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.

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 breaking 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.

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.