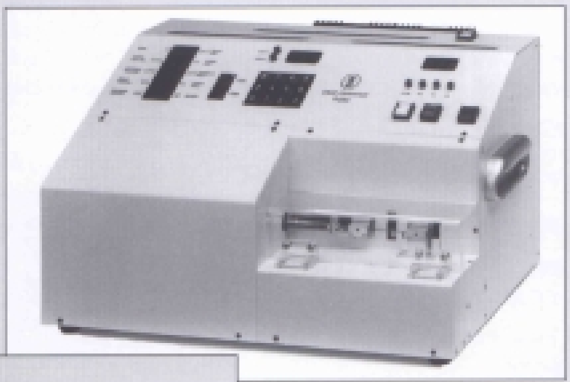
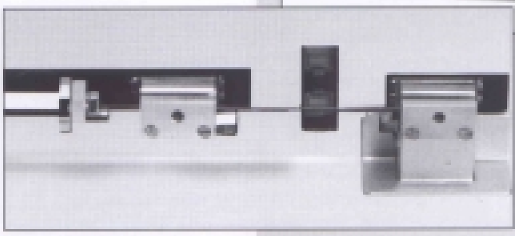
DMZ-Universal Puller

PULL IT AND USE IT!



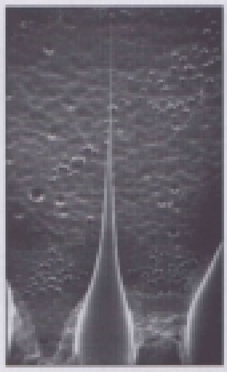
YOU DON'T NEED TO CHECK THE TIP SIZE AND SHAPE OF YOUR MICROELECTRODE. HIGHLY REPRODUCIBLE AUTOMATIC ELECTRODE FABRICATION WITH THE DMZ-UNIVERSAL-PULLER.



Glass tubes are clamped automatically.
Fully automatic polishing of the two tips.

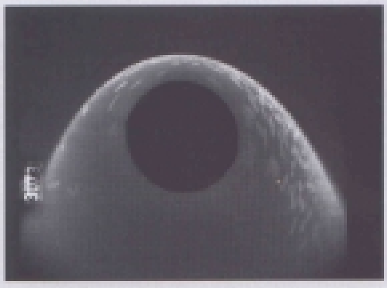
Opening 1,2 µm

Intracellular Electrode



Opening 0,8 µm

Patch Electrodes



... and polished by the puller

27 µm

Unpolished...

THE ELECTRON MICROGRAPHS ARE REPRODUCED BY KIND PERMISSION OF PD DR. ULRICH HEINZMANN, INSTITUTE OF NUCLEAR BIOLOGY, MUNICH, F.R.G.

AutoMate Scientific®
READY FOR RESEARCH™

800.998.MATE | www.autom8.com | 812 Page St, Berkeley, CA 94710 USA
tel 510.845.6283 | fax 510.280.3795 | e-mail info@autom8.com

USER'S MANUAL

PRECAUTIONS

DANGER! For continued protection against fire hazard:
In no way, do not cover the instrument, even if it is switched off!!

DANGER! Disconnect the power cord before attempting any maintenance!
Dangerous voltages inside the instrument. Refer servicing to qualified personnel!

DANGER! Fingers can be jammed and burned or eyes injured by glass splinters when the heater appears or retracts!

Warning! This equipment is not intended for use in human application or human experimentation!

Warning! The filament is very hot (1000 °C).

Warning! Replace only with the same rating of fuse!

DANGER!! FIRE HAZARD! Even when not in use, do not cover!

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

Table of contents

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

1 Features of the puller

The puller has the following fully microprocessor-controlled variables:

1. Distance of pull (longitudinal)
2. Force of pull (time-controlled program)
3. Force of pull (distance-controlled program)
4. Time- or distance-controlled heat application
5. Power of the heat actually radiated by the filament, regulated by an optical (ultrared) sensor

The puller features:

- Permanent storage of **80 programs**.
- One- or two-stage pulling programs, in which all variables can be set independently for each stage, with the option of repeating the first stage.
- Full automation. There is no risk of breaking even thin-walled capillary glass in the glass holders because the clamping of the glass in the holders is carried out by two micromotors which result in precisely defined clamping forces.
- Choice of capillary glass outer diameter of 1 - 2 mm.
- Symmetrical pipette tips in multi-pull programs (one, two or three preliminary pulls, up to nine preliminary pulls from the Ser.N° up beginning with 25 ..). This is achieved by readjustment (centring) of the position of the glass tubing relative to the heating filament after each stage of the pull.
- Automatic (programmable) control of the duration of heating. This is achieved by automatic positioning (advance or withdrawal) of the "U"-shaped heating filament relative to the glass, thus avoiding the need for air-jet cooling.
- Compensation for variations in the wall thickness of the glass tubing. This is achieved by the (programmable) inclusion in the pulling programs of a phase in which the stiffness of the tubing is sensed during pulling.
- Free choice and absolute reproducibility of tip diameter (down to 0.1 µm), taper and electrode resistance (up to 100 MΩ).

- Especially suitable for pulling patch electrodes of precisely defined tip o.d. (usually 1 - 80 µm). The puller will also heat polish the electrode tips after pulling.

- Canthal® heating filaments. This material is extremely durable, but the heating filaments can nevertheless be changed easily.

- Electrode tip sizes and shapes are relatively (compared with other pullers) independent of the precise shape and position of the heating filament. Repeated, time-consuming readjustment of the heating filament is thus not necessary.

- The excellent reproducibility of electrode tip characteristics (even over months) means that electrodes can be made as required, immediately before use. Prefabrication of large numbers of electrodes well in advance of an experimental series is no longer required.

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

WARNING: This equipment is not intended for use in human application or human experimentation!

The documentation accompanying the puller consists of two parts:

1. **First steps**. Brief instructions for setting the puller in operation and making your first pipettes. These instructions are followed by more detailed descriptions, which also refer to the second part of the documentation (the user's manual).

2. The **User's Manual**, containing a complete and detailed description of the puller, its components and functions.

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

2 FIRST STEPS

This section of the documentation tells you how to produce your first pipettes within minutes of unpacking the puller.

NB.: In the puller documentation, the various controls on the puller are always written in **bold**, in exactly the same way that they appear on the puller, e.g. **MAINS**. The table and figures to which reference is made below are in the User's Manual.

Make your first pipette:

1. Ensure the power cord is connected and switch on the puller by pressing **MAINS**.

2. Insert a glass blank GC 150 TF (not GC 150 F!) into the two open glass holders, taken from the box supplied.

3. Select a program (program 10): press **P(A)**, then enter 10 on the numeric keypad.

4. Press **START**.

5. After the pipettes have been pulled, the glass holders still hold the pipettes. Press **START** again. The puller heat-polishes the right-hand pipette. When this is concluded, remove the right-hand pipette from the reopened glass holder.
   Press **START** yet again. The puller heat-polishes the left-hand pipette. When this is concluded, remove the left-hand pipette from the reopened glass holder.

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

2.1 First steps: detailed description

1. Ensure the power cord is connected. Switch on the puller by pressing **MAINS**. The pulling rod moves to the right to the "ready" position.

2. Select a program from Table 1 (User's Manual). Here program no. 10 (P10) has been used. Table 1 shows the settings of all puller parameters for the 20 standard programs for various electrodes and glass types. These programs are already installed by the manufacturer, but may be modified at will. Check the width of the heating filament in the puller. Please note that the programs P00 - P13 use a 3-mm-wide heating filament, the programs P14 - P19 a 4.5-mm-wide filament. This, too, may be varied as desired. The 3-mm filament is installed by the manufacturer and spare filaments of both sizes are supplied in the spare-parts box (for changing the filament see section 6.3 in the User's Manual, "Replacing the heating filament").

The 4.5-mm heating filament is recommended for pulling glass with an o.d. of 2 mm or aluminosilicate or common soda glass.

3. Open the Perspex lid, insert a glass pipette blank (type GC150 T or GC150TF, taken from the box supplied) into the open glass holders so that it rests on the two bearing surfaces (see Fig. 4, 1).

NB: Should the glass holders be closed when attempting to insert a blank (as would be the case if the puller had been started without a glass blank in place) press **READY**, then **BREAK** and, after some seconds, **READY** again (these are the large, illuminated switches at the right-hand side of the control panel). The glass holders should now be completely open. If not, repeat the procedure.

4. Press **P(A)** (Fig. 1, 9) and enter the corresponding number of the program (here **1 0**) on the numeric keypad (Fig. 1, 11). In the display 10 should appear, confirming that program no. 10 is now activated.

N.B.: Before proceeding further, deactivate the tip polishing process which would normally follow pulling. Press **P(B)** and then **AD**; a three-digit number (xyz) will appear in the display. Press **0** (zero) on the numeric keypad and "enter" by pressing **E** (the enter key). The display should now show 0yz. If you make a mistake, clear the display (press **C**) press the correct numbers (**0 y z**) and enter (press **E**) See also point 5 below.

Caution! The heater appears!

Close the Perspex lid and press **START** (illuminated switch on the right). The glass holders close automatically and heating begins. The pipette blank will be elongated a little by the heat and the preliminary pull, after which it is centred. The pulling and centering is repeated before the final pull which separates the two pipettes. Both glass holders now open and the finished pipettes can be removed (see description of programs). This is an example of a program with a total of three pulls, the first two of which were concerned with the preliminary centering and elongation (two preliminary pull program, see Table 1, note 2).

5. Polishing. The puller may be used to polish patch electrodes after pulling. To activate the polishing process, it is necessary to alter one of the parameters stored in the puller before starting the pulling. This is done simply as follows: Press **P(B)** and **AD**. The number 0yz should appear in the display (see point 4 above). Change this by pressing **2** and then **E** (= enter) on the numeric keypad. The display should now show 2yz. If you make a mistake clear the display and enter the correct number (**C 2 y z E**) via the numeric keypad. Entering the value 2 has changed 0yz into 2yz. This indicates a polishing duration of 2 s at a heating current of yz0 (see Table 1, note 4). Two ranges (low and normal) of heating strength for the polishing process are available (see Table 1, note 3 and section 2.2, the description of the controls on the left-hand side of the control panel, in the User's Manual).

To pull and polish electrodes choose the same type of glass blank as before (GC150 T or GC150 TF). Press **READY**, insert the glass blank into the glass holders, close the Perspex lid and press **START**. In this case the glass holders now do not open after pulling.

Press **START** again. The right-hand holder moves automatically a little to the right so that when the heating filament subsequently moves into outside position it encloses the tip in the middle of its curved surface. The heater now moves to the outer position and heat-polishes the right-hand pipette. When this is concluded the right-hand glass holder will open automatically, allowing the polished pipette to be removed.

Press **START** yet again. The left-hand pipette moves into the polishing position and is heat polished, after which the holder opens and the pipette can be removed.

The polishing parameters can be altered before pulling by using the keys **P(A)**, **t(H)** and **s(H)** (see Table 1, notes 5 and 6 and description of program 10). Values between 001 and 090 are recommended. The values actually set can be displayed by pressing **P(A)** and then **t(H)** or **s(H)** and changed when the puller is in the "ready" condition. The polishing parameters cannot be changed after starting the pulling/polishing process. Once started, the polishing process can be aborted only by switching off the puller. To deactivate the polishing process in a program press, before starting the pulling program, **P(A)** and **AD** (the display should show 2yz, see above) and then **0** and **E** on the numeric keypad (the display should now show 0yz). If you make a mistake press **C** (clear), **0 y z E** (enter) on the numeric keypad (see also point 4 above).

N.B.: Pulling glass with a 2-mm o.d. (e.g. GC 200). Occasionally, and particularly after pulling thinner glass, the glass holders may not open wide enough to accept 2-mm o.d. blanks. If this should occur, press **READY** then **BREAK**, and after a delay of some seconds, **READY** again. The glass holders should now open completely. Use the same procedure if the glass holders are closed when you wish to insert a blank (as would be the case if a pulling program had been started without glass in the holders).

N.B.: Should the heating filament be positioned in front of the glass holders (and thus prevent normal insertion of a glass blank) **DO NOT**, under any circumstances, attempt to insert a glass blank into the holders by pushing it through from the right (and thus through the filament). Instead, switch off the puller (**MAINS**), wait 20 s then switch on again. The heater will assume its rest position, after which you can insert the glass blank normally. If this has happened, do not forget to reselect your program, because switching off and on resets the selected program to P00.

6. Suggestions for variations to program. (Example is program P10). Smaller tip diameters may be achieved by increasing the heating current for the final pull. Press **P(B)** then **H**. The display shows, say, 105. Increase this value to e.g. 115 by pressing **1 1** and **E** on the numeric keypad; the display should now show 115. If you make a mistake clear the display and enter the correct number (**C 1 1 5 E**). A further means of achieving smaller tips is to decrease the pulling delay. Press **P(B)** then **t(F1)**. The display shows, say, 120. Decrease this value to e.g. 110 by pressing **1 1 E** on the numeric keypad. If you make a mistake clear the display and enter the correct number (**C 1 1 0 E**).

WARNING: This equipment is not intended for use in human application or human experimentation!

3 The puller's controls

The two groups of controls are located on the sloping top panel of the instrument. This panel is hinged (Fig.1, 1 and 2) to allow service access. On the right hand side is the group of illuminated switches and indicators controlling individual pulls, on the left are keys defining the variables and a numeric keypad. These are used to select (and alter if necessary) the 80 stored programs and the time sequence of the pulls.

3.1 The right-hand side of the control panel

The puller is switched on and off using the **MAINS** switch (3). The lower keys bring the puller into a state of readiness (**READY**, 4), start a pull (**START**, 5) or, in case of trouble, interrupt the pull sequence (**BREAK**, 6). The latter lights up when the program detects a disturbance in the pulling sequence which stops the program. The stages of the pulling sequence are indicated by the real time counter (7, 100-ms units from the start of the pull) and the lamps (8) which light up at various critical points within the sequence: "**F(TH)**" is lit as long as the heater is on and a small sensing or preliminary or sensing pull is operating. It is extinguished when a (programmable) threshold extension is reached. At this point "(**TH**)" lights up. "**F1**" is lit when the first phase of the main pull begins, "**F2**" lights up when the second phase of the main pull begins.

3.2 The left-hand side of the control panel

Pressing the keys **P(A)** or **P(B)** (9) causes the number (e.g. P14) of the last-used program to appear in the display (10). To change the program selected simply type the appropriate number (e.g. **0 9**) on the numerical keypad (11), it will appear in the display (10).

> Note: The programs P00, P09, P10, P11, P12, and P13 have been tested in each individual puller and the values of the parameters stored in the memory adjusted to achieve the specified tip characteristics (see table). The numeric values may thus deviate slightly from the values both in the table and in any numeric examples given in the manual.

The keys **P(A)** and **P(B)** (9) further define the effects of pressing the function keys (12, see also section 3, Description of programs). Depressing a function key (12) causes the value set for this variable in the current program to appear in the display (10). If the value of this variable is to be changed, simply type the new numerals (from left to right) on the numeric keypad (11) and press **E** (enter). The new value will appear in the display (10). For example, to change the value 214 to 014 press **0** and **E**. If a mistake is made, clear the display (**C**) and enter the whole new number (the entire sequence would then be **C 0 1 4 E**).

3.21 The function keys

- **Note 1: In the following, "H" always refers to the heating power, "F" to the force applied to the pulling rod, "s" to the distance moved by the rod and "t" to a time interval.**

- **Note 2: The DMZ Universal Puller employs three types of pull:**

1. **a low force pull (termed sensing), which is used to compensate for variations in glass dimensions**
2. **a series (up to three) of relatively low force pulls (termed preliminary) used to produce specified elongations of the glass**
3. **a final or main pull (F1 and F2), which may have two phases and which finally separates the two pipettes.**

Heat, **H**: The value can be set between 000 and 999. The actual power of the radiated heat is measured by an ultrared photosensor, and is proportional to the value set.

Force Preliminary Pull, **F(TH)**: The voltage applied to the force coil during a preliminary or sensing pull is proportional to the value set here (020 -100)**. When P(A) is chosen, F(TH) is a weak preliminary pull - point 2 above - and when P(B) is lit, F(TH) is the sensing pull - point 1 above.**

Distance Threshold **s(TH)**: The value set here (001-080, unit 0.12 mm) is the distance moved by the pulling rod before the preliminary or sensing pull is terminated.

Delay Heatstop, **t(H)**: The value set here (000 - 999, unit 0.5 ms) is the delay between the end of the sensing pull and switching off the heating (and retracting the heating filament). This function is valid only if **s(TH)** = 000.
This key also determines the position (distance) of the right-hand electrode when polishing (see Table 1, note 5). [The value is displayed, and can be altered only when **P(A)** is activated. Values are 000 - 080].

Distance Heatstop, **s(H)**: The value set here (000 - 127, unit 0.12 mm) is the position (of the pulling rod) at which the heating is terminated and the filament retracted, after the pulling rod has reached the position [s(TH)] at which the sensing pull is terminated. This function is available only if **t(H)** = 000.
This key also determines the position of the left-hand electrode when polishing (see Table 1, note 6). [The value is displayed and can be altered only when **P(A)** is activated, at 000 - 080].

Delay Pull 1, **t(F1)**: The value set here (000 - 999, unit 0.5 ms) is the delay between the end of the sensing pull and the start of phase 1 of the main pull.

Force Pull 1, **F1**: The voltage applied to the force coil during phase 1 of the main pull is proportional to the value set here (000 - 999).

Distance Pull 2, **s(F2)**: The value set here (000 - 127, unit 0.12 mm) is the distance between the position of the pulling rod at the start of phase 1 of the main pull (i.e., the position at the end of the sensing pull) to the position of the pulling rod at the start of phase 2 of the main pull.

Force Pull 2, **F2**: The voltage applied to the force coil during phase 2 of the main pull is proportional to the value set here (000 - 999).

Adjust, **AD**:

1. When **P(A)** is pressed:

   Value X0X: (X = any value except 0); no preliminary pull (this only when **P(A)** is pressed, see Table 1, note 2).
   Value 0X0: normal heating range (during main pull and polishing, see Table 1, notes 1 and 3).
   Value XYZ: X = 1: low heating range at final pull with more precise control of heating strength (see examples Table 1).
   Y = 1: one preliminary pull.
   Y = 2: two preliminary pulls.
   Y = 3: three preliminary pulls (see also Table 1, note 2).
   Y = 4 ... 9 four to nine preliminary pulls.
   Z = 1: low heating range during polishing, with more precise control of heating strength (see Table 1, note 3).

2. When **P(B)** is pressed:
   Value 000: no polishing. See Table 1 note 4).
   Value XYZ: the duration of heat application during polishing is proportional to X; the heating power to YZ (see Table 1, note 4).

4 Description of programs

4.1 Single-pull programs

To obtain single-pull programs press only the program key **P(A)** (Fig. 1, 9) and enter the number of the programm (**P00 - P79**) on the numeric keypad (11). Do not press **P(B)**. **AD** must have the value 000. The various functions (12) now apply to a single pull.

Single-pull programs proceed with the following sequence:
On switching the puller on (**MAINS**, Fig.1, 3) the pulling rod with the left-hand glass holder (Fig.1, 16) moves into the "ready" position and the **READY** switch lights up.

A glass pipette blank (1 - 2 mm o.d.) is inserted manually into the open glass holders (Fig. 1, 16 and 17), so that it rests on the two bearing surfaces (Fig. 4, 1) in the glass holders.

On pressing **START** the glass holders close automatically and clamp the glass. The timer (Fig.1, 7) is activated. The heating current is switched on (power **H**) and the filament moved into position. The force coil exerts a small sensing pull with force **F(TH)** (a typical value for **F(TH)** would be 020). When heated sufficiently the glass under the filament becomes plastic and the traction on the pulling rod causes the glass to elongate. The pulling rod thus moves back. The distance moved is measured and the sensing pull switched off when the set distance threshold [**s(TH)**] is reached. This sensing pull routine serves to compensate for small differences in pipette dimensions.

At the conclusion of this sensing pull, the main pull (phase 1) is initiated after a delay [**t(F1)**], with a force **F1** . This results in further elongation and, on reaching the distance **s(F2)** the pulling force changes to **F2**. Within this pulling sequence heat application is terminated in either of two ways:
(a) if Delay Heatstop **t(H)** has been selected (Distance Heatstop **s(H)** must be 000) the heating continues for the time **t(H)** or,
(b) if Distance Heatstop **s(H)** has been selected (Delay Heatstop **t(H)** must be 000), heating continues until the distance **s(H)** is reached.
After reaching **t(H)** or **s(H)** the heat is switched off and the heater retracted. The pull sequence pulls the pipettes apart, the sequence stops, the glass holders open and the pipettes may be removed.

4.2 Multi-pull programs

These programs include up to nine (9) preliminary pulls and produce steeply tapering electrodes or patch-clamp electrodes. Press either **P(A)** or **P(B)** and enter the program number (**P00 - P79**) on the numeric keypad. In these programs the variables for the preliminary and main pulls are selected by first activating **P(A)** or **P(B)**.

After pressing **P(A)**, the functions **H**, **F(TH)** and **s(TH)** define the characteristics of the first pulling stages (one, two, three, or more preliminary pulls). There are two ranges of heating strength available for the main pull, a normal and a low range. The key **AD** in combination with **P(A)** selects the range. The low range allows the control of heating strength to be more precise and is particularly suited to the production of patch electrodes with large tip diameters (see section 2.2 and Table 1, note 1). The key **AD** also determines whether the first stage of the pulling sequence employs one, two, three, or more preliminary pulls (see description of the function keys above and Table 1, note 2). The remaining functions are normally disregarded (except for **t(H)** and **s(H)**, see section 3.3, Polishing patch electrodes).

After pressing **P(B)**, the functions keys define the variables for the main pull. **AD** defines whether or not electrode tips are polished (see section 2.2, function **AD**, section 3.3 Polishing patch electrodes and Table 1, note 4).

The first phase of a multi-pull program is initiated and proceeds as in the single-pull programs (section 3.1), except one, two, three or more preliminary pulls are employed. The combination of the values set for the variables is such that a constriction is produced in the glass blank, but the two halves are not pulled apart. At the end of the first preliminary pull the glass is moved to the right, so that the constriction is aligned with the heating filament. This can be repeated a second or a third time (up to nine times). The final pulling phase (the main pull) then commences automatically and proceeds exactly as in the single-pull program.

4.3 Polishing patch electrodes

Pressing **AD** after **P(B)** allows selection of a fully automatic polishing routine after completion of the final pull. With this program activated, the glass holders do not open after the final pull. After pressing **START**, the right-hand holder moves to the right and the heater is switched on for the selected time at the selected power (see section 2.2, function key **AD** and Table 1 note 4). After the heater is switched off the glass holder opens, allowing the finished electrode to be removed. Pressing **START** again repeats the process for the left-hand electrode. The distances moved by the glass holders to the polishing positions are set using the keys **t(H)** (right-hand electrode) and **s(H)** (left-hand electrode) when **P(A)** is activated. Values between 001 and 080 are suggested (see Table 1, note 4).

5 Using the puller

5.1 Examples of programs

Table 1 summarises programs which have been most widely used. Typical uses of the electrodes/pipettes are also given for orientation (see also First steps). Despite the utmost care taken in the construction small variations between individual pullers are unavoidable thus requiring minor adjustments to the values given, in particular Heat (strength), the Heatstop variables and Delay Pull 1. Descriptions of programs P10 - P13 with commentaries for orientation are found on pages 19 - 22.

5.2 Effects of changes in parameters

Table 2 on page 23 summarises qualitatively the effects of changing individual parameters on the shape of the electrode/pipette.

5.3 Understanding the pulling procedure

The following is a step-by-step description of a pull, using program P12 (values as in Table 1b on page 18, and Diagram 1and 2 on pages 14 and 15.

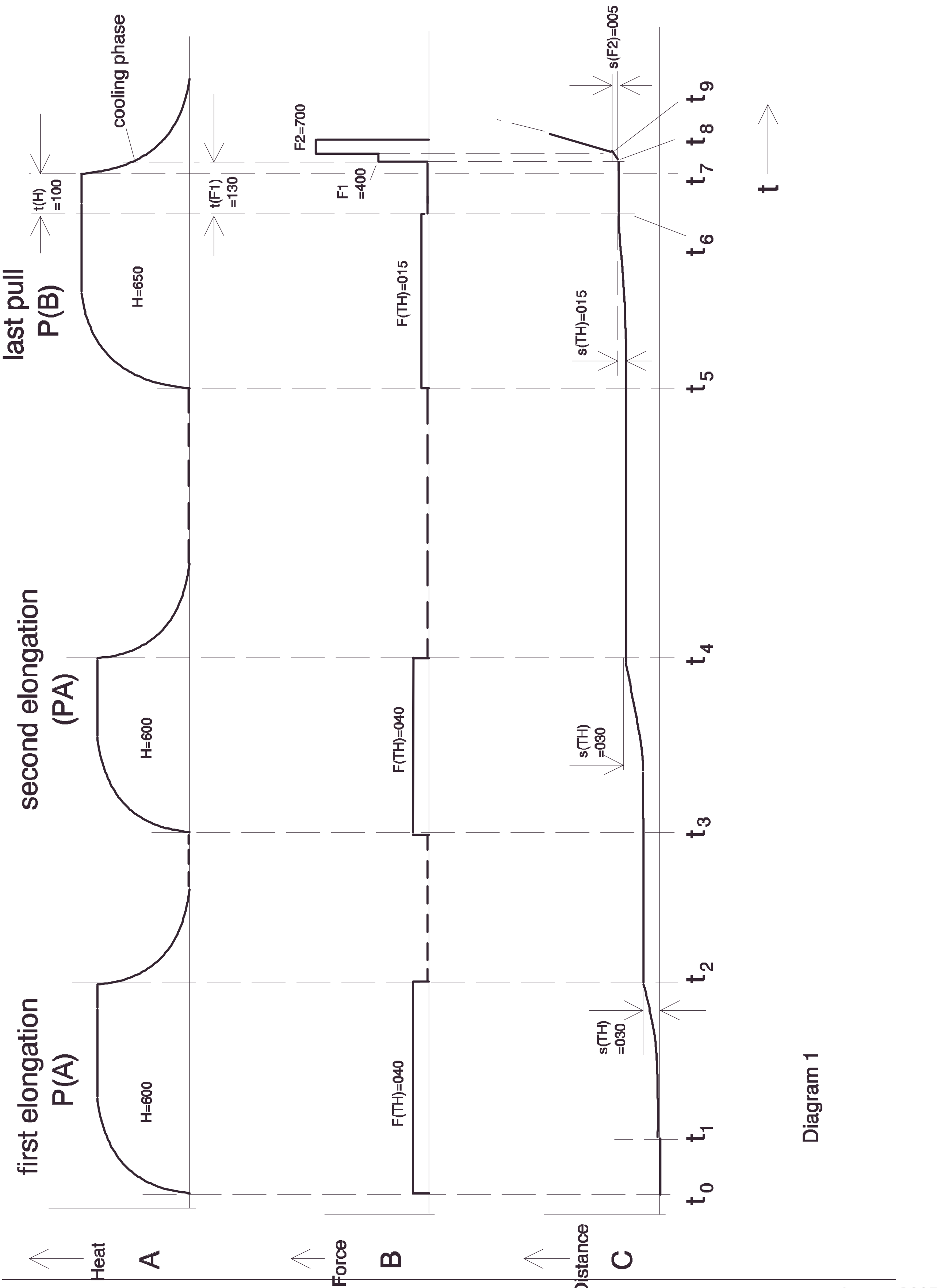
When **START** is pressed, the glass holders close, the heater advances, is switched on and heats the glass (heating strength **H** = 600, Diagram 1A and Figure 1). The preliminary pull (low force, (**F(TH)** = 040, diagram 1B t_0, Fig. 1) starts to extend the softened glass until a certain distance threshold (**s(TH)** = 030 diagram 1C,
t_1 -t_2, Fig. 1) is reached. At this time (t_2) the heater (Diagram 1A) and the force **F(TH)** are switched off and the glass tubing is moved to the right to bring the constriction in the glass to the position of the heater (Diagram 1, t_2 - t_3).

This preliminary pull can be repeated once or twice more (i.e., a maximum of three times altogether). For the second (and third, if chosen) preliminary pull the program uses the same variables, i.e., heat 600, 040 for the force and 030 for the elongation distance threshold.

After concluding the preliminary pull(s), the program continues with the final pull (**P(B)**, Diagram 1, t_5 and Fig. 2). After the pipette has been repositioned to the right, the heater is advanced and heats the glass again (heat strength **H** = 650 Table 1, row **P(B)** program P12 and Fig. 2). A small force (the sensing pull) is applied (**F(TH)** = 020) such that when the glass has softened it elongates until the distance threshold
s(TH) = 015 is reached (Diagram 1C, t_6) In this phase of the pull the stiffness of the glass is sensed. Reaching this point results in the force **F(TH)** being switched off, thus terminating

the elongation. The two programmed delays (**t(H)** = 100 and **t(F1)** = 130 now become operative. After delay **t(H)** the heat is switched off (Diagram 1, t_7) and the glass cools a little. After delay **t(F1)** the first main pulling force **F1** = 400 is switched on (Diagram 1, t_8), which elongates the glass to a further relative distance threshold **s(F2)** = 005 at which point the second main pull **F2** = 700 is switched on (Diagram 1 t_9) and finally pulls the pipettes apart.
The final pull is also shown magnified (diagram 2) on page 15.

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com


first elongation
P(A)
second elongation
(PA)
last pull
P(B)
cooling phase
H=600
H=600
H=650
t(H)
=100
t(F1)
=130
F2=700
F1
=400
F(TH)=040
F(TH)=040
F(TH)=015
s(F2)=005
s(TH)=015
s(TH)
=030
s(TH)
=030
t0
t1
t2
t3
t4
t5
t6
t7
t8
t9
t
Diagram 1
Heat
A
Force
B
Distance
C

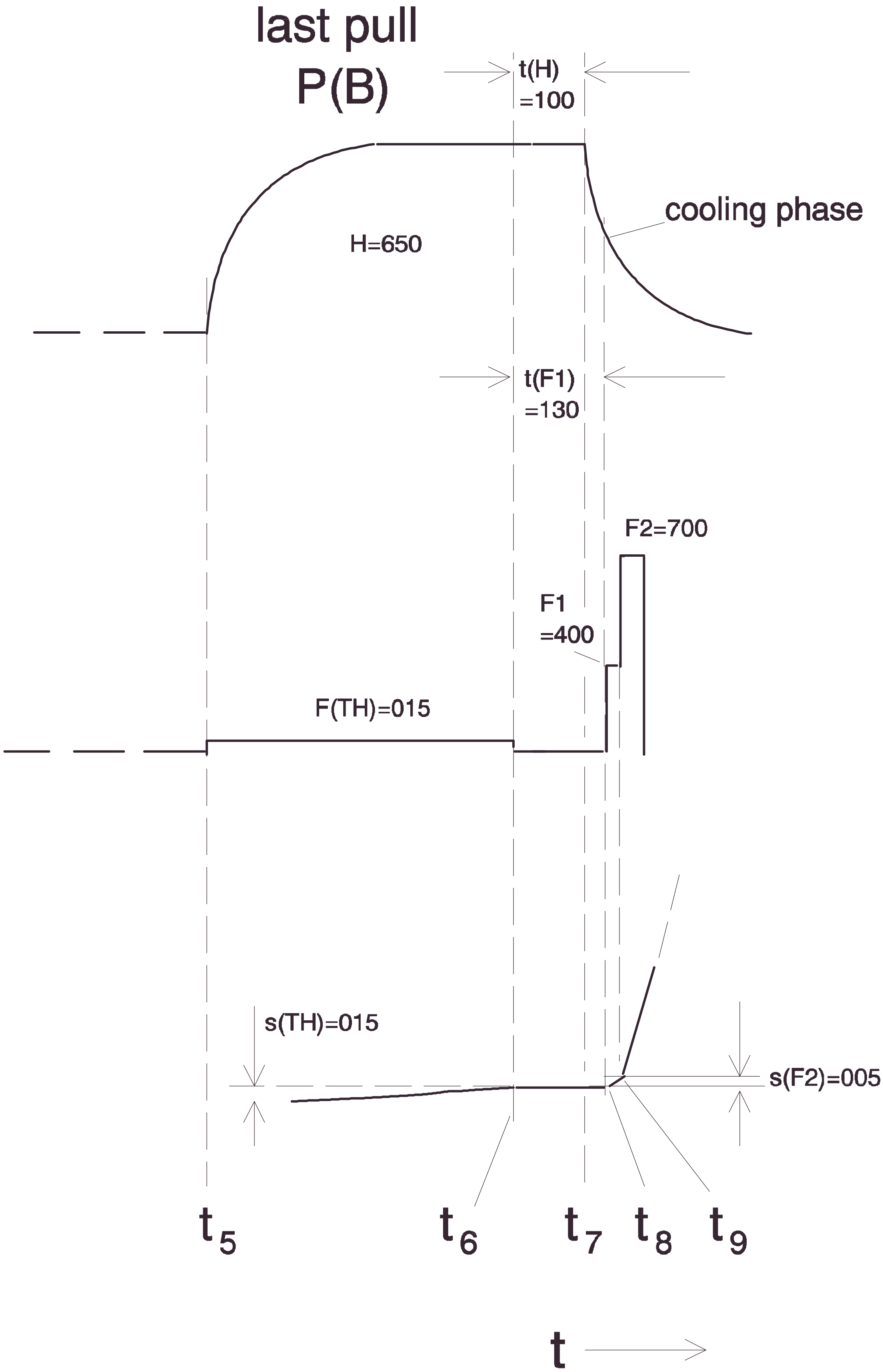

last pull
P(B)
t(H)
=100
H=650
cooling phase
t(F1)
=130
F2=700
F1
=400
F(TH)=015
s(TH)=015
s(F2)=005
t5
t6
t7
t8
t9
t

Diagram 3 Distance Heatstop

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com

Fig1, Fig2, Fig 3

DMZ-Universal Puller

Heater Filament 3.0mm												
Intracellular				**Injection**			**Patch**		**Patch**	**Patch.**	**Patch**	
Glass: Glark GC150F GC150F GC120F thickw. & Filament				**Glass:** Harvard Apparatus GC150F thickwall		Harvard Apparatus GC150TF thinwall	Harvard Apparatus GC150TF thinwall		Harvard Apparatus GC150 TF thinwall	Harvard Apparatus GC150F thickwall	Harvard Apparatus GC150F thickwall	
	P00	**P01**	**P02**		**P03**	**P04**	**P05**	**P06**	**P07**	**P08**	**P09**	
P(A)				**P(A)**								
H	450	270-370	5OO	*H*	500	400	400	4OO	400	500	500	
F(TH)	020	O16	O4O	*F(TH)*	O3O	O3O	O2O	O2O	O2O	O2O	O2O	
s(TH)	025	O10	O15	*s(TH)*	O22	O22	O47	O4O	O47	O21	O21	
t(H)	O3O *7	OOO *8	32O *7	*t(H)*					OOO	052	O52 *5	
s(H)	OOO *7	O26 *8	OOO *7	*s(H)*					OOO	040	O40 *6	
t(F1)	230	OOO	42O	*AD*	12O *1;2	12O *1;2	O1O *2	O1O *2	111 *1;2;3	121 *2	121 *1;2	
F1	3OO	160	4OO	**P(B)**								
s(F2)	030	O70	OO2	*H*	82O	72O	O7O	16O	7OO	620	520	
F2	6OO	700	5OO	*F(TH)*	O35	O35	O3O	O3O	O3O	O2O	O16	
AD	OOO *9	OOO *9	OOO *9	*s(TH)*	O12	O12	OO7	O1O	O12	008	008	
				t(H)	O3O *7	O3O *7	OOO *8	O3O *7	O3O *7	030*7	030 *7	
				s(H)	OOO *7	OOO *7	OO3 *8	OOO *7	OOO *7	OOO *7	000 *7	
Allowed only when P(A)				*t(F1)*	O5O	O5O	OOO	12O	O9O	100	100	
is lit !				*F1*	17O	17O	O85	O8O	17O	070	070	
				s(F2)	OO3	OO3	O12	OO2	OO2	OO4	OO4	
				F2	185	185	12O	11O	185	080	080	
				AD	OOO	OOO	OOO	OOO	OOO	330	330 *4	
	short	100 MOhm	very short		1.5 µm	2.0 µm	0.8 µm, slim	1.0 µm	O.8 µm, long	0.8 µm	2.0 µm	

Note1: 1xx=LOW RANGE OF HEAT (final pull); 0xx=NORMAL RANGE.
Note2: 000=NO PRIMARY-PULL (SINGLE PULL); x1x=ONE-PRIMARY-PULL;
x2x=TWO-PRIMARY-PULL; x3x=THREE-PRIMARY-PULL.
Note3: xx1=LOW RANGE OF HEATING (POLISHING); xx0=NORMAL RANGE.
Note4: 0xx=POLISH OFF; 511=polish. 5 s, heat: 110.

Note5: POLISH-DISTANCE RIGHT ELECTRODE.
Note6: POLISH-DISTANCE LEFT ELECTRODE.
Note7: DELAY HEATSTOP used.
Note8: DISTANCE HEATSTOP used.
Note9: Must be OOO.

Table 1a

DMZ-Universal Puller

		P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
		Heater Filament 3.0mm				Heater Filament 4.5mm					
		Patch		Intracell.	Macro-Patch	Patch	Patch	Intraperf.	Inject.	Intracell.	
	Glass:	Harvard Apparatus GC150TF thinwall or GC150F thickwall		Harvard Apparatus GC150F thickwall	Assistent Haematokrit No.564	Harvard Apparatus SM150F Alusilicate	Harvard Apparatus GC150F thickwall	Harvard Apparatus GC200 OD=2mm	Harvard Apparatus GC150TF thinwall	Harvard Apparatus GC150F thickwall	Harvard Apparatus SM150F Alusilicate
		P10	**P11**	**P12**	**P13**	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**
	P(A)										
	H	400	400	500	350	8OO	5OO	67O	46O	45O	8OO
	F(TH)	O16	O3O	O4O	O16	1OO	1OO	O6O	O2O	1OO	1OO
	s(TH)	O17	O15	O40	O21	O24	O24	O28	O22	O35	O35
	t(H)	O50 *5			O12 *5						
	s(H)	O40 *6			O60 *6						
***Notes 1...8** are described below	**AD**	121 *1;2;3	O2O *2	O1O *2	121 *1;2;3	121 *1;2;3	121*1;2;3	12O *1;2	12O *1;2	O1O *2	O1O *2
	P(B)										
	H	520	2O7	450	O32	75O	24O	22O	72O	2OO	7OO
	F(TH)	O18	O16	O2O	O8O	O4O	O4O	O4O	O35	O2O	O2O
	s(TH)	O15	O08	O12	O45	O17	O17	O13	O12	O1O	O1O
	t(H)	O3O *7	O4O *7	1OO *7	OO6 *7	OOO *8	OOO *8	OOO *8	O3O *7	O8O *7	O8O *7
	s(H)	OOO *7	OOO *7	OOO *7	OOO *7	OO3 *8	OO3 *8	OO3 *8	OOO *7	OOO *7	OOO *7
	t(F1)	100	200	230	O5O	OOO	OOO	OOO	O6O	16O	15O
	F1	040	220	4OO	O2O	O38	O38	O48	17O	18O	18O
	s(F2)	OO2	OO4	OO3	O55	OO4	OO4	OO4	OO3	O25	O25
	F2	200	230	7OO	O3O	O4O	O4O	O5O	185	65O	65O
	AD	245 *4	OOO	OOO	470 *4	OOO	OOO	OOO	OOO	OOO	OOO
		2.0 µm	0.8 µm	20-40 MOhm	28 µm	3 µm	1 µm	1.5 µm	long	short	short

*** Note1: 1xx**=LOW RANGE OF HEAT **(final pull)**; **0xx**=NORMAL RANGE.
*** Note2: 000**=NO PRIMARY-PULL (SINGLE PULL); **x1x**=ONE-PRIMARY-PULL; **x2x**=TWO-PRIMARY-PULL; **x3x**=THREE-PRIMARY-PULL.
*** Note3: xx1**=LOW RANGE OF HEATING (POLISHING); **xx0**=NORMAL RANGE.
*** Note4: 0xx**=POLISH OFF; 245=polish. 2=2s, 45=heat: 450.
*** Note5:** POLISH-DISTANCE RIGHT ELECTRODE.
*** Note6:** POLISH-DISTANCE LEFT ELECTRODE.
*** Note7:** DELAY HEATSTOP used.
*** Note8:** DISTANCE HEATSTOP used.

Table 1b

6.1 Detailed description program P09 (see also Table 1)

P(A)

H	500	Heat for glass softening
F(TH)	010	Preliminary pull, force for glass elongation
s(TH)	021	Distance threshold for elongation (**H** and **F(TH)** terminated when reached)
t(H)	052	Position of right-hand electrode for polishing
s(H)	040	Position of left-hand electrode for polishing
AD	121	Low heat range for main pull (Table 1 note 1), **two** preliminary pulls (Table 1, note 2) i.e. a three-stage pull, low heat range at polishing (see table 1b note 3).

P(B)

H	520	Heat strength for main pull (see **AD** above)
F(TH)	016	Sensing pull, force for sensing glass stiffness
s(TH)	008	Distance threshold for elongation (**F(TH)** terminates)
t(H)	030	Delay before heat is terminated; starts at **s(TH)**
s(H)	000	Distance threshold for termination of heat. Mutually exclusive with t(H) (Table 1, notes 7 and 8)
t(F1)	100	Delay before starting main pull **F1**; starts at **s(TH)**
F1	070	Force, first phase of main pull
s(F2)	004	Distance threshold for start of second force phase, main pull **F2**. Distance measured from **s(TH)**
F2	080	Force for second phase of main pull
AD	330	Polishing program activated, 2=2 s duration, heat strength 45=450. To deactivate polishing set **AD** = 045 here.

To achieve smaller tip diameters decrease **P(B) t(F1), and** increase **P(B) F1 and F2**.

6.1 Detailed description program P10 (see also Table 1)

P(A)

H	400	Heat for glass softening
F(TH)	016	Preliminary pull, force for glass elongation
s(TH)	019	Distance threshold for elongation (**H** and **F(TH)** terminated when reached)
t(H)	050	Position of right-hand electrode for polishing
s(H)	040	Position of left-hand electrode for polishing
AD	121	Low heat range for main pull (Table 1 note 1), **two** preliminary pulls (Table 1, note 2) i.e. a three-stage pull, low heat range at polishing (see table 1b note 3).

P(B)

H	520	Heat strength for main pull (see **AD** above)
F(TH)	018	Sensing pull, force for sensing glass stiffness
s(TH)	015	Distance threshold for elongation (**F(TH)** terminates)
t(H)	030	Delay before heat is terminated; starts at **s(TH)**
s(H)	000	Distance threshold for termination of heat. Mutually exclusive with t(H) (Table 1, notes 7 and 8)
t(F1)	100	Delay before starting main pull **F1**; starts at **s(TH)**
F1	040	Force, first phase of main pull
s(F2)	002	Distance threshold for start of second force phase, main pull **F2**. Distance measured from **s(TH)**
F2	200	Force for second phase of main pull
AD	245	Polishing program activated, 2=2 s duration, heat strength 45=450. To deactivate polishing set **AD** = 045 here.

To achieve smaller tip diameters decrease **P(B) t(F1), or, less preferable,** increase **P(B) H**.

6.2 Detailed description program P11 (see also Table 1)

P(A)

H	400	Heat for glass softening
F(TH)	030	Preliminary pull, force for glass elongation
s(TH)	015	Distance threshold for elongation (**H** and **F(TH)** terminated when reached)
AD	020	Normal heat range for main pull (Table 1 note 1), **two** preliminary pulls (Table 1, note 2) i.e. a three-stage pull

P(B)

H	207	Heat strength for main pull (see **AD** above)
F(TH)	020	Sensing pull, force for sensing glass stiffness
s(TH)	010	Distance threshold for elongation (**F(TH)** terminates)
t(H)	040	Delay before heat is terminated; starts when **s(TH)** is reached
s(H)	000	Distance threshold for termination of heat. Mutually exclusive with t(H) (Table 1, notes 7 and 8)
t(F1)	130	Delay before starting main pull **F1**; starts at **s(TH)**
F1	170	Force, first phase of main pull
s(F2)	004	Distance threshold for start of second force phase, main pull **F2**. Distance is measured from **s(TH)**
F2	180	Force for second phase of main pull
AD	000	Polishing program deactivated

To achieve larger tip diameters decrease **P(B) H** or decrease **P(B) t(F1)** or decrease **P(B) F2**.

5 Detailed description program P12 (see also Table 1)

P(A)

H	500	Heat for glass softening
F(TH)	040	Preliminary pull, force for glass elongation
s(TH)	040	Distance threshold for elongation (**H** and **F(TH)** terminated when reached)
AD	010	Normal heat range for main pull (Table 1 note 1), **one** preliminary pull (Table 1, note 2) i.e. a two-stage pull

P(B)

H	650	Heat strength for main pull (see **AD** above)
F(TH)	020	Sensing pull, force for sensing glass stiffness
s(TH)	012	Distance threshold for elongation (**F(TH)** terminates)
t(H)	100	Delay before heat is terminated; starts when **s(TH)** is reached
s(H)	000	Distance threshold for termination of heat. Mutually exclusive with t(H) (Table 1, notes 7 and 8)
t(F1)	260	Delay before starting main pull **F1**; starts at **s(TH)**
F1	400	Force, first phase of main pull
s(F2)	003	Distance threshold for start of second force phase, main pull **F2**. Distance is measured from **s(TH)**
F2	700	Force for second phase of main pull
AD	000	Polishing program deactivated

To achieve electrodes with lower tip resistance decrease **P(B) H** or increase **P(B) t(F1)** or decrease **P(B) F2**.

5 Detailed description program P13 (see also Table 1)

P(A)

H	350	Heat for glass softening
F(TH)	016	Preliminary pull, force for glass elongation
s(TH)	021	Distance threshold for elongation (**H** and **F(TH)** terminated when reached)
t(H)	012	Position of right-hand electrode for polishing
s(H)	060	Position of left-hand electrode for polishing
AD	121	Low heat range for main pull (Table 1 note 1), **two** preliminary pulls (Table 1, note 2) i.e. a two-stage pull, low heat range for polishing

P(B)

H	032	Heat strength for main pull (Table 1, note 1)
F(TH)	080	Force for main pull
s(TH)	045	Distance threshold for terminating main pull
t(H)	006	Delay before heat is terminated; starts at **s(TH)**
s(H)	000	Distance threshold for termination of heat. Mutually exclusive with t(H) (Table 1, notes 7 and 8)
t(F1)	050	
F1	020	Not used
s(F2)	055	Not used
F2	030	Not used
AD	470	Polishing program activated, 4=4 s duration, heat 50=500. To deactivate polishing, set **AD** = 050 (Table 1, note 4)

The high value of **P(B) s(TH)** (045) ensures that the pipettes are already separated, so **F1** and **F2** have no influence.

To achieve smaller tip diameters increase **P(B) H** or decrease **P(B) F(TH)**.

6.5 Table 2: Effect of changes in puller parameters

Tip diameter ↑ means a larger electrode tip opening and a lower resistance. Taper ↑ means a steeper tapering of the electrode, i.e. a shorter and sturdier electrode.

Electrode tip form will change as indicated by the arrows:
For multi-pull-programs: when P(B) is lit and for single-pull-programs: when P(A) is lit!

		Opening	Taper
H	↑	↓	↓
F(TH)	↑	↑	↑
s(TH)	↑	↓	↓
t(H)	↑	↓	↓
		alternative (and mutually exclusive:	
		one parameter must be 000 !)	
s(H)	↑	↓	↓
t(F1)	↑	↑	↑
F1	↑	↓	↑
s(F2)	↑	↑	↑
F2	↑	↓	↑

6.6 Explanations and comments to Table 2

The following explanations are intended as an aid to achieving more rapidly the desired results with the DMZ Universal Puller. It must be understood that the various parameters can influence each other mutually, so that in making tests, it is advisable to alter only one parameter at a time. **To understand better the processes involved in pulling and the explanations given below, the reader should also consult the diagrams on pages 14 and 15.**

1. Increasing the **heating H** raises the temperature of the glass during the sensing pull F(TH), the delay periods and the main pulls F1 and F2. The result is a smaller tip diameter and a less steep taper. Excessive heat results in extremely long tips. Conversely, reducing the heat prolongs the pulling process resulting in very short tips. In the extreme case, the glass may even tear apart or the pulling process be terminated.

2. The **sensing pull F(TH)** begins immediately on switching on the heating. This is a very weak pull which only begins to move the pulling rod **after** the glass has reached its melting point. Increasing the sensing pull (max.: 100) results in the pulling rod reaching its threshold **s(TH)**, at which the main pull begins, sooner. This is equivalent to reducing the duration of heating for the duration of the sensing pull so that the glass at the melting site has less time to become fluid than with a lower sensing pull (min.: 020) and is thus more viscous, resulting in greater tip diameters.

3. The **distance s(TH)** is the threshold which terminates the sensing pull F(TH). Increasing (↑) this threshold (max. 127) means that the pulling rod takes longer to reach this point, thus increasing the duration of the sensing pull. The glass thus not only remains longer in the position where it is melting, thus becoming more fluid (see 2. above), it also thins out, and the tip diameters decrease. An high value for s(TH) may result in the glass separating before s(TH) is even reached. In this case all subsequent parameters have no further influence on the tip form. An example of this special case is found in Program P13 (Table 1).

4. At the instant at which the pulling rod reaches s(TH) and the sensing pull f(TH) terminates, two variable delays begin: **delay heatstop t(H)** and the **pull delay t(F1)**. The prerequisite for these is that t(H) has been selected (see manual). During delay t(H), the heating continues at the same intensity.

A). When delay heatstop expires, the heating is switched off and the heating unit retracts . The longer the time selected for **t(H)**, the longer heating continues and the smaller the tip diameter. For **t(H)** to be effective, the **distance heatstop s(H) must be set to zero (000)** (see 7 below).

B). The **heatstop distance s(H)** can be used as a (mutually exclusive) alternative to delay heatstop (see 4a above). This possibility is described in greater detail below (see 7 below).

C). The **pull delay t(F1)** begins at the same time as the delay heatstop (see 4, 4a above). In general, the value for **t(F1)** should be greater than that for t(H), so that the pull F1 starts after the heating phase has terminated and the glass is beginning to cool. (See diagrams on pages 14 and 15). Increasing **t(F1)** results in the glass being cooler when the pull F1 starts and tip diameter is larger. Varying t(F1) allows precise control of glass temperature from the end of the heating phase into the cooling phase, without changing the global heat setting and is thus the preferable means of varying electrode tip diameter.

5. Raising (↑) the force of the **main pulls F1 and F2** increases the speed with which the glass is pulled apart in the cooling phase. The reduced cooling time results in smaller tip diameters.

6. The threshold distance **s(F2)**, upon reaching which the second main pull F2 is initiated, has the following effect: F1 extends the glass until, on reaching **s(F2)**, the second pull F2 starts. If F1 is relatively small compared with F2 the higher the value for **s(F2)** the cooler the glass when F2 starts: increasing **s(F2)** increases tip diameters (providing, of course, that the glass has not already separated before reaching s(F2), in which case F2 has no relevance).

7. The **heatstop distance s(H)** is a (mutually exclusive) alternative to delay heatstop t(H) (see 4 above). To use this, **s(H)** can be given values of 001 - 127; **delay heatstop t(H) must be set to zero (000)**. Under these circumstances, heating **continues** during F1 and F2 until a certain extension (the threshold **s(H)**) of the glass is reached, upon which the heating is turned off and retracted. Increasing s(H) thus prolongs heating during the main pulls F1 and F2 resulting in long tips with small diameters.

Behavior of tip diameters during heater application:

7 Maintenance

Certain moving parts in the puller require cleaning and/or lubrication at regular intervals (not greater than 6 months).

7.1 Cleaning the pulling rod

N.B. It is not necessary to clean the pulling rod for this model!

7.2 Lubricating the threaded spindle of the heater-positioning motor

Remove the small cover of the right-hand glass holder (Fig. 4, 2) by loosening the black knurled screw. Remove the four screws holding the right-hand cover panel (Fig. 1, 14) and lift the cover at the corner (Fig. 1, 15). Take care not to disturb the pulling rod (Fig. 1, 16)!

N.B. DANGER! Fingers can be jammed or eyes injured by glass splinters when the heater appears!

Lubricate the threaded spindle (Fig. 5, 1) with "Molykote" paste (in spare-parts box). To spread the paste turn the spindle using a screw-driver inserted into the slit (Fig. 5, 2). Leave the heater at about the middle of its excursion.
Replace the cover panel and the four screws and the cover of the right-hand glass holder. Tighten the black knurled screw. On switching on the puller (**MAINS**) the heater moves back to its rest position.

7.3 Replacing the heating filament

The heating filament has, under normal conditions, a very long lifetime unless bent or otherwise mechanically damaged. However, to ensure reproducibility, the filament should be examined visually regularly (every week). If spot-like protrusions on the surface are noticed, or if the filament is bent, the filament should be exchanged. In this case only the filaments supplied by the manufacturer should be used. Handle the filaments carefully and do not bend them, they fit exactly!

!!When excessive heat is needed, change the filament!!

To replace the heating filament:

Switch off the puller (**MAINS**).

DANGER! Before changing the filament disconnect the mains plug!

Remove the four screws holding the lower part of the right-hand cover panel (to which the Perspex lid is attached, Fig. 1, 14). Grasp the panel at the right-hand corner and remove it by pulling it up and towards yourself.

Give the spindle (Fig. 5, 1) a few turns using a screw driver inserted in the slit (2) until the heating filament holder is in its most advanced position. Do not screw the spindle (1) out completely! Loosen the small black grub screw of the upper filament holder using the hexagonal key from the spare-parts box. Loosen the knurled screw of the lower filament holder.

DANGER ! HOT !! You can burn your fingers!

Pull the filament out of the slots.

Danger! Fingers can be jammed or eyes injured from glass splinters when the heater appears! Fingers can be burned when handling the filament!

Insert the new filament as far as it will go into the slots. Partially (gently) tighten the screws . Adjust the horizontal and vertical position of the filament approximately by moving the upper and/or lower parts of the filament (the fine adjustment is described immediately following). Under no circumstances should the filament be adjusted by bending.

Tighten the screws and screw the metal cover back in place. Leave the heater in its advanced position (do not screw the spindle (1) completely out of its hole!)

Important: This cover prevents eye damage by flying glass splinters if a glass blank breaks. It must be screwed firmly in place before switching the power on. The puller may otherwise be seriously damaged if the heater unit is obstructed by the metal cover when moving back into position.

Fine adjustment of the position of the heating filament: **after closing** the cover as described above, switch on the puller (**MAINS**). The heating unit will immediately return to its rest position. Insert a glass blank into the glass holders and press **START**. Immediately before the puller has moved the heating unit to its advanced position, switch the puller off (**MAINS**). Now remove the metal cover again
Give the spindle (Fig. 5, 1) a few turns using a screw driver inserted in the slit (2) until the loop of the heating filament has reached the glass.
Carefully adjust the position of the filament as above. The glass tube should be centred precisely in the loop of the heating filament.

Do not bend the heating filament!

Tighten the grub screws on the upper heating filament holder and tighten the knurled screw on the lower holder. For good contact fix the filament carefully! Tighten the knurled knob by hand. Finally, insert the hexagonal key as a lever into the round holes of the knob and turn the knob by 30-40 degrees!

Do not overtighten the screw! Otherwise the wall of the clamp can be bent.

If the filament has been correctly inserted into its slots, the distance between the rear wall of the glass tubing and the filament will be correctly adjusted. Now screw the metal cover pane back in place and switch on the puller (**MAINS**). The heating unit will return to its resting position. On pressing **BREAK** (Fig. 1, 6) the glass holders will open and the glass blank can be removed.

8 Trouble shooting

8.1 The glass breaks in the glass holders

Cause 1: If glass has broken previously, glass fragments may remain in the holders and cause subsequent blanks to break.

Remedy: Remove all fragments from the glass holders with a brush

Cause 2: The rubber pressure pad(s) is(are) damaged.

Remedy: Replace the rubber pressure pads as follows.

1. Disconnect the puller from the mains.
2. Remove the cover panel (Fig. 1, 18, three screws).
3. Remove the screws 5 and 7 (Fig. 4) from the left- or the right-hand glass holder.
4. Remove plate 8 whilst holding the glass holder firmly.
5. Pull the glass holder by hand out of the apparatus.
6. Remove the bronze block from the glass holder by turning the spindle clockwise for several turns. Use the screw driver included in the spare-parts box.
7. Pull the old white rubber pressure pad off the bronze block, clean the surface of the block (knife, acetone, etc.)
8. Glue on a new pressure pad ("Superglue"). Ensure no glue enters the holes bored in the bronze block. If this happens the holes must be cleaned. The middle threaded hole can be cleaned by screwing a 3-mm metric screw into the hole.
9. Using scissors, cut off excess rubber flush with the sides of the bronze block.
10. Replace the bronze block in the glass holder in same way it was removed: set it on the spindle and guide pegs with the new rubber to the front and turn the spindle counterclockwise until the block returns to its original position.
11. Replace the glass holder in its mounting (approach from behind), replace the front plate with its two screws.
12. Ensure that the red/black cable supplying the glass clamp motor is free.This is particularly important for the left-hand (moving) glass holder, since the connecting cable may hinder the free movement of the pulling rod. Check by moving the pulling rod through its complete

excursion from left to right and observing the movement of the connecting cable.

13. Replace the cover (Fig. 1, 18).
14. Test the puller. If the axes of the glass holders are not exactly concentric, the glass blank will move away from its axis during pulling resultion in non-symmetric tips. If this happens, adjust the plate by loosening the screws (5 and 7) slightly and tilting the plate slightly upwards or downwards. Contact the manufacturer if satisfactory results cannot be obtained

Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com   info@zeitz-puller.com

8.2 Rattling motor noise

When checking the puller according to the following instructions, always observe the caution notes. These notes begin with the word DANGER!

When the puller is turned on (**MAINS**, see **Remedy A)** or when the pull sequence is started (**START**, see **Remedy B**), a rattling motor noise may be heard. This indicates that the bronze block (Fig. 5, 5) of the heater advance has become completely detached from the spindle (Fig. 5, 1). The spindle has an external thread and the bronze block an internal thread and under normal conditions the spindle is screwed into the bronze block. The length of the spindle and its thread are so designed that in the case of an error the heater advance cannot jam mechanically, in either its advanced or retracted position. Complete detachment of the bronze block from the spindle thread is normally prevented by two reflected light sensors (6) and a small mirror which is glued to the guide track (7) which moves with the heater (The mounted mirror cannot be seen, it is situated between the black aluminium part (8) of the sensor and the track (7)). The travel of the heater advance is the distance between these two sensors (see scetch Fig. 1 on the end of this chapter). The error case occurs when the mirror is beyond either of the reflected light barriers (see sketch Fig. 2 on the end of this chapter).

Error location and remedy

Remedy A. Heater in the retracted position.

The bronze block must be screwed back onto the spindle (Fig. 5, 1):

Step 1. Switch off the puller (**MAINS**) and pull out the mains plug. Open the lower right cover panel (Fig. 1, 14) .

If the heater is in its rear position, turn the spindle (Fig. 5,1) clockwise using a screwdriver in the slit (2). At the same time, and using a second screwdriver, push the bronze block forwards (i.e. towards you) so that its thread engages in the first turn of the spindle's thread. (If the heater is in its forward or working position, see Remedy B)

Continue to turn the spindle clockwise until the heater is at approximately the middle of its travel. For safety reasons the cover panel (Fig. 1, 15) must be replaced before switching the puller on. Use the screws which were removed above. **Failure to close the cover properly may result in the advancing heater colliding with the cover panel and causing serious damage to the instrument**.

Switch the puller on by pressing the **MAINS** key. If there is no further cause of error, the heater should automatically return to its rest position inside the instrument.

If a rattling motor noise is immediately heard again, there are three possible causes :

Possibility 1. The motor end-stage is defective (Fig. 3, 10; located on the heat sink).

Possibility 2. There is an error in the sensors (Fig. 5, 6)

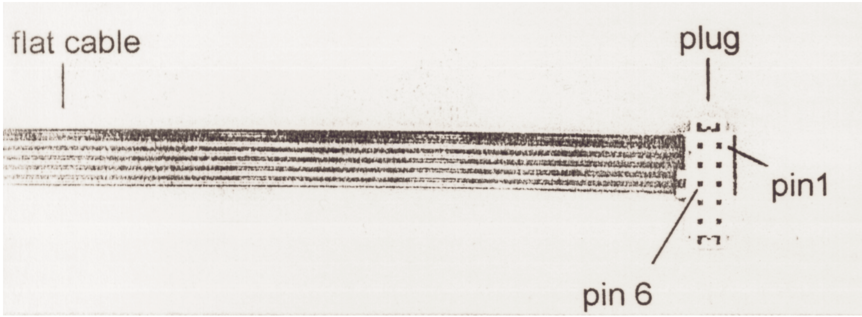
Possibility 3. There is an error in the circuitry handling the sensor signal on the control circuit board (Fig. 3, 11).

To exclude the first possibility, identify the red and blue leads (Fig. 3, 12) and detach the plugs. The motor should stop immediately (see next section)

To exclude the second possibility, detach the plug (Fig. 5, 9) leading to the sensors whilst the rattling noise continues (the cover panel must be removed again to do this).

DANGER!
Take care! Fingers can be seriously injured if jammed between the aluminium block (Fig. 5, 10) and the bronze block (5) as the heater reverses. Keep hands and fingers away from here!

Briefly earth (i.e. connect with any bare metal part of the instrument chassis) pin 6 of the detached plug (see picture below). To do this insert a suitable pin in the appropriate hole of the plug. Earthing this pin normally causes the motor to stop immediately, providing the heater had been moving towards its rest position (i.e. at the rear of its travel).



Should the motor not stop immediately, the third possibility must be suspected. In this case contact the manufacturer or the distributor.

If the sensor is defective (second possibility) it can be exchanged for a new one.

Remedy B. Heater in the advanced position.

If a rattling noise is heard when the heater is in its working (outer) position, the bronze block (Fig. 5, 5) has advanced off the front end of the spindle thread.(1) i.e. the sensor has not recognised the working position of the heater. To find and remedy the error, the threads of the bronze block and the spindle must first be reengaged.

For safety, switch the puller off (**MAINS**) and remove the mains plug. Open the lower right cover panel (Fig. 1, 14) .

DANGER!
Take care! Fingers can be seriously injured if jammed between the aluminium block (Fig. 5, 10) and the bronze block (5) as the heater reverses. Keep hands and fingers away from here!

Turn the spindle (Fig. 5, 1) counterclockwise using a screwdriver in the slit (2) and, at the same time push the bronze block (5) towards the rear until the threads of the spindle and bronze block engage. Continue to turn the spindle (1) until the heater is at approximately the middle of its travel.

For safety reasons the cover panel (Fig. 1, 15) must be replaced before switching the puller on. Use the screws which were removed at step 1 above. **Failure to close the cover properly may result in the advancing heater colliding with the cover panel and causing serious damage to the instrument.**

Now switch the instrument on (**MAINS**). The heater moves automatically to its rest position inside the instrument. If the detachment of the bronze block from the spindle was just coincidental no error is present and the instrument should now again function normally.

If a rattling motor noise is again heard when a pull sequence is commenced with the **START** key, there are three possible causes :

Possibility 1. The motor end-stage is defective (Fig. 3, 10; located on the heat sink).

Possibility 2. There is an error in the sensors (Fig. 5, 6).

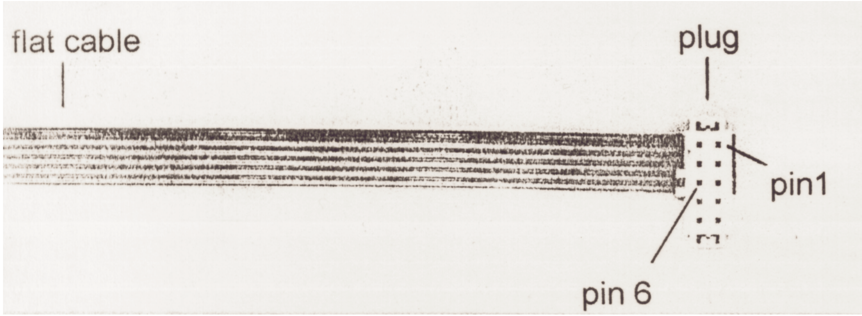
Possibility 3. There is an error in the circuitry handling the sensor signal on the control circuit board (Fig. 3, 11).

To exclude the first possibility, identify the red and blue leads (Fig. 3, 12) and detach the plugs. The motor should stop immediately.

To exclude the second possibility, detach the plug (Fig. 5, 9) leading to the sensors whilst the rattling noise continues (the cover panel must be removed again to do this).

DANGER!
Take care! Fingers can be seriously injured if jammed between the aluminium block (Fig. 5, 10) and the bronze block (5) as the heater reverses. Keep hands and fingers away from here!

Briefly earth (i.e. connect with any bare metal part of the instrument chassis) pin 1 of the detached plug (see picture below). To do this insert a suitable pin in the appropriate hole of the plug. Earthing this pin normally causes the motor to stop immediately, providing the heater had been moving towards its working position (i.e. at the forward end of its travel).



Should the motor not stop immediately, the third possibility must be suspected. In this case contact the manufacturer or the distributor.

If the sensor is defective (second possibility) it can be exchanged for a new one.

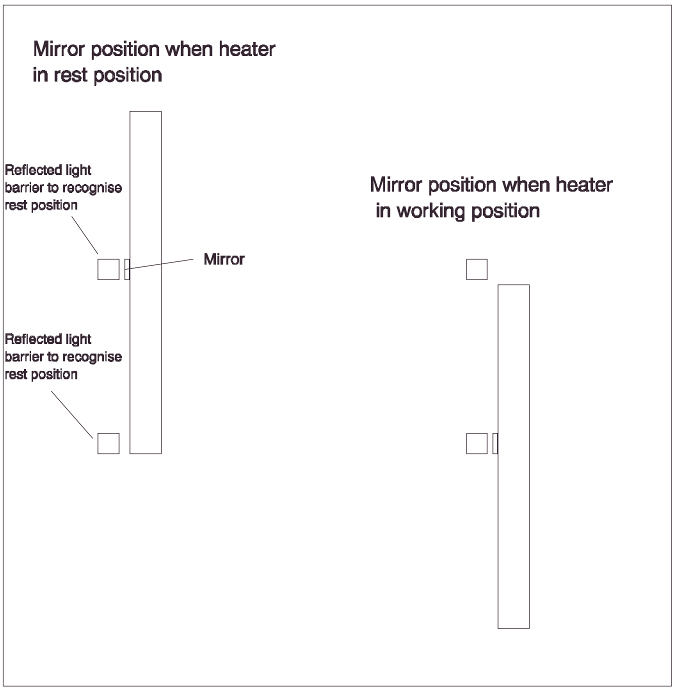

Mirror position when heater
in rest position
Reflected light
barrier to recognise
rest position
Mirror
Reflected light
barrier to recognise
rest position
Mirror position when heater
in working position

Fig. 1

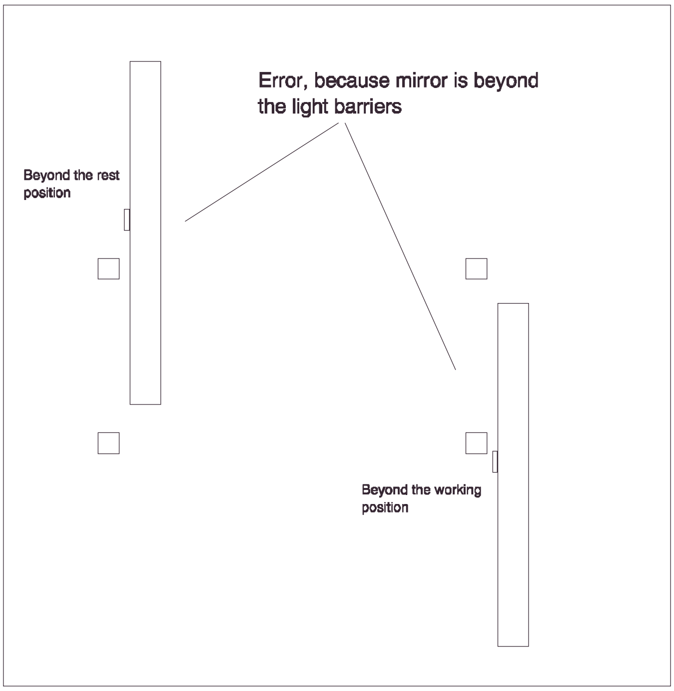
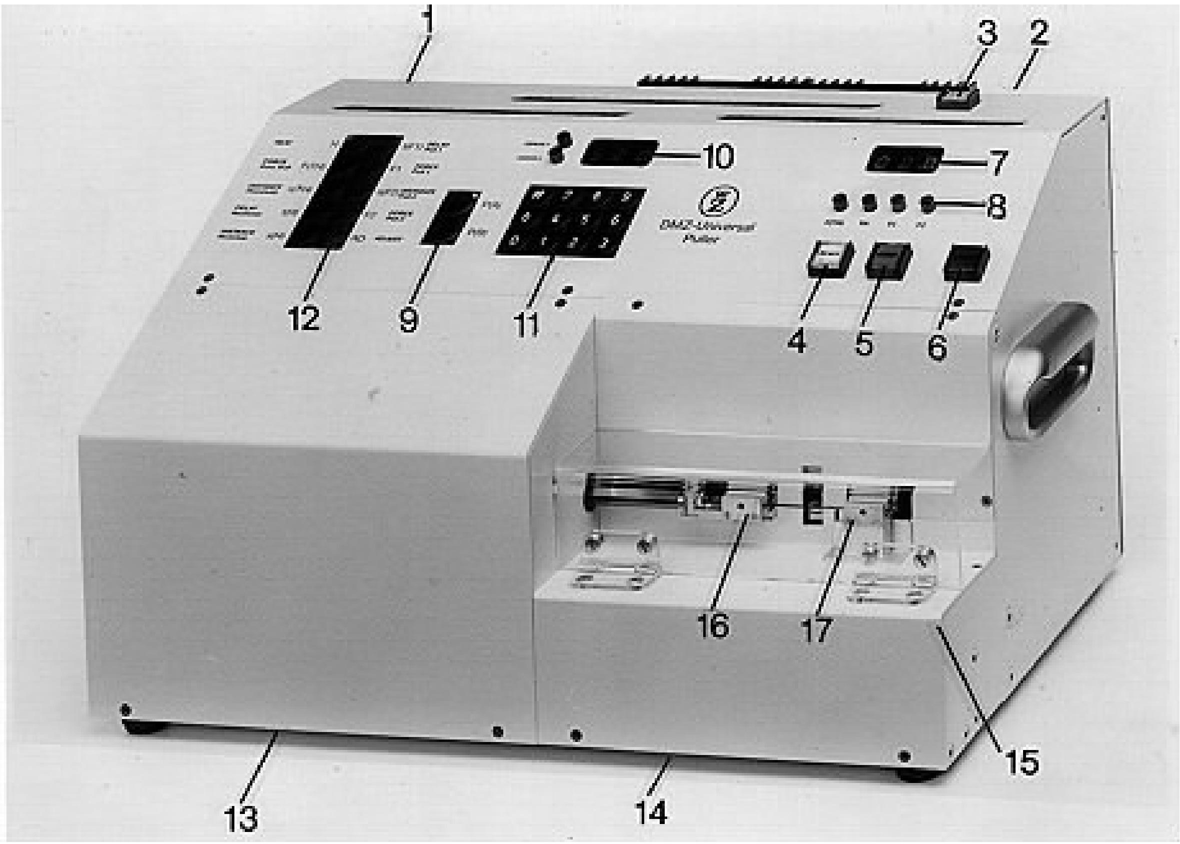
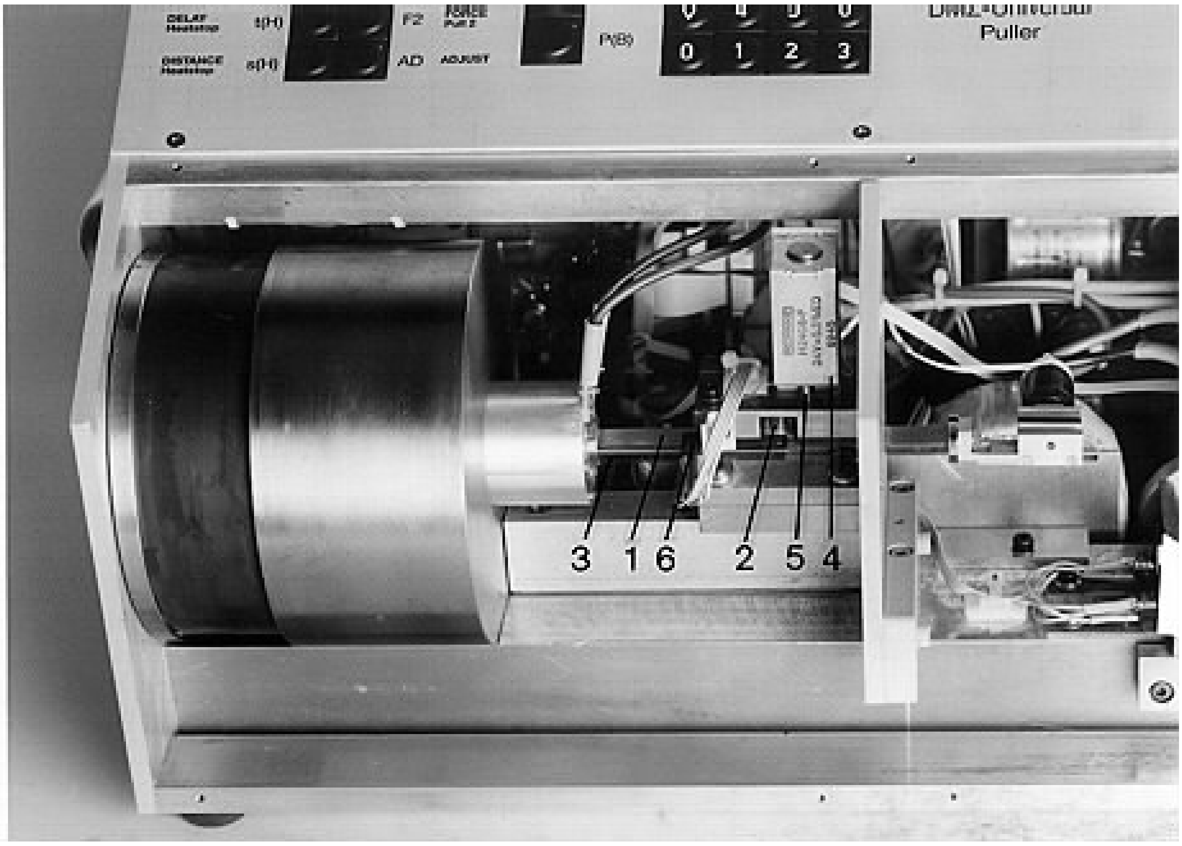
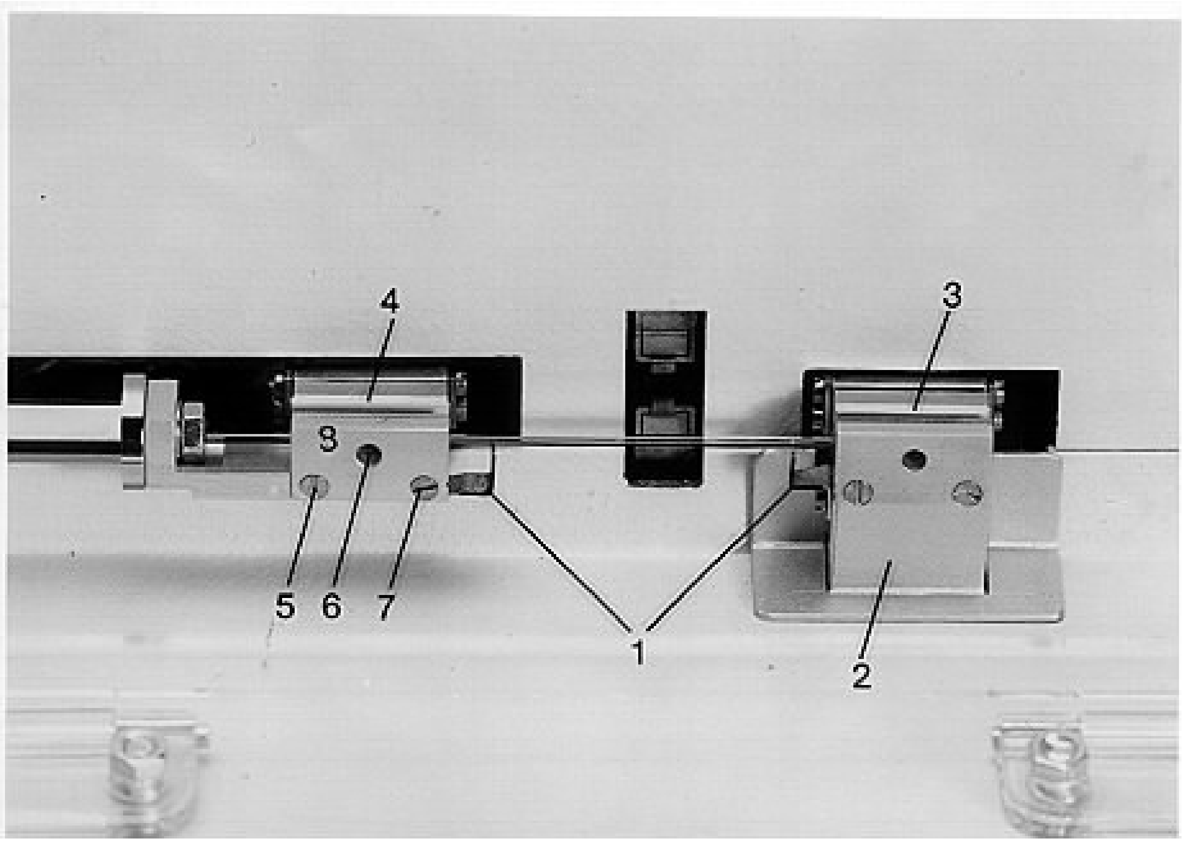

Error, because mirror is beyond
the light barriers
Beyond the rest
position
Beyond the working
position

Fig. 2


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
DMZ-Universal
Puller



Zeitz-Instruments GmbH, Muenchen, Germany, Hot-Line+49 0172 8125656
www.zeitz-puller.com info@zeitz-puller.com


4
3
8
5
6
7
1
2

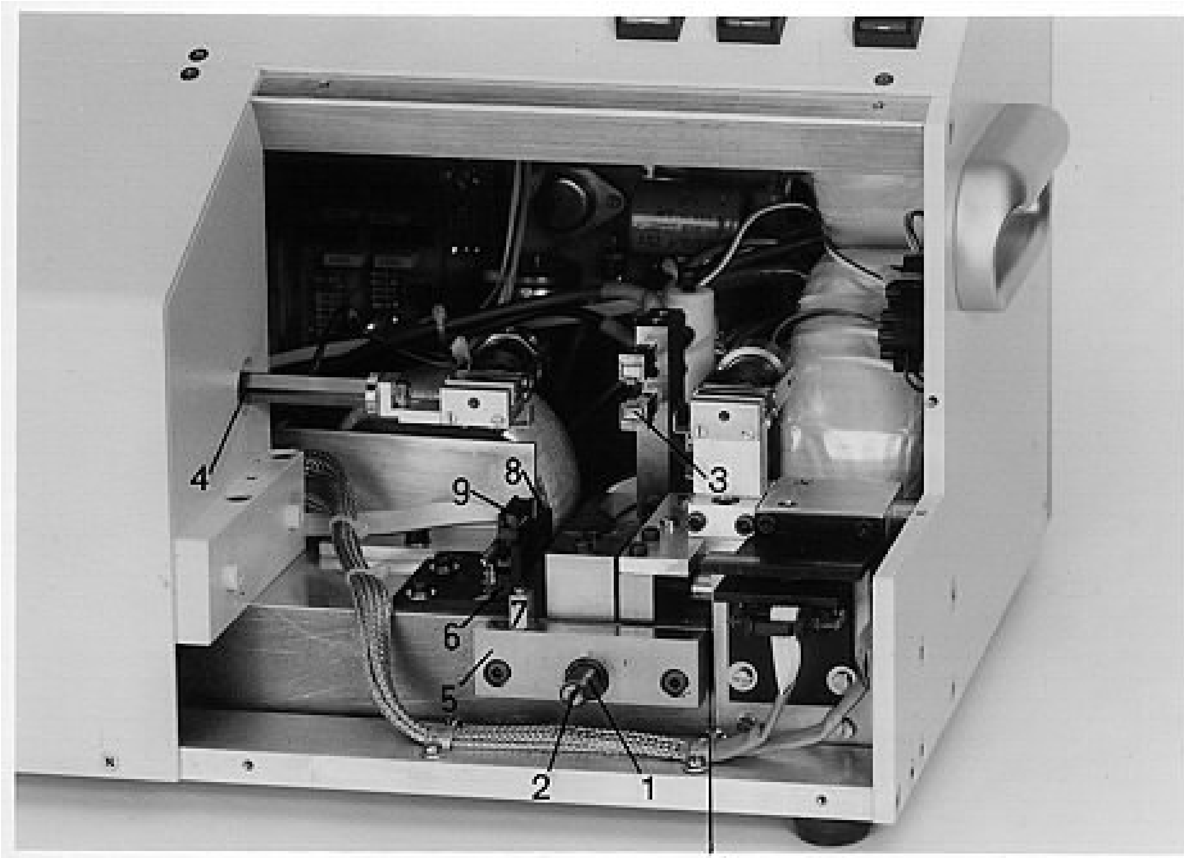


Fig. 5

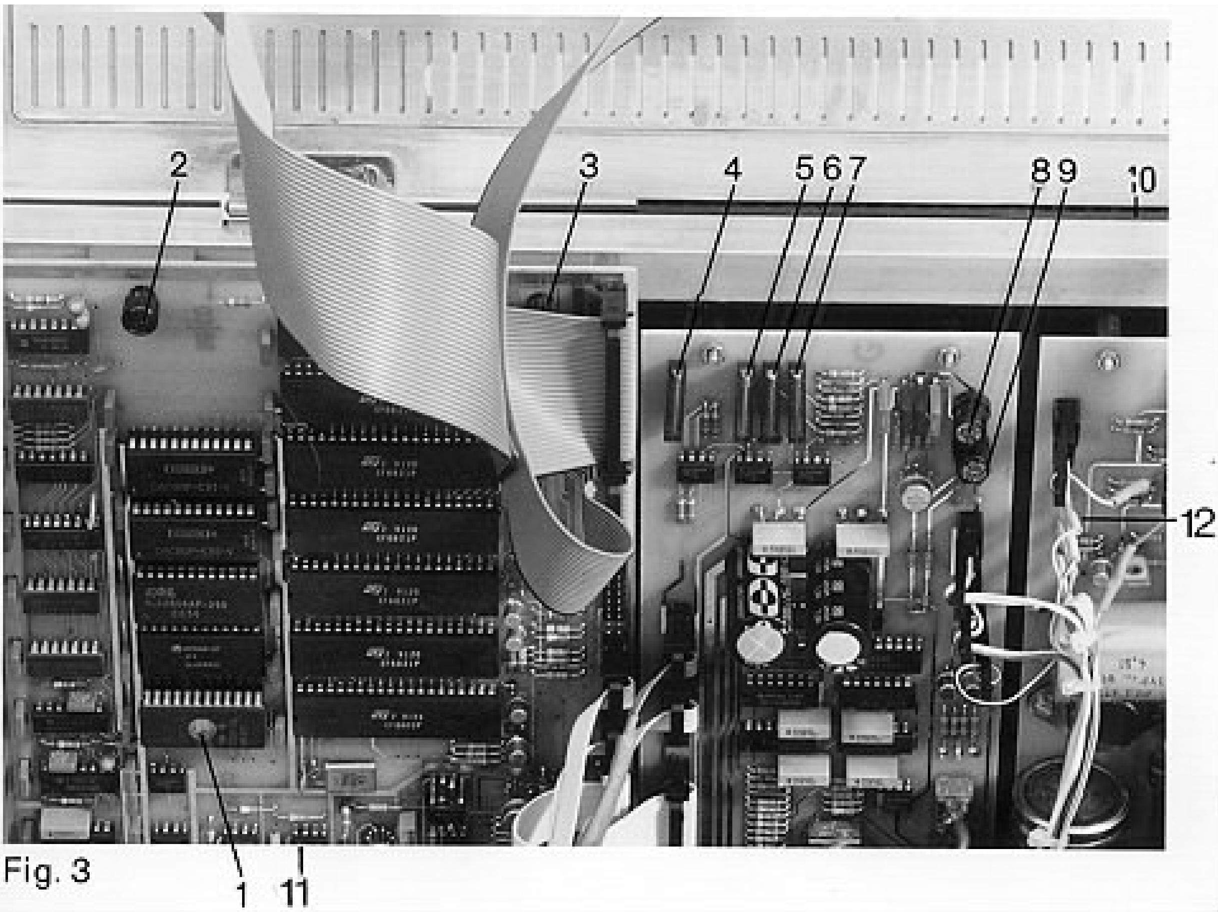


Fig. 3