.

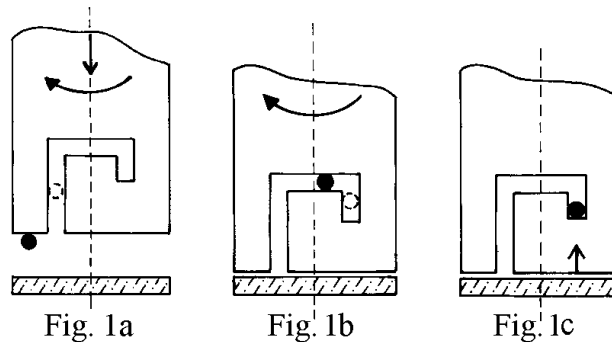
The pick-up coils are shielded with a triple permalloy shield. The shaft of the spinner system is connected with the shaft of the driving pulley by a universal coupling joint. The motor rotation is transferred by the driving belt. The speed of specimen rotation (89.3 rev/s) is derived from a crystal oscillator.

3.2.1 Specimen holder

The new version JR-5A of spinner pick-up unit permits easy installation of the specimen holders via a bayonet attachment of the specimen holder' shaft. This new bayonet spindle speeds up and simplifies the manipulation with the specimen holder.

Holder installation process:

Take the holder in one hand and hold a drive pulley beneath the pick-up unit with your other hand, to prevent turning of the shaft during the holder installation.

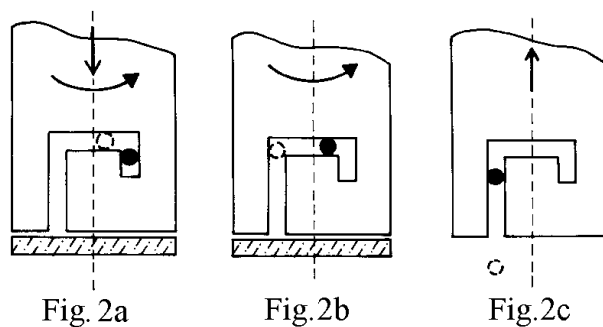


Put the holder on the shaft, press down slightly and at the same time turn the holder clockwise until the drive pin slides into a notch of the holder. At this moment, press slightly more strongly downwards (see Fig. 1a) to overcome the pressure of an elastic pad under the shank of the holder until the drive pin fits into a horizontal part of the bayonet groove (see Fig. 1b). Continue turning the holder clockwise, without downward pressure until the holder pops upward by a small amount (~1mm). At this moment the drive pin engages the end of the bayonet groove and retains the holder in a fixed orientation relative to the drive-shaft (Fig. 1c).

The upwards "jump" of the holder is necessary evidence of proper installation of the holder. In the case of an absence of this jump, it is necessary to find out the cause. Even a small impurity inside the shank of the holder can cause this problem and, in turn, the automatic mechanism for changing specimen orientation may fail.

Holder removal:

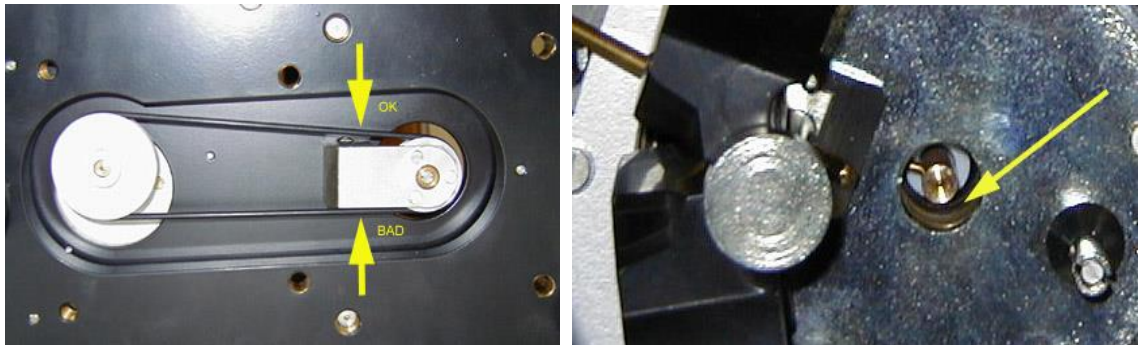
Hold the driving pulley by your left hand to prevent turning of the shaft. Push down the holder and, at the same time, turn the holder anticlockwise until the drive pin meets the horizontal part of the bayonet groove (see Fig. 2a). Continue turning the holder, without downward pressure, until the drive pin reaches the vertical part of the bayonet groove (see Fig. 2b). Take the holder out in this position (by pulling the holder upwards, Fig. 2c).



3.2.2 Mechanical set-up JR-5A

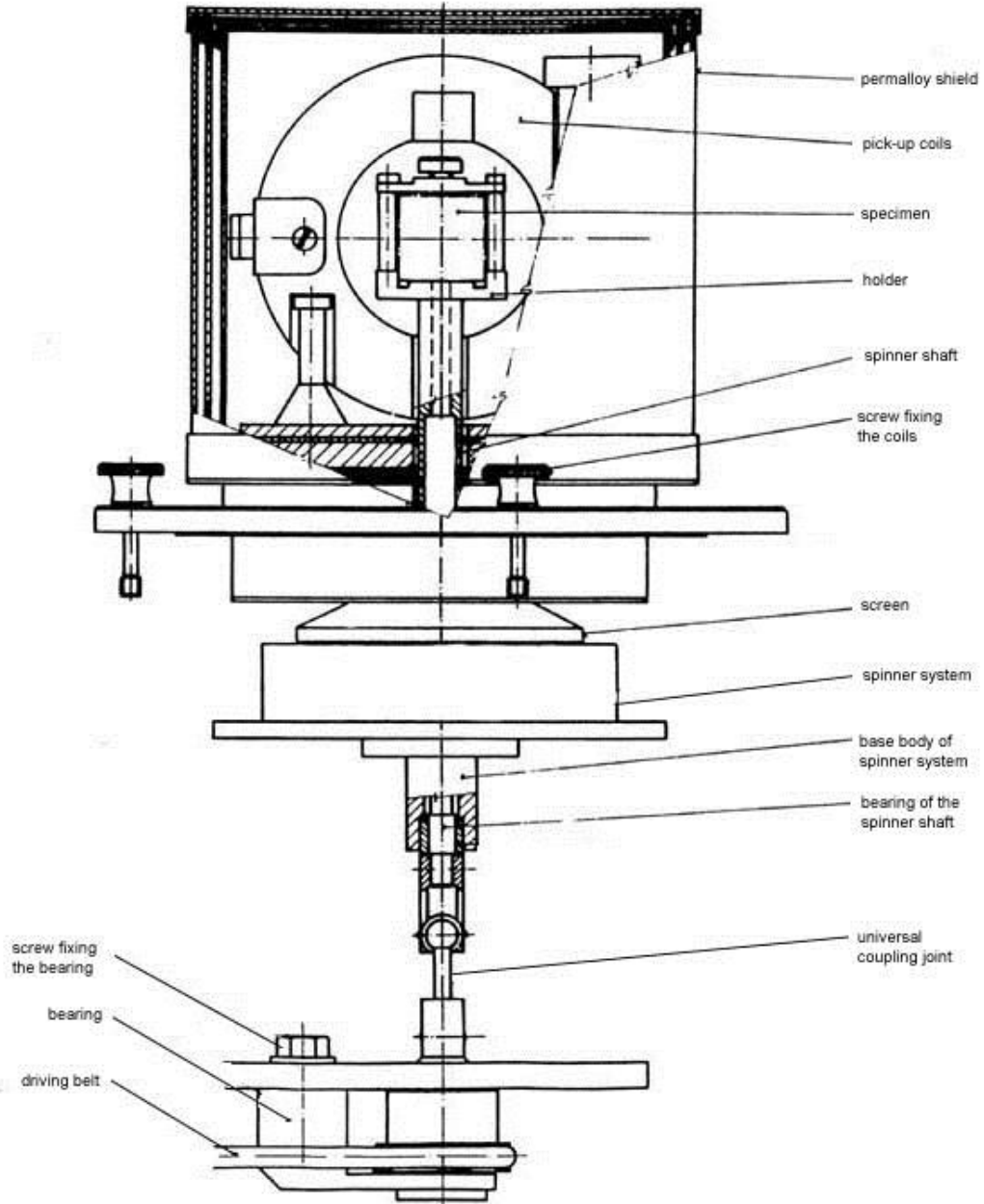
This chapter is for servicing purposes only. It is not necessary to read this part of the manual until problems are encountered or until routine servicing is perceived necessary.

For secure, reliable and smooth instrument running, the shaft of the spinner system (Fig.3) and the shaft of the pulley must be coaxial. If necessary, the pulley can be set in the horizontal plane after loosening two screws. Check that the drive belt does not touch the pulley bearing - box.



Check a clearance between the elastic pad and the hole, the shaft should be coaxial with the hole; in case the pad touch the hole, the system can vibrate. The correct function of the automatic manipulator depends on the correct setting of mechanical parts. In the case of incorrect function it is important to analyze the reason first and then perform an appropriate adjustment. Use the program JR5COM.EXE for testing each automatic function (e.g. key up, key down, next position etc.). JR5COM.EXE sends individual commands to the instrument and displays messages. The number of the serial port is preset in the file REMA5.FAC, parameter COM. The current configuration REMA5.FAC file must be present in working directory (or suitable path should be set). When the control unit is preset in automatic mode (see later), information regarding the angular position of the holder and of the hexagonal key is displayed on the front panel. A dot preceding the figure expressing the position number indicates the proper angular position of the holder with respect to the axis of the hexagonal key. A dot following the figure indicates the correct setting to one of the three positions of the hexagonal key around its own axis.

Fig. 3 Pick-up unit, spinner system



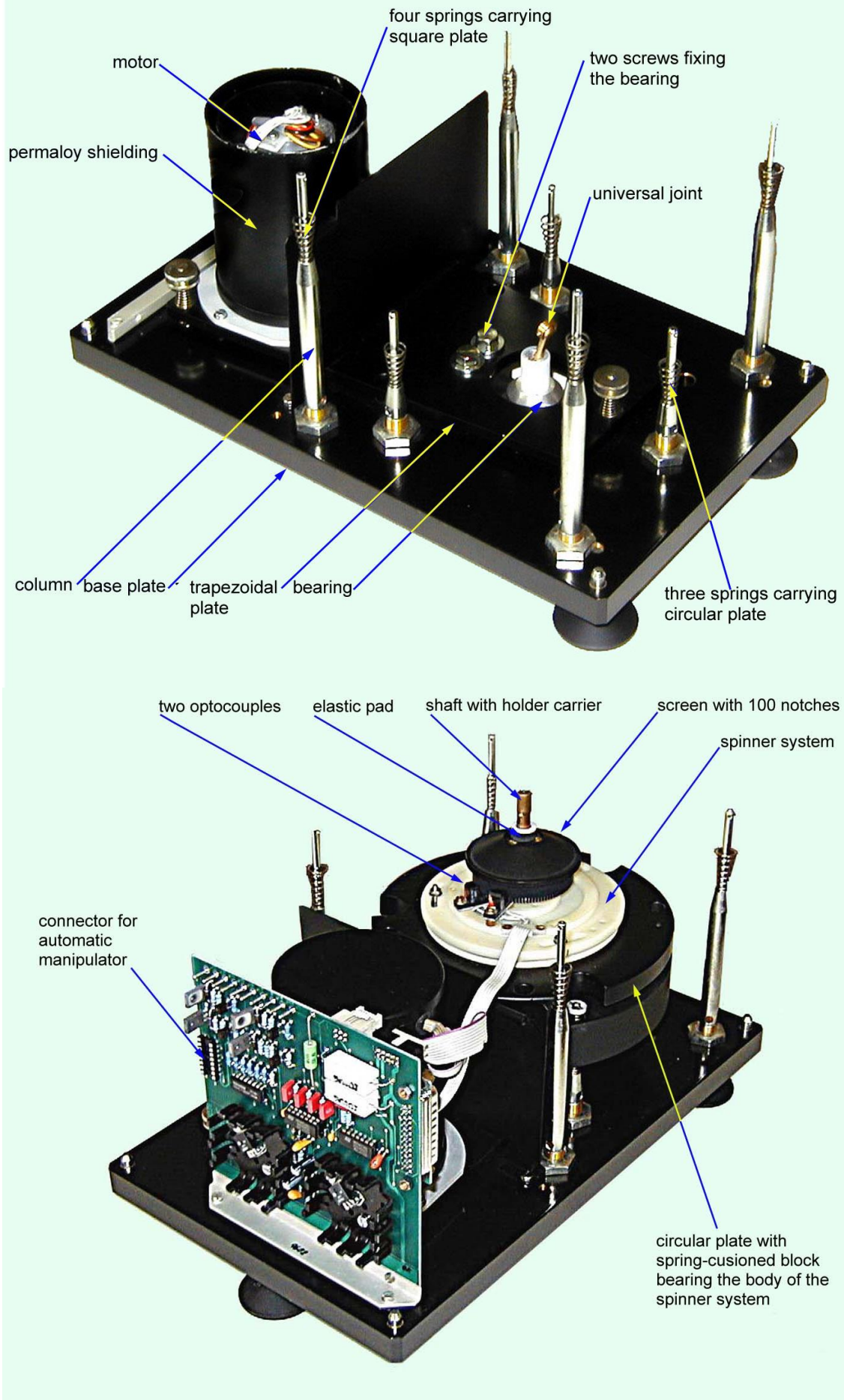


Fig. 4 Pick-up unit, partial configuration

Troubleshooting and probable reasons for improper function of the automatic manipulator and necessary correction:

1. *The holder stops in the incorrect angular position with respect to the axis of the hexagonal key - incorrect angular position in horizontal plane (see Fig. 5B).*

The axis of the ring and the axis of the hexagonal key must lie in the same vertical plane.

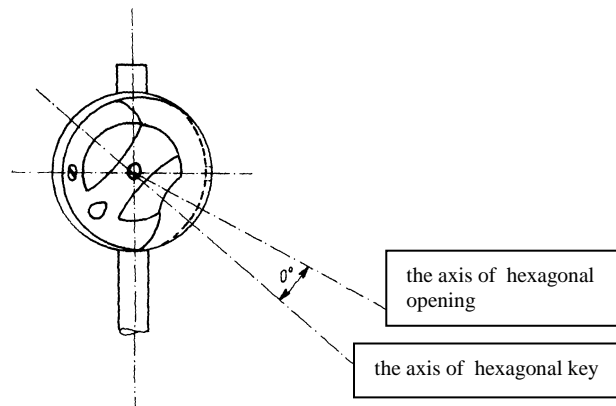


Fig. 5A. The rear view - the angle in vertical plane

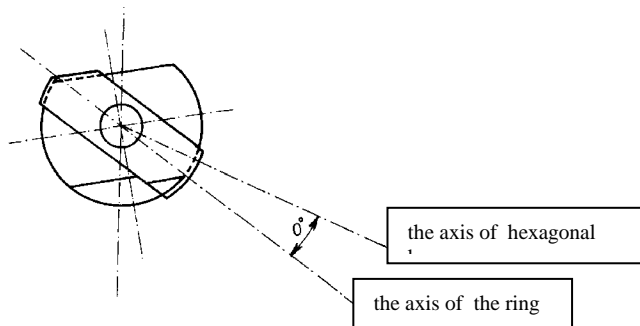


Fig. 5B The top view - the angle in horizontal plane

Setting:

Using command **u** (go **u**p) raise (shift) the hexagonal key to the working position. If necessary, turn the holder by a small angle (and/or turn also the rotating inner spherical core of the holder by a small angle) during raising the key. The key should fit into the hexagonal opening in the holder. If the dot preceding the figure expressing the position number does not light, loosen three nuts M3, which are under the square. Using command **d** (go **d**own) shift the hexagonal key to the rest (down) position, do not touch the holder and rotate the spinner system around a slight amount clockwise and anticlockwise.

Set the rotation system in the "middle" of the interval in which the light dot preceding the position number is on, subsequently tighten the three nuts and re-check the correct setting by executing "up" and "down" commands.

Next rotate the holder by hand to various angular positions in horizontal plane, while the hexagonal pin is in the rest (down) position. In any position check the proper function of the "up" and "down" commands. If necessary repeat setting again.

- 2. *The axis of the hexagonal opening and the axis of the hexagonal key do not lie in the same vertical plane (see Fig.5A).***

The axis of the ring and the axis of the hexagonal key in the vertical plane must be identical.

Adjustment:

It is possible to make a correction by changing the height of four long adjustable columns which bear the square plate and/or by changing the height of three adjustable screws which bear the circular plate (see Fig. 4). It is necessary to keep the main rotation axis of the holder perfectly perpendicular to the square plate and of perfect parallelism of all plates, and check the clearance between the upper part of the holder and right and left Helmholtz coil at the same time. Note that this adjustment is very sensitive: Be sure the columns does not turn while tightening the nuts. Hold them by inserting a metal rod into the hole in the appropriate column .

Check the correct setting by alternate "up" and "down" commands. The holder should be stationary as the hexagonal key rises to the working position. Another effect can occur, namely that the walls of the hexagonal key do not make with the hexagonal opening in the holder (see Fig. 6). This effect can be temporarily excluded by a very slight rotation of the spherical shell of the holder so that you will be able to successfully perform the correct adjustment of the height of the columns.

- 3. *The angular position of the hexagonal opening and the angular position of the hexagonal key do not mate: The walls of the hexagonal key are not parallel to the hexagonal socket (see Fig. 6).***

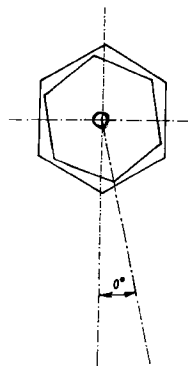


Fig. 6

Adjustment:

Raise the hexagonal key to the working position by using command "up" (if necessary turn the hexagonal key gently by a slight amount so that the hexagonal pin will fit in the hexagonal opening). Set individual positions by using the command "go to next". Check that all three measurement positions, (indicated by a light dot after the figure expressing the position number), is accompanied by simultaneous arrestment of the holder inner spherical shell by a spring-loaded ball (you will hear a " click " sound when the holder engages the correct positions). If this does not occur, take the cover off the pick-up unit. Loosen two small screws which fix the screen with three slots. The screws must be loosened to such a degree only that you can freely move the screen round, but the screen must not slip during indexing the hexagonal key. By successive slight rotation of the screen you must achieve the condition that an arrestment by the ball coincides with the light dot being on (following the position number).
Warning: Never turn the inner spherical shell of the holder by hand if the hexagonal key is "up", in the inserted working position – this may damage the motor gear-box.

When the housing is removed from the spinner unit, it may be necessary to prevent direct illumination of photoelectric elements which generate the signals for the control function.

4. *The inner spherical shell of the holder does not turn freely by gentle finger action.*

Adjust the screw in the base of holder spindle. This controls the tension in the spring which holds the inner spherical shell in position.

5. *The hexagonal key does not have free access into the hexagonal opening, which obstructs the movement between the working and rest positions.*

If cleaning the hexagonal opening and hexagonal key is ineffective, it is necessary to check the coaxiality the hexagonal opening and hexagonal key (see Point 2), or the mating of hexagonal key and socket (see Point 3 and Fig. 6).

3.3 Measuring Unit

The measuring unit incorporates electronic circuits for signal processing and evaluation, circuits for control of motor speed, a microcomputer and a LED display. For communication with a computer the instrument is equipped with the RS-232C serial channel.

On the rear panel are situated the "ON/OFF" switch, the "SET" push-button, the 25-pole "RS-232C" connector for connecting a computer , a 9-pole "PICK-UP UNIT" connector for connecting the pick-up unit and a 25-pole "MOTOR" connector for connecting the pick-up unit motor. On the front panel the display and the push-buttons are placed.

3.3.1 Description of controls

The controls are push-buttons on the front panel, the "ON/OFF" switch and the "SET" button on the rear panel.

ON/OFF	switching the instrument on and off.
SET	entering the set mode (see 5.3).
START/STOP	start of measurement, termination of any current operations.
CAL/CORR	start of calibration or correction for the holder.
AUTO	switching on and off the autorange mode.
[up], [dw]	increasing or decreasing the value being set. In the local mode this value represents the measuring range, the buttons function only if the autorange mode is off. In the set mode this value represents a parameter which has been set by the "NEXT" button.
NEXT	setting the next position value. In the set mode the value represents the next set type of parameter.

3.3.2 Display

The measuring unit incorporates a LED display which shows :

POSITION	after switch on, the letter P (Position) and one of the digits 1,2,3,4 or 6 representing the number of positions in the measuring cycle. In the set mode the letter A (Adjustment) is displayed and the digit 1-6 representing the type of the set parameter (see 5.3). In case of operation fail the letter E (Error) and the number of the error are displayed - see Appendix A.
VECTOR COMPONENTS	after switch on, the type of specimen (cube or cylinder) and the calibration standard nominal value are displayed. In the measuring mode the mantissa of two components of the RM vector or OFL (OverFLow). In the set mode the parameter being set is displayed.
EXPONENT	exponent of the components of the RM vector. The exponent also specifies the measuring range. In the lowest range the index L (Long time) can be added indicating that the time of measurement has been set to 100 s.
Flag REM	the instrument is set to REM ote mode
Flag A/m	components of the RM vector in [A/m] units
Flag T	components of the RM vector are shown in [T] units

4. Installation Procedures

The first installation and training is performed exclusively by the AGICO technician or by the authorised representatives. If you need later to reinstall the apparatus, due to the removing the instrument to another place or any other reasons, be sure the following conditions are met to achieve guaranteed parameters.

4.1 Choosing the Place

Place the apparatus to a room with relatively magnetically clean environment.



- The instrument must not be placed near sources of alternating magnetic field, e.g. big transformers, electric motors, electricity power source wires, thermal sources etc.
- Do not place the instrument near thermal and electrical sources and prevent the pick-up unit from direct sunshine. The coils must not be exposed to heat from the sun or from other sources, which would affect the precision of measurement.
- Do not place the pick-up unit near the other instruments or computer's monitors.
- The temperature in the room should be stable as much as possible. The temperature variation in the room should not exceed 3 °C / hod.
- Place the instrument and pick-up unit on a wooden table with good stability
- It is recommended to place the pick-up unit on a separate stand or a small table which should be of such a height so that the middle of the pick-up unit coincides with the level of the working table. This arrangement makes the operation easier.



- After transport the red retaining screws must be removed from the pick-up unit. If the nominal sensitivity and precision of the magnetometer are to be retained, the pick-up unit, the holders and the specimens must be kept absolutely clean.

4.2 Interconnection of Units

Be sure the instrument is unplugged from mains during connecting the cables. Fixed to the pick-up unit are two connecting cables with a 9-pin and a 25-pin trapezoid connectors which must be plugged into the rear panel of the measuring unit. Fix the connectors by screws, plug the mains socket and switch the instrument on.

4.3 Magnetometer Switching On

The magnetometer is powered on by the "ON/OFF" switch. The supply voltage is specified on the label on the rear panel.

Upon the switch on the display shows (example) :

P4	C Y L.	6.45	0	A/m
P4	number of measuring positions in the measuring cycle or PA (in case of automatic mode)			
CYL	type of specimen CYL. - cylindrical specimen cub. - cubic specimen			
6.45	nominal value of calibration standard 6.45E00 A/m			
0	measuring range			
Flag A/m	flag of [A/m] units			

The type of specimen, the number of measuring positions and the type of units can be changed by the user. When the magnetometer has been switched on, the local mode is automatically entered and the instrument can be controlled by the front panel push-buttons. The autorange mode is active and the parameters and calibration constants (determining the magnetometer amplification and phase setting) are read from an EEPROM memory.

It is recommended to start measurement approx. 15 min. after the switching on the instrument. During that time several trial measurements support stabilization of the temperature in the bearings. Then proceed with routine measurements.

5. Operation

The magnetometer can be operated either from the front panel or from the keyboard of an external computer via the RS-232C channel.

5.1 Local Mode (control from the front panel)

After the switching on the instrument the local mode is automatically set.

START/STOP	start or stop of the current measurement; when the motor is running, only this button is active.
CAL/CORR	start of calibration or start of correction for the holder; according to the inserted specimen the instrument automatically chooses the operation (see 6.1 and 6.2). When the motor is running, only the " START/STOP " button is active and can be used to interrupt the process.
AUTO	switch on and off the autorange mode (indicated by a LED).
[up], [dw]	active only if " AUTO " is off, increasing or decreasing the measuring range. The displayed range depends on the type of measuring units. A/m: -4, -3, -2, -1, 0, 1, 2 T : -10, -9, -8, -7, -6, -5, -4
NEXT	cyclical change of the measuring position. The position is set as follows: If the components of the RM vector are displayed, the next measurement will be taken in the position following the displayed number of position. In the opposite case, e.g. after the " NEXT " button has been depressed, the measurement will be taken in the shown position. The " NEXT " button is used only if one or more positions are to be skipped. Note: The last measuring position can be set in the set mode.

5.2 Remote Mode (control by computer program)

The magnetometer is delivered with a serial RS-232C channel. The communication begins by sending the character "**R**" (ASCII) from the computer. The magnetometer responds by the transition to the remote mode, which is indicated by the **REM** flag. Since that instant all push-buttons are disabled, except "**START/STOP**" which can be

used to return the magnetometer to the local mode. In the remote mode the instrument can be controlled from the computer keyboard by transmitting one-byte commands in the ASCII code.

<i>Command</i>	<i>Function</i>
R (Remote)	The magnetometer enters the remote mode.
Q (Quit)	The magnetometer returns to the local mode.
S (Stop)	Stops the measurement. If the motor is running, the magnetometer responds to the command S (Stop) only, other commands are ignored.
A (Auto)	Autorange is active.
C (Calibration/Correction)	Calibration procedure or correction for the holder.
1 through 6	Start measurement in positions 1 to 6.
@	Sets the instrument into " repeat " mode. The repeat mode closes automatically after having measured specimen, after Stop or Quit commands and after error condition occurs.
X (eXit)	Finish the repeat mode.

The following commands set a fixed measuring range and switch the autorange off. The displayed range depends on the type of units.

Command	Range (A/m)	Range (T)
I	- 4 ^L	- 10 ^L
J	- 4	- 10
K	- 3	- 9
L	- 2	- 8
M	- 1	- 7
N	0	- 6
O	1	- 5
P	2	- 4

General communication scheme

Computer

1. Transmits a command.

Instrument

2. Executes the required operation.

3. Transmits a message + [CRLF].

4. Receives the message, decodes it and proceeds with next operation.

Note: The transmitted command by computer may be followed by characters [CRLF] which are ignored by the instrument.

5.2 Remote Mode - automatic holder

Command

Function

E (Execute)

Executes the specimen measuring in three positions in automatic specimen holder.

u (up)

Sets the hexagonal pin to the working position.

d (down)

Sets the hexagonal pin to the rest position.

g (go to next)

Indexes the hexagonal pin to the next position (turn by 120 degree around its axis).

y (init)

Indexes hexagonal pin to the initial (index) position in which the specimen can be put into the holder.

Note: The commands **u,d,g,y** executed separately can be used for testing the functions of the automatic manipulator.

5.3 Set Mode

When the "SET" button on the rear panel is depressed while the instrument is in the local mode, the magnetometer passes to the set mode.

In this mode the display shows in the location of **POSITION A** (Adjustment) specifying the type of parameter :

A1	- type of specimen	CYL
A2	- last position of the measuring cycle	6
A3	- type of units	A/m
A4	- serial channel baud rate	4.8
A6	- nominal calibration standard value	7.16

The parameter **A6** can be set only if the jumper S1 on the board with the push-button "**SET**" is strapped.

Functions of buttons in the set mode

START/STOP	termination of the set mode, the display shows information as after power on, the set parameters and calibration constants are stored in the EEPROM memory
NEXT	cyclic increase of the type of parameter (A1, A2 , A3, A4, A1,...)
[up]	increase of the value being set
[dw]	decrease of the value being set

The buttons "**AUTO**" and "**CAL/CORR**" are disabled.

5.3.1 Setting the type of specimen

By buttons [**up**] or [**dw**] the type of specimen is changed. For a cylindrical specimen the symbol **CYL.** (**CYL**inder), for a cubic specimen the symbol **cub.** (**cub**ic) is displayed.

JR-5 / JR-5A version enables to preset four values of calibration standards.

The type of the specimen is labelled as follows:

CYL .	- standard cylindrical specimen
' CYL .	- alternative cylindrical specimen, e.g. specimen 19 mm in diameter
cub.	- standard cubic specimen
' cub.	- alternative cubic specimen

Note: Labelling of the specimen type (CYL, cub,..) does not exclude the possibility of using other types of specimens according to the user's needs.

5.3.2 Setting the type of holder and the last measuring position

By buttons [**up**] or [**dw**] the number of position from the sequence 1,2,3,4,6,h,A is cyclically increased or decreased. The meaning is the following:

Standard mode

Digit 1,2,3,4,6 specifies the sequential number of the last measuring position (standard specimen holder and the program REMA5.EXE). If you use REMA5 for remote control of the instrument set last measuring position to 4 or 6.

Hand mode

The symbol " **h** " means the automatic holder operated by hand. This option is useful for JR-5 without automatic position manipulator if you prefer to use the special three position measurement routine using automatic holder.

Automatic mode

The symbol " **A** " means the automatic manipulator. Do not set up this mode if the instrument is not equipped with automatic specimen manipulator, otherwise **E5** or **E7** error appears on the instrument display after the set mode is finished and the time out is over.

Exchange the standard specimen holder for an automatic one (see chapter 3.2.1).

Set the instrument into the **Local mode** (push button **Start/Stop** or command **Quit** if needed).

By pushing the button **Set** on the rear panel of the instrument put the instrument into the set mode.

By pushing the button **Next** set the choice of " **A2** " parameter.

By pushing the button [**up**] or [**dw**] set the symbol " **A** " for automatic holder.

By pushing the button **Start/Stop** finish the set mode.

Execute the calibration.

In the case of the setting of the instrument into the automatic holder mode, after finishing the set mode, the instrument executes automatically the command **y (init)** which indexes the hexagonal key into the initial (index) position. This activity can last several seconds and the information is displayed after successful execution of the setting of the hexagonal pin. The symbol " **A** " (indicating the setting of the instrument into the auto-holder mode), is displayed instead of the number of the last position of the measuring cycle.

Note: The stored components of the residual magnetization of the holder are cleared if you change anything during adjustment A2. If you use standard specimen holder and the measurement routine for four or six positions, the results are correct even if you do not perform the correction for the holder. However for automatic and hand mode the correction for RM of the holder must be performed before the measurement of the specimen.

5.3.3 Setting the type of displayed units

By buttons [**up**] or [**dw**] the type of units is changed which is indicated by the flag A/m or T.

5.3.4 Setting the RS-232C serial channel baud rate

By buttons [**up**] and [**dw**] the baud rate in the sequence .3, .6, 1.2, 2.4, 4.8 is cyclically increased or decreased. The value represents the serial channel baud rate in kBd. The instruments manufactured later than August 2000 have the fixed baud rate 4.8 kBd only.

5.3.5 Saving the nominal value of the calibration standard and gain into EEPROM memory

The operation must be performed in case of exchanging calibration standard and/or if the part of the magnetometer effecting the gain has been replaced. It is assumed, however, that a repair or exchange of pick-up coils, pre-amplifier or analog board will always be performed by the manufacturer who will set the parameters.

Setting the calibration standard nominal value and instrument gain

Switch the magnetometer off and pull out the board with the "**SET**" button.

Lay the board with the motherboard connector on the left. In the top right corner of the set-button board there is a pair of pins labelled "S1". A connector or "jumper" is normally attached to only one of these pins. Remove it and reinstall the jumper to the both pins to close the circuit.

Insert the board in the magnetometer and switch the magnetometer on.

By depressing the "**SET**" button enter the set mode and by depressing the "**NEXT**" button set the parameter "A6".

By buttons [**up**] and [**dw**] set the value of a "new" calibration standard.

Terminate this procedure by pressing "**START/STOP**".

Perform the calibration (see section 6.1).

The first result need not correspond to the new standard. Repeat the calibration.

Set the magnetometer to the set mode (by pressing set button on rear of instrument) and by depressing the "**START/STOP**" button save the constants into the EEPROM memory.

Switch the magnetometer off, unstrap the jumper S1 and store it on one pin of the jumper and reinstall the board. Never leave the jumper S1 closed.

6. Measurement

The speed of specimen rotation (89.3 Hz) is microcomputer controlled. The state when the inaccuracy of speed stabilization exceeds 1%, is indicated by a lighting dot preceding the number of the measured position. If the dot blinks when the motor starts, it does not mean that there is an error, but if it continues blinking all the time during the measurement, the mechanical set-up must be checked according to 3.2.2. It may indicate a mechanical or electrical fault.

In case of a fault or damage of the specimen or holder when the inaccuracy of speed of stabilization is exceeded by over 5%, the motor stops and the display shows the error message **E2** (Error 2 - Bad revolution).

After the measurement the holder stops in a defined angular position which respects the next measuring position.

6.1 Calibration

The magnetometer calibration is a simple measurement of the standard which yields the gain and phase for calculating the remanence vector components. The calculated calibration constants can be saved into EEPROM memory (which is non-volatile).



Without calibration a maximum possible phase error of 1.5% could combine with the intensity error of 3.5% due to laboratory temperature change. Thus, without calibration the results measured could differ by as much as 5% from true values. In case of considerable temperature variations it is recommended to repeat the calibration of the magnetometer always if the temperature change in laboratory is higher than 3 °C (approximately 1% decrease in RM moment per 3 °C).

Calibration procedure:

1. Insert the calibration standard in the holder so as the arrow on the standard be parallel with the arrow on the holder; this position corresponds to the position No. 1 (Fig.7).
2. Lock the coils, fix the shield and press the button "**CAL/CORR**".
3. The start of measurement is indicated by **C1** (Calibration) on the display. After the measurement the RM vector components are displayed.

The RM vector components are calculated using the gain coefficient recalled from the EEPROM memory. The component on the left gives the value about 0.00 and the component on the right gives the value of the standard with the max. error of 3.5% depending on the room temperature. After the successful calibration the newly calculated phase and gain values substitute the constants read from the EEPROM memory. The newly calculated gain and phase values are stored in the RAM memory and used for next processing.

If you wish to save the new phase value in the EEPROM memory, depress the "**SET**" button on the rear panel. [The gain value is saved in the EEPROM memory only if the special jumper inside the instrument is closed, see 5.3.5]. The magnetometer enters the set mode and on depressing the "**START/STOP**" button the information is saved into the EEPROM memory. This operation should be performed in case of a mechanical intervention into the spinner system or any other change which affects the configuration of the spinner system and of the pick-up coils. Without save the phase parameter in EEPROM memory may not correspond to the geometry of the spinner system and pick-up coils.

When the magnetometer is switched off and on again, the original constants saved in the EEPROM memory are recalled.

In case that the standard is not properly placed in the holder, the measurement terminates with the error message **E1** (Error 1 - Wrong standard), the calibration constants are not calculated and the original values are valid.

If calibration is attempted without the standard, correction for the holder is automatically started. It is indicated by the letter **H** (Holder correction) on the display. The measurement can be interrupted by the "**START/STOP**" button.

If- by mistake - the standard is substituted with a specimen whose RM vector corresponds to the lowest measuring range, the procedure correction for the holder is started instead of calibration, and may be terminated by the error message **E3** (Error 3 -Wrong holder) if some of the components of the RM vector is greater than 200 $\mu\text{A/m}$.

6.2 Correction for the Holder

Correction for the holder is a measurement of an empty holder at a prolonged time of measurement of 100 s. The measurement is started by depressing the "**CAL/CORR**" button, the letter **H** (Holder correction) should appear on the display.

Initially the components of the RM vector are tested. If they are less than 200 $\mu\text{A/m}$, the prolonged measurement starts. If this condition is not fulfilled, the measurement stops, the display shows the measured components and the error message **E3** is displayed (Error 3 - Wrong holder). This normally indicates that the holder is dirty, or that you left a specimen in it.

If one of the RM vector components exceeds 100 $\mu\text{A/m}$, it is recommended to remove the holder, clean it and demagnetize. It is usually sufficient to rinse it in clean water with some amount of detergent and dry it up.

If the RM vector of the specimen left by mistake in the holder exceeds the corresponding lowest measuring range of the magnetometer, the procedure calibration, is started instead of correction for the holder. In this case it terminates with the error message **E1** (Error 1 - Wrong standard).

After successful correction for the holder, the measured components are stored into RAM memory and since then these values are subtracted from all measurements measured in the two lowest magnetometer ranges. The stored components of the residual magnetization of the holder are cleared if you change the type of the specimen (adjustment **A1**) or the type of the holder (adjustment **A2**) or if you switch off the magnetometer.

NOTES FOR AUTOMATIC HOLDER JR-5A

The automatic specimen holder consists of a partly spherical outer shell and a rotatable inner spherical core in which the specimen is secured by a plastic screw. The system of specimen orientation occurs by specimen rotation around the imaginary body diagonal of a cube (the 111 axis of crystallography) which only has three-fold symmetry. For this reason it is impossible to find a combination of positions which would eliminate the residual value of the remanent magnetization of the holder as with traditional four- or six- orientation magnetometer measurement. It is necessary to rely entirely upon the correction done by the instrument. An empty automatic specimen holder is measured during the correction measurement, with a 50 seconds measurement in each orientation.

6.3 Measurement in Local Mode

6.3.1 Shape and size of the specimen

The nominal specimen is either a **cube** with an edge of **20 mm** or a **cylinder 25.4 mm (1 inch) in diameter, 22 mm long**. Calibration relates to the respective volume of the specimen. All deviations from the nominal dimensions (affecting the accuracy of the measurement) must be taken into account. Strongly inhomogeneous and damaged specimens, that could cause strong vibrations or imbalance while spinning, cannot be measured.

6.3.2 Marking of specimens

One side of a cubic specimen or the base of a cylindrical specimen is marked with an arrow which defines the coordinate system in which the RM vector is measured.

The system of measuring positions is identical for cubic and for cylindrical specimens. They both are always calibrated in the measuring position No.1 (Fig.7). The dashed arrow or the dashed circle in Fig.7 marks the reversed position of the holder (turned by 180 °).

6.3.3 Measurement in six positions

Standard measurement of the RM vector consists of successive measurements in six positions of specimen with regard to the holder. Use the standard specimen holder for six positions (which is the case of cylindrical holder denoted by two black dots on the front side instead of a black circle.) The complete measurement yields four values for each RM vector component from which the average values are calculated. This process eliminates any residual non-compensated value of the holder RM and reduces measuring errors caused by an inaccurate shape of the specimen and by instrument noise. The mutual positions of the specimen and the holder for individual measuring orientations are shown in Fig.7. The system of positions is identical for cubic and for cylindrical specimens.

- Fix the specimen in the holder in position No.1, the autorange mode is active and start the measurement by depressing the "**START/STOP**" button. After calibration or correction, position No.1 is automatically preset. However, if the previous operation did not end in the final position, position No.1 should be set by the "**NEXT**" button before measurement start.
- When the "**START/STOP**" button has been depressed, the motor starts to rotate. In position No.1 the suitable measuring range is automatically chosen (autorange is on) from the entire range of the magnetometer (in other positions the choice of range is limited due to saving measuring time) and displayed together with the denotation of the position. The measurement proceeds for the time corresponding to the chosen range,

then the motor stops, the display shows two components of the three possible M_x , M_y , M_z , always in the order x , y , z . If the magnetometer is not controlled by an external computer, the components must be recorded by hand.

- The specimen is placed in the holder in position No.2 and the "**START/STOP**" button is depressed. In a position whose number is larger than 1, the one lower range is tested. If it is suitable, it is used. If not, the higher range(s) is(are) tested. The newly set range overwrites the range originally set in position No.1. After measurement in position No.2 the holder and specimen stop in the angular position corresponding to measuring position No.3, i.e. the arrow on the holder is on the reverse side of the holder (Fig.7).
- The whole procedure is repeated until the specimen has been measured in all six positions. If the measurement is to be taken in one selected position only, (regardless of the measuring cycle) the required position is set by using the "**NEXT**" button and the measurement can be executed.

If the measurement is to be taken in a fixed range, the autorange mode is cancelled by depressing the "**AUTO**" button. The desired range is set by using [**up**], [**dw**] buttons. If the range is not sufficient, the measurement results in **OFL** (**O**ver**F**Low) state.

When the "**START/STOP**" button is depressed while the motor is running, the measurement is interrupted. In this case, the holder does not stop in one of the six defined angular positions.

6.3.4 Measurement in four positions

Very often is sufficient to reduce the measuring cycle to 4 measuring positions. For this measurement routine use standard holder for four or six positions. If four measuring positions are used, the residual non-compensated value of the RM vector of the holder is eliminated if any of the two possible combinations of positions are used. It must be noted, however, that one of the three components is always measured four times while the remaining two components are only measured twice.

Combination	1-2-3-4	It is recommended to set the last position at 4.
Combination	1-3-5-6	The last position must be set at 6, position 2 and 4 is skipped using the " NEXT " button.

If less than four positions are used, the residual components of the holder are not eliminated. We must rely upon the electronic compensation. No correction is made for errors due to irregular shapes of specimens. It is therefore recommended to reduce the measuring cycle to less than four positions only for approximate measurements, e.g. for sorting of specimens.

Fig.7 STANDARD HOLDER

POSITION NUMBER	SPECIMEN POSITION	HOLDER POSITION	MEASURED COMPONENTS	POSITION NUMBER	SPECIMEN POSITION	HOLDER POSITION
1			X Z	1		
2			Y Z	2		
<hr/>						
3			X Z	3		
4			Y Z	4		
5			X Y	5		
6			X Y	6		

Fig.7a AUTOMATIC HOLDER

POSITION NUMBER	SPECIMEN POSITION	MEASURED COMPONENTS	POSITION NUMBER	SPECIMEN POSITION
1		X Z	1 ¹	
2		Y Z	2	
3		X Y	3	

¹Note: Cubic specimen in the automatic holder: RM components are recalculated by control software – available in remote mode only.

6.3.5 Measurement with automatic holder

Put the specimen into the holder in the position No.1 and secure the specimen by a small screw on the right side of the rotating core using the special screwdriver. Do not unscrew the screw too far or it will prevent motion of the inner spherical shell. Use only minimum force necessary. You must exercise maximum care to obtain the best centering possible during installation of the specimen. For this purpose there are two black rings on the rotating core.

If a specimen vibrates considerably during the measurement it is impossible to measure it in the automatic specimen holder. Damage to the holder mechanism could occur. In such a case it is better to use standard specimen holder.

6.4 Measurement in Remote Mode

The measurement in remote mode is controlled by external computer program. Programs **REMA5.EXE** for standard specimen holders and **REMA5A.EXE** for automatic specimen holders serve for control the instrument by a computer via the serial port COM1 or COM2. The number of serial port is preset in file **REMA5.FAC**, the parameter named COM. The program enables on line measuring of the remanent magnetization vector, its conversion to geographic and paleogeographic system and data recording to the diskette. Data is recorded on the diskette in the coordinate system of a specimen, to facilitate their further processing according to the customer's need.

Four orientation parameters named P1, P2, P3 and P4 were introduced for an easy change of sampling system. These parameters are stored in REMA5.FAC file and the program REMA5 reads them after run is executed. The current REMA5.FAC file must be therefore always present in working directory of REMA5.EXE program. The sense and description of individual orientation parameters is explained in the following chapter and in the REMA5FAC.DOC file. You can change the parameters by using any text editor, but it is necessary to preserve outlined data format of REMA5.FAC file.

The format of a record on the diskette is as follows (file with extension **.JRA**):

	chars
name of specimen	10
specification of specimen (note)	8
component x (specimen system)	6
component y	6
component z	6
range (exponent of 10)	4
azimuth	4
dip	4
foliation plane:	
- azimuth of dip	4
- dip	4
lineation plane:	
- trend	4
- plunge	4
CR-LF	2

The program REMA5 version 3.8 and higher stores the sampling angles in the data file for the system of sampling P1-P2-P3-P4 (this means orientation parameters), which was set by customer in the configuration file REMA5.FAC. This make it possible to process the data in a uniform way in the future by the advanced processing interpretation program REMASOFT being under preparation.

The data file has the name of the locality, entered by the user, with the **.JRA** fixed extension. The file is ASCII coded and a line (one record) is reserved for each specimen. That enables to edit the data files by text editors or data base programs, if needed.

7. Additional Information

7.1 The RS-232C Serial Interface

The JR-5 can be connected with an external computer via the RS-232C serial channel with which almost all desk computers and minicomputers are equipped. The magnetometer can be set according to the parameters given in Section 2, i.e. baud rate 300, 600, 1200, 2400, 4800 Bd, 7 data bits, odd parity, 2 stop bits.

The RS-232C connector (25 pins male connector)

1, 7	Earth
2	Data transmitted from the magnetometer
3	Data received from the computer
4	RTS
5	CTS
20	+10 V

On input pin 5 the computer informs the magnetometer that it is ready to receive data. If only lines 2, 3 and 7 are used, switch the magnetometer off, pull out the RS-232C board and place it with the internal connector on the left. The S1 jumper in the right-hand corner must be in the right position. On output pin 4 RTS the magnetometer informs the computer that it is ready to receive data.

7.2 Maintenance and Repairs

Regularly clean the interior of the pick-up unit and the cover and keep them absolutely clean. After two or five days of use, rinse the holder in alcohol, or in clean water.

Demagnetize the holder in an AC magnetic field of several tens of kA/m, if needed.

Only when it is necessary, e.g. after breakage of a specimen and when is impossible to remove fragments under the square plate without its removal, follow this process:

Take out four springs and spring plates and put them on marked places to prevent their exchange. Loosen the screw of the cable clip and disconnect the 16-pin connector with flat cable from the vertical board of electronics. Then lift slightly and carefully the plate 2-5 with coils, take out 4 bigger springs and put them on marked places, too. Subsequently put carefully the plate 2-5 with coils and equipment for specimen position change in a safe place and clean properly the spinner system.

Note: The springs must not be mistakenly exchanged during dismantling and assembly, otherwise mechanical conditions may change and this could cause wrong function of the specimen position changer.

It is recommended to clean regularly the specimen holder. Do not measure strong and weak specimens indiscriminantly. Clean the holder more frequently, even several times a day, if needed. The automatic holder requires especially great care; check the cleanliness of the hexagonal opening and of the holder shank before installation of the holder.

It is strongly recommended not to interfere with the magnetometer electronics. In case of malfunction contact the manufacturer.

7.4 Accessories

Standard:

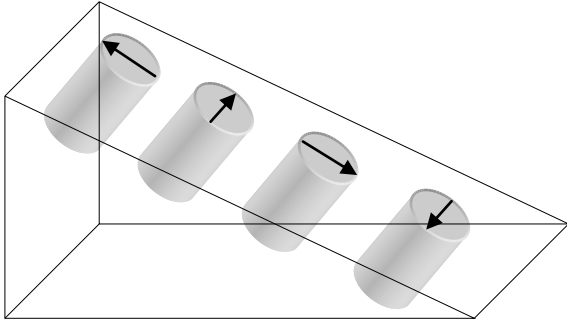
Pick-up unit	1 pc
Measuring unit	1 pc
Main cord	1 pc
Cubic specimen holder	2 pcs
Cubic standard	1 pcs
Cylindrical specimen holder-four positions	1 pcs
Cylindrical specimen holder-six positions	1 pcs
Cylindrical standard 1inch	1 pcs
Automatic specimen holder 1inch cylinder	2 pcs (option JR-5A only)
RS-232 C cable	1 pc
Spare parts	1 set
Driving belt	1 pc
Special screwdriver	1 pc
Instruction manual	1 pc
Packing list	1 pc
Warranty certificate	1 pc

Optional :

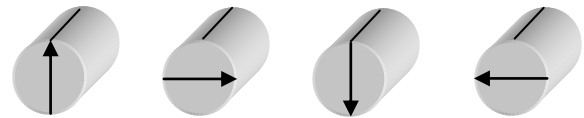
- Automatic specimen holder 25mm cylinder (red arrow)
- Cylindrical standard 25mm (red sign)
- Automatic specimen holder 1inch cylinder and 20mm cube
- Automatic specimen holder 25mm cylinder and 20mm cube

7.5 Orientation Parameter (file REMA5.FAC)

Parameter P1



is clock value of **the direction** of the fiducial **mark drawn** on the frontal side of cylinder. This arrow is X1 axis of the specimen coordinate system. The orientation of the arrow may, or may not, be measured.



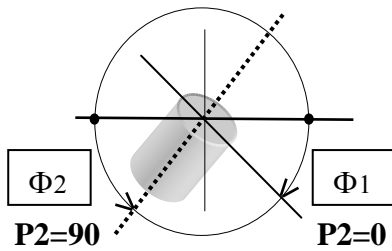
P1=12

P1=3

P1=6

P1=9

Parameter P2



value is 0 or 90.

P2=0 if the dip of the frontal side (Φ_1) is measured.

P2=90 if the plunge of the cylinder (drilling) axis (Φ_2) is measured.

Parameter P3

is clock value of **the direction** (visualized by arrow which need not necessarily be drawn) **which is measured** in the field.

Parameter P4 value is 0 or 90

0 means that azimuth of dip and dip of mesoscopic foliation are measured.

90 means that strike (right oriented) and dip are measured.

Examples:Czech system:

P1 = 6	fiducial mark is oriented downwards
P2 = 0	dip of frontal line is measured
P3 = 6	azimuth of dip of frontal plane is measured
P4 = 0	azimuth of dip and dip of mesoscopic foliation are measured

University of Santa Barbara:

P1 = 12	fiducial mark is oriented upwards but its orientation is not measured => P1 does not equal P3
P2 = 0	dip of frontal line is measured
P3 = 3	the strike of frontal plane is measured
P4 = 90	strike and dip of mesoscopic foliation are measured

Paleomagnetic laboratory in Espoo:

P1 = 12	fiducial mark is oriented upwards and its orientation is measured => P3 = 12
P2 = 90	plunge of cylinder axis is measured
P3 = 12	see P1
P4 = 0	azimuth of dip and dip of mesoscopic foliation are measured

8. Appendices

8.1 List of Errors

<i>ERROR</i>	<i>DESCRIPTION</i>	<i>COMMENT</i>
E1	Calibration error. Measured components are out of expected limit.	Standard in wrong position. The standard must be in position No.1. Attempt to calibrate with a specimen.
E2	Bad revolution error. Fast, slow or irregular rotation of the specimen.	Possible specimen fragments in the spinner system, mechanical braking. Check the coaxiality of the shaft drive, driving belt, the spinner system.
E3	Compensation error. At least one component of the holder RM vector exceeds 200 $\mu\text{A}/\text{m}$.	Take the holder out of the instrument, clean it and demagnetize.
E4	Index pulse error. Wrong setting of the main screen of the spinner system on the index pulse.	
E5	Hexagonal key up/down error. Incorrect setting of the hexagonal pin to the rest position or to the working position.	The most frequent reason of this condition are crossed or turned axes of the hexagonal opening and the hexagonal pin, or an incorrect angular position of the holder and the hexagonal pin while lifting to the working position.
E6	Hexagonal key turn pulse error. Missing pulse which indicates the turn of the key by 120 degrees.	
E7	Hexagonal key index pulse error. Missing pulse which indicates the setting of the key to its initial position.	
E8	Calibration gain error. Gain out of expected limits.	Check if the proper nominal calibration standard value is set in the instrument. Check the calibration standard.
E9	EEPROM read/write error.	Consult the manufacturer.

8.2 Magnetometer Messages - Examples

If the magnetometer is controlled by an external computer, it transmits messages via a serial channel. Messages are also transmitted in case the serial communication port of the instrument is connected to a printer.

The message string has the fix length and consists of 25 ASCII characters, followed by [CRLF] end of line sequence. Instead of index **L** (Long time) the character "apostrophe" is used.

<i>Command</i>	<i>Message</i>
R	** REMOTE MODE
Q	** LOCAL MODE
S	** STOP
A	** AUTO RANGE
I	** MANUAL RANGE -04'
U	** BAD COMMAND
@	** REPEAT MODE
d	** KEY DOWN
u	** KEY UP
g	** POSITION READY
y	E5 POSITION FAILED
1	P1 -10.25 -14.28 E - 03 A/m
2	P2 OVERFLOW RANGE
3	E2 BAD REVOLUTION
4	** SET MODE !
C	C1 + .00 + 6.25 E 00 A/m
C	E1 + .00 - 6.25 E 00
C	E3 + 3.45 + .09 E - 04'
C	H1 + .15 + .27 E - 04'

8.3 Program for Testing the Communication with a Computer

The communication between the magnetometer and a computer has been devised so as even the simplest computer can communicate with the magnetometer. The number of serial port is preset in the file REMA5.FAC, parameter COM.

The following examples written in the BASIC language contain the communication part only. The program can be written in two ways.

EXAMPLE 1

Computer transmits the command and waits for a message from the magnetometer. This, however, does not enable transmitting of the "S" (Stop) command from the computer during the measurement. The "START/STOP" button must be depressed instead, if needed; this however returns the magnetometer to local mode.

```

OPEN "com1: 4800,o,7,2" AS #1 : CLS
loop : INPUT " Select : A C R S Q 1 2 3 4 5 6 I J K L M N O P" ; C$
        IF LEN(C$) <> 1 THEN GOTO loop
        PRINT #1,C$ ' send command
        INPUT #1,D$ ' receive message
        PRINT D$ : PRINT
        GOTO loop

```

EXAMPLE 2 Program JR5COM.BAS

The computer receives the character in interrupt routine, the S (Stop) command can anytime be transmitted to the magnetometer.

```

CLS
OPEN "I", #3, "REMA5.FAC": INPUT #3, IP1, IP2, IP3, IP4, SPORT : CLOSE #3
SPORT$ = RIGHT$(STR$(SPORT), 1)
OPEN "com" + SPORT$ + ":4800,o,7,2" FOR RANDOM AS #1
PRINT "***** Program JR5COM - test of communication "
PRINT "Current communication port : COM"; SPORT$
PRINT "For change edit the file REMA5.FAC": PRINT
PRINT "---> R Remote mode"
PRINT " Q Quit the program and return to LOCAL mode"
PRINT " S Stop current operation"
PRINT " A Auto range"
PRINT " C Calibration / Correction"
PRINT " 1...6 start measurement - position 1 ... 6"
PRINT " I...P set manual range E-4L , E-4 ... E+2"
PRINT " @ set repeat mode"
PRINT " X eXit repeat mode - current measurement is finished"

```

```

PRINT "-----"
PRINT "  E  Execute measurement - automatic holder only"
PRINT "  u  hex key Up - working position"
PRINT "  d  hex key Down - rest position"
PRINT "  g  Go to next position"
PRINT "  y  Init position"
PRINT
PRINT "Enter command : R Q S A C 1 2 3 4 5 6 I J K L M N O P @ X E ": PRINT
loop: WHILE NOT EOF(1)
A$ = INPUT$(LOC(1), #1) ' read message
PRINT A$;
WEND
S$ = INKEY$ ' test keyboard
IF LEN(S$) = 0 OR S$ = CHR$(13) THEN GOTO loop
PRINT S$ : PRINT #1, S$ ' send command
IF S$ = "Q" THEN GOTO finish
GOTO loop
finish: INPUT #1, D$ : PRINT D$ : PRINT "Program terminated"
END

```

Example of REMA5.FAC

6,	0,	6,	0,	1
P1	P2	P3	P4	COM

Parameter COM: 1 serial port COM1
2 serial port COM2

Description of orientation parameters P1 to P4 see chapter 7.5.