

SERVICE MANUAL

for the

Danni-flex

Models 450 and 455 CPM

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DANNI-FLEX MODEL 450/455 SERVICE MANUAL

If you have any questions, please contact our service department at:

1-800-225-1814 or 614-488-7961

EQUIPMENT NEEDED

Digital Multi-meter
Large diagonal cutters
Phillips screwdriver
Standard screwdriver
Socket Set
Hex-Key Set

ABBREVIATIONS

(PCB) - Printed Circuit Board
(CKT) - Circuit

NOTES

This document assumes a basic knowledge of operation of the 450/455 CPM device. If you are unfamiliar with the 450/455, please read the operators manual before proceeding.

The following calibration parameters should be checked following any repairs:

- 1) Range of motion
- 2) Force reversal
- 3) Speed

COVER DISASSEMBLY

To remove bottom-base cover of cpm, use large pair of diagonal cutters to carefully pry plastic fasteners apart and remove them from base cover. (Plastic fasteners may be reused if they are not damaged). Remove CPM carrying handle with phillips screwdriver. The bottom base cover may now be removed.

CPM MECHANICAL DEVICE DESCRIPTION

The following discussion pertains to the mechanical aspects of the CPM, including descriptions of the drive mechanism and critical coupling areas.

Any reference made to the left or right side assumes the CPM is being viewed with the thigh end of the device closest to the observer. (patient's view)

MOTOR/BALL-SCREW COUPLING

The Motor, which controls the movement of the cradle, is coupled to the ball-screw with a motor/ball-screw coupling. The motor/ball-screw coupling consists of a cylindrical rubber piece and two aluminum end pieces. One end piece is pinned to the ball-screw and the other is pinned to the motor shaft. There should be no more than 1/16 - inch of play between the rubber and the two end pieces at any time. No play at all in the motor/ball-screw coupling can cause excessive load to be applied to the motor. More than 1/16 - inch of play can cause slippage of the rubber portion of the coupling between the end pieces which would cause the cradle to slip into full extension when the device is under load.

BALL-SCREW NUT/U-BRACKET/CALF CRADLE ASSEMBLY

As the motor turns, the ball-screw turns which causes the ball-screw nut to travel along the ball-screw. The ball-screw nut is attached to a trunion mount bracket which is riveted to the aluminum u-bracket assembly. The u-bracket assembly has plastic slider blocks on each end which are mounted to the calf cradle struts.

CPM ELECTRONIC CIRCUIT DESCRIPTION

The following discussion pertains to the CPM electronics. References will be made to the CPM machine and to the electrical schematic (part number 12633).

The Danni-flex Model 450 and Model 455 lower limb CPM devices contain an embedded micro-controller which controls the operating functions of the CPM.

KNEE PIVOT POTENTIOMETER

This discussion will begin with the Potentiometer which is found at the left knee-pivot of the CPM. It is covered by a white plastic cover. (also see the upper-left corner of the circuit schematic). This potentiometer (knee-pot) measures the knee-pivot angle. The voltage present on the wiper of the knee-pot (R1) is conditioned by op-amp (U15) and then fed into the microprocessor (U1).

The (knee-pot) is pressed into the left knee-pivot casting using a special fixture which calibrates the potentiometer as it is being pressed into the casting. If the knee-pot fails, the CPM should be returned to Danninger.

Resistor (R10) is an offset-adjustment resistor used to "fine tune" the range of the knee-pot wiper voltage after knee-pot installation. This pot should not need adjustment unless the knee-pot has been removed and/or installed. (See calibration instructions for further information on R10 adjustment).

The two comparators in U14 are used to shutdown the cpm if the knee-pot wiper voltage is outside of the voltage range determined by the voltages present on pins 3 and 6 of U14.

SAFETY SHUTDOWN MECHANISMS

The CPM will stop in response to the following knee-pot error conditions:

- 1) Knee-pot wiper voltage is out of range.
- 2) Knee-pot wiper voltage does not vary when machine is supposed to be running.
- 3) Knee-pot wiper voltage varies erratically.

The machine will not run until the error condition returns to normal.

CPM ELECTRONIC CIRCUIT DESCRIPTION CONT.

MOTOR DRIVE CIRCUITRY

The motor is pulse width modulated at a frequency of approximately 2-Kilohertz.

Speed control is accomplished by varying the duty cycle of the pulse width modulated waveform.

Field Effect Transistors Q1, Q2, Q3, AND Q4 form an H-bridge configuration. These FET's are located in the lower left section of the schematic. Q2 and Q4 control the direction in which the motor will travel. In the "RUN" mode, one of the two transistors (Q2 or Q4) will be on, and the other will be off.

Q1 and Q3 control the driving and braking of the motor. When two FET's across from each other are on (Q1 and Q2) or (Q3 and Q4), the motor terminals will be shorted together and motion of the motor shaft will be impeded. When FET's diagonal to each other (Q1 and Q4) or (Q3 and Q2) are on, the motor will turn.

U6, U7, U8, and U9 are used in conjunction with the microcontroller to supply the pulse width modulation signals used to drive FET's Q1 and Q3.

U9 is set up as a divide by 16 counter which divides the microcontroller E-clock by 16.

U8 is a dual-JK flip-flop, U7 is a 4-bit binary up/down counter, and U6 is a voltage level comparator.

U10 and U11 are voltage level shifters used to drive the FET H-bridge.

Relay K1 is used to short the motor terminals together when the power switch on the foot end of the CPM is in the standby (off) position.

Transistor Q5 must be turned on in order for the motor to run, and is provided as a safety shut down of the motor current.

CPM ELECTRONIC CIRCUIT DESCRIPTION CONT.

FORCE SENSING CIRCUIT

The force applied to the cradle of the CPM device is measured by sensing the current flowing through the motor.

When Q5 is turned on (lower left on schematic), the current traveling through the motor travels through the 1 ohm resistor R23. The voltage created across R23 is sampled by turning on Q9 at which time this voltage is filtered and presented to an Analog to Digital converter (Pin 45 "PE1") on the micro-controller.

A fixed portion of the unregulated power supply voltage is applied to an Analog to Digital converter at pin 47 "PE2" on the micro-controller from the voltage divider made up of R36 and R37.

The above two circuits provide the values necessary to determine the speed of the motor and the force applied to the motor output shaft.

If the motor current and/or motor load is too high, the motor will reverse direction.

HAND HELD PATIENT CONTROL PENDANT

The components in the hand-held pendant are labeled such that the letter "P" is part of the component name. For example RP1 and UP1.

The pendant cable contains the following signals:

- 1) The eight bit data bus of the micro-controller
- 2) + 5 volts
- 3) Address line A0 from the micro-controller
- 4) The Read/Write line from the micro-controller
- 5) The LCD clocking signal called "LCD E"
- 6) The Pendant data latch decoder line
- 7) The keypad interrupt request line
- 8) Signal return (Ground)
- 9) Safety ground consisting of braided shield and drain wire.

DIAGNOSTIC MODE

The Diagnostic Mode is a trouble shooting aid which has proven to be an invaluable tool in the problem diagnosis phase of repair. When the CPM fails for any reason in the diagnostic mode, one of several statements will be displayed on the Pendant display.

To enter the DIAGNOSTIC MODE, the following steps should be taken:

- 1) Move the set/lock switch (located at the foot end of the CPM base frame) to the lock position.
- 2) Set the power switch to the standby (off) position.
- 3) Depress and hold both the EXTEND and PAUSE keys on the pendant.
- 4) Set the power switch to ON.
- 5) let your fingers off the EXTEND and PAUSE keys.
- 6) Move the pendant switch to the set position within 10 seconds. The display will show "DIAGNOSE".
- 7) Press the START/STOP key to get the normal display with the extension angle setting in the left window, the STOP and knee-pot angle in the center window, and the flexion angle setting in the right window. In this mode the unit will operate very similar to the normal mode of operation.

To EXIT from the diagnostic mode set the power switch to STANDBY and then to ON again.

The following diagnostic messages can appear on the LCD:

"TOO ERRATIC"
"BAD AVERAGE"
"OUT OF RANGE"
"NO CHANGE"

TOO ERRATIC and BAD AVERAGE messages are displayed if the knee-pot center wiper voltage is erratic. Possible problems which could cause these messages are: Intermittent open in knee-pot coil cord or wiring, Intermittent problems with knee-pot, problems with the Analog to Digital converter on the micro-controller.

OUT OF RANGE is displayed if the knee-pot center wiper voltage is outside of the range determined by the voltages on pins 3 and 6 of U14.

DIAGNOSTIC MODE CONT.

NO CHANGE is displayed if the CPM is in the RUN mode (supposed to be running) but the knee-pot center wiper voltage is not changing fast enough. This message can occur if there are problems with the knee-pot and/or associated wiring, Micro-controller Analog to Digital converter problems, Motor and/or mechanical binding problems causing the motor to run too slowly or not at all.

CALIBRATION INSTRUCTIONS FOR MODELS 450 AND 455 CPM DEVICES

If the micro-controller has been replaced, the LCD module will display the letters ASF. These letters stand for the parameters which have not yet been calibrated. "A" stands for Angles. "S" stands for Speed. "F" stands for force. After the calibration of any of these parameters is complete, that letter will disappear from the LCD display.

Plug in the wall-plug-in power supply.

ANGLE CALIBRATION

NOTE: The knee pivot angle should be measured by using a protractor or some other angle measuring apparatus.

STEP 1 - Move the SET/LOCK switch (located at the foot end of the CPM base frame) to the LOCK position.

STEP 2 - Set the power switch to the STANDBY (off) position.

STEP 3 - Depress and hold the EXTEND and FLEX keys on the pendant while moving the power switch to the ON position.

STEP 4 - Release the EXTEND and FLEX keys. (the display will be blank)

STEP 5 - Move the SET/LOCK switch to the SET position within 10 seconds. The display will show "CAL EXT" in the center window and the digital representation of the knee-pivot potentiometer (knee-pot) center-wiper voltage will appear in the left window of the display.

STEP 6 - Adjust the Knee pivot of the CPM leg cradle to a knee pivot angle of 0 degrees. This can be accomplished by depressing the up or down arrow keys on the pendant and letting the unit run until it reaches 0 degrees. This angle should be measured at the knee pivot on the knee-pot side of the CPM.

STEP 7 - If the displayed value is below 35 or greater than 41 then the trim pot R10 on the main PCB must be adjusted. The trim pot should be adjusted to achieve a reading as close as possible to 38. If the reading is still out of range then either the knee-pot was not inserted properly or there is a problem with the electronic components, circuitry or wiring (see electronic circuit description).

CALIBRATION INSTRUCTIONS FOR
MODELS 450 AND 455 CPM DEVICES

STEP 8 - Press and release the EXTEND key to hold the value on the display. Press and release the START/STOP key within 2 seconds to store the calibration value for 0 degrees extension.

STEP 9 - If the display reads "SEE MANUAL", the knee-pot value is out of range. To correct this go to step 4 and adjust R10.

STEP 10- Adjust the unit for 90 degrees, measured at the knee pivot as described in step 6. The knee pivot should be at a right angle.

STEP 11- Press and release the FLEX key to hold the value on the display. Press the START/STOP key within 2 seconds to store the calibration value. The display will read "CAL COMPLETE" in the left and center windows and the knee-pot angle in degrees will appear in the right window.

STEP 12- If the display reads "SEE MANUAL", the knee-pot value is out of range. The angle calibration will have to be done again. Switch the power switch to standby. Start at step 1. Make sure the angles are measured properly. Before doing step 5, adjust trim pot R10 on the main PCB to achieve a reading as close as possible to 38. WARNING: Do not adjust trim pot R10 after doing step 5 as this will cause the calibration to be wrong. If the unit still will not calibrate the knee-pot will have to be reinserted.

STEP 13- To get out of the angle calibration mode switch the power switch to standby.

ANGLE CALIBRATION CHECK

STEP 1 - Set the power switch to the ON position.

STEP 2 - Make sure the pendant switch is in the SET position so that the settings can be changed.

STEP 3 - If the display shows an SF in the center window, press the START/STOP key to get into the normal mode. The display will show the extension angle setting in the left window, STOP and the knee-pot angle in the center window, and the Flexion angle setting in the right window.

CALIBRATION INSTRUCTIONS FOR
MODELS 450 AND 455 CPM DEVICES

STEP 4 - Loosen the knobs on the thigh tubes. Pull up on the cradle to separate the thigh tubes. Hold the inner thigh tube (the one connected to the knee-pot) at the knee-pivot's extension limit. With the knee-pot in this position, press the START/STOP key. The unit should start running. NOTE: It is normal for the unit to stop automatically when the knee-pot position does not change.

STEP 5 - Hold the thigh tube at the knee pivot's flexion limit. Press the START/STOP key. The unit should start running. If the unit does not start running at both ends then the trim pot R10 on the main PCB will have to be adjusted until the unit does start running at both ends. If the trim pot R10 is adjusted then the angle calibration will have to be done again starting at step 1. WARNING: Do not adjust trim pot R10 after doing step 4 as this will cause the calibration to be wrong.

STEP 6 - Set the flexion limit to 110 degrees by pressing and holding the FLEX key while pressing the up arrow key. The angle setting will change slowly for the first 5 degrees and fast after that until the keys are released.

STEP 7 - Press the START/STOP key to start the unit running. If the unit runs toward extension press the START/STOP key to stop the unit and press it again to start it in the opposite direction. When the unit reaches 110 degrees it will pause. While the unit is paused press the START/STOP key to stop the unit at 110 degrees.

STEP 8 - Check the angle at the knee-pot to make sure it is within 1 degree of the setting.

STEP 9 - To turn the unit off put the power switch in the standby position.

CALIBRATION INSTRUCTIONS FOR
MODELS 450 AND 455 CPM DEVICES

SPEED CALIBRATION

STEP 1 - Set the SET/LOCK switch to the LOCK position.

STEP 2 - With the power switch set to standby, press and hold both the PAUSE and SPEED keys on the pendant while turning the power switch ON. Release the PAUSE and SPEED keys. Display will be blank. Move the pendant switch to the SET position within 10 seconds. The display will show "CAL SPEED" in the left and center windows and the low speed calibration value will appear in the right window.

STEP 3 - Press the START/STOP key to start the motor. NOTE: The unit will not reverse directions automatically in this mode. To reverse direction press the START/STOP key once to stop the unit and press it again to start the unit in the opposite direction.

STEP 4 - Measure the speed with a tachometer at the end of the ball-screw or with a 12 inch ruler by measuring the distance that the calf cradle struts travel along the ball-screw.

STEP 5 - Adjust the calibration value using the UP and DOWN arrow keys until the tachometer reads 15 (+ or - 2) RPMs. With a ruler, the length of travel of the calf cradle struts should be 3 inches per minute (+ 1/4 in. - 0 in.).

STEP 6 - Press the SPEED key to store the calibration value. The display will read "CAL COMPLETE".

STEP 7 - To get out of the speed calibration mode switch the power switch to STANDBY and back to ON.