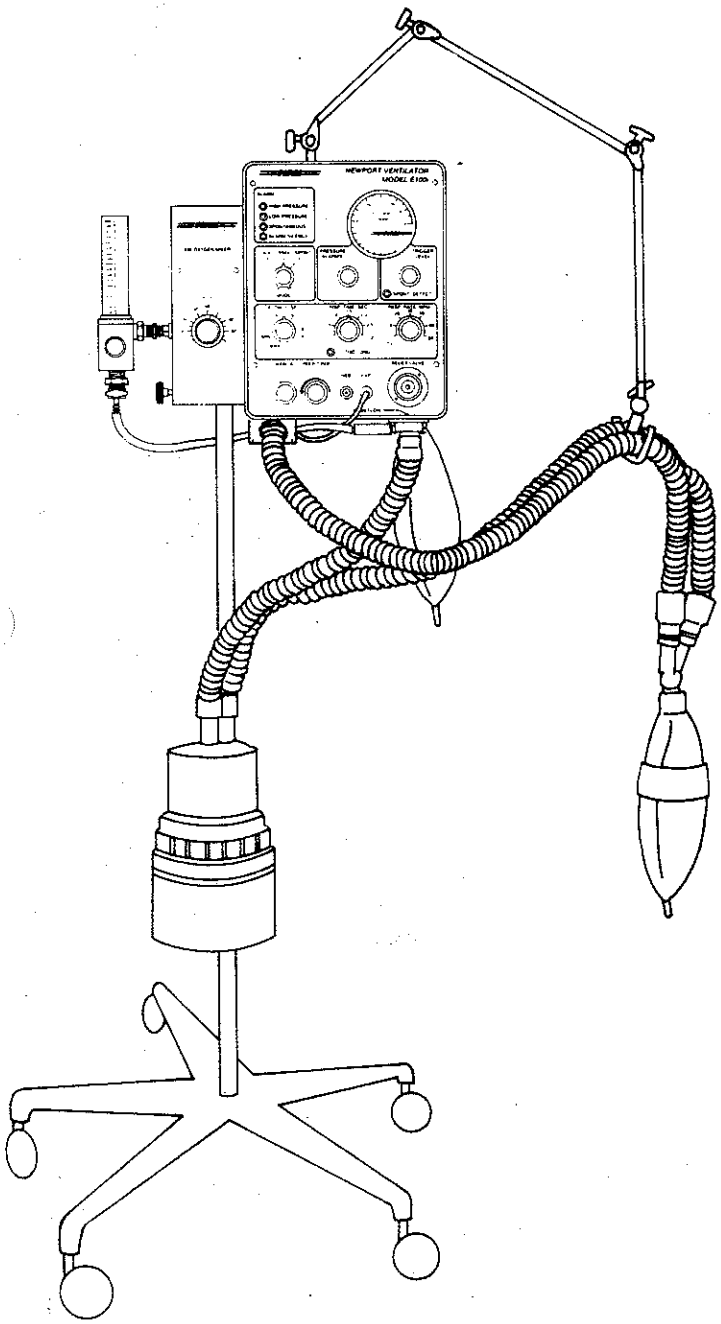
NEWPORT E100i VENTILATOR



Service Manual

MODEL E100i

NEWPORT MEDICAL INSTRUMENTS, INC.

Newport Medical Instruments, Inc.

NEWPORT E100i VENTILATOR

Service Instructions

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Newport Medical Instruments, Inc.
760 W. 16th St., #N
Costa Mesa, CA 92627

Customer Service: 714 • 642•3910
800 • 451•3111 Fax 714 • 548•3091
Service Dept.: 714 • 650•0430
800 • 892•6954 Fax 714 • 645•2049

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CHAPTER I

INTRODUCTION

The Newport Medical Instruments E100i ventilator is a medical device classified as a pneumatically powered, microprocessor controlled ventilator with continuous flow. It can function as a Time Cycle, Constant Flow, Volume Limited or as a Time Cycle, Constant Flow, Pressure Plateau, ventilator. It is designed for the infant, pediatric and adult patient requiring the administration of:

Supplementary Oxygen Therapy
Assist/Control Mechanical Ventilation (A/C)
Synchronized Intermittent Mandatory Ventilation (SIMV)
Continuous Positive Airway Pressure (CPAP)
Positive End Expiratory Pressure (PEEP)

The E100i ventilator operates in three basic modes:

Assist/Control (A/C)
Synchronized Intermittent Mandatory Ventilation (SIMV)
Spontaneous

All of the controls are operational in both the A/C and SIMV modes. The Spontaneous mode allows the patient to breathe from a continuous flow of gas at the prescribed FiO2 with or without the addition of Continuous Positive Airway Pressure.

Primary pneumatic and electronic controls found on the Newport Medical Instruments E100i ventilator are:

FLOWMETER	PEEP/CPAP
FIO_2	RELIEF VALVE
FLOW (L/sec.)	PATIENT TRIGGER LEVEL
RESPIRATORY RATE (BPM)	INSPIRATORY TIME
MANUAL BREATH BUTTON	VENTILATOR MODE

In addition to these controls, four visual alarms are found on the face of the ventilator.

HIGH PRESSURE	When lit, an audible alarm is triggered.
LOW PRESSURE	When lit, an audible alarm is triggered.
SPONTANEOUS	Select 15 or 30 sec. delay. When lit, an audible alarm is triggered.
INSPIRATORY TIME TOO LONG	

Just below the alarm indicators is a push button labeled ALARM SILENCE. When depressed, the alarm is silenced for 55 seconds. The silence period begins again whenever the button is depressed.

Even when the audible alarm is silenced, the alarm's red indicator light remains flashing until the cause of the alarm condition is corrected. The audible alarm is automatically reactivated after the silence period has elapsed.

When the alarm condition is corrected, the alarm silence is cancelled, even if the 55 seconds have not elapsed. The alarm can also be reset manually by momentarily switching the mode selector switch in and out of the different modes.

There are also audible alarms for a power failure, or air/oxygen mixer malfunction.

WARNINGS AND PRECAUTIONS WHEN USING E100i VENTILATOR

The following warnings, precautions and procedures are general guidelines to assist the practitioner.

DO NOT use the ventilator in the presence of flammable anesthetics.

DO NOT use any instrument that has been exposed to oil, grease or any other contaminant.

Newport Medical Instruments, Inc. warrants its product for a period of one year from date of purchase. For details see Warranty.

Any authorization for alteration of modification by buyer must be approved in writing by Newport Medical Instruments, Inc.

Liquid (i.e. water) or other contaminants in either gas supply source may cause malfunction of this equipment and other equipment attached to it.

Personnel operating this equipment are responsible for reading and thoroughly understanding all product information and documentation provided.

Note that when the "Inspiratory Time Too Long" indicator is lit, the inspiratory time is shortened to deliver a 1:1 I:E ratio. During time cycled, volume limited ventilation, this will mean a decrease in the delivered tidal volume. To correct the situation, decrease the set inspiratory time until the warning indicator goes out, then increase the mechanical flowrate setting to achieved the desired tidal volume.

If the low pressure alarm limit indicator comes in contact with the trigger level indicator during adjustment of either, the other may be moved out of position. Always check the position of both the trigger level indicator and the low pressure alarm indicator after adjustment of either of the two.

Oxygen concentration should be monitored at or near the proximal airway with a calibrated oxygen analyzer, equipped with selectable high-low FiO_2 limits.

The mixer alarm sounds when either the air or oxygen supply sources drops to 32 PSIG or less. While the mixer alarm is sounding, the oxygen concentration, the continuous flow flowrate, and the mechanical flowrate may not be delivered as set.

CAUTION: IF MIXER ALARM SOUNDS, SIGNIFYING A DROP IN INLET GAS PRESSURE, PROVIDE AN ALTERNATE SOURCE OF VENTILATION FOR THE PATIENT UNTIL THE INLET GAS PRESSURE IS RESTORED.

NOTE: The mixer alarm WILL NOT FUNCTION when both supply sources are at zero PSI.

The mixer may become non-functional or damaged if used without the water trap and/or filters provided.

The mixer is designed to mix oxygen and air only. DO NOT modify inlets to accommodate other source gases such as those used in anesthesia.

Test calibration of measurement gauges and equipment for accuracy prior to use.

Use only silicone base lubricant for O-rings and teflon on threaded areas of connectors, nipples, etc.

CHAPTER II

GENERAL THEORY OF OPERATION

The Newport Medical Instruments E100i ventilator has been designed to operate in A/C, SIMV, or Spontaneous modes. These modes should never be switched in mid-operation, as serious harm to the patient could result.

A/C (Assist/Control)

During assist/control ventilation, a positive pressure breath is delivered with each spontaneous inspiratory effort by the patient. Tidal volume is determined by flow and inspiratory time settings. If the patient does not trigger the machine, the ventilator automatically delivers breaths according to the rate set on the BPM control. FIO_2 is selected at the mixer.

SIMV (Synchronized Intermittent Mandatory Ventilation)

During SIMV mode of ventilation, the E100i ventilator will deliver a set number of mechanical breaths to the patient.

In between mechanical breaths, the E100i incorporates a continuous flow, if selected, for the spontaneously breathing patient. Blended gas from the air/oxygen mixer is directed into the spontaneous breathing reservoir bag and into the patient circuit when the Constant Flow is turned ON and/or flow from the flowmeter is turned ON.

The number and timing of synchronized mandatory breaths is determined by the Breath Per Minute control. To achieve effective synchronization, each minute is divided into Synchronized Timing Periods.

TIME/BPM = STP (Synchronized Timing Period)

e.g., 60 sec. / 6 BPM = 10 sec. STP.

The STP is broken up into 75 percent and 25 percent time windows.

If a patient effort is sensed during the 25 percent window, a synchronized mandatory breath will be delivered at that time. If no patient effort is detected, the E100i will initiate the mandatory breath at the end of that 25 percent time window. The ventilator will never initiate a mechanical breath during the 75 percent time window. The patient may continue to breathe spontaneously from continuous flow until the next synchronized mandatory breath is due.

If the patient is apneic for the duration of the STP, the E100i will deliver the mandatory breath at the end of each 25 percent window. If the patient resumes spontaneous efforts after a mandatory breath is given, the machine may initiate the next synchronized mandatory breath within the same STP. However, the overall respiratory rate will not be affected

SPONTANEOUS

In the Spontaneous mode, the patient will breathe exclusively from the continuous flow. The constant flow switch should be turned ON. This provides 5-12 L/min. of continuous flow which enters a 2-liter reservoir bag. When the bag is full, the mixed gas overflows into the patient breathing circuit. If patient inspiratory flowrates exceed the continuous flowrate, the patient draws gas from the black reservoir bag.

When necessary to meet spontaneous inspiratory flow demands, the constant flow may be supplemented by adding flow from the flowmeter attached to the side of the mixer.

All breaths are completely controlled by the patient with respect to rate, tidal volume, and peak flow. FIO_2 is set at the mixer and CPAP (0-25 cm/H_2O), if required, can be dialed in. The spontaneous breaths are monitored by the spontaneous detection indicator and the spontaneous alarm. The trigger level MUST be set properly for the spontaneous detection indicator to recognize the patient's spontaneous breaths. A delay time control is on the back of the ventilator which can be set at 15 or 30 seconds. Any time interval between detected breaths that exceeds this setting will activate the spontaneous alarm.

CONSTANT CONTINUOUS FLOW

A 5-12 liter per minute constant continuous flow is incorporated when the CONSTANT FLOW switch is in the ON position. This constant flow is a function of the Air/Oxygen mixer and is directed through the top of the venturi jet housing (HSG100M). It closes the emergency intake valve (VLV100P), fills the reservoir bag (BAG120P), opens the one-way valve (FLP100P), enters the patient breathing circuit through the main flow adapter (ADP600M), passes through the patient airway wye connection and escapes through an open positioned exhalation valve into the atmosphere. This feature functions during all available modes of ventilation.

FLOWMETER

Rotating the auxiliary flowmeter control knob counterclockwise adds a flow of 0-15 liters per minute (40 LPM flush) of the selected O_2 mixture to the reservoir bag. Flow should be adjusted to prevent the reservoir bag from depleting when there is a high inspiratory demand during spontaneous breathing.

FIO_2

The FIO_2 or air/oxygen control selects the desired mixture of air and oxygen. The mixture ranges from 21% to 100% oxygen. The control knob is calibrated from .21 to 1.0 FIO_2.

TRIGGER LEVEL CONTROL

This is one of three adjustable pressure sensors, each consisting of an infrared emitter and photo transistor detector. The TRIGGER LEVEL control allows for patient initiated inspiration in both A/C and SIMV modes. The control setting is from -10 cm/H_2O to +25 cm/H_2O.

When the patient starts to breathe spontaneously and the resulting negative pressure reaches the set trigger level, the ventilator is activated. The trigger level must be adjusted every time the PEEP/CPAP is altered.

It also functions as a Spontaneous Detect, Apnea/disconnect monitor in the SPONT. Mode.

PEEP/CPAP

Positive End Expiratory Pressure (PEEP) and Continuous Positive Airway Pressure (CPAP) are available from the E100i ventilator. The multiple turn PEEP/CPAP control (PEP200A) regulates the amount of pressure directed through the exhalation valve socket (OUT310M) to the topside of the exhalation valve diaphragm which creates resistance to the continuous flow during the expiratory time and results in an elevated baseline pressure (range from 0 to 25 cm/H_2O).

EMERGENCY INTAKE

If the oxygen and air supply sources fail simultaneously, the spontaneous inspiratory effort by the patient, transmitted through the venturi manifold, opens the one-way valve and the emergency intake valve (VLV100P) and allows atmospheric (21% oxygen) to enter the patient breathing circuit.

MANUAL INFLATION

Depressing the manual inflation button (BUT201M) overrides the programmed ventilator function, regardless of the ventilator cycle, AC power status (on or off), or position of the master solenoid (open or closed).

If the manual button is depressed for 30 seconds continuously, with A.C. power ON, an alarm condition occurs. After the button is released, the ventilator resets and continues working as usual. This error routine is a software protection in the event that a hardware malfunction should occur. (Refer to page 18 for more information on Manual Inflation).

A mechanical breath will be delivered to the patient as long as the button is depressed. Pressure is directed through the master solenoid (SOL200P) in two directions.

I. (A) Through inspiratory pressure line, orifice and nebulizer outlet.

(B) Through orifice and check valve (VLV500A), exhalation valve socket (OUT330M) to pressure/close exhalation valve forming a closed circuit.

II. Pressure goes through flow rate control (FLW210A) and flow is directed through the muffler, then through the main flow adapter (ADP600M) to patient circuit.

PNEUMATIC AND ELECTRONIC POWER SOURCES

PNEUMATIC

50 PSIG oxygen and air supply sources are connected to the air/oxygen mixer (MIX100P). These are blended by the FIO_2 control to the desired O_2 concentration which is directed through three outlets to the inlets of:

Continuous flow systems
Electronically Controlled Solenoid (SOL200P)
Manual Inflation Button (BUT201M)
PEEP/CPAP control valve (PEP200A)
Flowmeter

When either the air or the O_2 inlet gas pressure drops below 32 PSIG, an audible alarm sounds.

ELECTRONIC

There are two power sources that can be used with the Newport Medical Instruments E100i ventilator.

A.C. POWER

The A.C. power cord can be plugged into a 100-120 V.A.C. (220 V.A.C. for O.U.S. requirements), 50/60 Hz receptacle.

The A.C. ON/OFF master switch is located on the back of the ventilator chassis.

Two three-pronged receptacles are located on the back of the ventilator chassis for use as a power source for a humidifier and/or battery backup. These receptacles will function independently of the A.C. ON/OFF switch and are NOT fused. They function ONLY when the ventilator is connected to A.C. power.

or

BATTERY BACKUP. An optional rechargeable portable battery source is available from Newport Medical Instruments. The battery backup (BB-200) consists of three rechargeable sealed lead acid batteries and a charger in a small case that attaches to the back of the E100i. The batteries are C.A.B. approved to altitudes of 26,000 feet, so are acceptable for aerial transport.

BATTERY BACKUP OPERATION. The BB-200 is designed to power the E100 series ventilators for approximately four hours. The batteries' service life and discharge capacity depend on the usage to which they are subjected.

The batteries in the BB-200 are designed to function equally well in standby (rarely used) or cyclic (frequently used) service. In standby, the batteries can be expected to last at least 3 to 4 years. Their life in cycling service depends on how deeply they are discharged. If the batteries are always used until the ventilator's audible low battery alarm sounds, they will last up to about 200 charge-discharge cycles. As the batteries near the end of their life, they do not normally fail quickly, but gradually lose their capacity, shortening the time they can power the ventilator. If the batteries can not power the ventilator for four hours after being fully charged, they should be replaced.

It is important to plug the BBU into an active A.C. outlet for charging soon after each usage, however short. This will ensure that full BBU capacity is available when needed. The BBU should not be used any longer than necessary after the ventilator's audible low battery alarm sounds, or the battery will be deeply discharged. Repeated deep discharges will shorten the batteries' life. A deeply discharged battery should be immediately charged for a minimum of 18 hours to ensure a full capacity charge.

If a battery is left in the discharged state for a prolonged period of time the cells may deteriorate making them incapable of accepting a charge. If the READY light comes ON immediately and remains ON when attempting to charge a deeply discharged battery, it indicates that the cells have deteriorated. Again, charge the batteries for a minimum of 18 hours and then check to see how long they will power the ventilator. If the batteries cannot power the ventilator for an acceptable period of time (4 hours), replace the batteries.

NOTE: The BBU does not power the A.C. receptacles on the back of the ventilator when the power cord of the ventilator is disconnected.

E100i VENTILATOR CONTROLS

INSPIRATORY TIME (sec.)

The time cycle is controlled by the INSP. TIME (SEC.) knob, which ranges from 0.1 to 3.0 seconds. If, for example, an inspiratory time of 0.5 seconds is chosen, the ventilator will deliver a mechanical flow for 0.5 seconds, and then cycle into the expiratory phase.

The E100i ventilator is programmed to prevent an inverse I:E ratio from occurring. If the selected inspiratory time is too long, the I.T. TOO LONG light will flash, and a (shortened I.T. time) 1:1 ratio is delivered.

Note: When the I.T. TOO LONG indicator flashes during Time Cycled, Volume Limited Ventilation, the shortened I. Time will also indicate a decrease in delivered tidal volume versus set tidal volume. When this occurs, the clinician should decrease the set I. Time until the I. TIME TOO LONG indicator ceases to flash, then increase the flowrate to achieve the desired tidal volume.

RESPIRATORY RATE (BPM)

This setting is infinitely variable from 1 to 120 Breaths per minute (BPM). The inspiratory time control will be overridden if the set BPM and inspiratory time conflict. For example, if the respiratory rate is set at 60 BPM and the inspiratory time at 1.0 seconds, there is no time allowed for exhalation. The ventilator will automatically readjust the inspiratory time to 0.5 seconds, and the IT TOO LONG light will flash. Thus an I:E ratio of less than 1:1 is not allowed.

PRESSURE ALARMS

The PRESSURE ALARM controls upper and lower pressure limits and alarm sensors in the A/C and SIMV modes only. Adjust so that the low pressure alarm sensor is slightly below the peak airway pressure required to ventilate the patient. Then pull out on the PRESSURE ALARM control knob to adjust the HIGH PRESSURE ALARM sensor independently. Both alarms should be adjusted so that they bracket the average peak ventilating pressure.

If the low limit is not reached due to system leaks or changes in patient condition, alarms are activated until the situation is corrected. The low pressure range is 0 to 80 cm/H_2O.

If inspiratory pressure exceeds preset upper limit, alarms are activated and the ventilator immediately aborts inspiration and cycles to exhalation. The high pressure range is 1 to 100 cm/H_2O.

FLOW (L/SEC.)

The FLOW (L/SEC.) control ranges from 0.1 to 1.6 liters per second of the selected oxygen mixture in increments of 0.1 liters per second. It allows the clinician to calculate the delivered tidal volume in the A/C and SIMV modes by multiplying FLOW x INSP. TIME.

PRESSURE RELIEF VALVE

This prevents system and proximal airway pressure from exceeding preset maximum. The valve can be adjusted from 0 to 100 cm/H_2O. For time cycled volume ventilation, the valve must be adjusted above the pressure required to deliver the preset tidal volume.

This valve can be manipulated to achieve a constant flow inspiratory hold (plateau). Duration of the plateau is adjusted by changing flow rate or inspiratory time.

MODE SELECTION SWITCH

The MODE switch allows the operator to select between A/C, SIMV, and Spontaneous ventilation. See THEORY OF OPERATION.

TRIGGER LEVEL

See THEORY OF OPERATION.

PEEP/CPAP

See THEORY OF OPERATION

CHAPTER III

ACCEPTANCE TEST

This acceptance test should be performed when you receive the Newport Medical Instruments, Inc. E100i ventilator. Complete the test before completing the warranty card.

It is recommended that a master record of maintenance and inspection be kept for the E100i. Record the findings of the acceptance test on this file and use for comparison later.

A. First check that all the control knobs rotate smoothly through their complete operating range.

FIO_2	0.21 to 1.0
FLOW (L/SEC.)	Min. to Max.
INSP. TIME (SEC.)	0.1 to 3.0
RESP. RATE	1 to 120 BPM
TRIGGER LEVEL	-10 to +25 cm/H_2O
HI & LO PRESSURE ALARMS	0 to 80 cm/H_2O (low press.)
and	20 to 100 cm/H_2O (hi press.)

B. Check that manometer needle rests at the 0 cm/H_2O position.

C. Attach the breathing circuit, 2 liter reservoir bag, and relief valve to ventilator. Attach 2 liter Test Lung.

D. Plug the A.C. power cord into a 100-120 V.A.C. (220 V.A.C. for O.U.S.) 50/60 Hz receptacle.

E. Connect the air and oxygen hoses to their respective 50 PSIG sources.

F. Set the controls to their **STANDARD POSITIONS.**

FIO_2	.60
MODE	A/C
FLOW (L/SEC.)	0.5
INSP. TIME (SEC.)	1.0
RESP. RATE (BPM)	20
TRIGGER LEVEL	-5 cm/H_2O
LOW PRESSURE ALARM	15 cm/H_2O
PEEP/CPAP	0 cm/H_2O

TEST AND FINAL CALIBRATION SHEET PROCEDURE (NEW VERSION)

1. Turn the Constant Flow Switch ON. Check the CONSTANT FLOW flowrate by disconnecting the inspiratory breathing hose from the patient wye and connecting it to a calibrated flowmeter (i.e. RT 200 or equivalent).

   The flow should read between 5 and 12 LPM. (This test can also be done using a Respirometer).

2. Check that both supply source pressures are 50 PSI (no alarm). Set the FIO_2 setting at .6 and decrease AIR inlet supply pressure slowly. The audible alarm should be activated when air inlet pressure is between 28 - 35 PSIG. Increase air inlet supply slowly to 50 PSIG. Alarms should reset.

   Repeat this procedure with O2 inlet supply pressure.

3. Check FIO_2 Calibration from .21 - 1.0. Refer to Chapter IV, AIR/OXYGEN MIXER TEST PROCEDURE, Page 20.

4. Switch the A.C. power switch located on the back panel to the ON position. All L.E.D. visual indicators should light up and the audible alarm should activate temporarily.

   Check that the ventilator is cycling.

5. Using a stopwatch, check that the ventilator is operating at the correct **RESP. RATE (BPM)**.

SETTING	ACCEPTABLE RANGE
120 BPM	116 - 120 BPM
80	76 - 84
60	56 - 64
30	29 - 31
20	19 - 21
1	1 - 2

Confirm the actual INSP. TIME with a stopwatch.

SETTING	ACCEPTABLE RANGE
3.0 sec.	2.8 - 3.2 sec.
2.0	1.9 - 2.1
1.0	0.9 - 1.1
0.1	0.05 - 0.15

6. Check the FLOW (L/SEC.) with a " Timeter RT-200" or a Respirometer.

Refer to Chapter VII for Calibration procedure.

CONSTANT FLOW switch must be in the OFF position.

Set the I.T. to 3.0 seconds and Resp. Rate to 10 BPM.

SETTING	ACCEPTABLE RANGE
0.1 L/sec.	3 - 9 LPM
0.2	9 - 15
0.3	15 - 21
0.4	21 - 27
0.5	27 - 33
0.6	33 - 39
0.7	39 - 45
0.8	45 - 51
0.9	51 - 57
1.0	57 - 63
1.1	63 - 69
1.2	69 - 75
1.3	75 - 81
1.4	81 - 87
1.5	87 - 93
1.6	93 - 99

No vibrating sound should be heard from the Flow Controller.

Switch A.C. power OFF and set all controls in their standard positions.

7. Check that the PEEP/CPAP level is adjustable in 1 cm/H_2O increments from 2 to 25 cm/H_2O.

Check that selected PEEP/CPAP pressure remains stable at each setting.

Repeat above steps with ventilator functioning, then return PEEP/CPAP to off setting (full clockwise).

8. With the A.C. power switch in ON position, make sure that I.T. TOO LONG L.E.D. flashes when INSP. TIME control knob position is between 1.5 and 1.6 seconds, and goes out slightly below the 1.5 sec. position.

9. Remove the test lung and the LOW PRESSURE alarm should activate.

10. Depress ALARM SILENCE button, and with a stopwatch, check that the alarm is reactivated after 55 seconds (± 5%).

11. Re-attach the test bag and set the FLOW (L/SEC.) to the MAX position.

    The HIGH PRESSURE alarm should be activated and inspiration terminated when the manometer needle reaches the HIGH PRESSURE indicator position.

12. Rotate RESP. RATE knob fully counterclockwise to 1 BPM setting. The other controls should remain in standard position.

    Adjust the TRIGGER LEVEL indicator to the -2 cm/H_2O position.

    Create a negative spontaneous inspiratory effort and ascertain that the ventilator is triggered each time the manometer needle passes through the indicator position.

13. Check that MANUAL inflation is activated when the button is pushed in, and deactivated when the button is released. Make sure that the ventilator enters the expiratory phase before the next inspiration occurs.

14. Remove test lung, and hold MANUAL button in for 30 seconds. The ventilator alarms should activate. Release MANUAL button and ventilator should reset and return to normal operation.

SET CONTROLS TO STANDARD POSITION

15. Insert 0-60 PSIG pressure gauge into the nebulizer outlet. Turn the NEB. switch ON. Indicated pressure should be between 26 and 30 PSIG.

Repeat Steps 1 - 15 with MODE Select in the SIMV position.

16. Set the Mode select Knob to the SIMV position.

To test SIMV set RESP. RATE to 6 BPM. This will give a Synchronized Timing Period (STP) of 10 seconds between each breath. The STP is broken up into 75% and 25% time window. Now, with a stopwatch, begin timing at the onset of exhalation. No trigger should occur until after 7.5 seconds of the STP has elapsed.

17. Set the Mode Select Knob to the SPONTANEOUS position.

Set the switch above the A.C. ON/OFF switch to 15 seconds. Verify with a stopwatch that when the Manometer needle does not pass through the Trigger level setting for 15 seconds, the alarm sounds. Now set switch to 30 seconds and reset SPONT. ALARM by getting the Manometer needle to pass through the Trigger sensor. Repeat the verification procedure. This time it should require 30 seconds for the alarm to sound.

18. Remove the A.C. power plug from receptacle and the audible alarm should be activated. Switch the A.C. power switch OFF and alarm is deactivated. (If the Battery Backup is attached, disconnect the BB-200 connector located next to the A.C. power switch for this test).

19. Reconnect the 10 pin plug from the Battery Backup to the back of the ventilator. Ascertain that the A.C. power cord is disconnected from the wall receptacle. When the power switch is turned ON the red L.E.D. located on the side of the BBU cover should illuminate - indicating BBU IN USE.

20. Watch Dog Timer test is an internal test and is only performed by N.M.I.

CHAPTER IV

PERFORMANCE TEST PROCEDURES

The following instructions provide a means of determining whether the Newport Medical Instruments E100i ventilator meets its design specifications.

It is a system of routine maintenance and calibration checks meant to be performed in the hospital by qualified personnel. The performance test should be performed monthly or more frequently if desired.

A routine maintenance procedure will remedy effects of long term continuous use and should be performed every six months by qualified personnel or in a Newport Medical Instruments, Inc. approved service center.

Follow each step in sequence, and if the established parameters are not obtainable, contact an authorized Newport Medical Instruments representative.

PREPARATION

Supply sources --- Install a 0-60 PSIG calibration regulator between the oxygen supply hose and the oxygen inlet on the air/oxygen mixer.

Install 0-60 PSIG calibration regulator between the air supply hose and purge filter bowl female fitting on the mixer.

Make certain that both regulator's controls are turned fully counterclockwise to 0 PSIG.

Connect oxygen and air pressure hoses to their respective supply sources. Make certain that all connections are tight.

Adjust both regulators to 50 PSIG.

Electric power source --- Plug the power cord into a 100-120 V.A.C. (or 220 V.A.C. for O.U.S.) 50/60 Hz receptacle.

Make sure that the ventilator ON/OFF power switch is in the OFF position.

BREATHING CIRCUIT

Connect the breathing circuit, without nebulizer, to the mainflow outlet and connect the exhalation valve drive line to EXP. outlet, making certain junctions are secure.

PRESSURE MANOMETER

Check pressure manometer needle for 0 cm/H_2O position. If necessary adjust as follows:

Insert a small common blade screwdriver through the hole in the 12 o'clock position of the manometer face plate to reach the adjusting screw.

Rotate the adjusting screw left or right as needed to center needle zero position.

Tap gauge gently to shock needle, then check needle for zero position.

If the manometer will not calibrate, there is an internal malfunction and the manometer must be replaced. Follow instructions in Chapter IV, page 25 for manometer assembly replacement. If the ventilator is cycling but no pressure change is reflected by the manometer, check to see if the tube from the Main Flow Adapter is connected to the manometer inlet fitting.

PRESSURE RELIEF VALVE

Attach a patient breathing circuit to the main flow outlet. Check that the pressure relief valve is installed properly in the pressure relief socket and make sure that the white knurled knob is turned fully counterclockwise to the 0 cm/H_2O position.

Check that all connections are secure, and the entire circuit is tight and leak free. Set mechanical flowrate at .5 L/SEC.

Attach the 2 liter reservoir bag to ventilator reservoir bag adapter and cap off the patient wye connector.

While depressing the MANUAL BREATH BUTTON rotate the white knurled knob of the PRESSURE RELIEF VALVE clockwise and check that 0-100 cm/H_2O is reached on the pressure manometer and that the needle is steady at any setting.

If 0 cm/H_2O pressure cannot be obtained with white knurled knob in full counterclockwise (0) position, the FLOWMETER may not be in the off position.

If 100 cm/H_2O pressure cannot be obtained, check that fittings are tight and that the white knurled knob is turned fully clockwise. Otherwise there may be a broken spring or the plunger may leak on the valve seat, if so, replace spring or valve.

MANUAL INFLATION

Depress the MANUAL BREATH BUTTON and readjust the white knurled knob until the manometer needle rests and stays at 65 cm/H_2O position. Release the button and the pressure should drop to 0 cm/H_2O.

Depress and confirm that 65 cm/H_2O is reestablished.

Depress the MANUAL INFLATION button several times and observe the manometer needle behavior. Pressure should rise instantly when the button is pushed in and drop instantly when the button is released.

Make sure that the button does not stick in the "IN" position when not actively pressed.

If 65 cm/H_2O is not generated, both supply source pressures may be too low, the PRESSURE RELIEF VALVE may be set too low, or there may be a gross leak in the breathing circuit. Adjust sources to 50 PSIG, readjust PRESSURE RELIEF VALVE to 65 cm/H_2O, correct leaks and check pressure again.

If the pressure builds up too slowly, there may be a gross leak in the circuit or the FLOW (L/SEC.) is set too low. Correct and check again.

MANUAL INFLATION CMV

Remove plug and attach a 2 liter reservoir bag to the patient wye connector. Switch the A/C POWER SWITCH ON. Set the RESP. RATE setting at 20 BPM. Depress the MANUAL inflation button and verify that the ventilator frequency is overridden and the manual breath is maintained until the depressed button is released.

NOTE: The LO Pressure Alarm will **NOT** function and the HI Pressure sensor will **NOT** limit Pressure as all electronic controls are overridden when the MANUAL BREATH BUTTON is depressed.

If the MANUAL BREATH BUTTON is depressed for 30 seconds continuously with A.C. power ON, an alarm condition occurs. After the button is released, the ventilator resets and continues working as usual.

The ventilator should cycle 2 seconds after the MANUAL BREATH BUTTON is released.

Change the RESP. RATE to 60 BPM and repeat the above procedure.

PEEP/CPAP CMV

Turn the CONSTANT FLOW ON. Change the RESP. RATE to 15 BPM and the PEEP/CPAP to +15 cm/H_2O. (If the audible alarm is activated, push alarm silence button). Observe the manometer needle behavior. When the ventilator cycles off, the needle should instantly drop to and remain at +15 cm/H_2O (+/- 3cm/H_2O). Adjust the TRIGGER LEVEL control 3 cm/H_2O lower than the indicated PEEP pressure. The ventilator should not cycle ON prematurely, that is, before the set RESP. RATE, unless there is a spontaneous inspiratory effort generated.

PEEP/CPAP

Switch the A/C POWER SWITCH off. Check that the PEEP/CPAP control is in the max. clockwise, closed position. Attach a 0-100 cm/H_2O pressure gauge to the EXP. outlet. The manometer pressure should read 0 cm/H_2O.

Rotate the PEEP/CPAP control counterclockwise until it stops. The manometer should read 25 cm/H_2O minimum. Remove the 0-100 cm/H_2O pressure gauge and attach breathing circuit exhalation valve drive line to the outlet.

The ventilator manometer needle should read 25 cm/H_2O ($\pm$ 2). Adjust the PEEP/CPAP control slowly clockwise until closed. Observe that the PEEP/CPAP pressure is adjustable in 1 cm/H_2O increments and remains stable.

If the 25 cm/H_2O PEEP/CPAP pressure cannot be obtained with the PEEP/CPAP control in the maximum open position, there may be a leak in the breathing circuit. If so, correct and test again. If not, there may be either a kink or leak in the PEEP/CPAP tube connections inside the ventilator box. The PEEP/CPAP regulator assembly may have an internal leak.

SUPPLY SOURCE PRESSURES

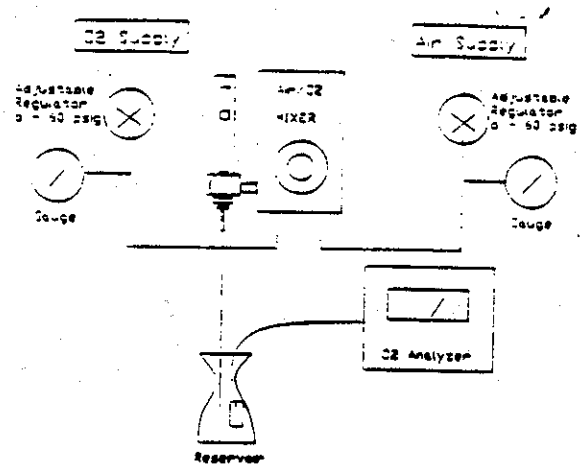
Open both supply sources and adjust each pressure regulator to 50 PSIG. Push filter bowl plunger upward and check that gas vents into the atmosphere.

ALARM PRESSURE TEST

Check that both supply source pressures are 50 PSIG (no alarm). Set the FIO_2 setting at .6 and decrease air inlet supply pressure. The Mixer audible alarm should activate between 28 - 35 PSIG. Increase the air inlet supply pressure slowly to 50 PSIG. Alarm should reset at or before 40 PSIG.

Repeat the above procedure with O_2 inlet supply.
A continuous alarm with both inlet pressures equal could mean dirty inlet filters, if so, replace filters.

AIR - OXYGEN MIXER TEST PROCEDURE



FIO_2 ACCURACY PROCEDURE.

1. Set-up FIO_2 test as shown in the diagram.
2. Turn the power switch of an O_2 Analyzer (OM-11 or equivalent) "ON" and wait for it to warm up for 30 minutes.
3. Set PEAK DETECTOR switch to OFF/CAL position and set RESPONSE CONTROL to the "0" position.
4. Calibrate to 20.9 using GAIN control.
5. Set sample FLOW CONTROL (flowmeter) to 15 L/MIN.
6. Rotate Mixer FIO_2 Knob fully counter-clockwise.
7. Insert the Sample Inlet Port from O_2 Analyzer into the reservoir.
8. Rotate the FIO_2 KNOB clockwise to the desired test position. Check the following settings:

FIO_2 Settings	Readings
.21	.0 - 24.0
.30	26.5 - 33.4
.60	56.5 - 63.4
.90	86.5 - 93.4
1.00	96.5 & above

IMPORTANT: When not in use place OM-11 in stand-by position (turn off "Operate" switch) thus saving O_2 sensor.

AIR/OXYGEN MIXER ACCURACY.

See test system diagram.

If the FIO_2 is not accurate, the most common problem is that the O_2 analyzer is out of calibration. If so, recalibrate. If not, it could be that there is improper purity of supply gases.

Check quality of supply gases. The wrong gas could be supplied to the inlet, so make sure that outlets and hoses are correct. The front or rear seats may be worn. If so, clean or replace seats.

If the above steps do not correct the situation, the calibration of the proportioning valve is incorrect or the pressure balancing module is malfunctioning.

If the knob is hard to turn, it may be that the face plate has shifted causing the knob to rub. If so, reposition faceplate.

If the FIO_2 is still not within tolerance after the above adjustments, the air or oxygen inlet filter may be dirty, causing that particular inlet pressure to drop below 31 PSIG. If so, replace the filter. Other possibilities are the regulator needle being out of calibration, or damaged o-rings on the regulator seat causing a leak or contaminated supply gases.

CONSTANT FLOW

Turn the CONSTANT FLOW SWITCH ON.
With Ventilator in the OFF position, connect a breathing hose from the main flow outlet to a calibrated Flowmeter (i.e. RT-200) or equivalent. Turn the white knurled knob on the PRESSURE RELIEF VALVE clockwise to the maximum setting.

Set the Flowmeter (RT-200) to HIGH RANGE of GAS FLOW RATE (# 36). Confirm a 5 - 12 LPM indicated flow on the RT-200.

NOTE: Constant Flow can also be checked by connecting a Respirometer to the end of the breathing hose and with a stopwatch, check the Flow for one minute (L/MIN).

If the flow is not in the 5-12 LPM range, it is unacceptable.

Disconnect the RT-200 from the circuit and reconnect the breathing hose to the patient wye.

FLOWMETER

Check that both supply source pressures are 50 PSIG, then set the FIO_2 CONTROL at .50. Connect a test flowmeter to the outlet of the E100i FLOWMETER and select a 5 LPM flow setting on the FLOWMETER.

Verify that the difference between indicated flow of the E100i FLOWMETER and the test flowmeter is not more than ± 10%. Repeat at 10, 12, and 15 LPM settings.

Remove the test flowmeter and connect the FLOWMETER tube assembly to the reservoir bag fitting.

If the test flowmeter tolerance is greater than ± 10% on all test settings, it may be that dirt or water is in the supply source pressure lines and water bowl, or that there is a dirty filter screen in the bowl. Ensure that both supply source systems are clean and dry, that all fitting connections are secure and that pressure is set at 50 PSIG. If the FLOWMETER is not functioning properly and does not respond to changes of control setting quickly, once again check for leaks at connector fittings and for dirt inside the flowmeter plastic dome.

CONTROLS

Make sure that the following control knobs travel smoothly through their complete operating range (SEE CHAPTER III - A).

STANDARD CONTROL SETTINGS

See CHAPTER III - F, PAGE 11.

MODE SELECTOR

Plug the ventilator electric power cord into 100-120 V.A.C. (220 V.A.C. for O.U.S.) 50/60 Hz hospital approved receptacle. Switch A.C. POWER SWITCH to ON.

All L.E.D.s and audible alarms are temporarily activated.

If the L.E.D.s do not come on, check for burnt out L.E.D. bulbs and replace. If the L.E.D.s come on, but the ventilator does not function, it may be that the MODE selector switch is faulty and needs replacement.

RESP. RATE

Check that controls are in standard position. To confirm the ventilator rate use a stopwatch. For acceptable ranges see CHAPTER III #5. If the acceptable range is not met, refer to CHAPTER VII.

INSP. TIME (SEC.)
Check that controls are in standard position. Use a stopwatch to confirm actual inspiratory time. For acceptable ranges see CHAPTER III #5. If the acceptable range is not met, refer to CHAPTER VII.

FLOW (L/SEC.)
Confirm that controls are in the standard position. Make sure that the nebulizer switch is turned OFF. Refer to CHAPTER III #6 for method of testing and acceptable ranges. If the INSPIRATORY TIME control test results are within tolerance, and acceptable tidal volumes are not reached when the FLOW CONTROLLER IS ADJUSTED, the FLOW CONTROLLER (FCL100P) needs to be replaced.

LOW PRESSURE ALARM
Check that ventilator controls are in the standard position.

When the ventilator cycles on, observe manometer needle peak inspiratory pressure position. Adjust the low pressure indicator position 2 cm/H_2O (PRESSURE ALARMS) below observed pressure. Alarm is not activated.

Disconnect the EXP. line from the outlet. The LO PRESSURE ALARM is activated since the manometer needle does not pass over the indicator.

Reconnect the EXP. DRIVE LINE. The visual/audible alarm deactivates the moment the manometer needle passes over the indicator position.

HIGH PRESSURE ALARM
Check that the ventilator controls are in the standard position. Adjust the high pressure limit indicator (PRESSURE ALARMS) 2 cm/H_2O below manometer indicated pressure. Increase the FLOW (L/SEC.) to 1.0 L/sec.

Observe that the alarm is activated when the needle reaches the HIGH PRESSURE ALARM LIMIT indicator position. The ventilator INSP. TIME should be aborted and begin expiratory phase.

ALARM SILENCE

With the controls in standard position, adjust the PRESSURE ALARMS low pressure indicator 2 cm/H_2O above observed manometer indicated peak pressure.

The visual/audible alarm is activated.

Use a stopwatch. Push the silence button in, the light stays on, and the alarm buzzer stops. The audible alarm is automatically reactivated after 55 seconds have elapsed. When the alarm condition is corrected, the alarm silence is cancelled, even if 55 seconds have not elapsed. The 55 second period begins every time the button is pushed.

INSP. TOO LONG

With the controls in the standard position, very slowly rotate the INSP. TIME control clockwise. Observe that the amber light comes on at the INSP. TIME control setting of 1.5 seconds.

ELECTRIC POWER FAILURE WITHOUT BB-200

With ventilator controls in standard position, remove the power cord plug from the electric outlet. A continuous audible alarm is activated.

Switch A.C.power ON/OFF switch OFF and the alarm should stop.

Reinsert power plug and turn switch ON, the audible alarm should sound momentarily.

If the alarm remains buzzing with the master switch in the OFF position or if the alarm buzz is intermittent instead of continuous, there is an electronic failure.

ELECTRIC POWER FAILURE WITH BB-200

With the ventilator controls in standard position, remove the power cord from the electric outlet. The BATTERY BACKUP will automatically take over electric power requirements of the ventilator. This will be indicated by the red "IN USE" L.E.D. on the BB-200 case. Failure of the backup may be due to an uncharged battery or an improper connection at the battery/ventilator interface.

NEBULIZER PRESSURE

Set controls to standard position. Attach 0-60 PSIG pressure gauge between nebulizer socket and nebulizer jet. Turn NEB. switch ON. The indicated pressure should be between 26 - 30 PSIG during inspiration and 0 PSIG during expiration.

CHAPTER V

REMOVAL AND REPLACEMENT OF KEY E100i PARTS

The following chapter covers the replacement of:

Front Panel
Manometer Assembly
PEEP/CPAP Assembly
Flow Control Assembly
Solenoid
Mixer Assembly
Venturi Assembly
Circuit Board
Inlet Filters of Mixer

FRONT PANEL

Remove the Main Flow Outlet Adapter (ADP402M) by unscrewing it from the main body of the ventilator. Using a 5/64" Allen wrench, remove the four button head screws holding the front panel in place.

Put right index finger into the main flow outlet and gently push outward on the panel while pulling on the FLOW (L/SEC.) knob with the left hand.

To replace, reverse the procedure.

MANOMETER ASSEMBLY

Remove the relief valve and Main Flow Outlet Adapter (ADP402M). Pull the panel from the box and place it down on a padded surface. Remove photo cell housing from the Header (J252) on the front panel PCB (P/N PCB350A). Using a 6/32" Allen wrench, remove the four screws holding the micro processor board (PCB150A). Be sure to mark each cable before disconnecting them from the micro processor board. Remove 1/16" urethane tubing at the Main Flow Adapter (ADP600M). Remove cap (CAP150P) from PRESSURE ALARMS knob and TRIGGER LEVEL knob. Loosen the brass nut within the knobs and remove the knobs.

When replacing, make sure that the o-ring (ORG110P) does not touch either the top or bottom edge of its slot in the manometer housing and that the nut cover does not grind against the front panel when the knob is turned.

Loosen the elastic stop hex nuts (NUT832P) with a 1/32" wrench and remove from the threaded studs.

When replacing, make sure that the flat edge of the hex nut closest to the top of the box is flush instead of at a point and that the nuts are not over-tightened, causing the indicator to drag. Make sure the edges of the brass shafts (SHF200M) do not touch the edges of the holes in the front panel.

Grasp the manometer housing (HSG300M) and remove it from the panel. Carefully slide the manometer housing off the 8/32" threaded studs and guide the two brass drive shafts (SHF200M) back out of the holes marked PRESSURE ALARMS and TRIGGER LEVEL.

To replace, reverse procedure.

*Note: For a better seal in any procedure where tubing will be disconnected, cut 1/16" off the end of smaller tubing and about 1/4" off larger tubing before reconnecting.

PEEP/CPAP ASSEMBLY

Follow panel removal instructions up to and including removal of RELIEF VALVE. Pull the panel 3-4 inches out. Remove the tubing from the PEEP/CPAP assembly and mark tubing for when tubing is replaced.

With a small flat head screwdriver remove the cap on the face of the PEEP knob. Remove the knob with a Collet wrench..

Using a 9/16" wrench, loosen the nut on the front side of the panel, taking care not to scratch the front panel.

Slide the knob and PEEP/CPAP valve assembly out of the hole marked PEEP/CPAP.

To install, reverse the procedure. A washer is placed between the Front Panel and the Peep assembly.

FLOW CONTROL ASSEMBLY

On a padded surface, lay the E100i on its right side with the air/oxygen mixer up.

With a small flat head screwdriver remove the cap covering the nut on the face of the FLOW knob.

Using a 5/16" socket, remove the FLOW (L/SEC.) knob by loosening the 5/16" nut and pulling the knob straight out.

Continue with the panel removal instructions up to and including removal of the RELIEF VALVE. Gently lay the panel face down on a padded surface.

Disconnect the cable of the Pilot Valve Assembly from the Front panel PCB at (J253).

Remove all tubing from the Flow Controller (FCL100P), solenoid (SOL200P) and the Pilot Valve (PLV100P) using a small screw driver or needle-nosed pliers. Lift the front panel up on its right side (FLOW CONTROL assembly up).

Note the location of all tubing before removing.

With a small flat-head or philips-head screwdriver, remove the three screws holding in the Indicator Plate (J223) in position. Now, with a 1/16" Allen Wrench remove the three screws (SCR444P) holding the Flow Assembly.

The flow control assembly can now be removed. Gently lay the front panel down.

For installation, use the reverse procedure.

See calibration of FLOW (L/SEC.) in CHAPTER VII.

MAIN FLOW ASSEMBLY
(Two Parts)
Follow panel removal instructions up to and including removal of RELIEF VALVE and Main Flow Outlet Adapter. Pull the panel out 4-5 inches.

- Main Flow Adapter (ADP600M) -
(Refer to Front Panel Assembly Drawing).
Remove tubing from restrictor (RES152P) and Fitting (FTG200M) on the Main Flow Adapter. Grasp the adapter and remove the jamb nut (JAM100M) from the front side of the panel by hand, or if necessary, with a Pin spanner.

Slide the Main Flow Adapter back out of the front panel.

Reverse the procedure for installation.

- Main Flow Housing (HSG100M)-
(Refer to Box Assembly Drawing)
Observe the 1/8" tubing leading from the nipple (CON200P) of the Main Flow housing to the CONSTANT FLOW ON/OFF switch between the housing and mixer assembly. Disconnect the tubing at the switch.

Using a 9/64" hex wrench, remove the two screws (SCR100P) from the top side of the Main Flow housing. Remove the housing.

When installing, reverse the procedure. Check and replace gaskets (GKT100P) if necessary.

AIR/OXYGEN MIXER

Follow panel removal instructions up to and including removal of the relief valve. Pull the panel out 4-5 inches. Remove the 12" length of urethane tubing (TUB600P) and the 1/16" tubing (TUB106P) from the Elbow (EK207) at the main flow outlet of the mixer. Remove the 1/8" tubing (TUB202P) that goes from the CONSTANT FLOW SWITCH to the reducer (RED100P) on the MIXER. Also remove the Tubing (TUB106P) at the connecter (C233) on the Mixer.

(Refer to the Pneumatic Diagram and Mixer Assembly Drawing.)

Using a 1/2" wrench, remove the Elbow (EK207) from the main flow outlet on the side of the mixer. Place aside and save.

With a 1/4" wrench, remove the nipple (CON200P) from the 10/32" hole in the side of the reducer (RED100P).

Using a 3/32" Allen screwdriver remove the two screws (SCR832P) holding the mixer onto the side of the box.

Lift and remove the mixer from the control box.

To replace, reverse the procedure. When replacing the elbow, remove the old teflon tape and take two turns with 1/4" teflon tape around the threads before inserting it into the mixer. Also make sure that the internal threads of the main flow outlet are clear of old tape. It is important that no pieces of tape fall into the main flow outlet.

MICROPROCESSOR BOARD (PCB150A)

Follow front panel removal instructions up to and including the removal of the RELIEF VALVE and outlet venturi adapter. Gently lay the panel face down on a padded surface. Remove all cables going to Headers J101, J102, J103, J104, J105, and J106 on the Main PCB. (Note the location of all cables.)

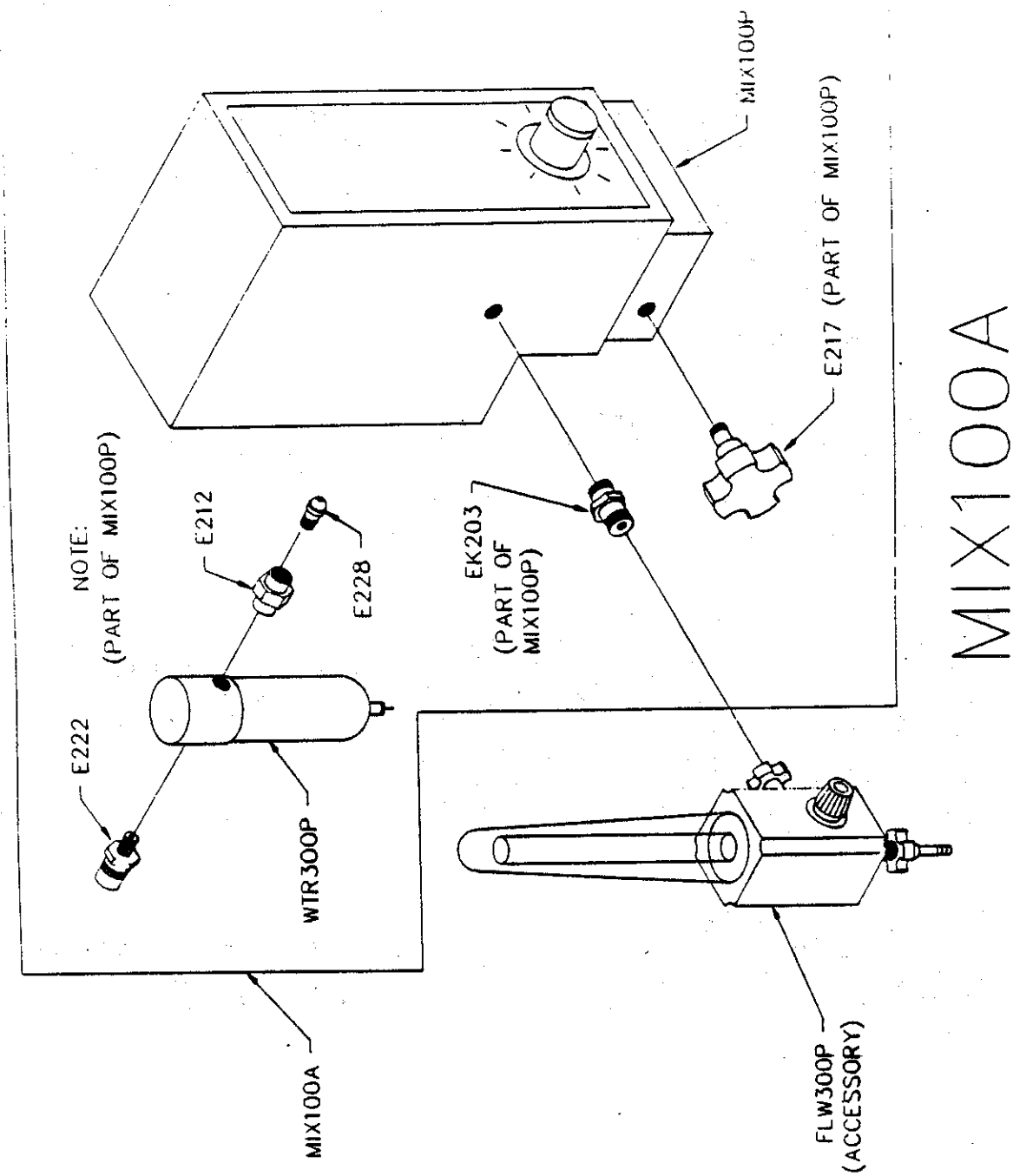
Using a 6/32" hex wrench, remove the four screws holding the PC board.

MIXER INLET FILTERS

To replace AIR and OXYGEN Filters, first remove the Gas Inlet adapters (E230 and EK202) with a 3/4" wrench. Carefully remove each Fitting. (Refer to the Diagram below of the "GAS INLET BLOCK OF Mixer".)

Filter kits with instructions are available through your NMI representative.

GAS INLET BLOCK OF MIXER



CHAPTER VI

E100i ELECTRONIC CIRCUITRY (PCB150A Rev.B 5.01)

The Newport Medical Instruments, Inc. E100i ventilator is electronically controlled by an 8-bit microprocessor unit. The control circuits are labeled as follows:

A. Power Supply Circuit
B. Battery Back up Circuit Description
C. Reset Circuit For Microcomputer Unit
D. Micro Processing Unit Controlled Logic Circuit
E. Analog to Digital Converter (ADC)
F. Input Circuit
G. Output Circuit
H. Watchdog Timer Circuit

A. POWER SUPPLY CIRCUIT

The power supply is operated by 117 volts A.C. (or 220 V.A.C.) 50/60 HZ or the BATTERY BACKUP UNIT (Model BB-200). When the BBU is installed, it automatically powers the E-100i when the A.C. power source is removed. The electronic circuit and the wave form at each point are seen in Figure i-2.

A.C. CURRENT OPERATION

The E100i electronic circuit requires two types of D.C. voltages, 5 and 12 volts. These voltages are obtained from the A.C. voltage of the power transformer, the bridge rectifier BR1, and the capacitors C1 and C2. In order to get stable D.C. current, VR1 and VR2 are used. Plus 5 volts is supplied to VR1 and plus 12 volts is supplied to VR2. The accuracy is ± 5%. The 12 volt supply is used for the solenoid valve and the 5 volt supply is used for the logic circuit. (See Figure i-2).

D.C. CURRENT OPERATION

While the battery backup (BB-200) is functioning, the respective voltage between point X and point B, or point Y and point B is 15-20 volts D.C. or 7-8 volts D.C. (See Figure i-2). The output voltages of VR1 and VR2 remain the same as described in "A.C. Current Operation".

B. BATTERY BACKUP (BB-200) CIRCUIT DESCRIPTION

The battery backup unit acts not only as an A.C. power failure backup, but also as a D.C. power source. Figure A shows the functional block diagram and Figure B shows the schematic diagram.

Power Supply Circuit

Z2 is a voltage regulator for the control circuit and the output voltage is approximately 12 volts. When the BB-200 is in use, 12 volts are applied from a ventilator unit through CR6. Z3 is a voltage regulator with output current restriction. Q1 and R5 detect the load current and limit the output current to approximately 300 mA. Therefore, the output voltage depends on the load current operation. In normal operation (no current limit), the output voltage is between 21.2 and 21.5 volts at TP1.

Charge and Ready Detection

Z1 is an integrated circuit and has four independent comparators (A,B,C,D). The comparator (D) compares the charge current with approximately 100 mA. The voltage at TP2 is approximately 0.1 volts. When the charge current is more than 100 mA, the voltage at TP2 is more than 0.1 volts, and the output of the comparator (D) is a logical low level and Q6 is off. The comparator (C) acts as an invertor and now Q6 is on and the CHARGE L.E.D. illuminates. As the charge progresses, the charge current decreases gradually, and when the charge current goes below 100 mA, the output of the comparator (D) turns to a logical high level, then Q5 (READY L.E.D.) comes on, and Q6 (CHARGE L.E.D.) goes off.

BB-200 In Use Detection

The comparator (A) detects the direction of the current flowing through R17. In the charge mode, the charge current flows from the battery to the common ground through R17 and generates a positive voltage against the common ground. On the other hand, the discharge current flows from the common ground to the battery through R17 and generates a negative voltage. In the charge mode, the output of comparator (A) is high level and Q4 is on.

Battery Low Voltage Detection

If the BB-200 is used in conjunction with an E100 series ventilator unit, this function alerts the operator that the battery is nearly discharged of its functional capacity and the automatic cutoff circuit will be activated (within 10 to 15 minutes).

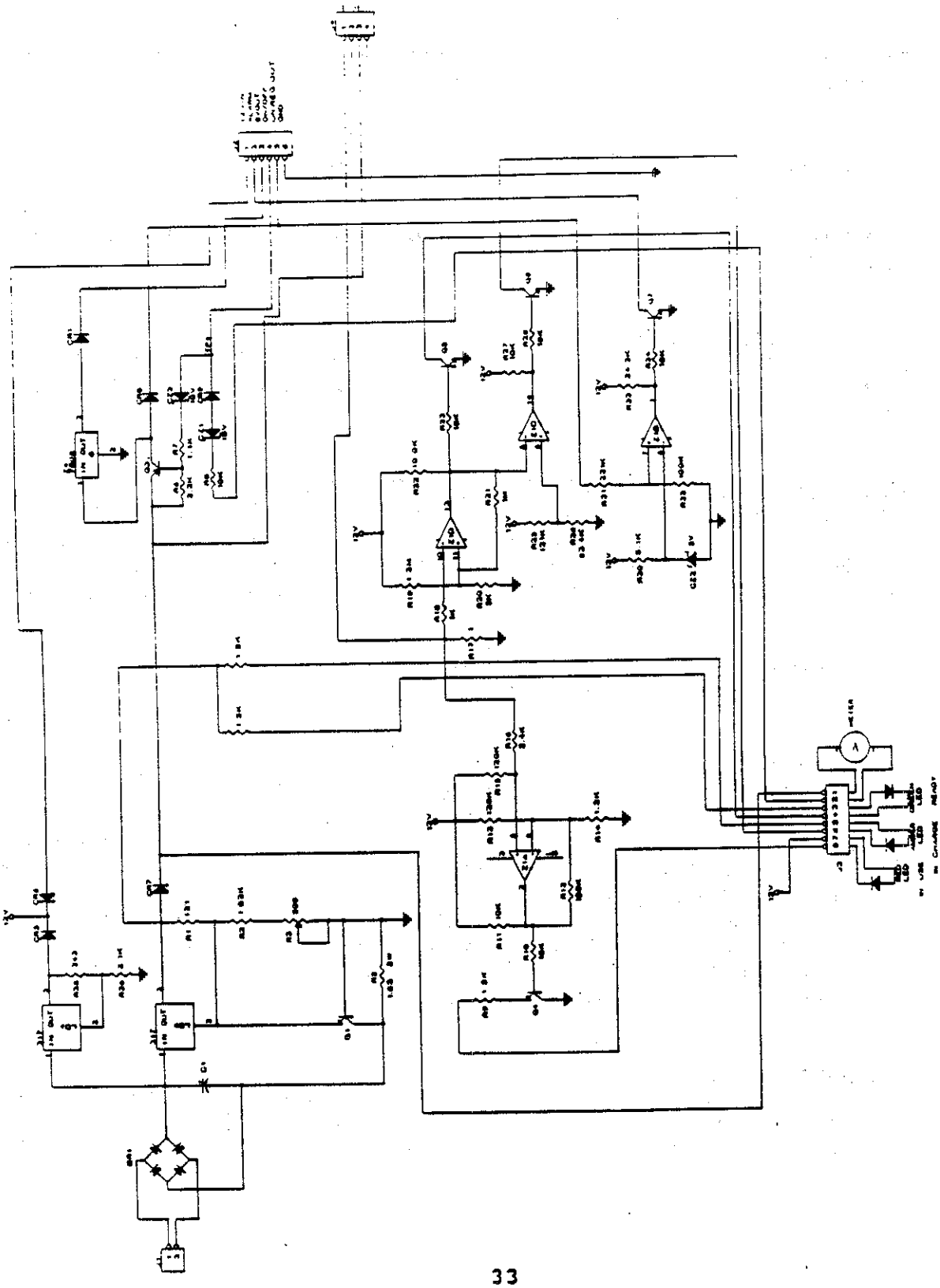
Switching Circuit

The switching circuit controls the output power of the BBU. When the power switch of the ventilator is off, TP4 (pin 4 of J2) is left open circuit and Q3 is off. By turning on the power switch, TP4 is connected to the common ground and Q3 comes on. If the terminal voltage of the battery goes lower than approximately 12 volts, the zener diode (CR2) takes the high impedance status and Q3 goes off. This shutting off at 12 volts is the automatic cut off function to protect the battery from over discharge.

Adjustment

The adjustment of the charge circuit should be performed following any repair, service or replacement of the circuit components. This adjustment is to be performed only at N.M.I.

BB-200 CIRCUIT DIAGRAM



BB-200

C. RESET CIRCUIT FOR MICROPROCESSOR UNIT

The reset circuit for the microprocessor unit assures that the microprocessor will initialize.

D. MICROPROCESSOR UNIT CONTROLLED LOGIC CIRCUIT

The microcomputer unit controlled logic circuit is composed of the microcomputer and the peripheral circuit.

MICROPROCESSOR UNIT

A CMOS 8-bit microprocessor unit is utilized. It has 192 bytes of RAM, 4k bytes of ROM, 53 parallel I/O pins, a 16 bit timer, and a serial communication interface.

CLOCK OSCILLATION CIRCUIT - SYSTEM CLOCK

The crystal (Y1), along with capacitors (C8) and (C9), produce a 4 MHz oscillation. This oscillation is then divided by four and a 1 MHz oscillation is obtained for the system clock. The waveform of the system clock can be obtained by oscilloscope at TP1.

OSCILLATION OF INPUT/OUTPUT PORTS

The microprocessor unit contains 7 ports.

INTERRUPT PORT

The E100i uses two software maskable interrupts, IRQ1 (P50) and IRQ2 (P51). When an interrupt request occurs, the normal program routine is suspended and the interrupt routine is fetched. The interrupt routine has a higher priority than the normal program routine. It will continue until completion unless interrupted by a non-maskable interrupt, reset, or power-down. IRQ1 is used for the manual breath. IRQ2 is used for high pressure, low pressure, and trigger detection. IRQ2 is logical OR of high pressure, low pressure, and trigger with D5, D6, and D7.

ADDRESS DECODER

The address decoder is labeled U5 on the main PCB schematic. It addresses the analog to digital converter (U8), The safety timer for master solenoid valve (U4), and the watchdog timer (U9).

SAFETY TIMER FOR MASTER SOLENOID VALVE

The 556 timer (U4) can keep Q2 closing the master solenoid valve up to approximately 5 seconds, insuring exhalation. If the microprocessor unit should malfunction, the master solenoid valve must close in 5 seconds.

E. ANALOG TO DIGITAL CONVERTER (ADC)

The analog to digital converter (U8) is an 8-channel, 8-bit resolution ADC. The E-100i uses four channels for addressing D000 to D003 hexadecimal. These channels are selected by A2, A1, and A0 of the microcomputer unit (U3). The strobe signal of start of conversion provides pin 1 of logic NOR (U6) with a high. The end of conversion is verified when pin 7 of the ADC returns high. The conversion time depends upon the analog voltage, but at most it must be less than 200 micro seconds. Then the microcomputer unit reads the 8-bit data to enable the output pin 9 of (U8).

F. INPUT CIRCUIT

ALARM SILENCER

(Audible alarm disable.) When the alarm silence switch is activated, P22 becomes low momentarily and the audible alarm is silenced for 55 seconds.

MODE SELECTOR SWITCH

A/C, SIMV, and SPONT. modes are selected by P25 (SIMV) and P54 (SPONT.) of the microprocessor unit (U3). When both of these pins have high level signals, A/C mode is selected.

PNEUMATIC SWITCH

P50 of the microprocessor unit must be low while the MANUAL BREATH BUTTON is pushed. As long as the MANUAL BREATH BUTTON is pushed, up to 30 seconds, the interrupt routine is executed. After 30 seconds, the manual too long timer will time out and error interrupt will execute.

TRIGGER, HIGH PRESSURE, AND LOW PRESSURE

These inputs function when the needle of the manometer passes each respective infrared photo sensor. The input pins P55 (TRIGGER), P56 (HIGH PRESSURE), and P57 (LOW PRESSURE) are high level at the quiescent time. These inputs are executed by an interrupt routine (P51) to assure each function for every breath. The three input pins are logically AND.

G. OUTPUT CIRCUIT

HIGH PRESSURE INDICATION
P60 of the microprocessor unit (U3) drives the HIGH PRESSURE red L.E.D., located on the front panel, through the invertor and opens the collector current buffer (U2).

LOW PRESSURE INDICATION
P61 drives the LOW PRESSURE red L.E.D., located on the front panel, through (U2).

SPONTANEOUS INDICATION
Operates only in the SPONT. mode setting of mode selection switch. If a patient effort is not detected in the proper amount of time (15 or 30 seconds selected by rear panel switch), P62 of the microcomputer unit (U3) drives SPONTANEOUS red L.E.D., located on the front panel, through (U2).

SOUND ALARM
P66 of U3 drives both buzzers through U2, JP1, and Q3. JP1 must be in lower position for E100i to operate normally.

A second buzzer has been incorporated into the E100iN. It is mounted on the bottom, inside of the ventilator box, This gives a louder and mor distinguished sound when the alarm is activated.

SAFETY TIMER RESET
P26 of the microprocessor unit sets or resets the function of the safety timer (U4) in order to make the master solenoid energize or deenergize.

I.T. TOO LONG INDICATION
P63 of the microprocessor unit drives this amber L.E.D. located on front panel, through U2, while the INSP. TIME knob setting along with RESP. RATE setting creates an inverse I:E ratio situation.

SPONT. DETECT INDICATION
P64 of U3 drives the amber L.E.D. through U2 while the manometer needle is passing the trigger photo sensor.

MASTER SOLENOID VALVE
P65 of U3 can drive the master solenoid valve through Q1 while Q2 is being turned on by Q4. In other words, Q1 and Q2 work as a logical NAND.

H. WATCHDOG TIMER CIRCUIT

The watchdog timer circuit is a 555 timing circuit independent of microprocessor unit function. If the microprocessor fails to reset the watchdog for any reason (i.e. power loss) the watchdog will timeout and reset the microprocessor unit.

CHAPTER VII

CALIBRATION OF PNEUMATIC CONTROLS

Refer to earlier chapters for range of controls.

Calibration can be checked with either a Respirometer or a Timeter RT-200.

FLOW (L/SEC.)

CALIBRATION PROCEDURE USING RESPIROMETER.

With the reservoir bag on, set to standard settings.

FiO_2	.60
INSP.TIME	1.0 sec.
RESP.RATE	20 BPM
MODE	A/C
PEEP/CPAP	0
TRIGGER LEVEL	-5 cm/H_2O
LO PRESS. ALARM ..	15 cm/H_2O

Attach a respirometer and a 2 liter test lung at the patient wye. Make certain that the respirometer vanes are facing the test lung.

Rotate the Flow Knob until the respirometer reads 0.5 liters with each inspiratory phase of the ventilator irrespective of Flow Indicator Plate setting.

If the Flow Indicator Plate arrow does not line up with the 0.5 l/sec. marking, remove the knob. First, using a small screwdriver, remove the face Cap (CAP 210P) from the Flow Knob (KNB210P). Then, using a 5/16" socket, loosen the brass nut on the Knob and remove.

Now loosen the three screws (0308) holding the Indicator Plate (J223) in position. This will allow you 1/10th of an inch to move the plate.

After setting the Indicator Plate in position to match the measured .5 l/sec. flowrate, check the Calibration of the flow at 0.1 l/sec. through 1.6 l/sec.

If flows are not within tolerance range a new Flow Controller (FCL100P) should be installed.

For replacement of the **FLOW CONTROLLER**, refer to Chapter V page 26 under Flow Control Assembly.

NOTE: N.M.I.'s Service Department should be informed immediately of any problems with the Newport E-100i Ventilator.

CALIBRATION PROCEDURE USING TIMETER RT-200.

To Calibrate using the RT-200 the following steps should be taken:

1. Turn Timeter RT-200 ON and use High Range No.36 on the Gas Flow Rate.
2. Place Relief Valve in position and connect the Main Flow outlet to the RT-200.
3. Turn Constant Flow Switch OFF.
4. Set I.T. to 3.0 sec. and RESP. RATE TO 10 BPM.

   Now begin to Calibrate Flow.

NOTE: The Timeter will read the Flow in L/MIN.. Refer to page 13 #:6 on the Tolerance range.

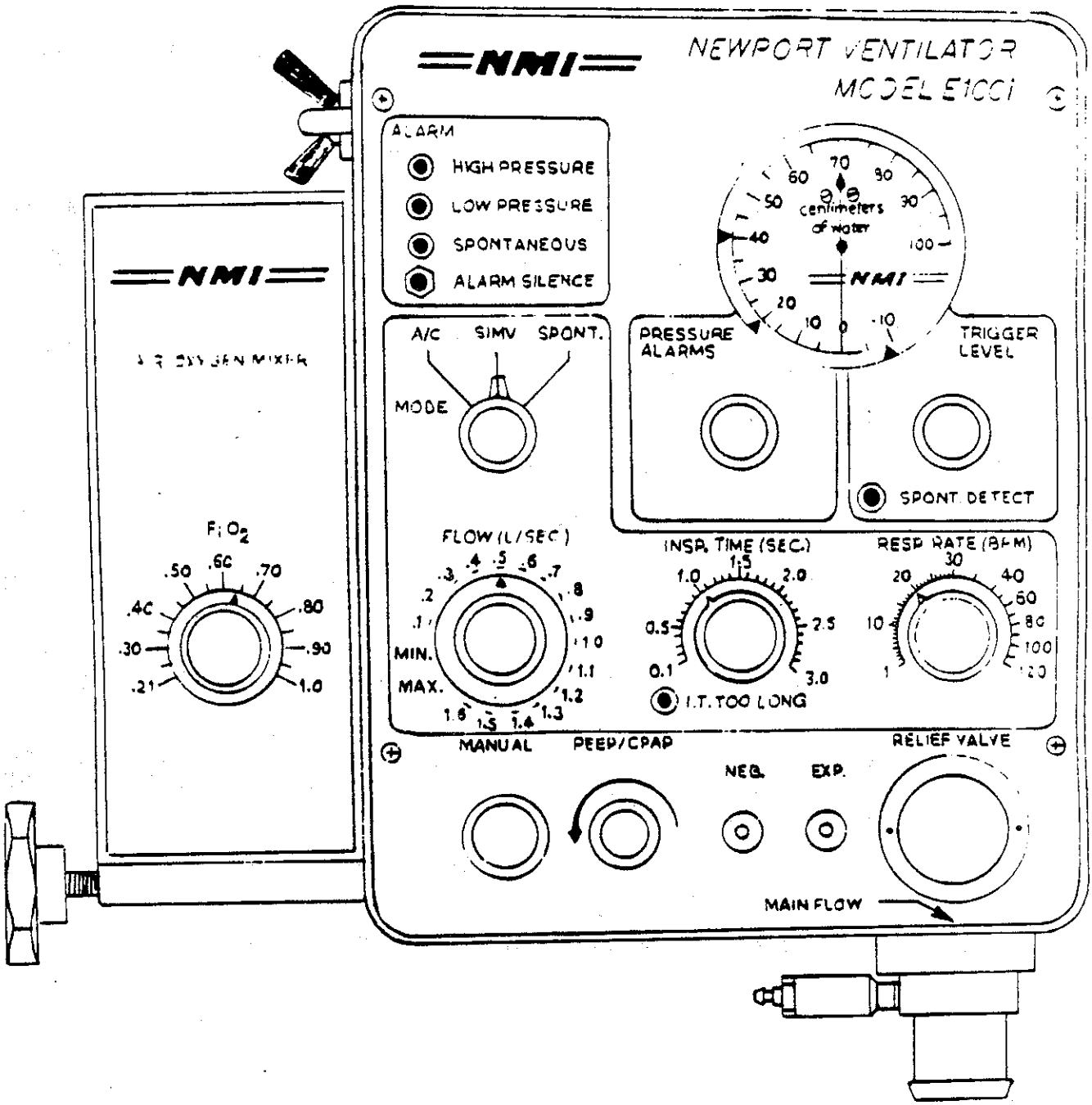
INSPIRATORY TIME AND RESPIRATORY RATE CALIBRATION

Calibration must be performed following any major repairs, or alterations to the electronic circuit of the INSPIRATORY TIME OR RESPIRATORY RATE CONTROL.

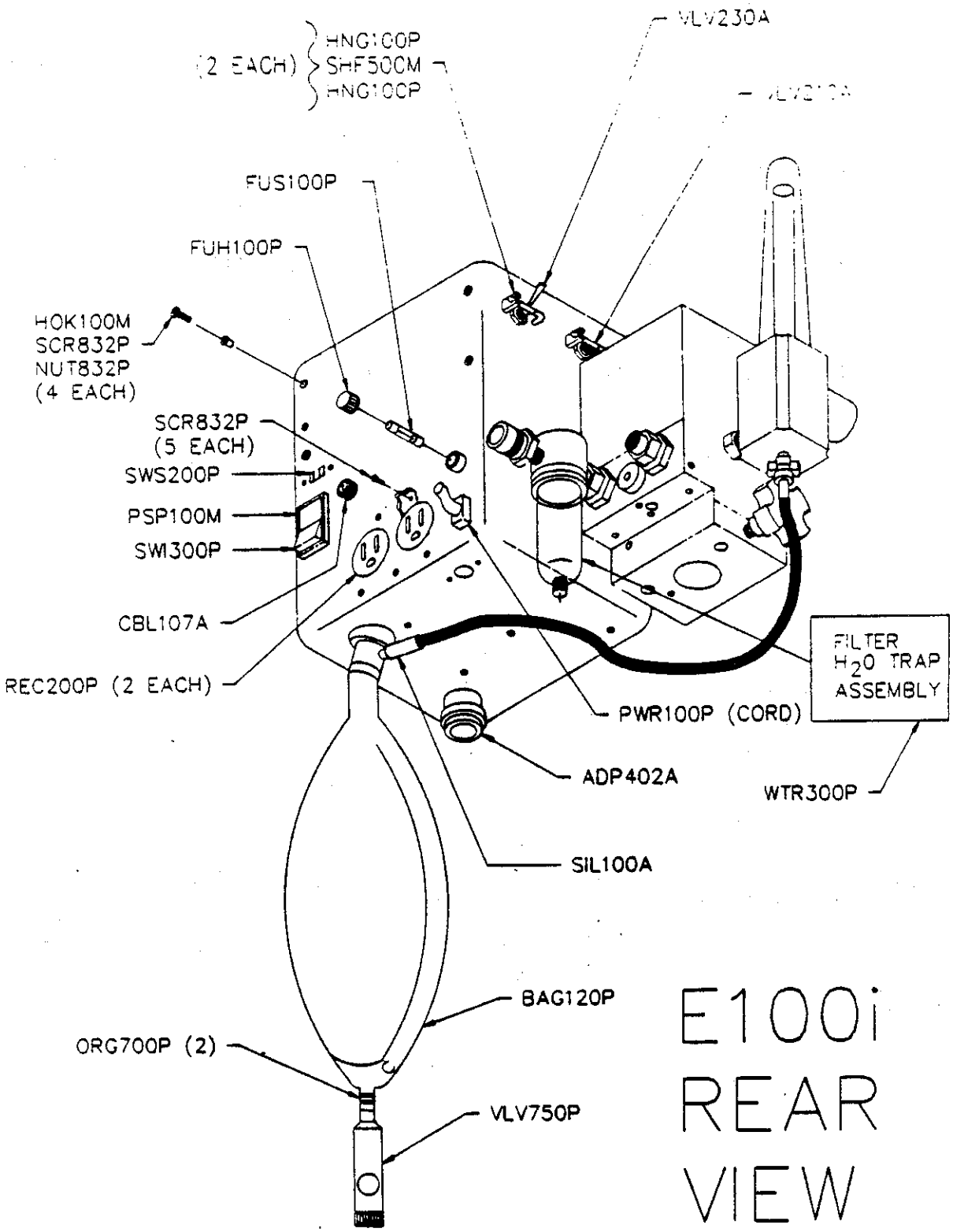
If any repairs or alterations have been made, please return to N.M.I. for recalibration.

NOTE: At no time should these knobs be removed.

E-100I FRONT VIEW

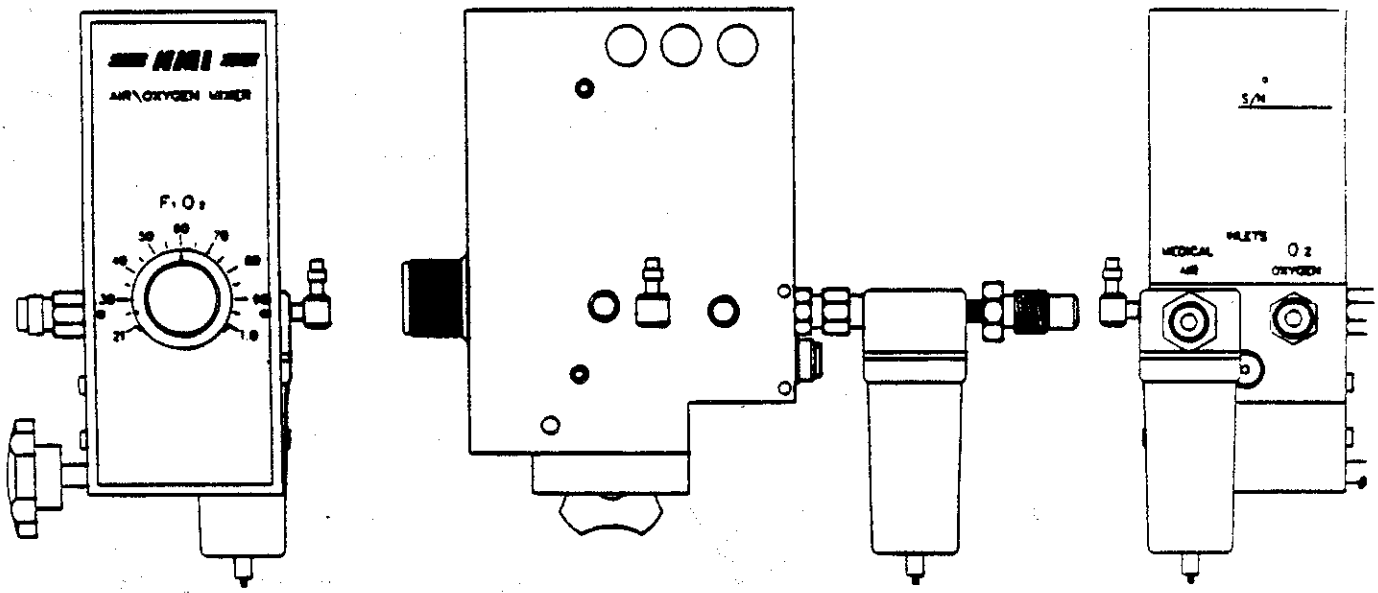


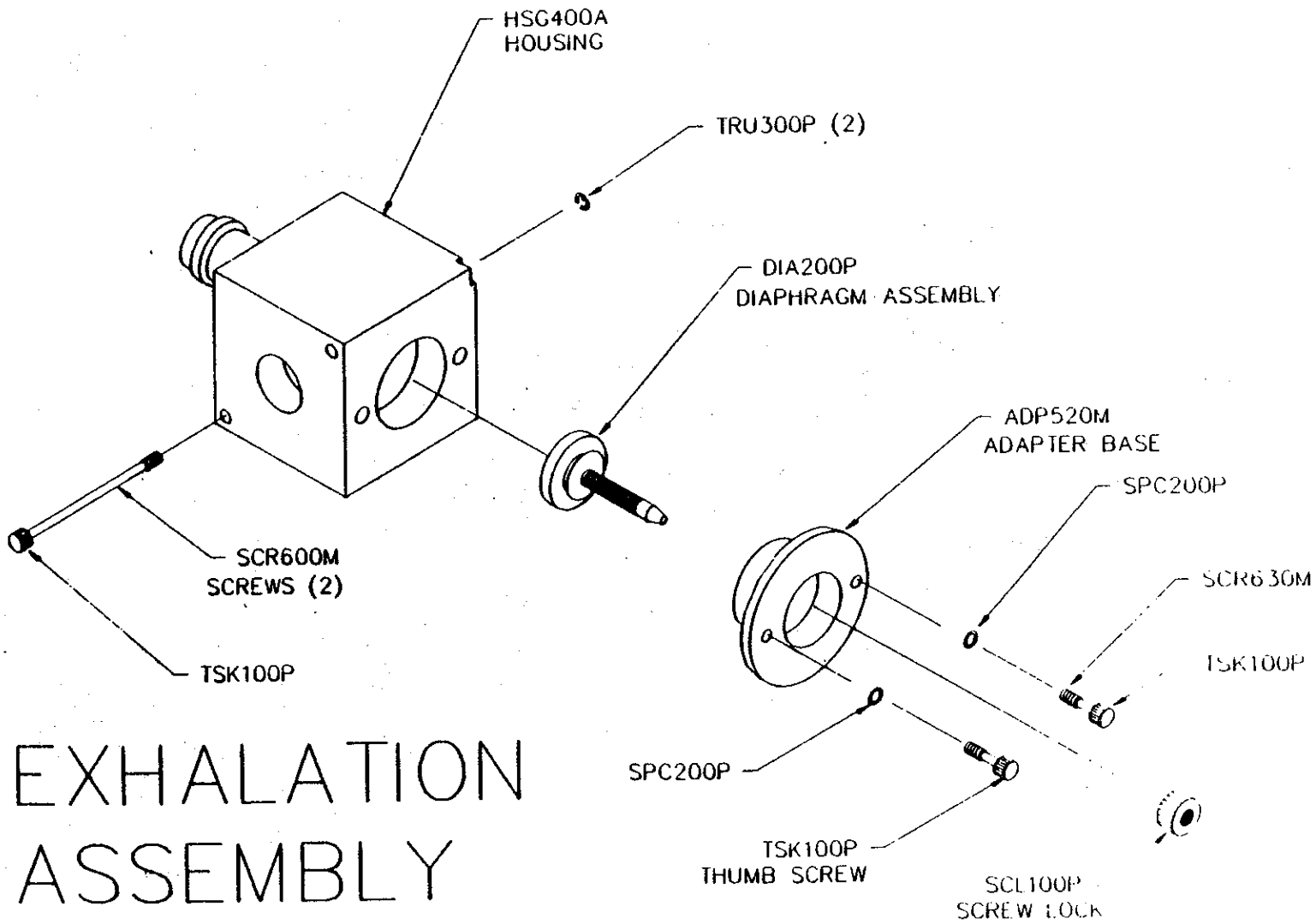
E-100I REAR VIEW



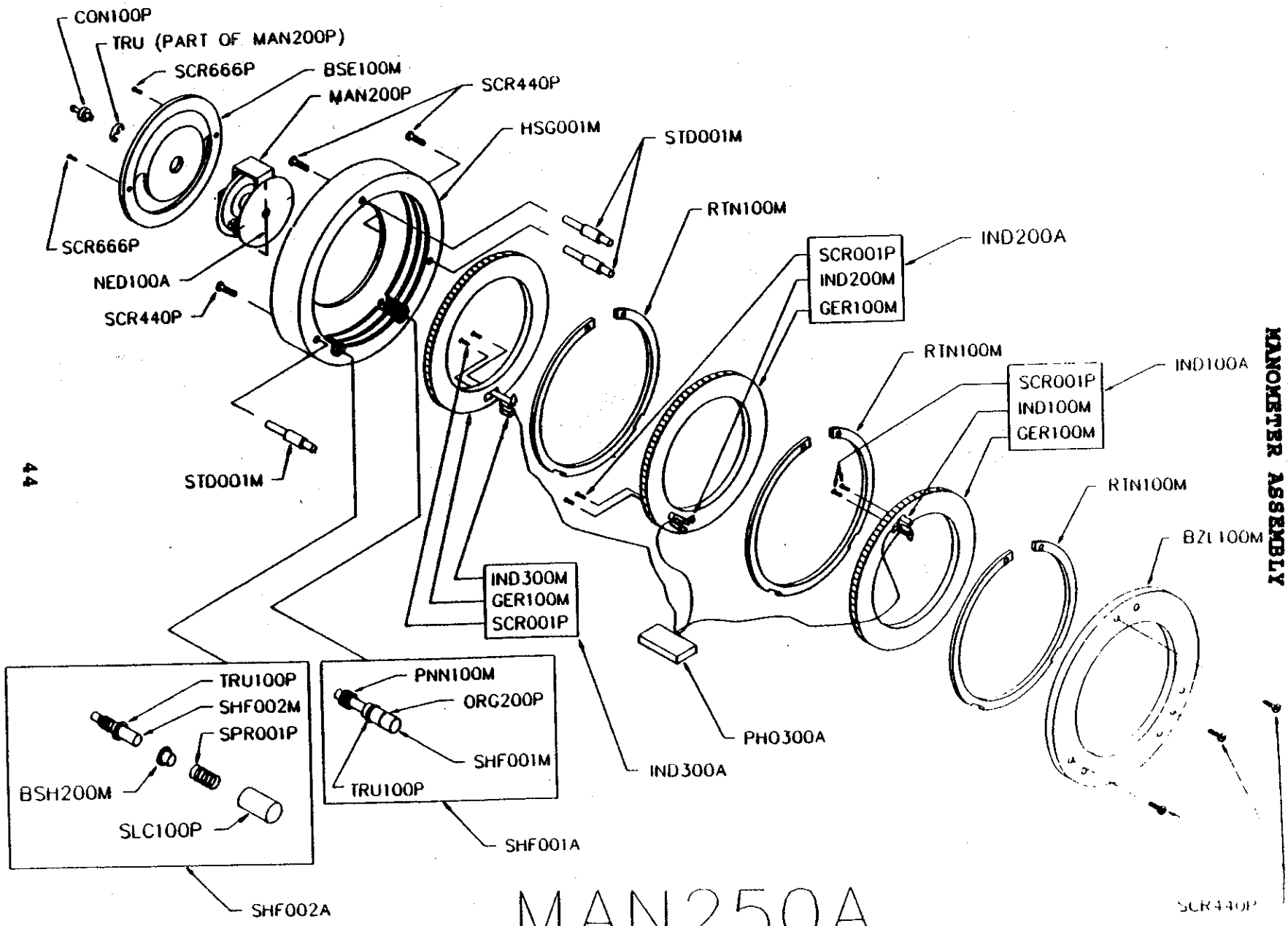
SPECIFICATIONS

1. Controllable Range ..... 21 - 100 %
2. FiO_2 Accuracy ..... +/- 3 % (@ 3 - 120 LPM)
3. Maximum Mixed Gas Flow Rate ... Above 120 LPM
4. Nominal Supply Gas Pressure ... 50 PSI (Both Gases)
5. Pilot Pressure ..... 29 PSI
6. Supply Gas Alarm Level ..... 31 PSI (+/- 3 PSI)
7. Maximum Supply Gas Pressure ... 100 PSI
8. Constant Flow ..... 5 - 12 LPM





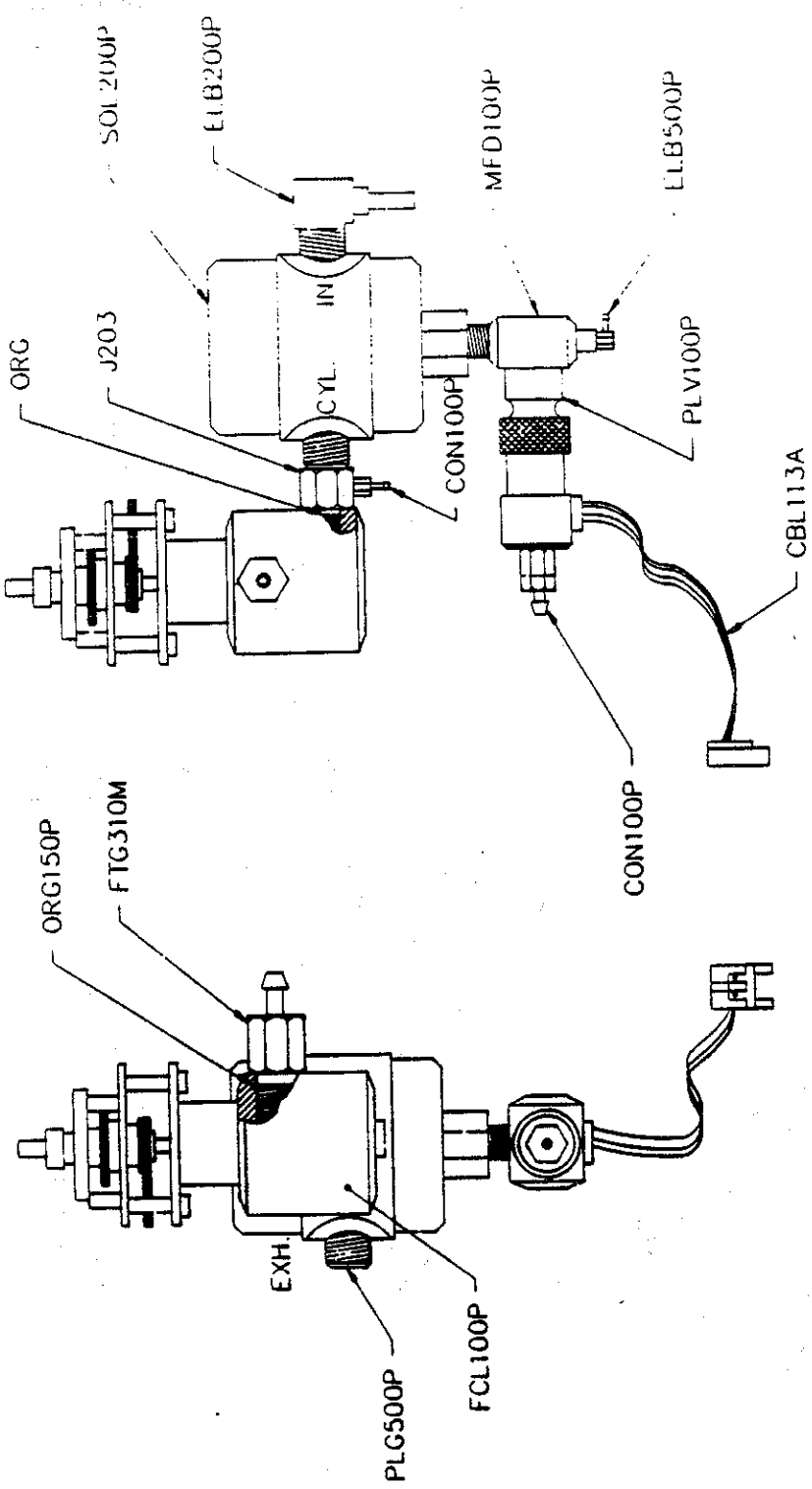
EXHALATION ASSEMBLY (EXH100A)



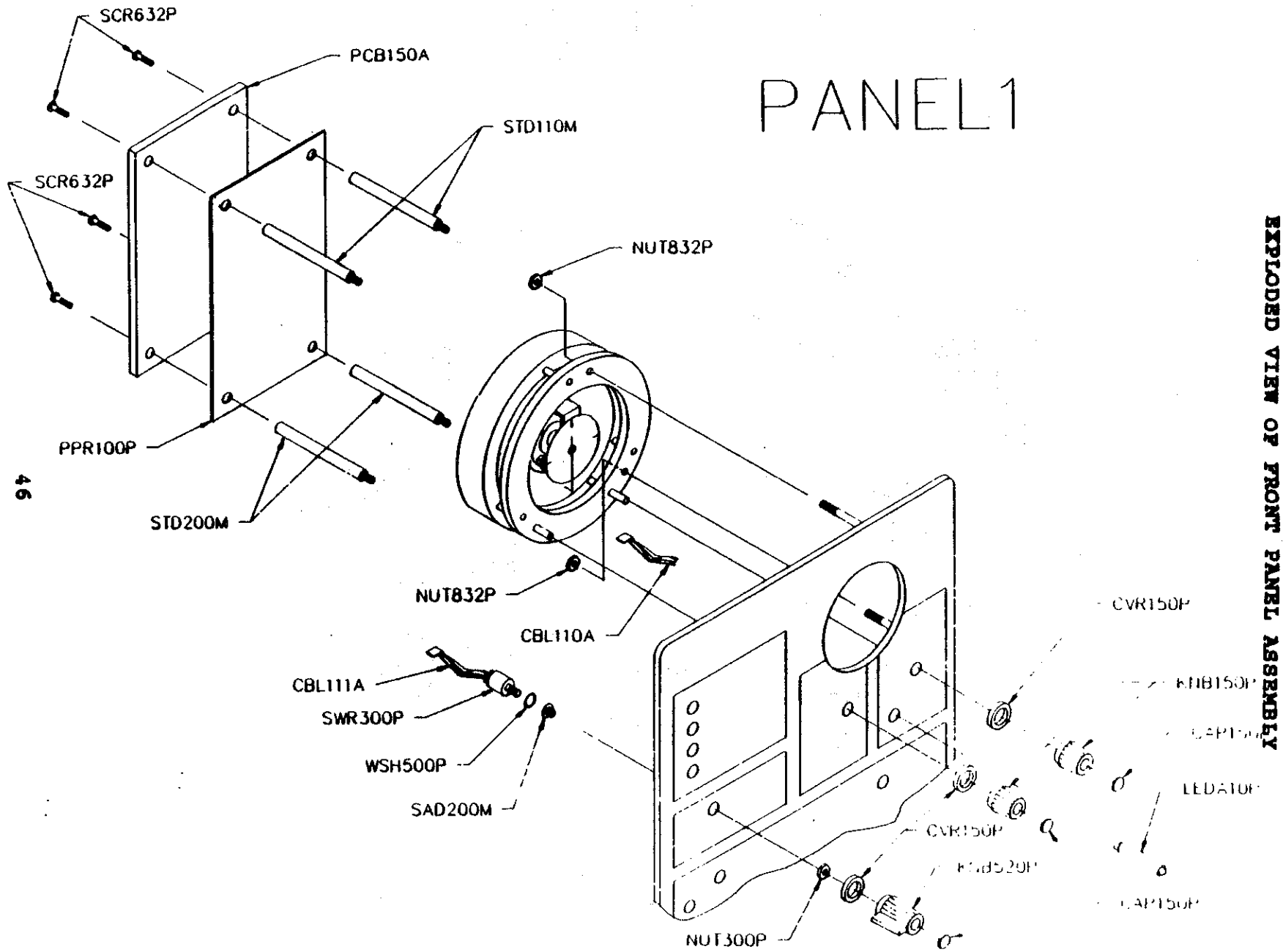
MANOMETER ASSEMBLY

MAN250A

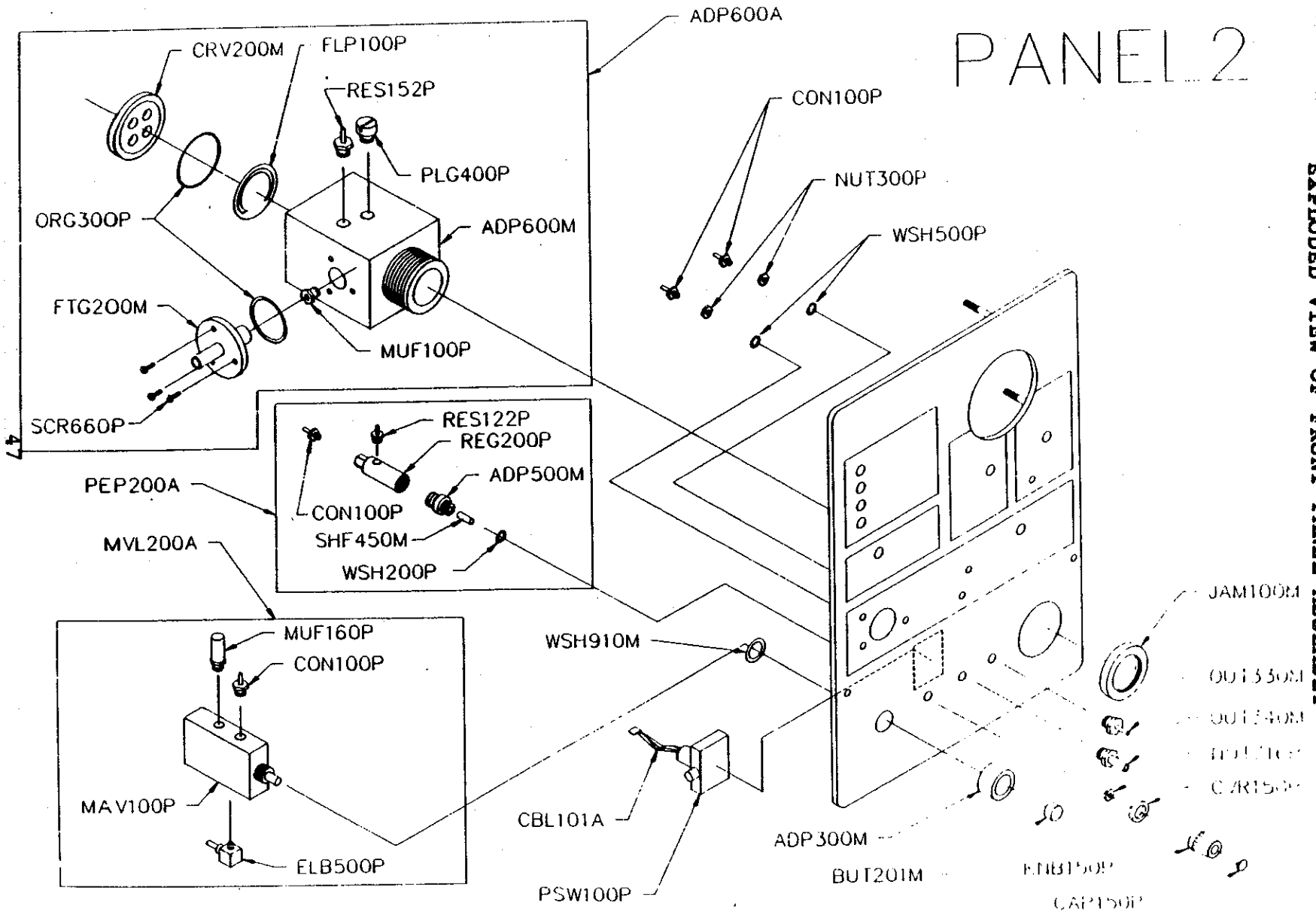
FLOW CONTROLLER ASSEMBLY

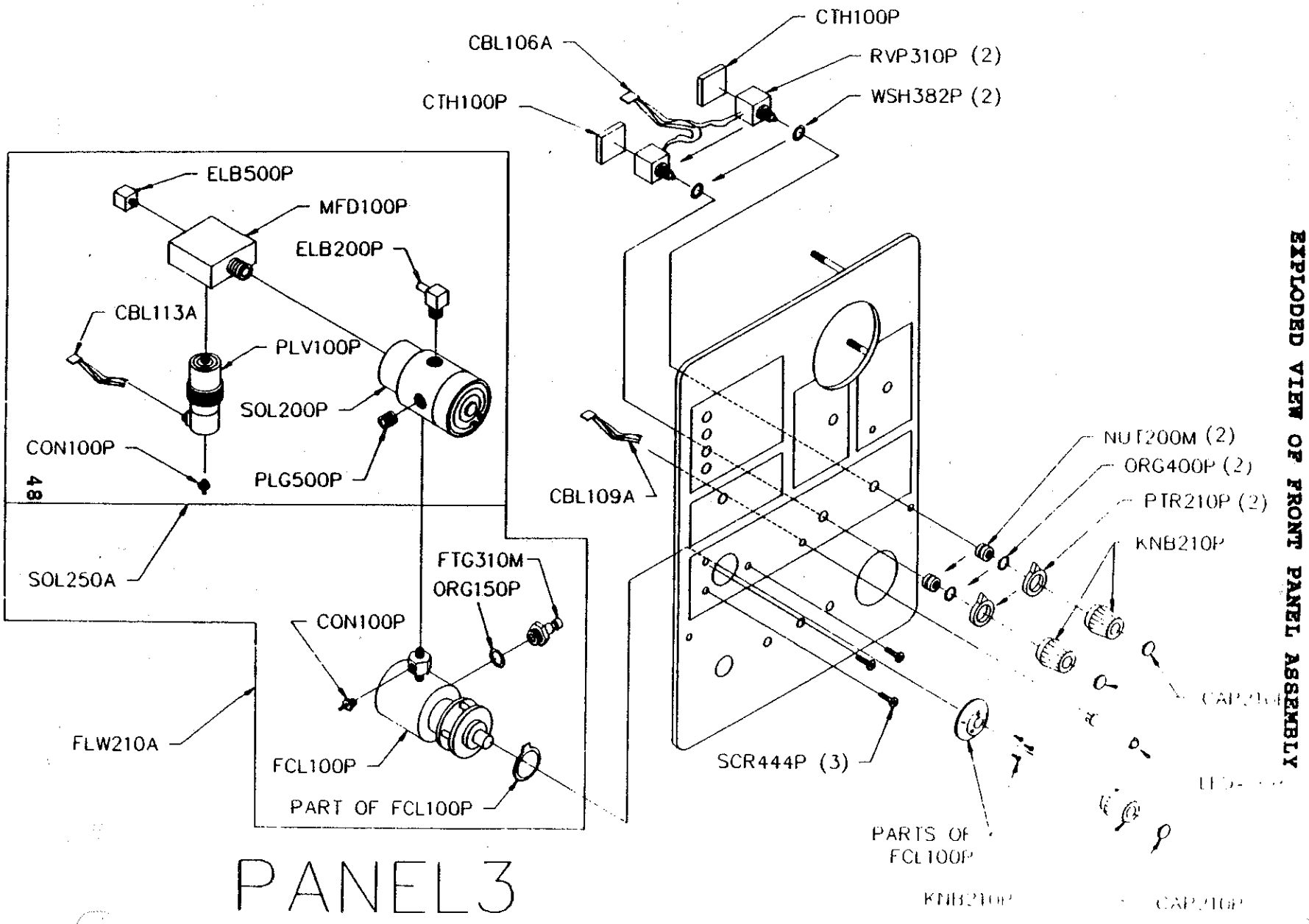


FLW210A ASSY.

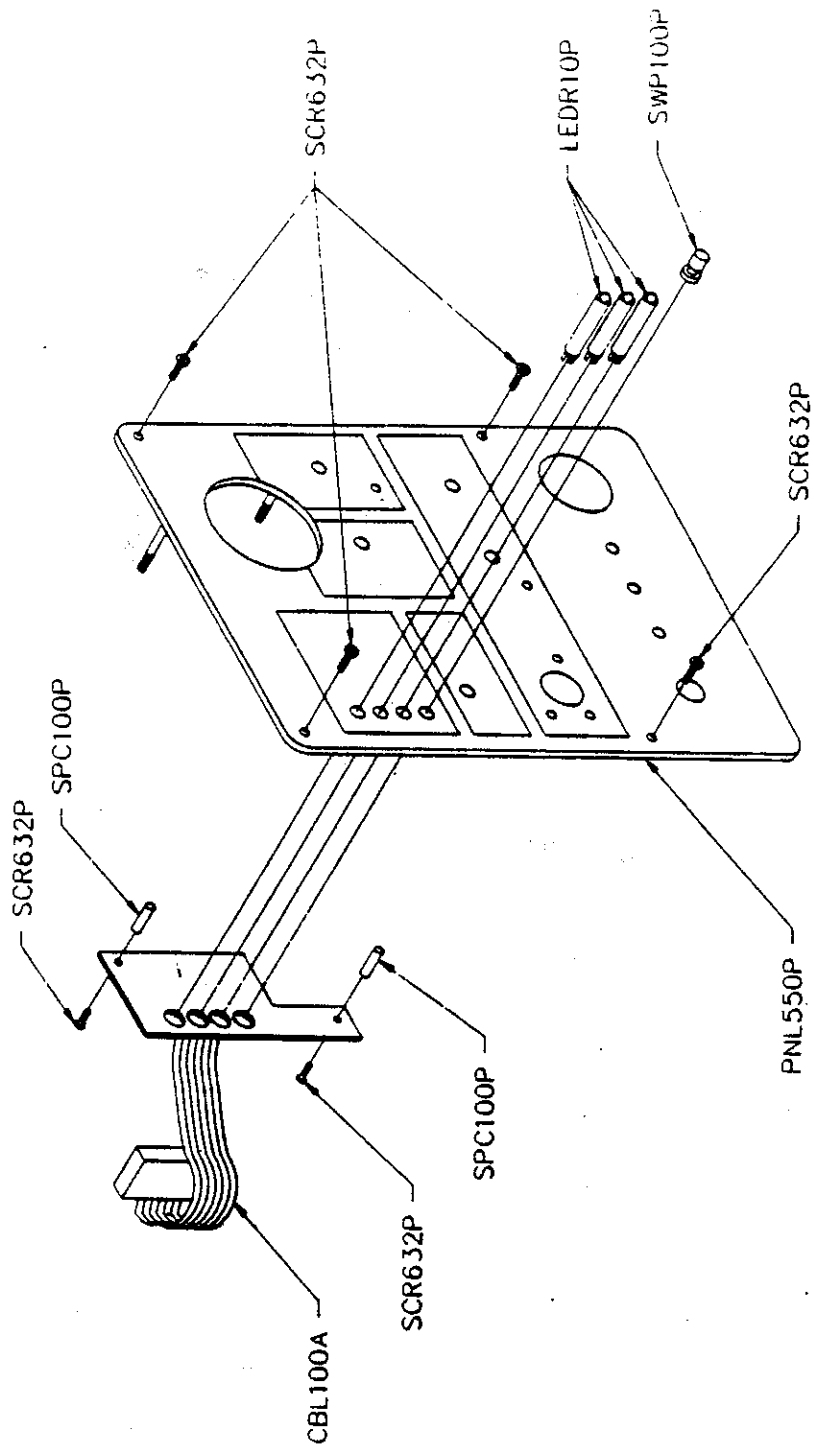


EXPLODED VIEW OF FRONT PANEL ASSEMBLY


PANEL 2
EXPLODED VIEW OF FRONT PANEL ASSEMBLY
ADP600A
CRV200M
FLP100P
RES152P
PLG400P
ORG300P
ADP600M
FTG200M
MUF100P
SCR660P
CON100P
NUT300P
WSH500P
RES122P
REG200P
ADP500M
PEP200A
CON100P
SHF450M
WSH200P
MVL200A
MUF160P
CON100P
MAV100P
ELB500P
WSH910M
CBL101A
PSW100P
ADP300M
BUT201M
JAM100M
47

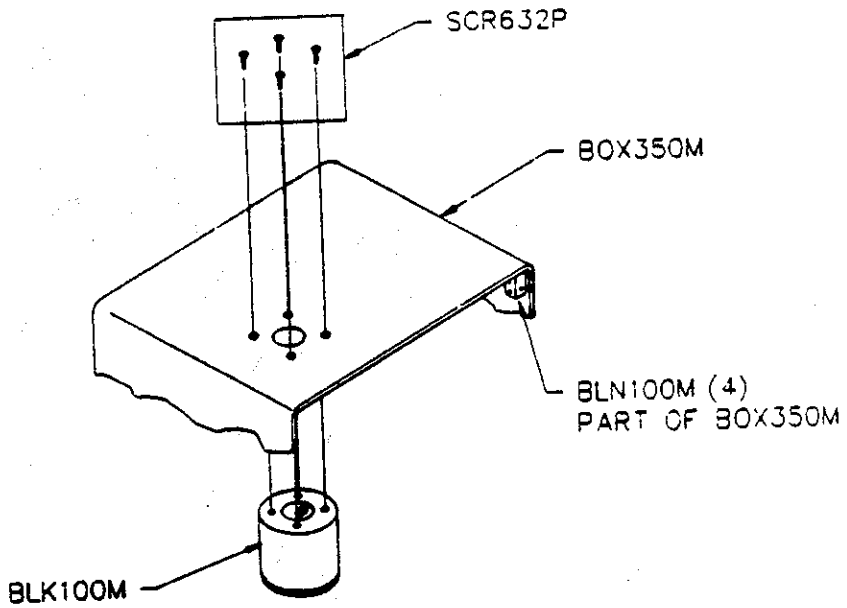

CTH100P
CBL106A
RVP310P (2)
CTH100P
WSH382P (2)
ELB500P
MFD100P
ELB200P
CBL113A
PLV100P
SOL200P
CON100P
PLG500P
48
SOL250A
CBL109A
NUT200M (2)
ORG400P (2)
PTR210P (2)
KNB210P
FTG310M
ORG150P
CON100P
FLW210A
FCL100P
PART OF FCL100P
SCR444P (3)
PARTS OF FCL100P
KNB210P
CAP210P
EXPLODED VIEW OF FRONT PANEL ASSEMBLY
PANEL3

EXPLODED VIEW OF FRONT PANEL ASSEMBLY



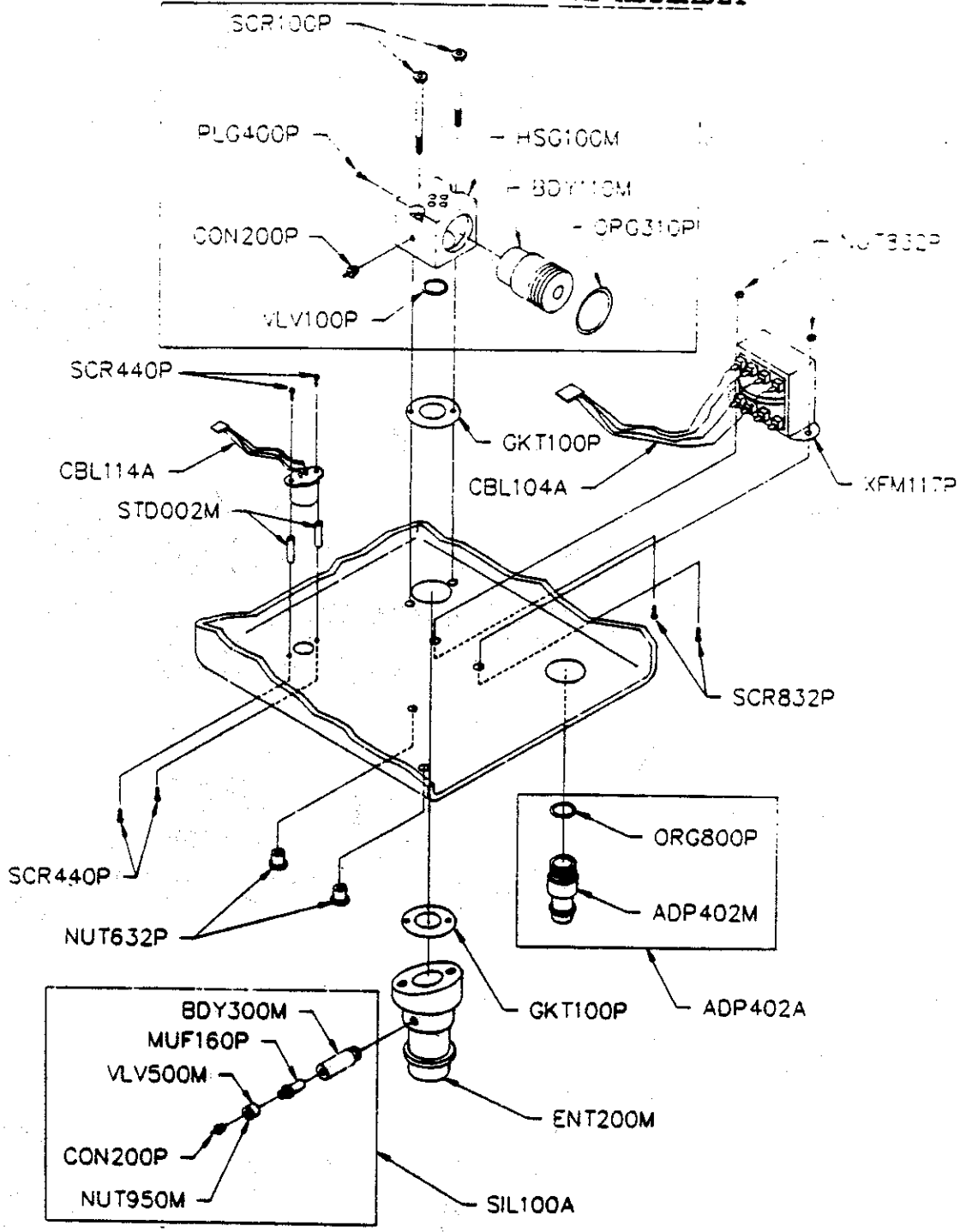
PANEL4

EXPLODED VIEW OF TOP BOX ASSEMBLY

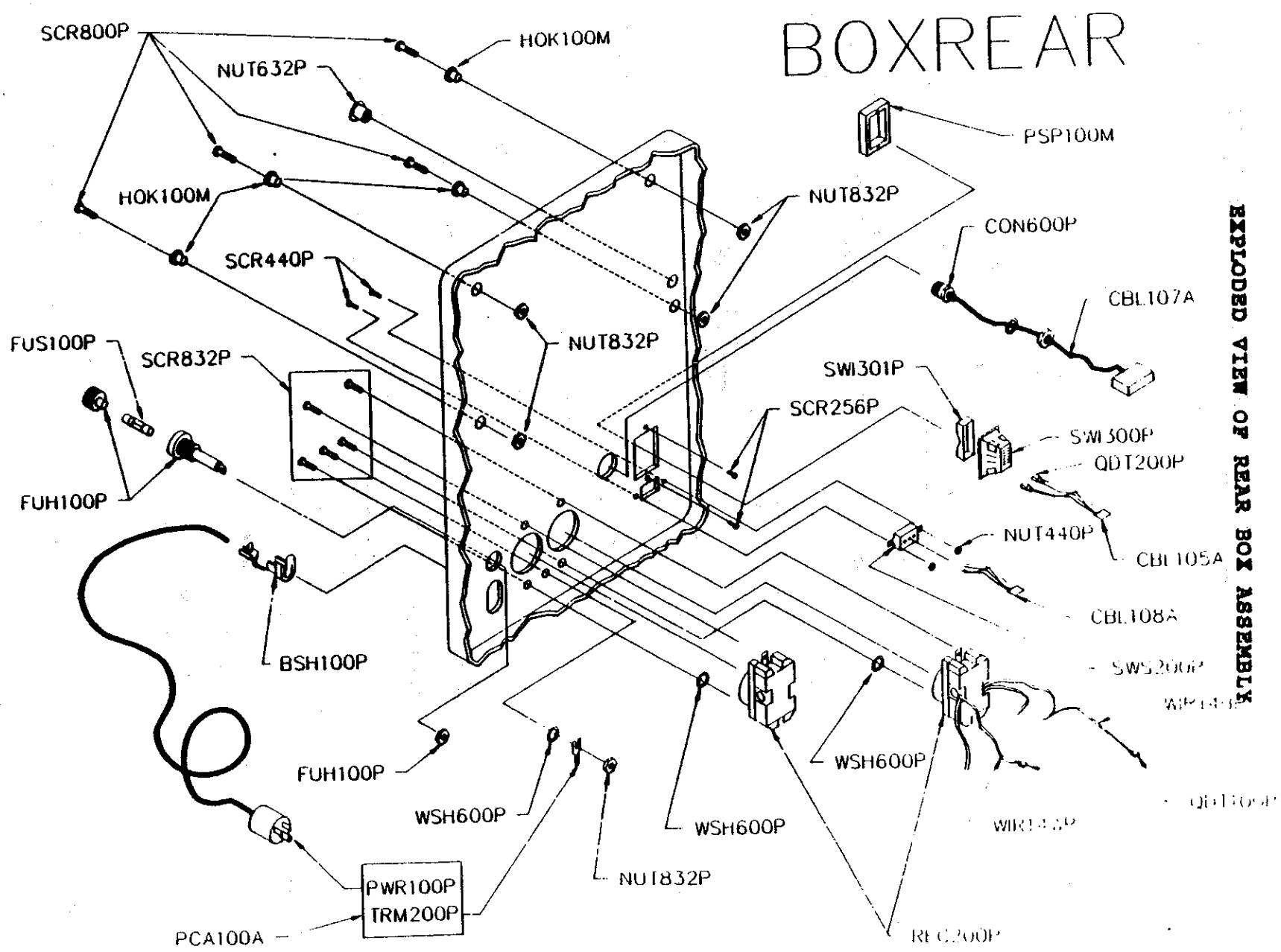


BOXTOP

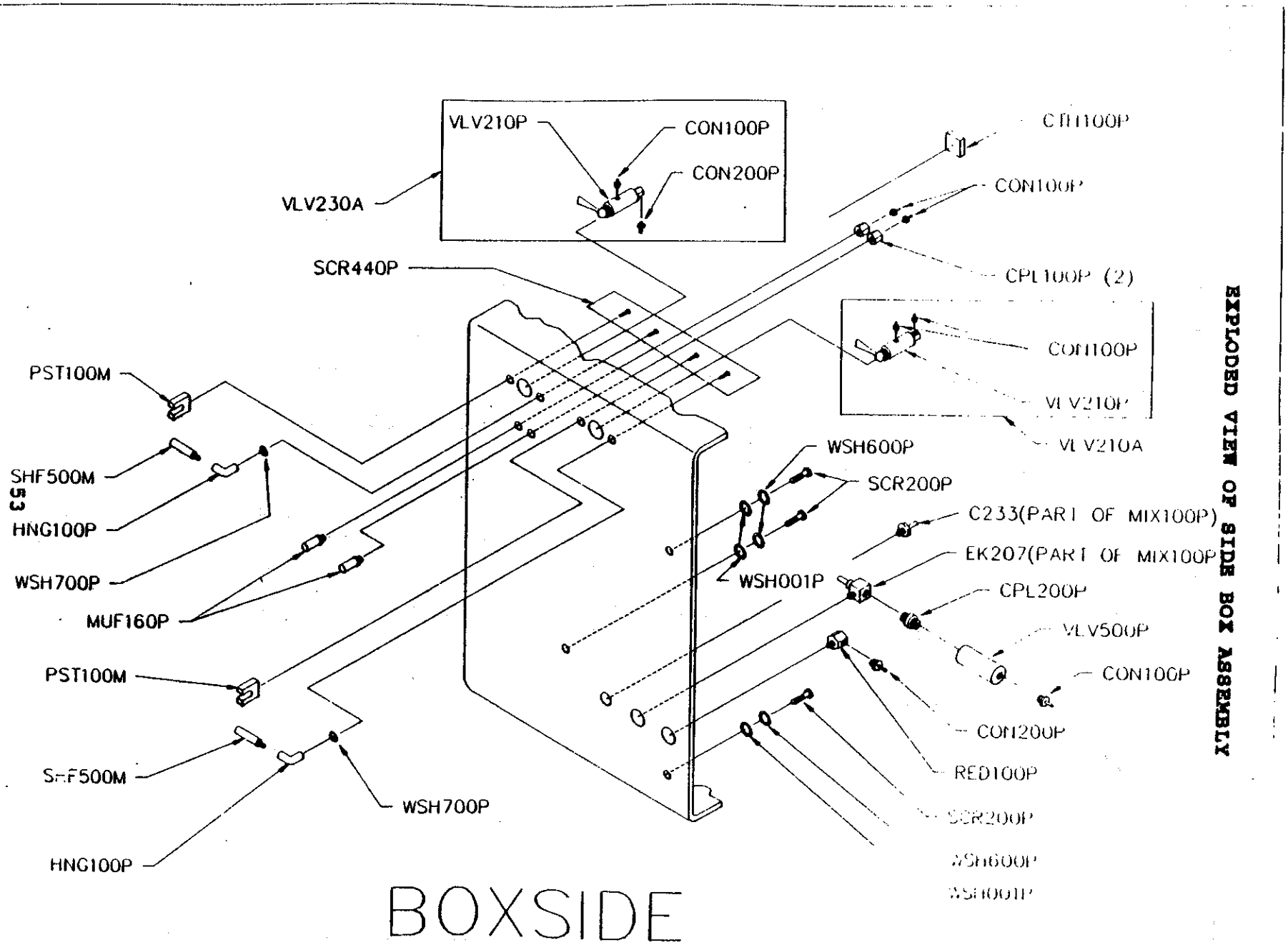
EXPLODED VIEW OF BOTTOM BOX ASSEMBLY



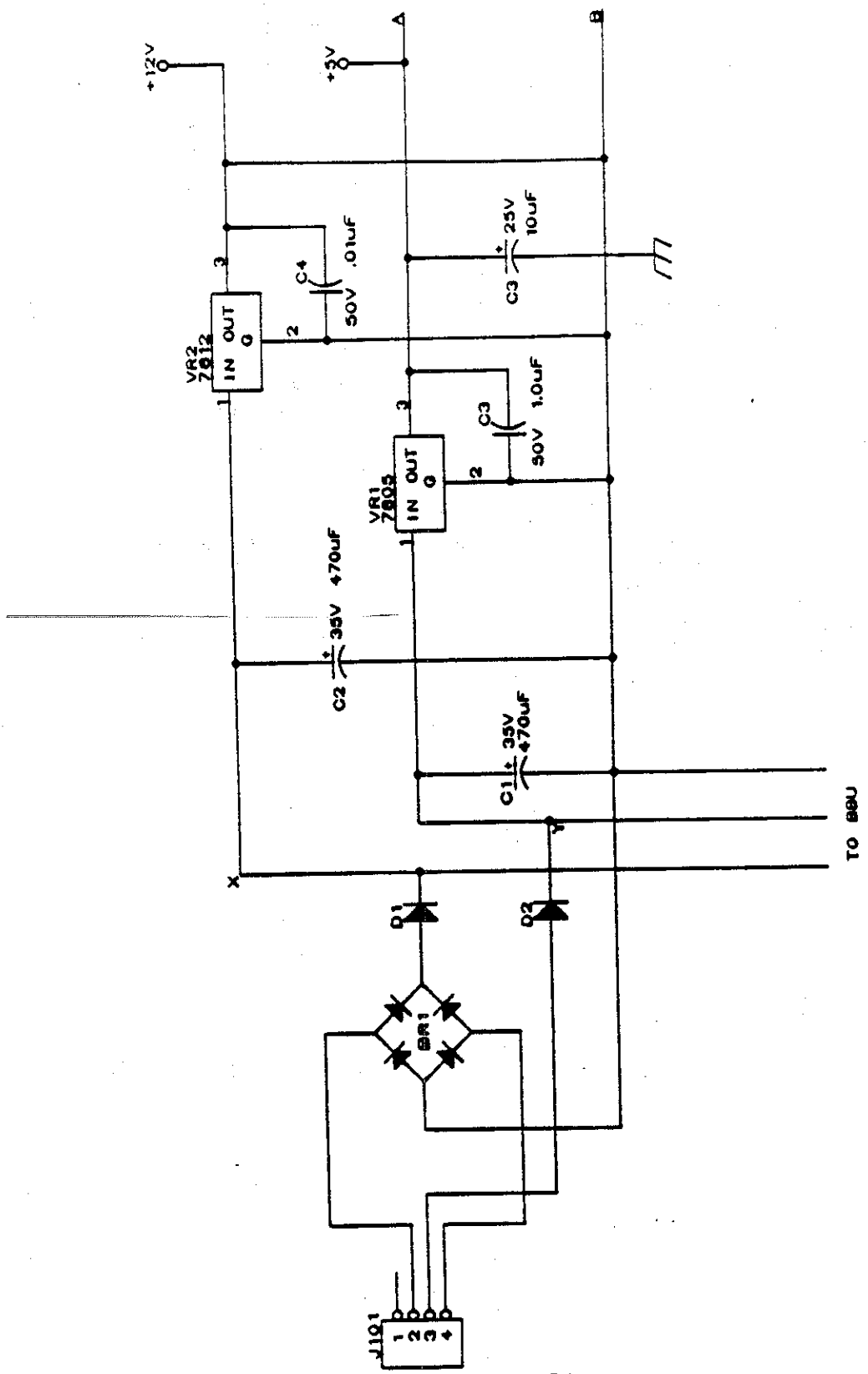
BOXBOTTOM



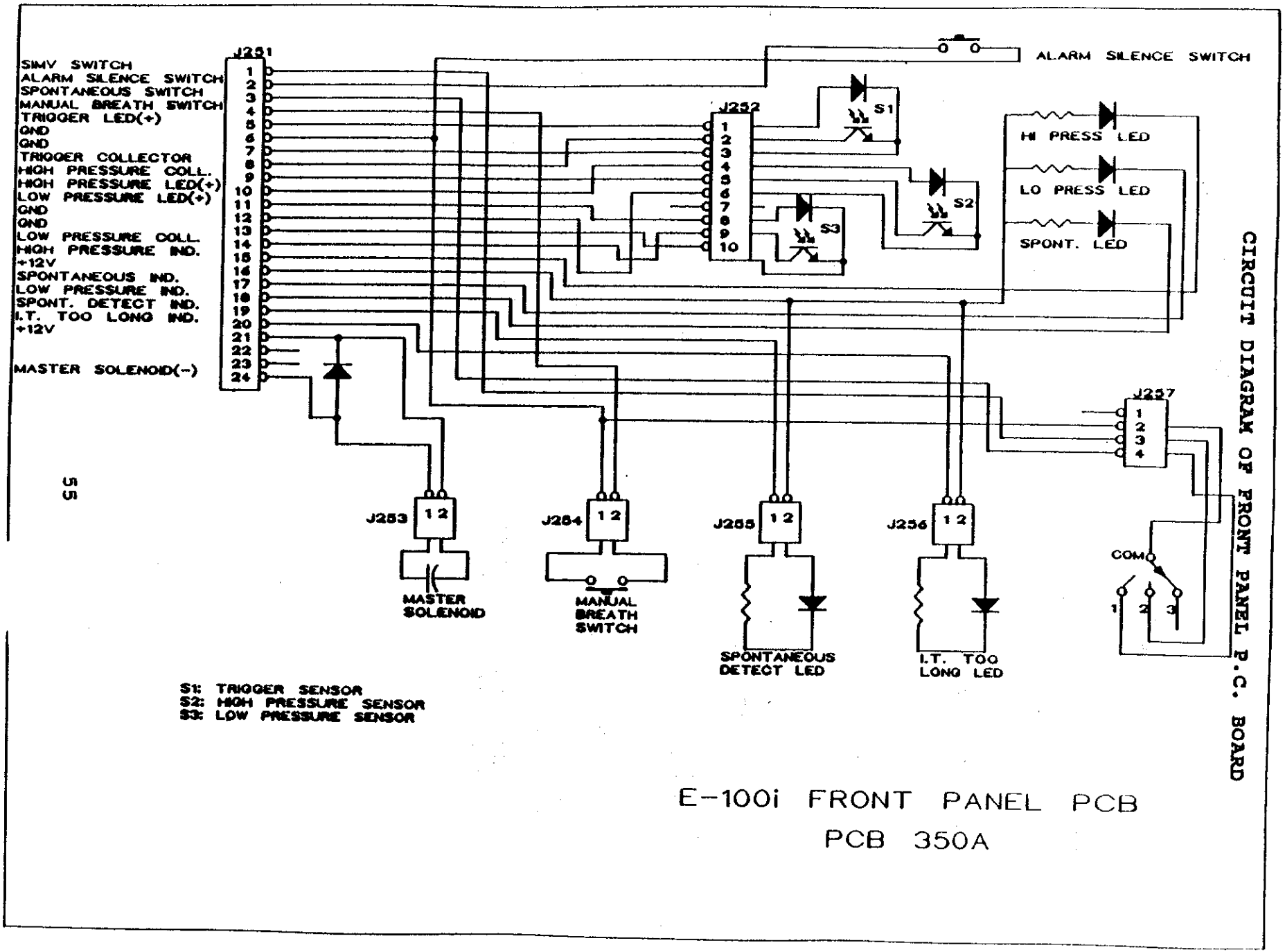
EXPLODED VIEW OF REAR BOX ASSEMBLY


VLV210P
CON100P
CON200P
VLV230A
SCR440P
PST100M
SHF500M
HNG100P
WSH700P
MUF160P
PST100M
SHF500M
WSH700P
HNG100P
CTH100P
CON100P
CPL100P (2)
CON100P
VLV210P
VLV210A
WSH600P
SCR200P
C233(PART OF MIX100P)
EK207(PART OF MIX100P
WSH001P
CPL200P
VLV500P
CON100P
CON200P
RED100P
SCR200P
WSH600P
WSH001P
EXPLODED VIEW OF SIDE BOX ASSEMBLY
53
BOXSIDE

POWER SUPPLY CIRCUIT DIAGRAM



E-100i POWER SUPPLY


SIMV SWITCH
ALARM SILENCE SWITCH
SPONTANEOUS SWITCH
MANUAL BREATH SWITCH
TRIGGER LED(+)
GND
GND
TRIGGER COLLECTOR
HIGH PRESSURE COLL.
HIGH PRESSURE LED(+)
LOW PRESSURE LED(+)
GND
GND
LOW PRESSURE COLL.
HIGH PRESSURE IND.
+12V
SPONTANEOUS IND.
LOW PRESSURE IND.
SPONT. DETECT IND.
I.T. TOO LONG IND.
+12V
MASTER SOLENOID(-)
J251
J252
J253
J254
J255
J256
J257
ALARM SILENCE SWITCH
S1
S2
S3
HI PRESS LED
LO PRESS LED
SPONT. LED
COM
MASTER SOLENOID
MANUAL BREATH SWITCH
SPONTANEOUS DETECT LED
I.T. TOO LONG LED
S1: TRIGGER SENSOR
S2: HIGH PRESSURE SENSOR
S3: LOW PRESSURE SENSOR
CIRCUIT DIAGRAM OF FRONT PANEL P.C. BOARD
E-100i FRONT PANEL PCB
PCB 350A

TOOLS AND STERILIZATION

The following tools and equipment are required for calibration.

Stopwatch
Timeter RT-200 or Respirometer
Oxygen Analyzer OM-11 or equivalent

Open end wrenches
- 1/4"
- 9/64"
- 5/16"
- 7/16"
- 1/2"
- 9/16"
- 5/8"
- 11/16"

Hex wrenches
- 5/64"
- 9/64"
- 3/16"

One 1/4" socket wrench.

Small blade common screwdriver, needle nose pliers, truarc pliers-universal, and small adjustable 4" wrench.

STERILIZATION

The E100i ventilator may be wiped down with a disinfectant solution.

CAUTION: The air/oxygen mixer SHOULD NOT be immersed or sterilized using gas or steam as it may damage the instrument.

PREVENTATIVE MAINTENANCE SCHEDULE

	12 Months	24 Months
Replace Filters, Mixer MFK100P	X	X
Replace Filter Condensation Jar JFK100P	X	X
Replace Reservoir Bag BAG120P	X	X
Calibration - Front Panel	X	X
Manometer Overhaul		X
Optional - Replace BBU-200 Batteries - 3 ea. BAT100P		X

RECOMMENDED SPARE PARTS (INHOUSE OR AT SERVICE CENTER)

Reservoir Bag	BAG120P	24.00
Pressure Pop-off	POP200A	
Diaphragm	DIA100P	
Jar Filter Kit	JFK100P	45.00
Mixer Filter Kit	MFK100P	40.00
1/4 Amp Fuses	FUS100P	
O-Rings	ORG300P	
Tubing, Urethane 150-3L	TUB100P	
Tubing, Urethane 150-3L	TUB200P	
Tubing, Blue Clippard 3814-G	TUB500P	

CLINICAL TROUBLESHOOTING

It is important for both the clinician and biomedical service people to have a thorough understanding of the Newport E-100i Ventilator pneumatic/electronic systems. The different alarm systems protect the patient in case of possible ventilator mechanical/electronic failure. Supporting the moral obligations of every involved professional to have a working understanding of the equipment as used in life-support situation, the following practical troubleshooting program is provided. It should be noted that this outline is not all-inclusive and is only intended as a guide.

Further questions or problems should be addressed to the Customer Service Department at Newport Medical Instruments,Inc.; phone number (714) 642-3910. The toll-free number (outside of California) is 1 (800) 451-3111.

PROBLEM	POSSIBLE CAUSE	REMEDY
PRESSURE MANOMETER		
* Manometer needle does not read 0 cm/H_2O when the breathing circuit is not attached, or if attached, with test lung removed and flowmeter control in OFF -closed position.	* Zero calibration is off.	* Recalibrate by gently turning the screw in the top of the manometer face-plate clock or counterclockwise. Check after removing the screwdriver that the needle remains in the "0" position, while gently tapping the face-plate area with fingers.
	* Manometer damaged.	* Replace manometer.
	* Bellow overpressurized.	* Call factory authorized representative.
* Pressure manometer needle resets in the positive pressure range after full exhalation.	* Exhalation valve internal resistance too high.	* Replace valve.
	* CPAP/PEEP control not in OFF position.	* Close valve.
	* Valve assembly leaks internally.	* Call factory authorized representative.
	* Patient airtrapping.	* Evaluate patient - remedy problem.
	* Using breathing circuit with smaller than usual I.D.	* Exchange for conventional size breathing circuit.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
PRESSURE MANOMETER		
* Erratic motion of manometer needle.	* Damaged pressure manometer.	* Call factory authorized representative.
	* H_2O in circuit tubing.	* Drain tubing.
OXYGEN CONCENTRATION		
* Delivered O_2 concentration varies more than 3% from selected concentration.	* Mixer contaminated with condensate.	* Call factory authorized representative.
	* O_2 analyzer not correctly calibrated.	* Calibrate according to Manufacturer Operation Manual.
	* O_2 concentration of gas in air cylinder is more than 21% O_2.	* Replace air cylinder and check O_2 concentration in room air.
SELF TEST		
* All lights on front panel remain ON longer than 2 seconds.	* Problem with microprocessor board.	* Contact NMI service center.
ALARMS		
* Air/Oxygen mixer alarms.	* Air and /or Oxygen supply source difficulties.	* Plug Air and O_2 supply lines in at exactly the same time or in reverse order.
	* Inlet gas pressures are not between 35 and 100 p.s.i.g.	* Ensure that both supply cylinders are full, valves turned fully OPEN and operating pressures between 35 and 100 p.s.i.g.

PROBLEM	POSSIBLE CAUSE	REMEDY
ALARMS - (Continued)		
		* Ensure hose disconnect fittings are correctly inserted into hospital wall outlets.
		* Check all of the above and that inlet gas is dry.
		* Ensure compressor A.C. power cord is plugged in and/or switch is in the ON position.
* Mixer does not alarm with only one gas source being connected.	* Condensate in mixer.	* Call factory authorized representative.
	* Dirty inlet filters.	
	* Leaking check valve.	
	* Alarm reed broken or damaged.	* Replace reed.
	* Bleedhole obstructed.	* Remove obstruction.
A.C. POWER FAILURE ALARM		
* Continuous alarm sound.	* Ventilator electric power cord acci-dentally disconnected.	* Reinsert plug.
	* Hospital electric circuit failure.	* Ventilate patient manually until problem is corrected or replace E100i with pneumatically powered and operated ventilator.

PROBLEM	POSSIBLE CAUSE	REMEDY
ALARMS - (continued)		
* Alarm does not sound during an electric disconnect or power failure.	* Ventilator ON/OFF switch is in OFF position.	* Switch ON.
	* Faulty ON/OFF switch.	* Call factory authorized representative.
	* Capacitor failure.	* Call factory authorized representative.
	* Electric cord was plugged into receptacles less than one minute before the problem occurred.	* Capacitor required one minute charging time.
ALARM SILENCE		
* Audible alarm remains silenced more than 55 seconds with alarm condition not yet corrected.	* Electronic malfunction.	* Call factory authorized representative.

PROBLEM	POSSIBLE CAUSE	REMEDY
HIGH PRESSURE ALARM		
	* Increased patient and/or breathing circuit resistance which causes an increase in ventilating pressure, exceeding the preset 20 cm/H_2O spread of the high and low alarm limits.	* Evaluate patient and remedy any mechanical problems. * Readjust the low pressure indicator position just below peak inspiratory pressure.
LOW PRESSURE ALARM		
	* Leak in breathing circuit and/or patient airway connecting system (cuff, etc.).	*Correct leak.
	* Inlet gas supply pressure loss.	* Reestablish gas supply sources. * Ventilate manually until pressure is restored.
	* Low pressure sensor was not adjusted for PEEP.	* Adjust indicator position 2-3 cm/H_2O below peak inspiratory pressure.

PROBLEM	POSSIBLE CAUSE	REMEDY
SPONTANEOUS ALARM		
	* No spontaneous breath detected in the time set on delay time control due to changes in patient status, ie., decreased respiratory rate or inspiratory effort.	* Evaluate patient rate and effort.
	* Improper delay time or trigger level setting.	* Reassess delay time and trigger level settings.
	* Leak in patient circuit/disconnect.	* Correct leak.
INSPIRATORY TIME TOO LONG		
* Inspiratory time too long amber light lights up.	* Inspiratory time selection is equal to or more than 1/2 of total cycling time.	* Readjust inspiratory time control and flow control.
* Alarm and/or mode selector indicator lights do not light up during the self-test sequence.	* L.E.D. burned out.	* Call factory authorized representative.
MECHANICAL/SPONTANEOUS VENTILATION		
* Reservoir bag depletes during spontaneous inhalation.	* Patient high inspiratory flowrate demand is not met.	* Adjust flowmeter so reservoir bag stays full during respiratory cycle.
	* Leak in the breathing circuit.	* Correct leak.
* Mode indicator lights do not light up while ventilator functions normally.	* LED's burned out.	* Call factory authorized representative.

PROBLEM	POSSIBLE CAUSE	REMEDY
MECHANICAL/SPONTANEOUS VENTILATION (continued)		
* Ventilator cycles prematurely into the inspiratory phase.	* Trigger level indicator is set above baseline.	* Adjust indicator position below baseline pressure.
* Ventilator does not respond to patient created inspiratory effort.	* Patient effort too weak.	* Readjust trigger level indicator position.
	*Incorrect trigger level indicator position. Manometer needle does not pass over indicator position.	* As above.
	* Leak in breathing circuit.	* Correct leak.
* Ventilator stops cycling. Low and/or high pressure alarms are activated.	* Electronic malfunction.	* Call factory authorized representative.
* Ventilator does not function in any mode.	* A.C. power cord not plugged in.	* Plug into approved receptacle.
	* ON/OFF switch in OFF position.	* Switch to ON.
	* Blown fuse.	* Replace with 1/4 Amp. fuse.
	* Electronic malfunction.	* Call factory authorized representative.
	* Inlet supply gas source failure.	* Re-establish functional system; correct inlet gas pressures to 35 - 100 p.s.i.g.

PROBLEM	POSSIBLE CAUSE	REMEDY
MECHANICAL/SPONTANEOUS VENTILATION - (Continued)		
* Desired machine tidal volume is not delivered during the selected inspiratory time.	* Leak in breathing assembly system.	* Correct leak.
	* Pressure relief valve setting is too low. Volume is vented when relief valve setting is reached.	* Readjust relief valve 3-5 cm/H_2O above the high pressure limit indicator position.
	* Flowrate l/sec. setting is too low.	* Use tidal volume graph, select correct l/sec. flowrate setting.
		* Use spirometer and adjust flowrate control until desired volume is reached.
PEEP/CPAP APPLICATION		
* PEEP/CPAP pressure does not meet maximum pressure specifications with PEEP/-CPAP control in fully OPEN (counterclockwise) position.	* Leak in breathing circuit or patient cuff, etc.	* Correct leak.
	* Faulty exhalation valve.	* Replace.
	* Leaking PEEP/CPAP control valve assembly.	* Call factory authorized representative.
	* Pressure relief valve is set lower than CPAP pressure.	* Reset.

PROBLEM	POSSIBLE CAUSE	REMEDY
PEEP/CPAP APPLICATION - (Continued)		
* Manometer needle dips below selected PEEP/CPAP pressure first, prior to stabilizing.	* Faulty exhalation valve.	* Replace.
	* Flowmeter control is OFF or 1/min. selection does not meet patient inspiratory flowrate demand.	* Adjust flowmeter to prevent bag from depleting during inhalation.
* With PEEP/CPAP control fully closed, positive pressure is still displayed on pressure manometer after patient exhalation.	* Inherent machine resistance pressure.	* Change exhalation valve or entire breathing circuit.
	* Patient airtrapping, clogged intubation tube, etc.	* Determine cause and correct problem.
	* Damaged manometer.	* Call factory authorized representative.
	* Leaking PEEP/CPAP control valve assembly.	* As above.
	* Problem with intubation tube (size, etc.).	* No remedy.
MANUAL INFLATION		
* Cannot generate sufficient pressure/insufficient chest expansion.	* Flowrate setting too low.	* Increase flow.
	* Pressure relief valve setting too low.	* Adjust relief valve pressure as required.
	* Gross leak.	* Correct leak and check pressure.

PROBLEM	POSSIBLE CAUSE	REMEDY
MANUAL INFLATION - (Continued)		
* Pressure builds up too slowly.	* Leak in breathing circuit.	* Correct leak and recheck pressure.
	* Flowrate setting too low.	* Increase as required.
* Pressure builds up too fast.	* Flowrate setting too high.	* Decrease as required.
* High pressure audible/visual alarm is activated during manual inflation.	* Inflation pressure exceeds ventilator high pressure limit indicator pressure.	* No remedy - manual breath overrides electrical alarm limits.
BATTERY		
* Battery pak fails to recharge.	* No A.C. Power.	* Ensure that ventilator A.C. cord is connected to wall receptacle and that BBU A.C. cord is plugged in to A.C. receptacle on rear panel of ventilator.
	* Batteries may need replacing.	* Contact NMI Service Center for replacements.
* "Ready" light comes ON immediately when battery backup is plugged in for charging after a prolonged discharging.	* Batteries are deeply discharged.	* Charge batteries for at least 18 hours, then check to see that battery will power ventilator for a minimum of 4 hours.
	* Batteries may need replacing.	* Contact NMI Service Center for replacements.
* BBU status indicators don't light up.	* LED burned out.	* Contact NMI Service Center for replacement.

PARTS LIST

E100i VENTILATOR MAIN ASSEMBLY

COMPONENT ID	DESCRIPTION	QTY	QTY TYPE
MBA210A	MIXER BOX ASSY E-100IiN	1	ASSEMBLY
PNL465A	PANEL ASSY, ELECT E-100i	1	ASSEMBLY
PNL560A	PANEL PNEU ASSY E-100iN	1	ASSEMBLY
ADP402M	VENTURI ADAPTER OUTLET	1	ASSEMBLY
CTH100P	CABLE TIE HOLDER # 08461	1	ASSEMBLY
ORG800P	O-RING #2-018 SILICONE	1	ASSEMBLY
SCR632P	SCREW, BTNHD F320-060-012	4	ASSEMBLY
LBL300P	LABEL, CSA	1	ASSEMBLY
LBL400P	LABEL, SERIAL #	1	ASSEMBLY
LBL500P	LABEL, LINE CORD	1	ASSEMBLY
LBL700P	LABEL, CAUTION (E-100i)	1	ASSEMBLY
TYR100P	TYWRAP, SMALL #TY23M	1	ASSEMBLY
PKG200P	PKG CTN, SMALL	1	ASSEMBLY
FRP100P	PACK FOAM - 3 PIECE	1	ASSEMBLY

PARTS LIST (continued)

COMPONENT ID	DESCRIPTION	QTY	QTY TYPE
BDY110M	VENTURI BODY	1	ASSEMBLY
BDY300M	BODY, ENTRAINMENT	1	ASSEMBLY
BLK100M	BLOCK, EXT ARM MTG	1	ASSEMBLY
BOX350M	BOX, REV "F"	1	ASSEMBLY
BSH100P	BUSHING, HEYCO #SR6L1 BLK	1	ASSEMBLY
CBL104A	CABLE ASSY, TRANSFORMER	1	ASSEMBLY
CBL105A	CABLE ASSY, ALARM, BBU SW	1	ASSEMBLY
CBL107A	CABLE ASSY, BBU	1	ASSEMBLY
CBL108A	CABLE ASSY, SPONT SELECT	1	ASSEMBLY
CBL114A	CABLE ASSY, BUZZER	1	ASSEMBLY
CON100P	CONNECTOR 211-1	10	ASSEMBLY
CON200P	CONNECTOR, 10/32 #211-2	5	ASSEMBLY
CPL100P	COUPLER, HEX 15004	4	ASSEMBLY
CPL200P	COUPLER, #11999	2	ASSEMBLY
ENT200M	ENTRAINMENT TEE	1	ASSEMBLY
FUH100P	FUSE HOLDER BUSS HKP	1	ASSEMBLY
FUS100P	FUSE 1/4 AMP #312.250	1	ASSEMBLY
GKT100P	GASKET, ENT. TEE	2	ASSEMBLY
HOK100M	HOOK PIN, S S BBU	4	ASSEMBLY
HNG100P	HINGE #333	2	ASSEMBLY
HSG100M	HOUSING, VENTURI JET	1	ASSEMBLY
MIX100P	MIXER, M-100 W/FILTER FTG	1	ASSEMBLY
MUF160P	MUFFLER, CLIPPARD 15070	3	ASSEMBLY
NUT440P	NUT, W/WASHER 4-40 KEPS	2	ASSEMBLY
NUT632P	NUTSERT 6/32 TSN	3	ASSEMBLY
NUT832P	LOCKNUT, 8/32 #F 570 080	7	ASSEMBLY
NUT950M	NUT, ENTRAIN SILENCER	1	ASSEMBLY
ORG310P	O-RING #2-021V884-75	1	ASSEMBLY
PSP100M	POWER SWITCH PROTECTOR	1	ASSEMBLY
PLG400P	PLG, VENT JET HSG # 11755	1	ASSEMBLY
PST100M	POST, DELRIN	2	ASSEMBLY
PWR100P	POWER CORD, C4700-010-GY	1	ASSEMBLY
QDT100P	QD CONNECT #2-520182-2 LG	2	ASSEMBLY
QDT200P	QD CONNECT #2-520084-2 SM	8	ASSEMBLY
REC200P	RECEPTACLE AC # 8210-S9	2	ASSEMBLY
RED100P	REDUCER, FABCO # 1820	1	ASSEMBLY
RES120P	RESISTOR RF120	1	ASSEMBLY
SCR100P	SCREW CAP #F300-080-124	2	ASSEMBLY
SCR256P	SCREW #F320 020 006	2	ASSEMBLY
SCR440P	SCREW, BTNHD F320 040 010	10	ASSEMBLY
SCR632P	SCREW, BTNHD F320-060-012	4	ASSEMBLY
SCR800P	SCREW BTNHD F320 080 020	4	ASSEMBLY
SCR832P	SCREW, BTNHD F320-080-012	7	ASSEMBLY
SCR200P	SOC CAP #F 300 080 012	3	ASSEMBLY
SHF500M	SHAFT, TOGGLE SWITCH	2	ASSEMBLY
STD002M	STANDOFF, BEEPER	2	ASSEMBLY
STV100P	SHUTTLE VALVE #MSV-1	1	ASSEMBLY

PARTS LIST (continued)

E100iN MIXER BOX ASSEMBLY

SWI300P	SWITCH, BBU AML24EBA2CC01	1 ASSEMBLY
SWI301P	SWITCH CVR #AML-54-F20 K	1 ASSEMBLY
SWS200P	SLIDE SWITCH #26F906	1 ASSEMBLY
TEE300P	TEE # 209-4	1 ASSEMBLY
TRM200P	TERMINAL, GROUND 55024-2	1 ASSEMBLY
TUB100P	TUBING URETH 150-3L 1/16"	1 ASSEMBLY
TUB102P	TUBING, 1/16" RED #148-2L	1 ASSEMBLY
TUB106P	TUBING, CLIP BLUE 1/16"ID	1 ASSEMBLY
TUB202P	TUBING, 1/8" RED #149-2L	1 ASSEMBLY
TUB600P	TUBING, #1159 CLEAR 85A	1 ASSEMBLY
TYR100P	TYWRAP, SMALL #TY23M	1 ASSEMBLY
TYR100P	TYWRAP, SMALL #TY23M	1 ASSEMBLY
VLV100P	VALVE, UMBRELLA	1 ASSEMBLY
VLV210P	VLV, 2WAY 10/32 #HO-20-2	2 ASSEMBLY
VLV500M	VALVE, MCV-2 MODIFY	1 ASSEMBLY
VLV500P	VALVE, MCV-2	2 ASSEMBLY
WSH600P	LOCKWASHER C 670 080 000	6 ASSEMBLY
WSH700P	WASHER, HNG F670 040 000	2 ASSEMBLY
WIR14BP	WIRE, 16 GAUGE TFF, BLACK	2 ASSEMBLY
WIR14WP	WIRE, 16 GAUGE TFF, WHITE	1 ASSEMBLY
WSH001P	WASHER #8 FW AN960C8	3 ASSEMBLY
WTR300P	WATER TRAP #204-3009-1A3	1 ASSEMBLY
XFM117P	TRANSFORMER DP-241-5-2016	1 ASSEMBLY

PARTS LIST (continued)

E100i MAIN PANEL ASSEMBLY

COMPONENT ID	DESCRIPTION	QTY	QTY TYPE
BSE100M	BASE, MANOMETER	1	ASSEMBLY
BSH200M	BUSHING	1	ASSEMBLY
BZL100M	BEZEL, MANOMETER	1	ASSEMBLY
CBL100A	CABLE ASSY, 26 FLAT	1	ASSEMBLY
CBL101A	CABLE ASSY, PNEUMATIC SW	1	ASSEMBLY
CBL106A	CABLE ASSY, POT	1	ASSEMBLY
CBL109A	CABLE ASSY, IT TOO LONG	1	ASSEMBLY
CBL110A	CABLE ASSY, SPONT DETECT	1	ASSEMBLY
CBL111A	CABLE ASSY, ROTARY SWITCH	1	ASSEMBLY
CON100P	CONNECTOR 211-1	1	ASSEMBLY
CTH100P	CABLE TIE HOLDER # 08461	2	ASSEMBLY
GER100M	GEAR SPUR	3	ASSEMBLY
HSG001M	HOUSING, MANOMETER	1	ASSEMBLY
IND100M	INDEX	1	ASSEMBLY
IND200M	INDEX	1	ASSEMBLY
IND300M	INDEX	1	ASSEMBLY
KNB210P	KNOB, LARGE GRAY S210-250	2	ASSEMBLY
KNB520P	KNOB, GRAY # SP151125	1	ASSEMBLY
LEDA10P	LED, AMBER PR 405-BA-12HN	2	ASSEMBLY
LEDR10P	LED, RED #PR405-BR-12H-N	3	ASSEMBLY
MAN200P	MANOMETER, 0-100 CM H20	1	ASSEMBLY
NED100A	POINTER ASSY	1	ASSEMBLY
NUT200M	NUT, FRICTION	2	ASSEMBLY
NUT832P	LOCKNUT, 8/32 #F 570 080	2	ASSEMBLY
ORG200P	O-RING, BUNA #2-006	1	ASSEMBLY
ORG400P	O-RING, BUNA #2-014	2	ASSEMBLY
PCB150A	PC BRD E-150A (REV "B")	1	ASSEMBLY
PCB350A	FRONT BOARD FOR E-100i	1	ASSEMBLY
PHO300A	PHOTOCELL ASSY	1	ASSEMBLY
PNL550P	PANEL, E-100i 120 BPM	1	ASSEMBLY
PPR100P	DYECUT FISHPAPER	1	ASSEMBLY
PSW100P	PSR SWTCH, CLIP #5100-3NO	1	ASSEMBLY
PTR210P	POINTER, GRAY #P210	2	ASSEMBLY
PNN100M	PINION	1	ASSEMBLY
PNN200M	PINION	1	ASSEMBLY
RVP310P	POT #88A1DB20N13 1% LIN	2	ASSEMBLY
SAD200M	MODE SWITCH ADAPTER	1	ASSEMBLY
RTN100M	RETAINER MANO	3	ASSEMBLY
SCR001P	SCREW #F 054 000 005	6	ASSEMBLY
SCR440P	SCREW, BTNHD F320 040 010	6	ASSEMBLY
SCR666P	SCREW #F320 060 008	2	ASSEMBLY
SCR632P	SCREW, BTNHD F320-060-012	6	ASSEMBLY
SLC100P	SLEEVE COVER	1	ASSEMBLY
SHF001M	SHAFT "A"	1	ASSEMBLY
SHF002M	SHAFT "B"	1	ASSEMBLY
SCR002P	SCREW # F 054 020 014	1	ASSEMBLY
SPC100P	SPACER #V804 8155-N-0632	2	ASSEMBLY

PARTS LIST (continued)

E100i MAIN PANEL ASSEMBLY

ID	DESCRIPTION	QTY	QTY TYPE
SPR001P	SPRING, COMPRESSION	1	ASSEMBLY
STD001M	STUD	3	ASSEMBLY
STO110M	STANDOFF, BRASS 1.85	2	ASSEMBLY
STO200M	STAND OFF, BRASS 3.25	2	ASSEMBLY
SWP100P	SWITCH, MSPS-103C-0 PBTN	1	ASSEMBLY
SWR300P	SWITCH, 50M45-01-1-03N	1	ASSEMBLY
TRU100P	TRUARC RING #5103-25	2	ASSEMBLY
TUB100P	TUBING URETH 150-3L 1/16"	1	ASSEMBLY
TYR100P	TYWRAP, SMALL #TY23M	4	ASSEMBLY
SCR003P	SCREW #2-56-5/8	1	ASSEMBLY
WSH382P	LOCK WSHR SS,F670 160 000	2	ASSEMBLY
WSH500P	WASHER, SMALL LOCK	1	ASSEMBLY
SCR004P	SCREW # F 054 020 028	1	ASSEMBLY

PARTS LIST (continued)

PNUEMATIC PANEL ASSEMBLY

COMPONENT ID	DESCRIPTION	QTY	UI	TYPE
ADP300M	ADAPTOR, MANUAL VALVE	1	ASSEMBLY	
ADP500M	ADAPTOR, BRASS PEEP CAP	1	ASSEMBLY	
ADP600M	ADAPTER, VENTURI	1	ASSEMBLY	
BUT201M	MANUAL VALVE BUTTON	4	ASSEMBLY	
CAP150P	CAP, SMALL GRAY C150	3	ASSEMBLY	
CAP210P	CAP, LARGE GRAY C210	1	ASSEMBLY	
CBL113A	CABLE ASSY, PILOT VALVE	1	ASSEMBLY	
CON100M	CONNECTOR, 211-1 MDFY	7	ASSEMBLY	
CON100P	CONNECTOR 211-1	1	ASSEMBLY	
CPL100P	COUPLER, HEX 15004	1	ASSEMBLY	
CRV200M	CARRIER, UMBRELLA	4	ASSEMBLY	
CVR150P	COVER NUT, GRAY N150	1	ASSEMBLY	
ELB200P	ELBOW, PARKER 229-6-4	2	ASSEMBLY	
ELB500P	ELBOW, DYNAMCO 1292-1	1	ASSEMBLY	
FCL100P	FLOW CONTROLLER	1	ASSEMBLY	
FLP100P	FLAPPER VALVE	1	ASSEMBLY	
FTG200M	FITTING ADAPTOR, BRASS	1	ASSEMBLY	
FTG310M	FCL FITTING 0.11 ID	1	ASSEMBLY	
JAM100M	JAMB NUT, VENTURI	3	ASSEMBLY	
KNB150P	KNOB, SMALL GRAY S150-250	1	ASSEMBLY	
KNB210P	KNOB, LARGE GRAY S210-250	1	ASSEMBLY	
MAV100P	MANUAL VLV CLIP #FV-3	1	ASSEMBLY	
MFD100P	MANIFOLD CLIP #15490-1	1	ASSEMBLY	
MUF100P	MUFFLER, CLIPPARD #15080	1	ASSEMBLY	
MUF160P	MUFFLER, CLIPPARD 15070	3	ASSEMBLY	
NUT300P	NUT, REGULATOR ADAPTOR	1	ASSEMBLY	
NUT716P	NUT, PEEP, NUPRO B-1SP4	1	ASSEMBLY	
ORG150P	O-RING, SILICONE #2-011	1	ASSEMBLY	
ORG300P	O-RING, SILICONE #2-021	1	ASSEMBLY	
ORG800P	O-RING #2-018 SILICONE	1	ASSEMBLY	
OUT330M	OUTLET, EXP. BRASS	1	ASSEMBLY	
OUT340M	OUTLET, NEBULIZER	1	ASSEMBLY	
PLG400P	PLG, VENT JET HSG # 11755	1	ASSEMBLY	
PLG500P	PARKER #219P-4 HEX PLG	1	ASSEMBLY	
PLV100P	PILOT VLV CLIP#3TO-3M-12	1	ASSEMBLY	
REG200P	REGULATOR, PEEP #MAR-1-NR	1	ASSEMBLY	
RES112P	RESTRICTOR RF112	1	ASSEMBLY	
RES122P	RESTRICTOR RF122 PEEP VLV	1	ASSEMBLY	
RES144P	RESTRICTOR FTG RF144	1	ASSEMBLY	
RES152P	RESTRICTOR RF152	3	ASSEMBLY	
SCR444P	SCREW, 4-40 X 3/16"	3	ASSEMBLY	
SCR666P	SCREW #F320 060 008	1	ASSEMBLY	
SHF450M	SHAFT, PEEP VALVE	1	ASSEMBLY	
SOL200P	HMPHRY 250A VLV #N7156	2	ASSEMBLY	
TEE100P	TEE T2 MEMCO FITTING	2	ASSEMBLY	
TEE200P	TEE, X2 MEMCO FITTING	1	ASSEMBLY	
TUB100P	TUBING URETH 150-3L 1/16"			

PARTS LIST (continued)

PNEUMATIC PANEL ASSEMBLY

ID	DESCRIPTION	QTY	QTY TYPE
TUB104P	TUBING, 1/16" YEL #148-4L	1	ASSEMBLY
TUB102P	TUBING, 1/16" RED #148-2L	1	ASSEMBLY
TUB105P	TUBING, 1/16" GRN #148-5L	3	ASSEMBLY
TUB106P	TUBING, CLIP BLUE 1/16"ID	2	ASSEMBLY
TUB600P	TUBING, #1159 CLEAR 85A	1	ASSEMBLY
TYR100P	TYWRAP, SMALL #TY23M	1	ASSEMBLY
VLV500P	VALVE, MCV-2	1	ASSEMBLY
WSH200P	WASHER, # 6 SS INT TOOTH	1	ASSEMBLY
WSH500P	WASHER, SMALL LOCK	2	ASSEMBLY
WSH310M	WASHER, BRASS ADAPTER	1	ASSEMBLY

WARRANTY

Newport Medical Instruments, Inc. (NMI) warrants this product to meet the published specifications and to be free from defects in material and workmanship under normal use for a period of three (3) years from date of purchase. The foregoing is in lieu of any other warranty, expressed, implied or statutory, including without limitation any warranty of machinability, warranty of fitness for any particular purpose, or warranty of any kind as to design. The sole liability of NMI under this warranty is limited to replacing, repairing or issuing credit at the discretion of NMI for the products, equipment or parts which fail to meet the published specifications or which become defective during warranty period and which are, upon examination by NMI, found not to meet the published specifications oR to be defective in materials or workmanship. NMI will not be liable under this warranty unless the following provisions are strictly complied with. (a) NMI is promptly notified, in writing, upon discovery of the failure of the said product or equipment to meet the published specifications or of the defects in materials or workmanship. (b) The defective product, equipment or part thereof is returned to NMI, transportation charges prepaid by the buyer. (c) The defective part is received by NMI for examination no later than one (1) month following the expiration of the warranty period and provided (d) that examination by NMI of said product, equipment or part shall disclose to NMI's satisfaction that such defect has not been caused by improper usage, accident, neglect, alteration, abuse, improper installation or unauthorized repair. Products, equipment or parts replaced under this warranty are warranted only through the terms of the original warranty. NMI neither assumes nor authorizes any other person or entity to assume for it any other warranty, obligation or liability in connection with its products or equipment whatsoever, and as to the fitness or usefulness of the equipment manufactured by it for any medical treatment, physical condition or other purpose whatsoever. In no event shall NMI be liable for personal injury, property damage or any special or consequential damage to the buyer, user or any other person whomsoever including, but not limited to, loss of profits, loss of use of the product or equipment, or foR damage of any kind whatsoever based on a claim for breach of warranty other than a refund of the purchase price of any defective product or equipment. Any authorization for repair or alteration by buyer must be in writing from NMI to prevent the voiding of this warranty. In the event NMI or its representatives render any technical advice or service of any kind to the buyer or anyone else in connection with the equipment or products covered by this warranty, the buyer hereby releases NMI from all liability of any kind whatsoever as a result thereof; and the warranty as herein before set forth shall not be enlarged or affected by said action of NMI.

NEWPORT MEDICAL INSTRUMENTS, INC.
Post Office Box 2600
Newport Beach, CA 92658

Sales & Marketing and Customer Service Department:

Telephone:	**(714) 642-3910**
Toll-free:	**(800) 451-3111**
Telefax:	**(714) 548-3091**
Telex:	**68-5603**

Technical Support and Service Department:

Telephone:	**(714) 650-0430**
Toll-free:	**(800) 852-6954**
Telefax:	**(714) 645-2049**
Telex:	**68-5603**

NEWPORT MEDICAL INSTRUMENTS INC.

E100i Remote Alarm Option Instructions

DESCRIPTION: The E100i remote alarm provides a standard 1/4 inch phone jack and an internal contact closure for activating a remote alarm device. The internal contact closes whenever the E100i High Pressure alarm, Low Pressure alarm, Spontaneous alarm, or Low Battery alarm (when using a BBU) is active. Also, the contact closes if there is a loss of power, and whenever the ventilator is turned OFF. The internal contact is electrically isolated from the ventilator's internal components and case.

USAGE:

Facing the front of the ventilator, the remote Alarm jack is located on the upper right side, and is labelled "REMOTE ALARM". The jack accepts a 1/4 inch, three circuit phone plug. The internal contact is closed (alarm active) whenever a ventilator alarm is active, and is not disabled by the ventilator's Alarm Silence function. When power is first applied to the ventilator, the remote alarm may be activated for approximately 45 seconds, while the internal power fail alarm power source charges. This will only occur if the ventilator has been off long enough for this power source to discharge.

SPECIFICATIONS:

Jack type: 1/4 inch, three circuit, Switchcraft #12B (equivalent), Tip and Ring terminals active, sleeve terminal grounded to chassis (line cord ground).

Plug type: 1/4inch, three circuit, Switchcraft #260, 267, or equivalent.

Contact Rating: 10VA max. resistive load. 100VDC max. switching voltage. 0.5 AMP max. switching current.

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