COHERENT RADIATION LABORATORIES

MODEL 54

ION LASER SYSTEM

OPERATIONS AND MAINTENANCE MANUAL

THE MODEL 54 ION LASER SYSTEM IS A HIGH QUALITY, PRECISION INSTRUMENT OF A COMPLEX NATURE. ALTHOUGH EASILY OPERATED, IT SHOULD BE USED ONLY AFTER THE OPERATOR HAS BEEN SUFFICIENTLY INFORMED AS TO ITS COMPLEXITIES, HIGH VOLTAGES, AND POSSIBLE HAZARDS IF USED IMPROPERLY. PLEASE NOTE ALSO THAT REPLACEMENT PARTS ARE COSTLY.

THIS MANUAL HAS BEEN PREPARED TO PROPERLY INFORM AND GUIDE THE OPERATOR. COHERENT RADIATION URGES THE USER TO BECOME FULLY ACQUAINTED WITH THE DATA CONTAINED HEREIN BEFORE ATTEMPTING OPERATION OR REPAIR OF THE LASER SYSTEM.

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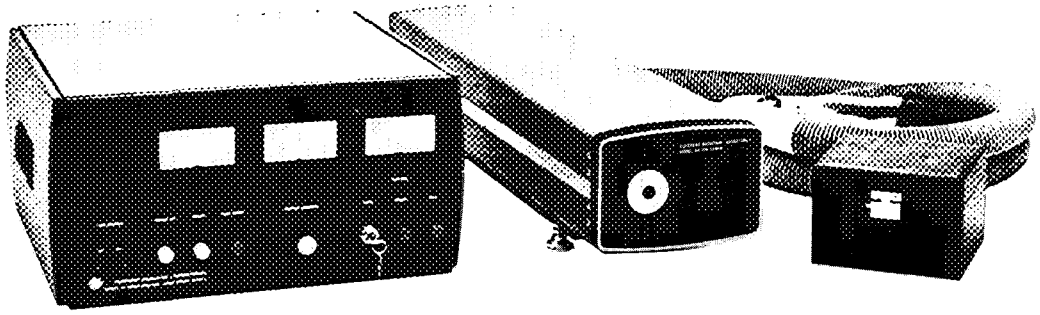


FIGURE A; MODEL 54 ION LASER SYSTEM

1.0 INTRODUCTION

The Coherent Radiation Model 54 Ion Laser is an economical source of coherent optical radiation in the blue-green region of the spectrum. Total power output is 500 mw with a minimum of 200 mw in each of the two principal argon lines, 514.5 nm (green) and 488.0 nm (blue).

The system is compact, lightweight, and easy to operate. It is reliable, durable, and versatile. In addition, it features a resonator construction which has been engineered to yield maximum stability and resistance to thermal, mechanical and vibrational forces.

2.0 SPECIFICATIONS

ARGON ION LASER-POWER OUTPUTS

All Lines	500 mw - TEMoo	
	Wavelength	Relative Power
Note: Single Line-Selectable with Prism	514.5 nm	200 mw
	501.7 nm	25 mw
	496.5 nm	35 mw
	488.0 nm	200 mw
Relative powers vary with excitation level.	476.5 nm	50 mw

Beam Diameter	. 1.1 mm at $1/e^2$ points
Beam Divergence	. 0.9 mr (Full angle at $1/e^2$ points)
Bore Configuration	. Segmented Graphite with Integral Symmetrical Gas Return Channels
Resonator Construction	. Compositon® (Composite Rod Ion Resonator Construction)
Excitation	. Regulated DC, Maximum 18 amps
Cavity Length	. 72.3 cm
Cavity Configuration	. Long Radius Spherical
Output Polarization	. 1:100 Electric Vector Vertical
Amplitude Drift	. 1% per hour and 3% per 8-hour day (after 30-minute warm-up period)
Noise	. Less than 1.5 rms - 10 Hz to 2 MHz (Measurement made with a wide bank photodiode driving a resistive load. AC noise voltage is measured on an rms voltmeter with 10 Hz to 2 MHz bandwidth.)
Head Dimensions	. 8"W x 6"H x 31.5"L
Head Weight	. 60 pounds
Power Supply Dimensions	. 18.25"W x 8.75"H x 18"D
Power Supply Weight	. 100 pounds
Input Power	. 220 VAC, Single-Phase 25 Amps
Cooling System	. Flow-through filtered tap water; 2 gpm @ 30 psi
Plasma Tube Warranty	. One Year unconditional (See Section 8.6)

3.0 SAFETY PRECAUTIONS

The following safety precautions should be studied prior to installation and use of the Model 54 Ion Laser.

1. ONLY a thoroughly trained operator should be allowed to use the Model 54 Ion Laser in any manner.

2. Install the laser in an area specifically designed to protect personnel from inadvertent exposure to the output beam. Protect against unauthorized access. Post warning signs. If possible, keep experimental setups at a low height to prevent encounter with an eye-level beam.

3. DO NOT look directly at scattered laser light from a light colored object as the light spot is extremely intense. The laser is capable of producing severe eye damage; therefore, primary consideration should be protection of the eye from a direct or reflected beam.

   Safety glasses which reject many laser wavelengths are available. Users should ascertain that the glasses have been specifically designed for wavelengths emitted by their particular unit. However, safety glasses alone are not considered sufficient to provide positive and complete protection against eye damage.

4. Reflecting or refracting objects should not be moved into the beam without careful consideration of the new beam path. The power level is sufficient to kindle many materials such as paper, cloth, wood, and paints. While usually minor, flesh burns are easily produced. Users should be aware that the focused beam is being investigated as a surgical scalpel.

4.0 INSTALLATION PROCEDURES

4.1 System Inspection

Upon receipt of the Model 54 Ion Laser System, the following information and suggestions should be noted.

1. The Model 54 Ion Laser System is shipped in three separate packages: the laser head, the power supply, and an accessory kit.

2. During unpacking and installation, do not move or adjust the tuning controls on the laser head. These controls have been properly set prior to shipment and premature adjustment may cause difficulty in obtaining laser output.

3. Remove all items and check against the shipping list. Inspect all items for visible shipping damage.

4. Report any damage to the shipping carrier and to COHERENT RADIATION immediately.

5. IMPORTANT: Retain the laser head shipping crate. DO NOT permit cannibalizing of the foam interior. The crate is specially designed for the protection of the laser plasma tube in the event it becomes necessary to move or ship the unit to another location.

4.2 System Installation

Before proceeding with any installation procedure, refer to Section 3.0 entitled SAFETY PRECAUTIONS.

4.2.1 Connecting Cooling System

Flow-through filtered tap water is employed to cool the laser. The supply must be capable of providing a minimum flow of 1.5 gpm at approximately 30 psi. A water filter is supplied with the accessory equipment and MUST be installed in the input water line, preferably at the supply valve.

NOTE: A red metal CAUTION tag has been attached to the power supply. As a precautionary device, remove and attach it preferably to the water supply line.

Refer to Figure 1, Power Supply - Rear View. Connect the water lines from the laser head to the FROM LASER and TO LASER water fittings on the rear panel of the power supply.

Using two ordinary garden hoses, connect the water supply and drain to the WATER IN and DRAIN fittings on the rear of the power supply. Be certain that the water flow is connected in the correct direction.

4.2.2 Power Connections

The Model 54 Ion Laser is designed to operate from a 220-volt, 30 ampere, single-phase service. It can, however, be adjusted to accept input line voltage between 195 and 240 volts. The power should be supplied from a switch box or other easily disconnected source. The wiring should be size No. 10 and must include a good electrical ground.

For ease in installation, the following sequence of steps is suggested:

1. Be certain line power is NOT energized.

2. Remove laser head lid.

3. Remove the single screw retaining the heat sink assembly. Raise the heat sink assembly to a vertical position. The rear side of the assembly is hinged for this purpose.

4. Insert an electrical cable through the opening provided in the rear panel of the power supply unit. (See Figure 1.).

5. Connect the cable to the terminal block, attaching the 220-volt wires to the two left terminals.

6. Connect the electrical ground wire to the third terminal (far right).

   (NOTE: In some units, the terminals will have numerical designations: Terminals #1 and #2 - 220V; and Terminal #3 - Ground.)

7. Set the auto-transformer to the correct tap for line voltage. The taps are located at the terminal strip on the top of the transformer. Only the wire going to terminal #4 should be changed. The correct setting is given on the following page.

Line Voltage	Tap Setting
195 - 208	4
209 - 220	5
221 - 240	6

Connect the two electrical plugs from the laser head to jacks J101 (a 7-pin connector) and J102 (a 9-pin connector) located on the rear panel of the power supply.

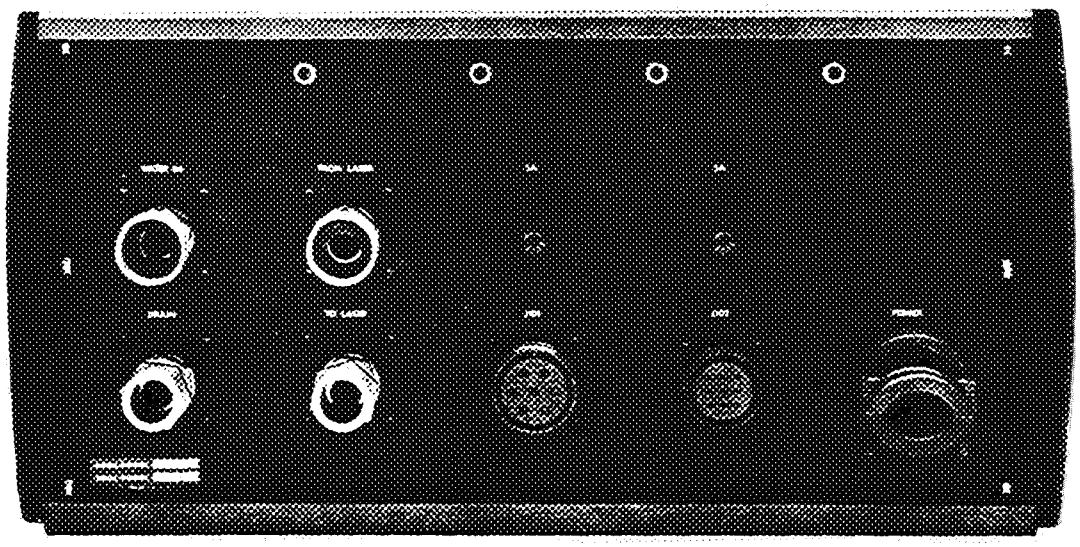


Figure 1; POWER SUPPLY, REAR VIEW

5.0 OPERATION

5.1 Operation and Check-Out Procedures

Before initial operation of the laser system, make the following checks to ensure optimum performance. Also, these instructions constitute the general operating steps to be followed each time the system is to be used.

1. Turn on cooling water. If a valve is used on the drain line, it must be opened before the supply line valve is opened. A safety relief valve is provided on the laser water fitting to protect against possible high water pressure or drain blockage.

2. Check that water is flowing freely and that no water leaks exist.

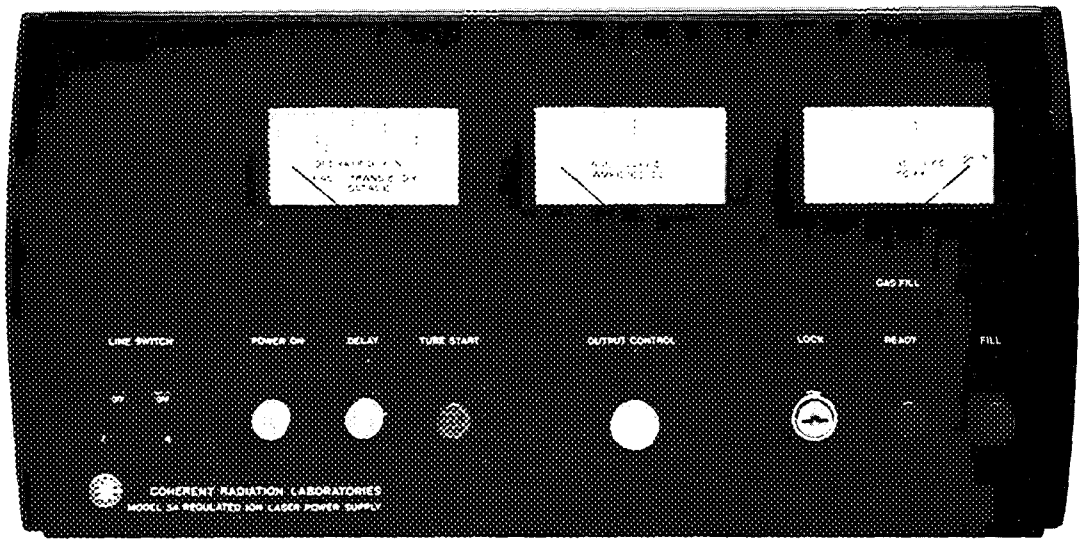


Figure 2; POWER SUPPLY, FRONT VIEW

3. Plug system in and/or energize supply line coming to laser power supply.

4. Check the unit covers to be certain interlocks are closed. System should not be operated while these covers are open.

5. Turn the LINE SWITCH at the power supply to ON. The switch is also an overload breaker and may sometimes trip-off when first energized. With the line switch ON, the POWER ON light will become lighted and the DELAY light will blink for approximately 15 seconds before remaining off. Do not proceed until the DELAY light is off.

6. Check the LASER PRESSURE meter. The normal indication should be approximately 300 millitorr (between 250 and 350 millitorr).

7. Turn the OUTPUT CONTROL to the extreme clockwise position. The PASS TRANSISTOR VOLTAGE meter should indicate very nearly zero.

8. Firmly press the TUBE START button one or more times until current is indicated on the LASER CURRENT meter.

9. Adjust the OUTPUT CONTROL until the LASER CURRENT meter indicates 18 amperes. The PASS TRANSISTOR VOLTAGE meter should be indicating in the green operating range. If the pass transistor voltage is out of range, the tap setting on the auto-transformer should be changed. A high pass transistor voltage indicates that the input line

is too high for the existing tap setting. The tap should be raised one step, i.e. from tap 5 to tap 6. A low pass transistor voltage indicates that the input line voltage is too low. The tap should then be lowered one step; i.e. from tap 5 to tap 4 . In most units, the tap wire is colored green for easy identification.

10. The laser mirrors have been properly adjusted prior to shipment. If the adjustments have not been disturbed, the system should produce visible laser light immediately upon starting. (If lasing is not observed, refer to Section 8.5.)

11. After the laser has been operating for several minutes the mirrors should be tuned for maximum output power by slowly adjusting the horizontal and vertical axis controls located on the rear of the laser head. This adjustment can be best accomplished with the use of a laser power meter such as the COHERENT RADIATION Model #201.

12. The normal operating LASER PRESSURE indication should be between 250 and 350 millitorr. If the pressure should drop below 250 millitorr, additional gas should be added by unlocking the gas fill system and alternately pressing the READY and FILL buttons. The pressure will slowly increase approximately 10 millitorrs per fill so it is advisable to wait several minutes between fills.

13. Turn the LINE SWITCH to OFF.

14. Allow the cooling water to flow for at least 10 minutes after the laser has been turned off. This is important, and operation should not be resumed until the waiting period has been accomplished.

NOTE 1: After a holiday or similar period of inactivity it may occasionally be observed that the laser gas pressure is down. To start, add no more than a total of 50 millitorrs together with repeated attempts at starting. Gas pressure will generally increase to the desired level without additional gas fills.

NOTE 2: After a long period of operation the laser may deactivate due to loss of water cooling. If this occurs refer to Troubleshooting Guide, Section 8.5, and make the necessary checks. Be certain, however, that the laser tube has resumed a room temperature level before reactivating. If the laser is reactivated too soon a thermal shock may occur causing the tube to crack, thereby making replacement necessary.

5.2 General Description

A general description of the system components and accessories is offered in the following paragraphs to further acquaint the customer with the system and additional accessories available from the factory.

5.2.1 Power Supply

The Model 54 power supply utilizes direct line rectification and transistor regulated current control. Input power requirement is single-phase, 220 VAC, 25 Ampere, 50/60 Hz. An auto-transformer with tap adjustments insures regulated current operation for line voltages between 195 and 240-volts rms. The auto-transformer is capable of adding voltages up to 25-volts in 12.5-volt steps to the line to neutral voltage.

The high heat dissipating components are mounted on a water cooled, aluminum heat sink. These components are the pass transistor bank, the bridge rectifier, and the temperature sensing thermostat.

5.2.2 Power Supply Controls

The system is activated by engaging the LINE SWITCH. This main power switch is a circuit breaker which must be manually closed but automatically opens in the event of excessive current, excessive temperature in the cooling system, or opening of the cover which actuates the cover interlock switch. Fast acting 30-ampere fuses are provided to protect the rectifiers in the event of a short circuit.

A time delay relay is provided which prevents application of starter voltage to the laser tube until the filament has had time to reach normal operating temperature.

Operating current is indicated on the LASER CURRENT meter. The PASS TRANSISTOR VOLTAGE meter measures the voltage across the pass transistor bank and indicates the operating range. A LASER PRESSURE meter readout is also mounted in the power supply for the purpose of indicating laser gas pressure. Pushbutton switches are provided for the purpose of actuating the gas refill system in the laser head.

Refer to Figure 2.

5.2.3 Cabling

Interconnecting cabling from the laser to the power supply is provided by COHERENT RADIATION. Additional wiring from the power line to the power supply is to be provided by the customer. Refer to the section on INSTALLATION PROCEDURES for applicable parameters.

5.2.4 Laser Head

The Model 54 laser head houses the plasma tube, the lightweight axial field magnet, the Compositon® resonator structure with its precision direct-drive mirror mounts, and various electrical components associated with ignition, control and protective interlock circuitry. Compositon

structure results in high performance levels in terms of angular, length, power output, and frequency stability. In addition, direct-drive mirror mounts (with reduction gears for ease of tuning) are provided to eliminate the vibrational instabilities associated with differential-spring mounts. Mirrors are interfaced with the resonator structure by means of a precision three-point pickup which eliminates alignment problems in the event of a mirror change. The channel between the Brewster windows and the mirrors is protected from dust and contamination by O-ring sealed glass shielding.

The laser head is supplied with adjustable 4-point mounting. Electrical power and water cooling is delivered to the head from the exciter through a flexible 8-foot umbilical. The head is carefully aligned at the factory and delivered with rear mirror mount adjusts only to eliminate the possibility of accidental misalignment.

The plasma tube consists of graphite bore segments separated by ceramic spacers and encapsulated in a quartz jacket. Located centrally, the discharge bore is surrounded by a number of gas return channels which serve to offset the gas pumping action exerted by the electron discharge on the heavy argon ions. Electrodes rated at three times actual operating conditions are employed. A stainless steel ballast tank with integral gas reservoir and automatic gas fill mechanism completes the plasma tube assembly.

Refer to Figure 3.

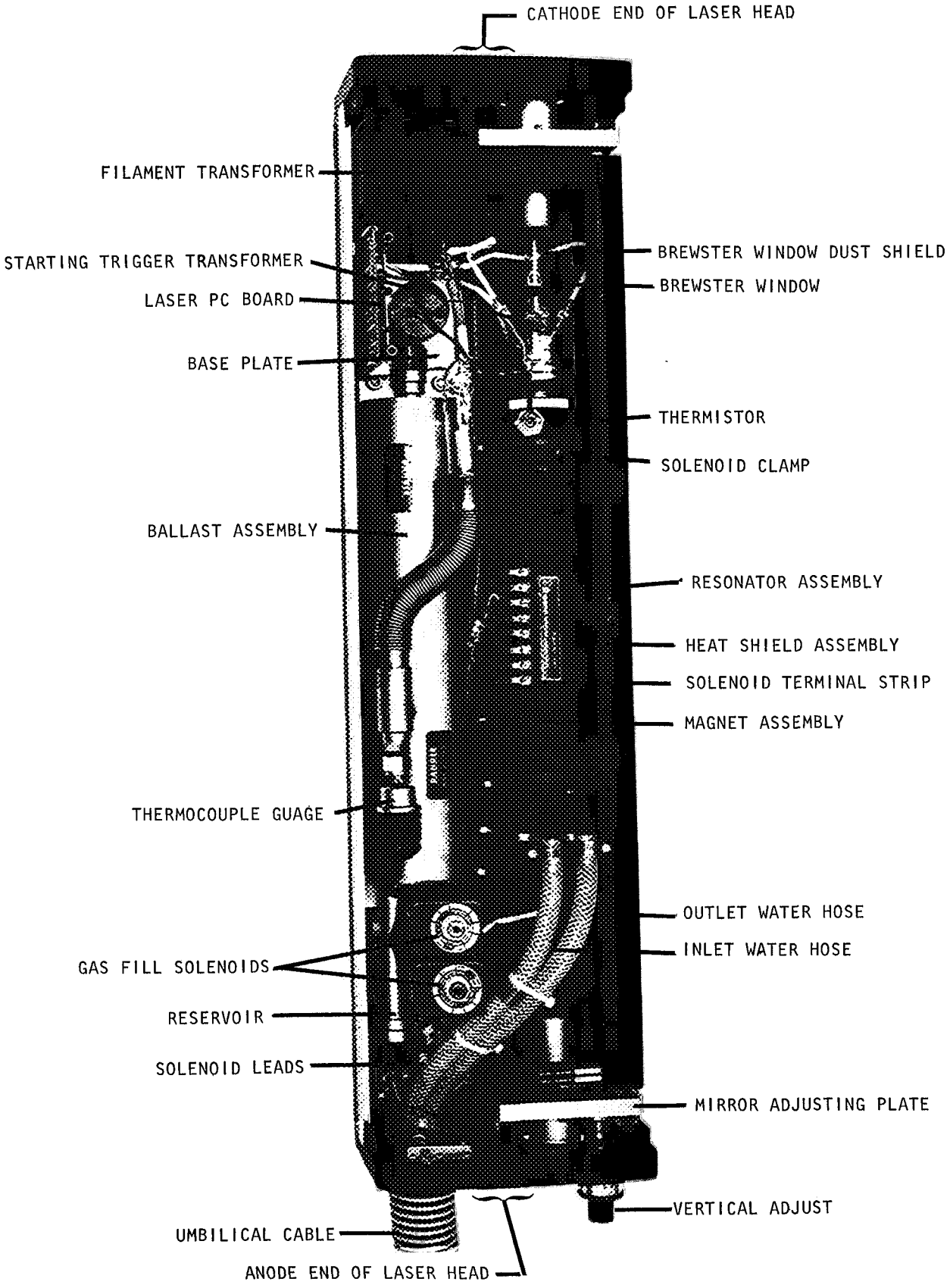


Figure 3; ION LASER HEAD
Internal View

5.2.5 Gas Supply System

A gas supply system is provided in the laser head (see Figure 4). The laser will require a gas fill at approximately 50 hour intervals when new. The interval between fills will lengthen as the tube ages. A thermocouple gauge is provided in the laser head to actuate the LASER PRESSURE meter on the front panel of the power supply. The correct operating pressure is stated on the test sheet delivered with the laser. When the pressure drops below the stated value, the refilling system should be activated. A pressure difference from the final test value of less than 10 millitorrs for argon will not noticeably affect the laser performance. After warm-up pressure should be read at 18 amperes LASER CURRENT.

A key switch is provided to aid in preventing careless or unauthorized use of the fill system. Turn the locking key clockwise, then alternately depress first the READY button and then the FILL button. An increase in the pressure as indicated by the LASER PRESSURE gauge should be observed. If the laser pressure is allowed to drop beyond these limits, a decrease in the output of the laser can be expected. Fill only after the laser is operating or, if pressure is too low to start, add only enough to permit starting.

If the fill system is actuated repeatedly, it is possible to bring the tube pressure up to an excessive value (greater than 350 millitorr) preventing starting of the discharge. The tube must then be reprocessed with suitable vacuum apparatus, preferably at the COHERENT RADIATION factory. This will not normally be considered a warranty repair.

5.2.6 Accessories

An Accessory Kit is supplied by COHERENT RADIATION with each laser system. This kit contains the basic tools required for routine maintenance of the laser system.

The Model 431 Prism Wavelength Selector, an optional accessory, is a full Brewster prism which permits operation of the Model 54 at any single wavelength within the argon laser spectrum.

The Model 421 Intra-Cavity Mode Selector, also an optional accessory, is an adjustable intra-cavity etalon which extends the coherence length of the Model 54 to greater than 10 meters by forcing the laser to operate on a single longitudinal mode.

For additional data regarding these accessories see the MAINTENANCE section of this manual.

6.0 THEORY OF OPERATION

6.1 Laser System (Refer to Figures 6, 7 and 8.)

The Model 54 Ion Laser consists principally of a high-current, gas arc-discharge tube, excited with direct current, placed in an optical cavity.

A high percentage of the gas atoms are in the ionized state. In all gas lasers population inversion amongst pairs of energy levels occur and, in the case of Ar^+, exhibit gain at frequencies in the visible part of the electro-magnetic spectrum. The Model 54 (Ar^+) emits a minimum of 0.5-watts in the blue-green region of the visible spectrum (476.5, 488.0, 496.5, 501.7 and 514.5 nm) with the principal laser emission at 488.0 and 514.5 nm.

The output characteristics of the laser are controlled by the cavity configuration, power input, discharge conditions, and atomic properties of the Ar^+ medium. The cavity configuration limits operation to a single transverse mode with a beam diameter of less than 1.1 mm at the $1/e^2$ points and a beam divergence of less than 0.9 milliradians (for TEM_{00}). The axial mode spacing 205 MHz. However, the Doppler broadened line width is of the order of a few GHz. Therefore, many axial modes may oscillate simultaneously (depending upon current level or gain in excess of losses). This limits fringe visibility (coherence length) to less than 10 cm under normal operation. A COHERENT RADIATION Intra-Cavity Etalon (Model 421), provided as an optional accessory to the Model 54, can increase fringe visibility to 10 cm.

6.1.1 Laser Tube

A solenoid electromagnet encloses the tube bore and provides an axial magnetic field of 950 Gauss. The function of the field is to increase the power output by increasing the ion density without lowering the electron energy enough to degrade the laser excitation. The magnetic field also decreases the formative time lag in arc initiation through this same mechanism.

The arc-discharge is restricted to a small diameter by a graphite bore structure with the bore holes maintained in optical alignment. The discharge is terminated at a concentric cathode and anode allowing the optical beam to pass through to the Brewster windows. A gas bypass is provided to minimize the unwanted effects of gas pumping. The voltage drop in the bore region is approximately 10 V/cm, at 18 A current, resulting in 3 kw being dissipated in the bore. A major consideration of tube construction is that of providing for the dissipation of this large power in a precisely aligned and relatively small structure. In the Model 54, the graphite disc temperature rises to 1000°C due to the discharge. At 1000°C, the discs radiate the energy at approximately 11 watts/cm^2 through a quartz wall to a water flow jacket about the tube. This water-cooling serves to remove virtually all the tube power from the optical cavity.

The gas ballast is a stainless steel tank connected to the quartz laser tube jacket via a stainless steel bellows and a glass-to-metal seal. The function of the ballast is threefold: (1) it supplies a large volume of gas which lessens the effect of gas clean up, (2) it maintains the gas pressure at the proper value at the cathode despite anode pumping (no gas bypass can be totally effective), and (3) it provides an expansion chamber for the gas driven from the bore when the bore reaches 1000°C during operation.

The power and control circuitry requirements for the dc excited ion laser tube are provided by the power supply. These involve filtered dc for the discharge tube and the electromagnet, as well as a controller for a thermocouple gauge tube. The power supply will be discussed in more detail within this section.

6.1.2 Optical Cavity

The optical cavity provides the feedback and output coupling for self-sustained oscillation and useful output and is composed of two 4m spherical

mirrors .73m apart. The 4m total reflector (located at the umbilical end of the laser head) is interchangeable with a wavelength selective prism (see ACCESSORIES) for single line operation. A broad band (440 to 660 nm) high reflectivity coating is applied to the total reflector. The 4m reflector (located at the output end of the laser head) is the coupling reflector. It has a normal multilayer dielectric coating for AR^+ laser medium. The reflectors are held in adjustable mounts. These have an angular resolution of 0.1 milliradians. When the prism wavelength selector is employed, single line oscillation is obtained and set on a particular line through use of a calibrated drum dial. The drum drives the prism through a lead screw. Dust shields enclose the Brewster angle windows and reflectors.

6.1.3 Cooling System

Refer to Figure 4.

Filtered water is used in a flow-through system to cool the power supply and laser head. Tap water or re-circulating cooling water is brought into the power supply where it flows through a large heat sink. The pass transistors and rectifiers are mounted on the heat sink. Heat dissipated by the transformer, filter choke and other power supply components, is transferred primarily to the heat sink by convection within the power supply cabinet. Water leaving the heat sink is conducted to the laser head where it flows through a channel between the laser tube and solenoid. A water-cooled heat shield is provided outside the solenoid for the purpose of preventing distortion of the laser resonator structure because of heat radiation from the magnet. A thermistor is mounted at the outlet end of the cooling jacket for the purpose of sensing the water temperature. If the water flow rate is inadequate, this temperature will rise and the thermistor will actuate circuitry which turns off the main power breaker in the power supply. Sufficient power is dissipated in the thermistor to cause it to heat to the trip point if it is not immersed in water. This protects the laser from damage if it should be operated with no water in the cooling system.

6.1.4 Gas Supply System

Refer to Figure 5.

The gas supply system consists of a reservoir filled with argon to a pressure of approximately one atmosphere and two solenoid valves in series connecting this reservoir to the laser. The small volume between the valves is filled by opening the first valve when the ready button on the power supply is depressed. This valve is then closed and the gas trapped in the small volume released into the laser when the second valve is opened by pressing the fill button. The buttons are electrically interlocked so that it is impossible to open both valves at the same time. The volume between valves and the make-up reservoir pressure are chosen to give an appropriate increase in laser pressure when the two valves are cycled as described above.

6.2 Power Supply (Refer to Figures 6, 9, 10 and 11)

The electrical system is primarily housed within the power supply although related components are also located within the laser head assembly. The following paragraphs contain circuit descriptions of the entire system.

The power supply provides dc power to the laser tube and magnet by means of direct line rectification from a 220V power source.

6.2.1 Circuit Breaker

The main power switch is a circuit breaker and 30-ampere fuses are provided to protect the rectifiers in the event of a short-circuit. Current through the laser tube is controlled by means of a transistorized constant current circuit using 15 transistors in parallel. Current

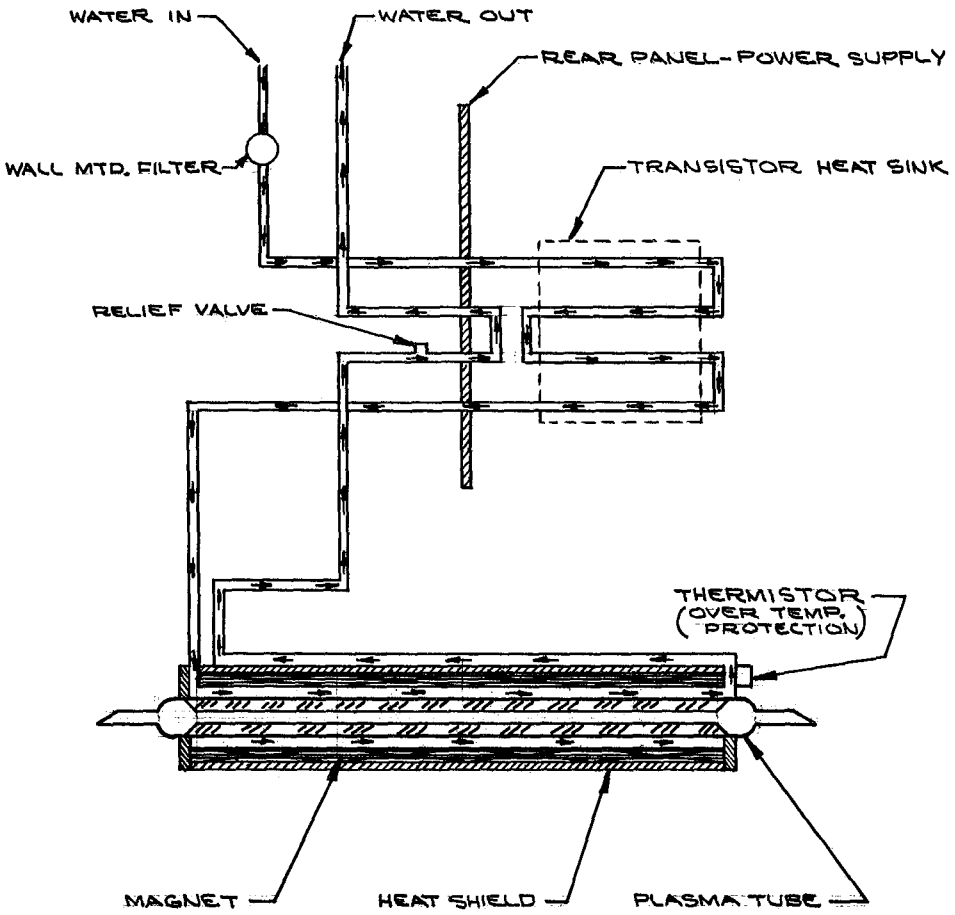


Figure 4; WATER FLOW SCHE

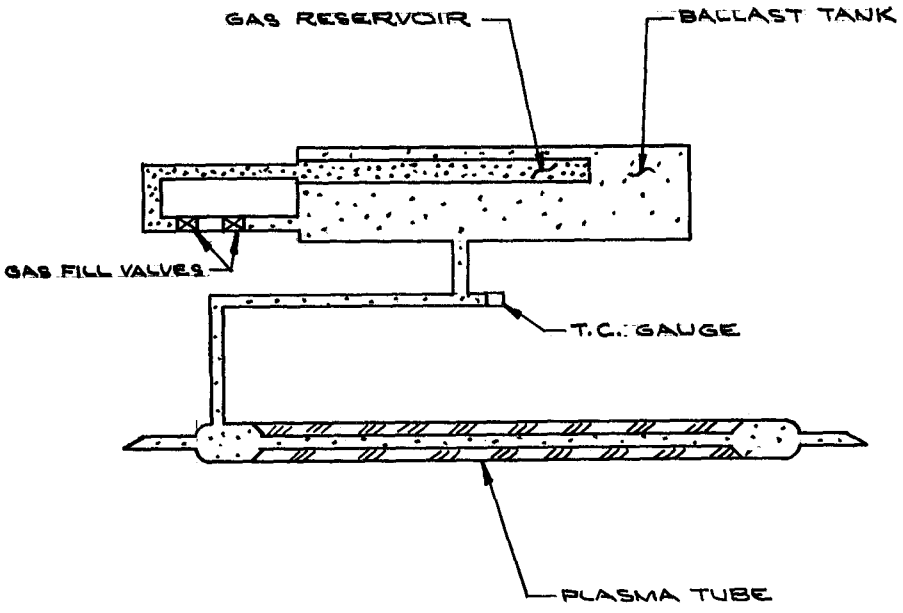


Figure 5; GAS SUPPLY SYSTEM SCHE

through these transistors is adjusted by means of the front panel OUTPUT CONTROL. Two over-temperature protective devices are provided. One is a mechanical thermostat mounted on the pass transistor heat sink. The other is a thermistor mounted in the water jacket of the laser head. If the temperature at either point is excessive, power is applied to the trip out coil of the circuit breaker, turning off all power.

Another protective circuit is provided which acts in response to total laser current. If this current should be excessive for any reason such as failure of the current regulator or excessive line voltage (beyond the capability of the regulator) this circuit will apply voltage to the circuit breaker trip coil.

6.2.2 Auto-Transformer

The Model 54 power supply is basically designed to operate from a 220-volt, single-phase line. The auto-transformer is provided to accommodate variation in line voltage and laser tube voltage. By changing tap and load connections, it is possible to use this transformer to either step up or step down the incoming line voltage. The transformer is capable of adding up to 25 volts to the line voltage. Because only a small voltage change is required, this transformer is much smaller than an equivalent 2-winding transformer. However, it provides no isolation from the power line.

6.2.3 Rectifier Filter Circuit

A full-wave bridge rectifier, CR4, is used to produce the DC power. This power is used for both the magnet and the laser tube. The magnet is connected directly across filter capacitor, C2 (the full unregulated DC voltage). The rectifier output is filtered by a choke input LC filter (L1, C1, L2, and C2).

6.2.4 Current Regulator

The laser tube is connected in series with a transistorized current regulator. Transistors Q3 through Q16 have their collectors and bases tied in parallel. A separate 3-ohm resistor is connected in series with each emitter to equalize current to this transistor bank. Transistors Q1 and Q2 are emitter followers which multiply the current from the front panel output control to a value sufficient to drive the bases of the main pass transistors. Zener diode CR2 is part of a protective circuit which prevents damage to the pass transistors in the event of excessive voltage. If the voltage at the transistor collectors exceeds 50 volts with respect to bases, this diode conducts and turns on the transistor bank at that level. Voltmeter M2 is provided to show the voltage being dropped across the transistor pass bank. Current will be regulated properly when this voltmeter indicates between approximately 10 volts and 40 volts. If this voltage range is exceeded, ripple may be expected on the laser tube current which will modulate the output. If the transistors are in saturation at approximately 3 to 5 volts on the pass transistor voltmeter or if the Zener diode is conducting at approximately 50 volts, the current regulator loses control and small line voltage variations result in relatively large laser tube current changes.

6.2.5 Starter Circuit

Power for the starter circuit passes through K2, a thermal time delay relay. When the contacts are open, neon lamp I2 blinks to indicate that the warm-up delay is not complete. After the contacts close (about 15 seconds after application of power) starter capacitor C4 will charge to approximately 200 volts. Depressing the TUBE START button, S2, will cause capacitor C4 to be discharged into the primary of T2 starter transformer (located in the laser head). A starting trigger of approximately 10 kilovolts will be generated at the transformer secondary. This trigger is fed to the starting electronics in the laser tube causing the ionization of the gas within the laser tube.

6.2.6 Over-Current Protection

The emitters of each transistor of the main pass bank are connected through 1K resistors (R24 through R37) to a single summing point. This is connected to pin 20 of connector J4 and thence to the Current Regulator printed circuit board. This voltage is proportional to the current to the laser tube. It is filtered by means of R154 and C105 and applied to the base of Q123. A bias voltage is applied to Q123 by means of R149, the screwdriver adjustable trip current set control. If the voltage at pin 20 is sufficient to cause Q123 to conduct, it, in turn, turns on Q124 and feedback through R152 causes both transistors to immediately switch to the full conducting state.

The collector of Q124 is connected through pin 12 of the connector to relay K1. K1 is thus energized and its contacts close applying voltage to the trip coil on the main circuit breaker. The trip coil throws out the breaker, removing power from the entire system.

6.2.7 Gas Supply Control Circuit

A key switch and two pushbutton switches are provided on the power supply front panel to actuate this system. The key switch S3 must be closed to apply power to the rest of the system. The two pushbutton switches S4 and S5 must be depressed one at a time to actuate the two valves in the gas fill system. The contacts of these switches are so wired that simultaneous operation will result in an open circuit to both valves.

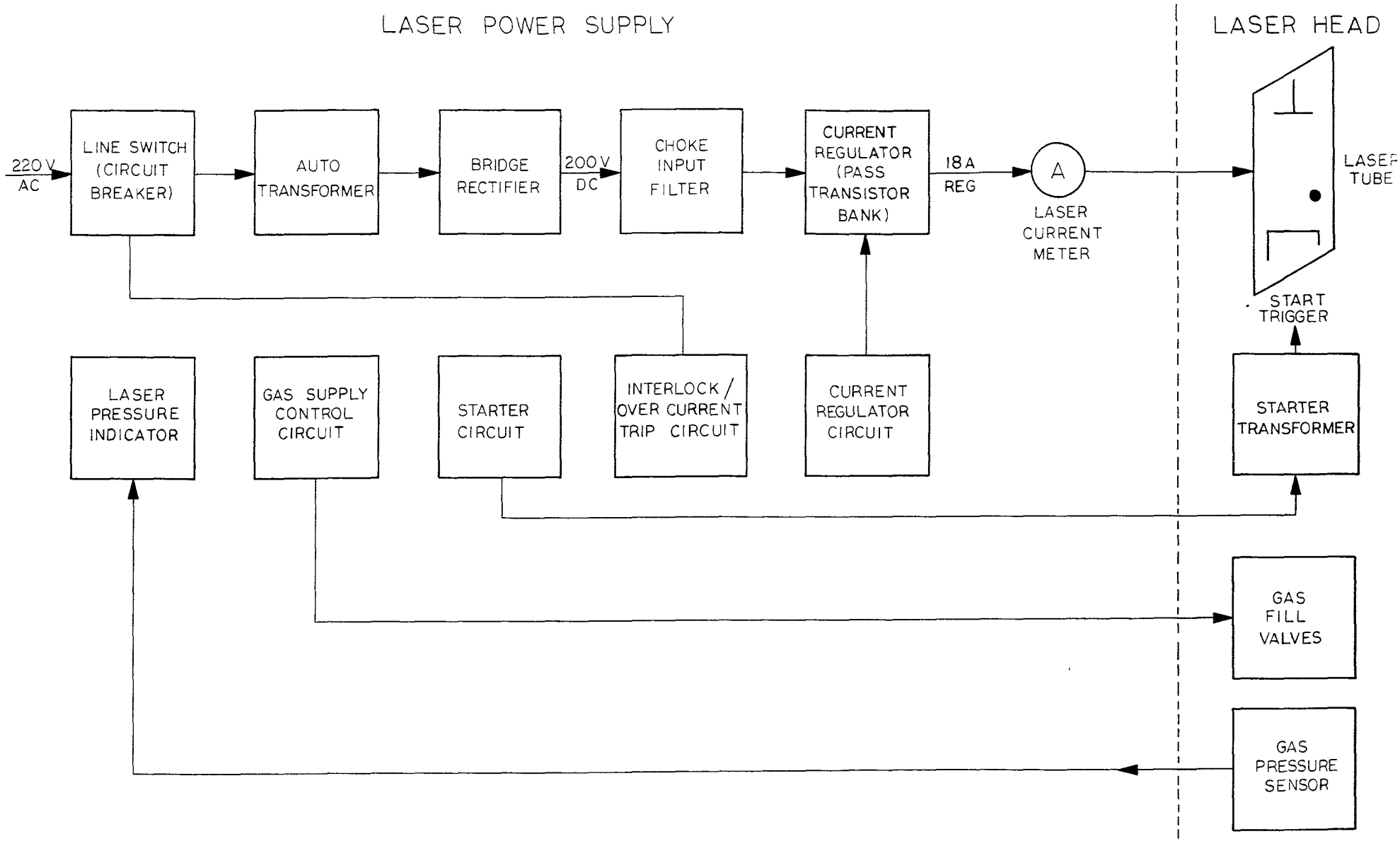
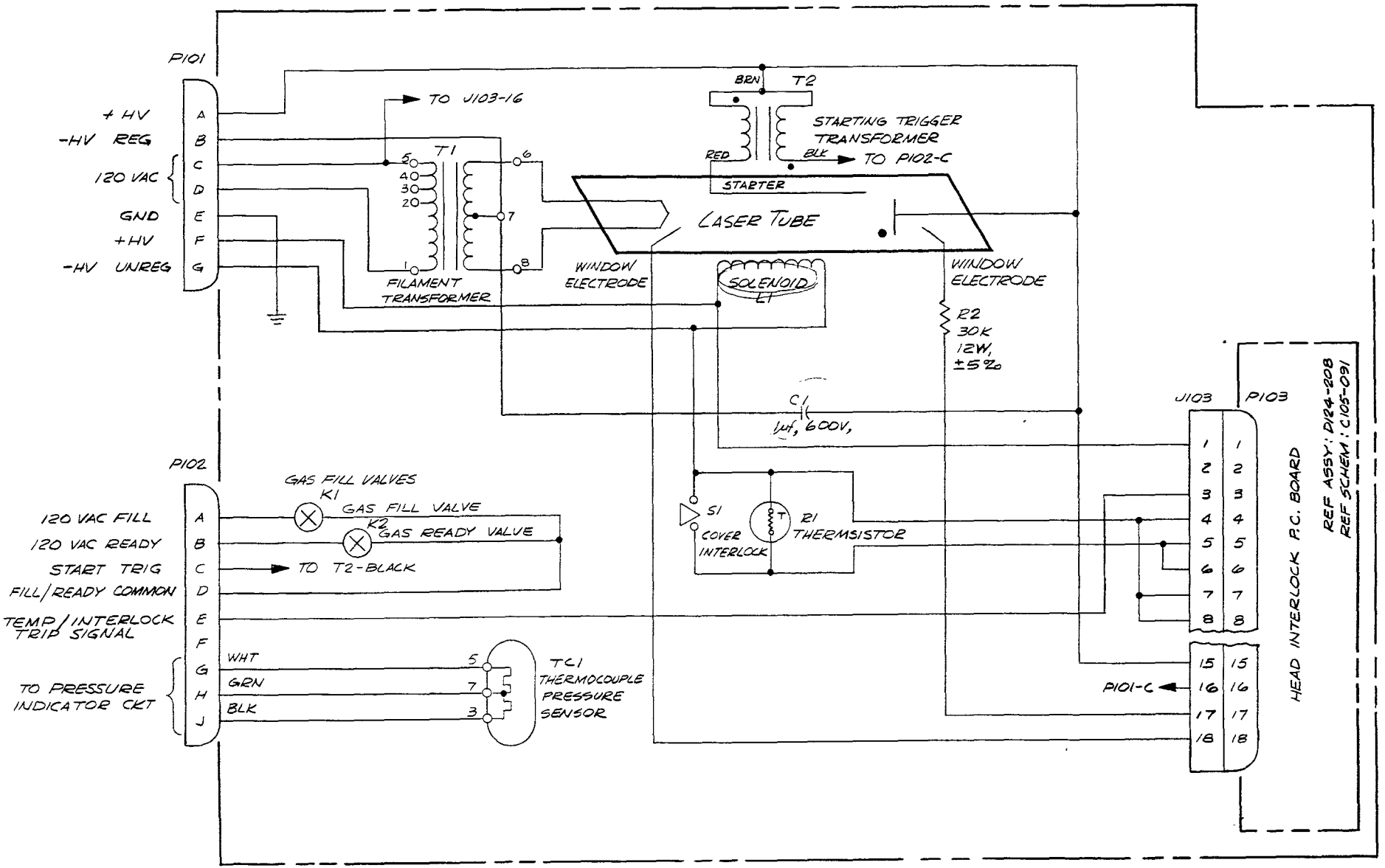


Figure 6; Block Diagram, Model 54 Electrical System



SCHEMATIC, ELEC-
LASER HEAD
MODEL 54

C105-089

Figure 7; Schematic, Laser Head
C105-089

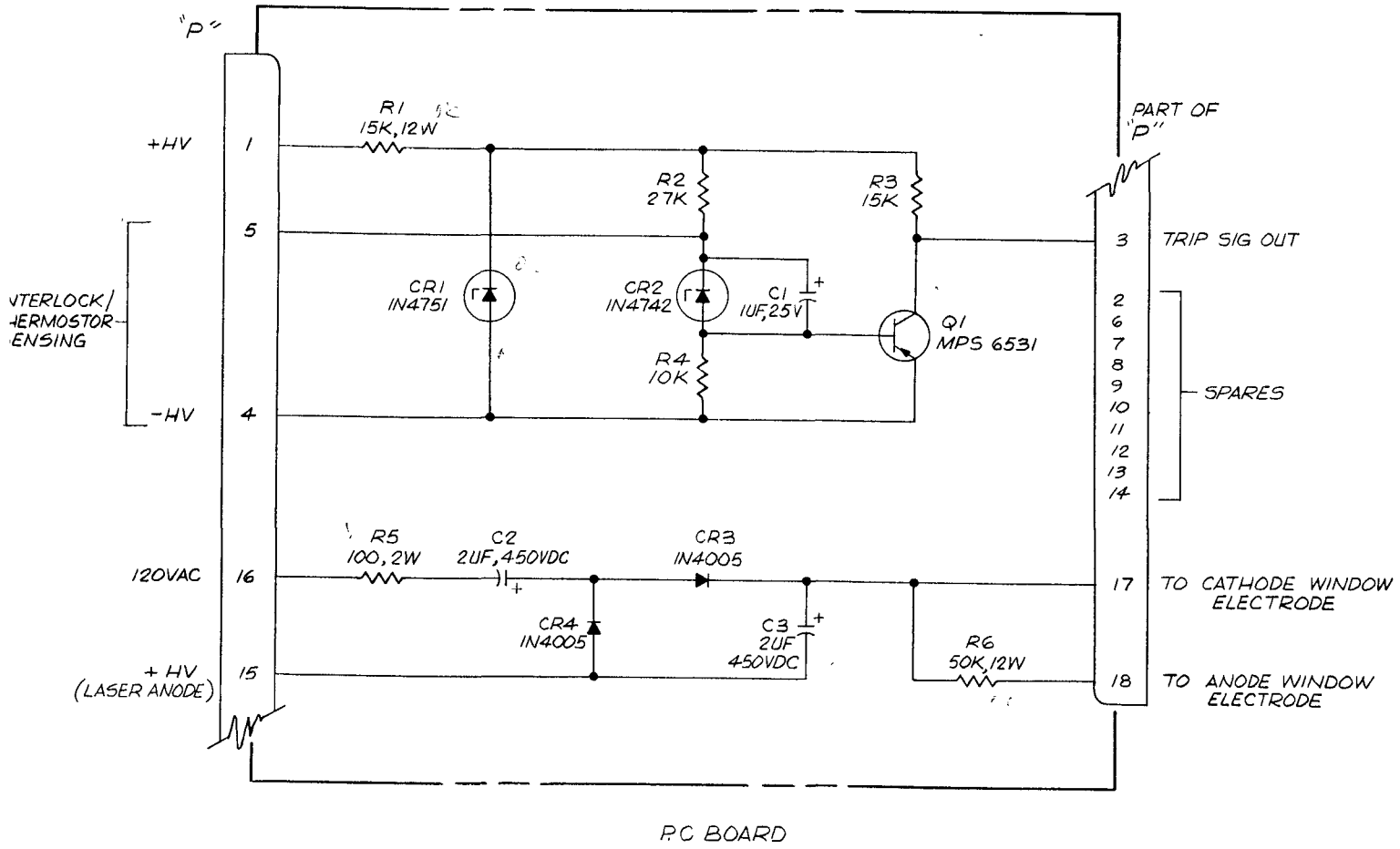
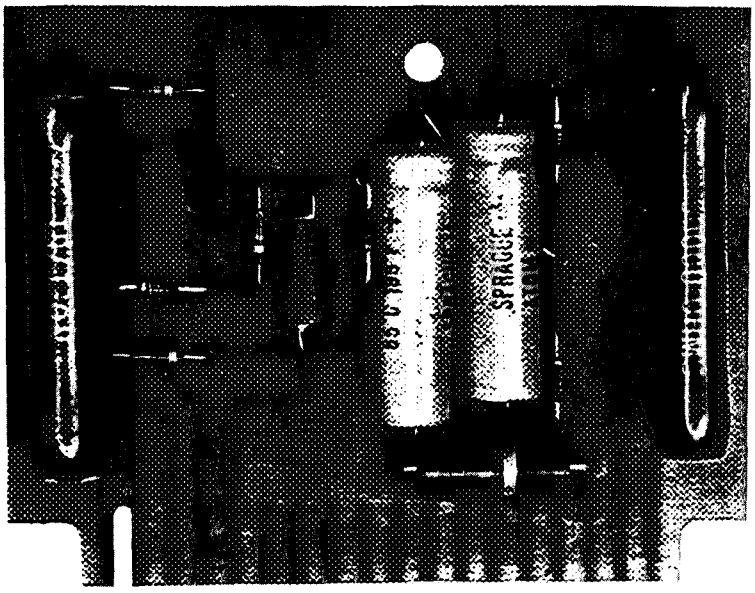
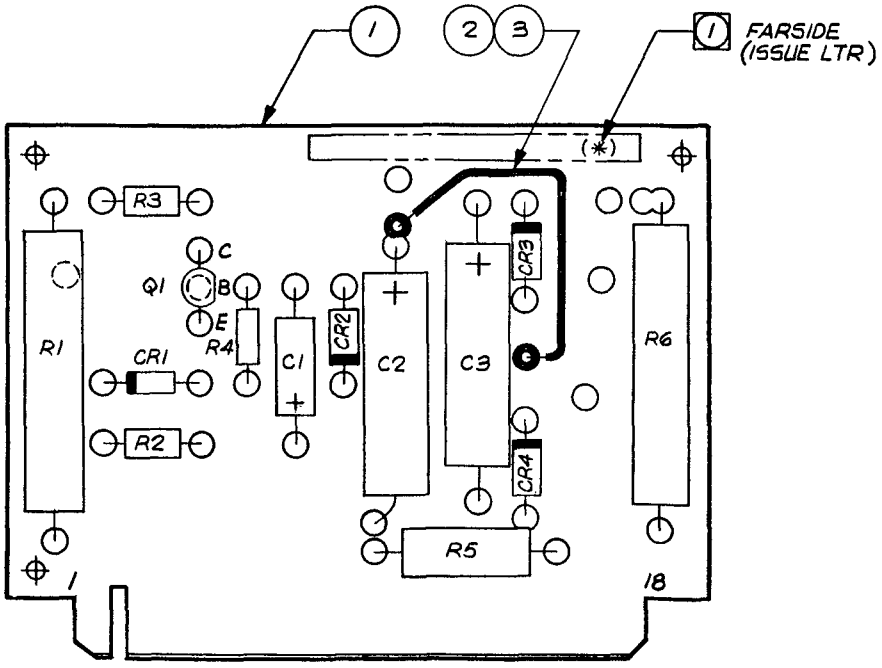


Figure 8; Schematic, Head Interlock PC Board C105-091 with Photo and Component Layout D124-208


SPRAGUE


1
2
3
1
FARSIDE
(ISSUE LTR)
(*)
R3
C
Q1
B
E
R1
R4
CR1
C1
CR2
C2
C3
CR3
R6
R2
CR4
R5
1
18

7.3 Part 2

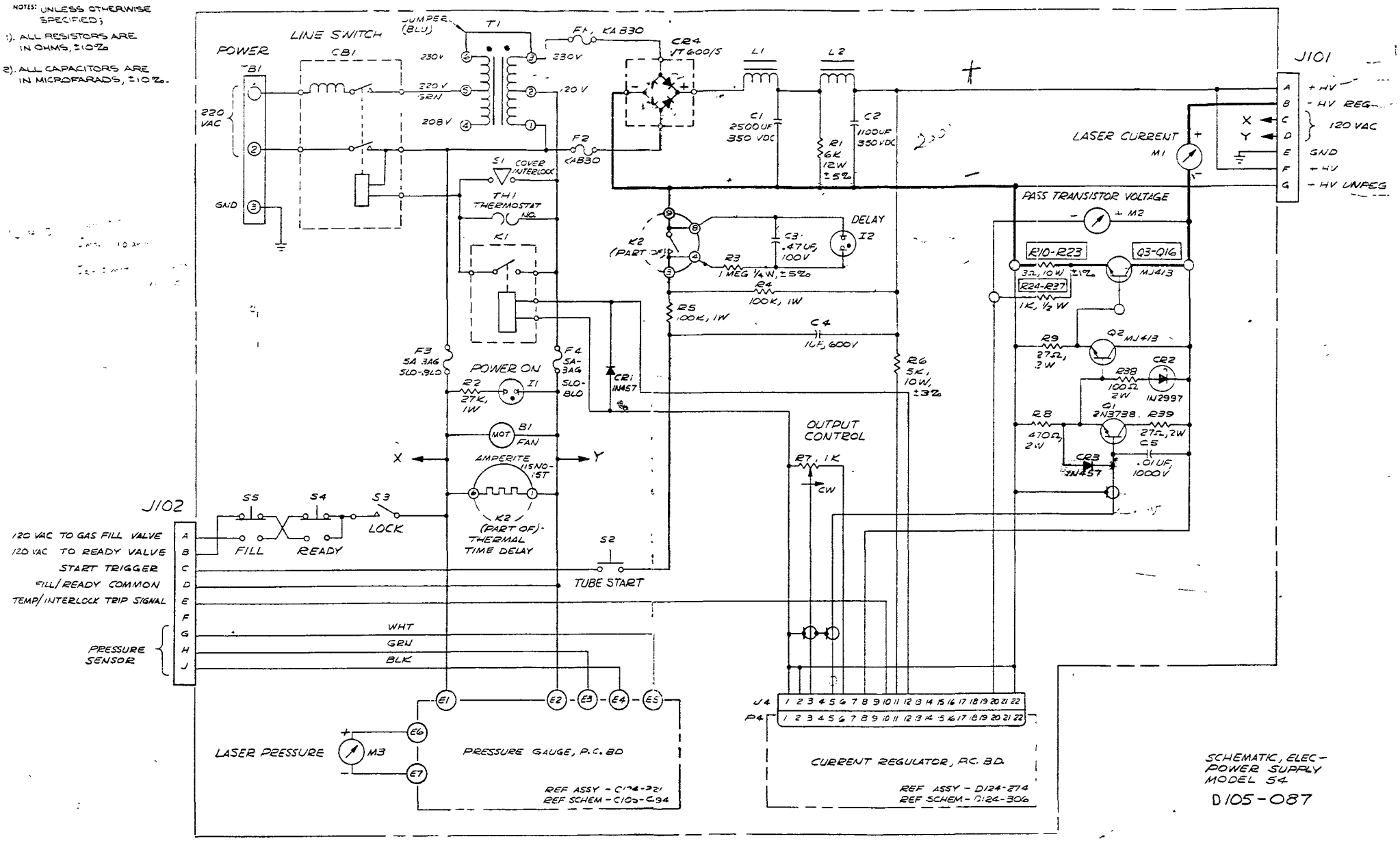
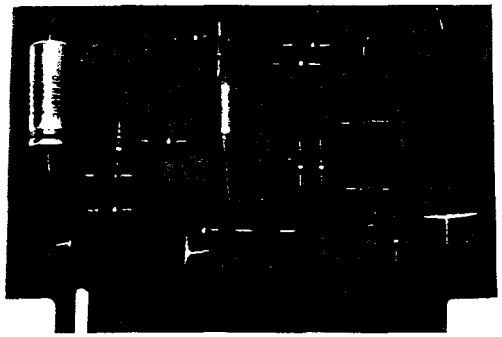
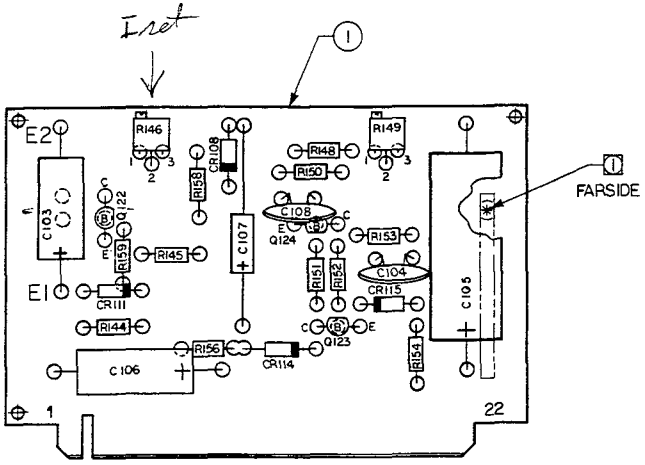


Figure 9; Schematic, Power Supply C105-087





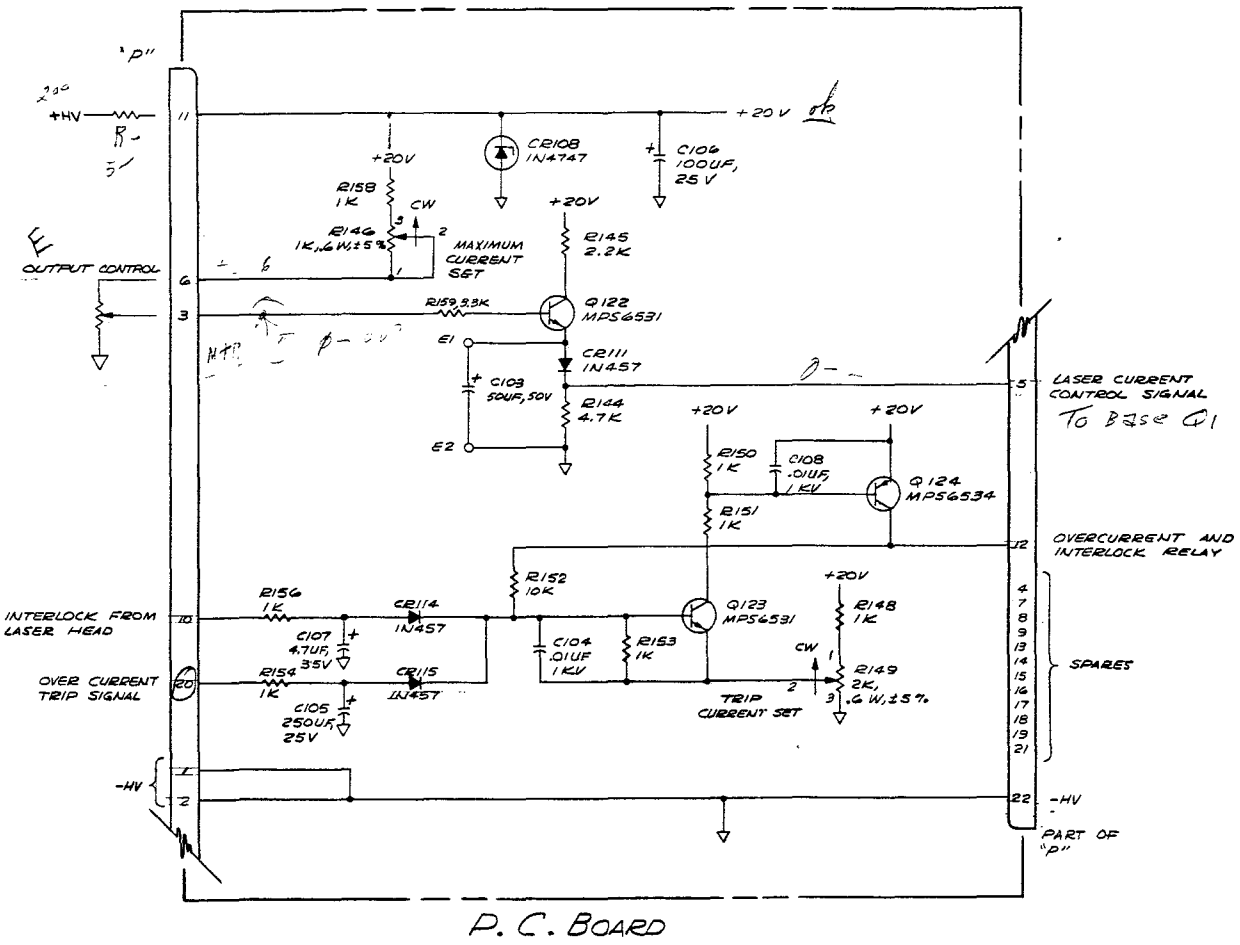


Figure 10; Schematic, Current Regulator
PC Board C124-306 with Photo
and Component Layout D124-274

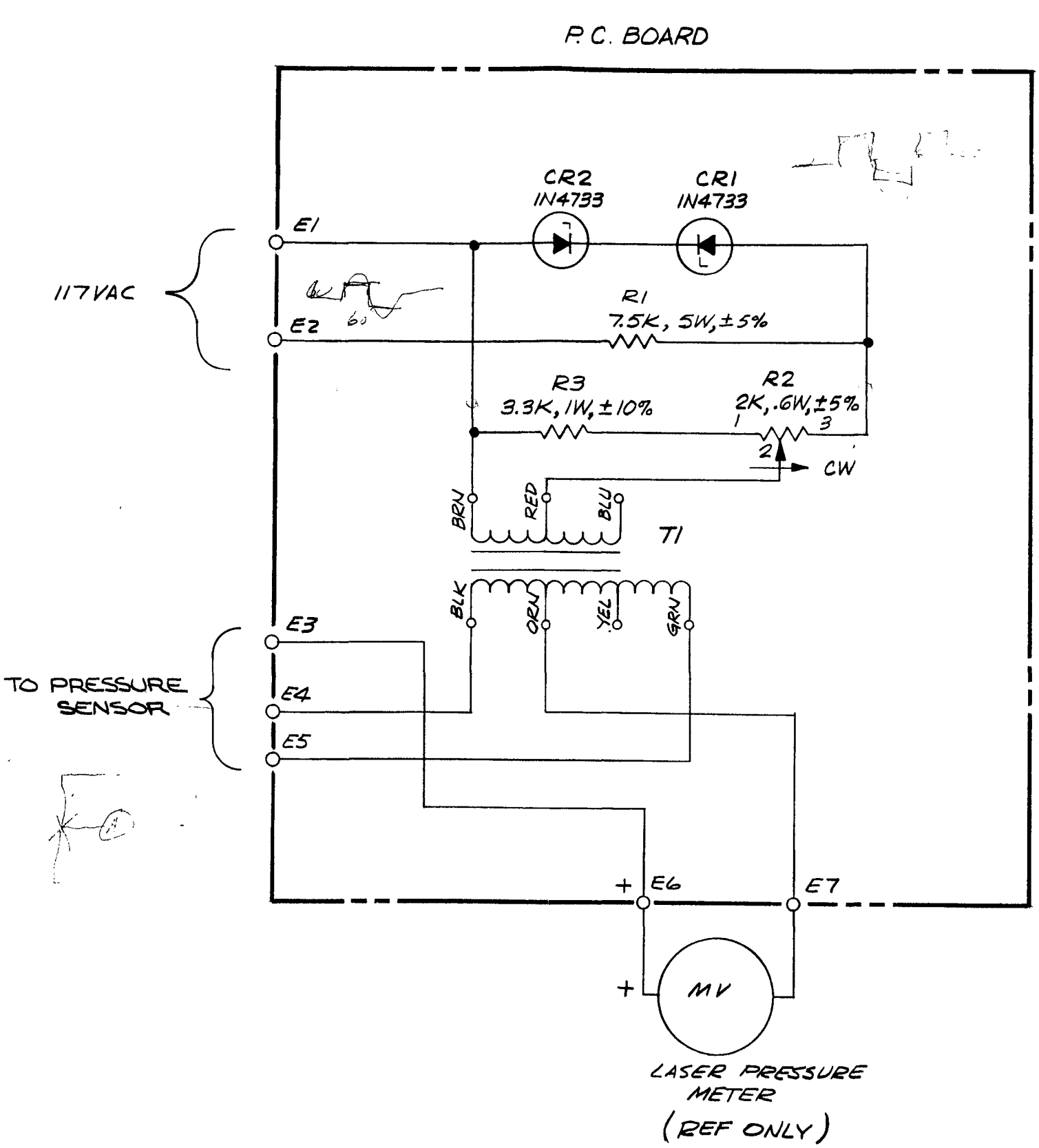
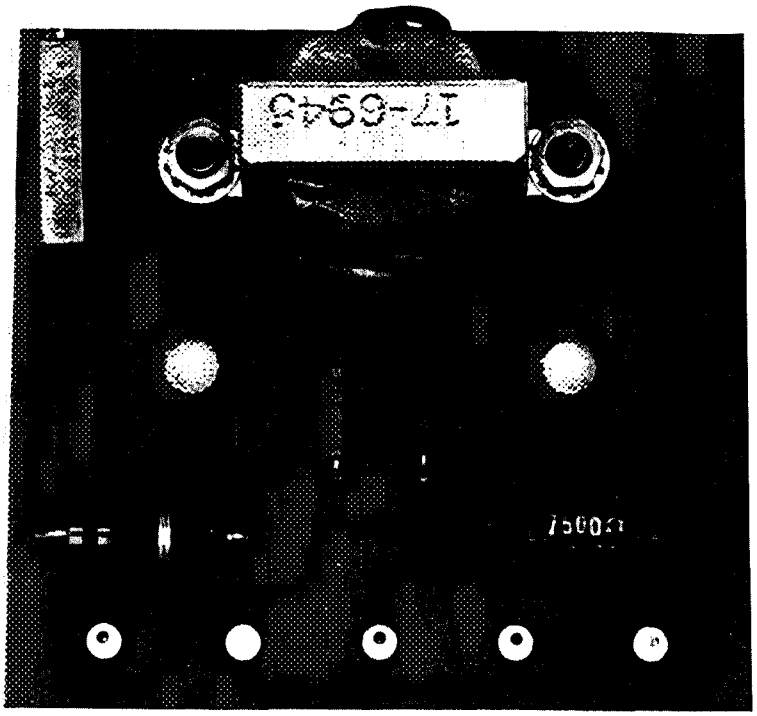
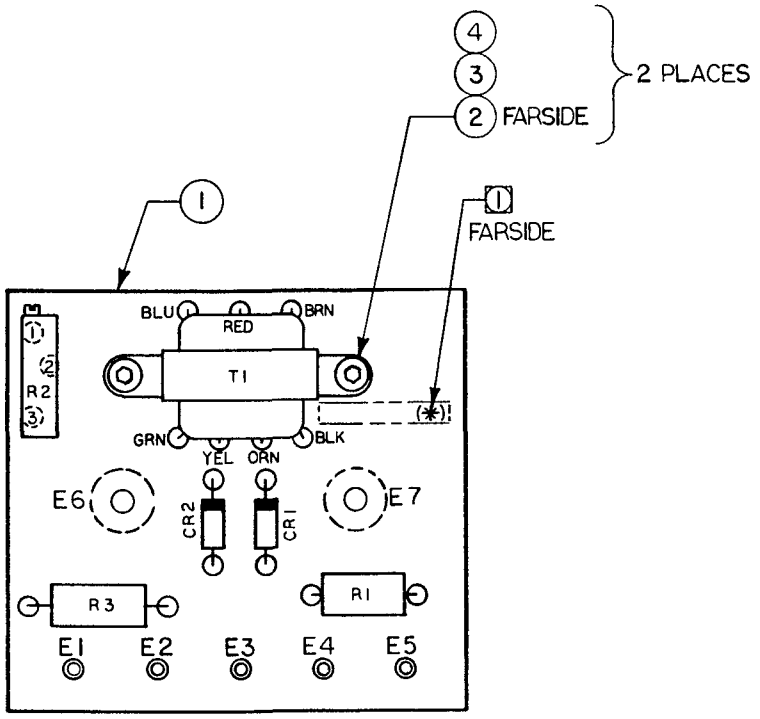


Figure 11; Schematic, Pressure Guage PC Board C105-094 with Photo and Component Layout D124-221




4
3
2 FARSIDE
2 PLACES
1
1 FARSIDE
J3
R2
BLU
RED
BRN
T1
GRN
YEL
ORN
BLK
E6
E7
CR2
CR1
R3
R1
E1
E2
E3
E4
E5

8.0 MAINTENANCE

8.1 Inspection and Periodic Maintenance

To ensure optimum performance of the Model 54 Ion Laser system it is suggested that periodic inspection and maintenance routines be established. A log should be kept to ascertain the number of hours the unit has been in actual operation. In this way, a close watch on gas refill requirements is maintained.

Laser optics should be inspected periodically to determine the necessity for cleaning. Major contributing factors to dirty optics are smoking and dust.

The following paragraphs include information on repair tools, cleaning, procedures for removal and replacement of major components and other pertinent data.

8.1.1 Tools

The below list of tools and accessories are suggested for proper operation and maintenance of the Model 54 Ion Laser.

a. Garden Hoses (2) - for cooling system. Length is based on customer requirements.

b. Cabling (#10) - length per customer requirement.

c. Accessory Kit - supplied by COHERENT RADIATION and containing one each Allen wrench set, hemostats, 5/8" socket wrench, Methanol, and package of Kodak lens cleaning tissue.

d. Soldering gun

e. Slot screwdriver

f. Open end wrench, two (5/8" and 11/32")

g. Voltmeter

8.1.2 Fuses

Fuses F1 and F2 are used to protect the rectifier. These are special short time lag fuses. If replacement of fuses is required, only the type of fuse specified should be installed. Ordinary power system fuses should not be used as the rectifiers would probably fail before the fuse blows. A blown fuse is usually an indication of an existing problem elsewhere in the system. If the rectifier fuses fail, faulty rectifiers or filter capacitor should be suspected. The filter capacitors should be tested, if possible, by disconnecting them from the circuit and testing them at a voltage of at least 300 volts. Refer to the TROUBLESHOOTING GUIDE, Section 8.5, for additional information.

8.1.3 Cleaning

The system should be kept as clean as possible. As long as covers remain closed, no appreciable dust accumulation is likely to occur. However, periodic inspection of the laser optics should be made. If they require cleaning, adhere to instructions.

A package of Kodak lens tissue is a part of the Accessory Kit provided by COHERENT RADIATION. The tissues are specially treated and care should be taken to keep fingers from touching any portion of the tissue which will ultimately come into contact with optic surfaces.

When preparing to clean the Brewster windows or wavelength selector prism (an optional accessory) fold the tissue to 1/4 size lengthwise, fold in half, and then fold in half again. The final size will be 1/16 the original size of the tissue. Clamp folded tissue with hemostats.

Refer to Figures 12 - 14.

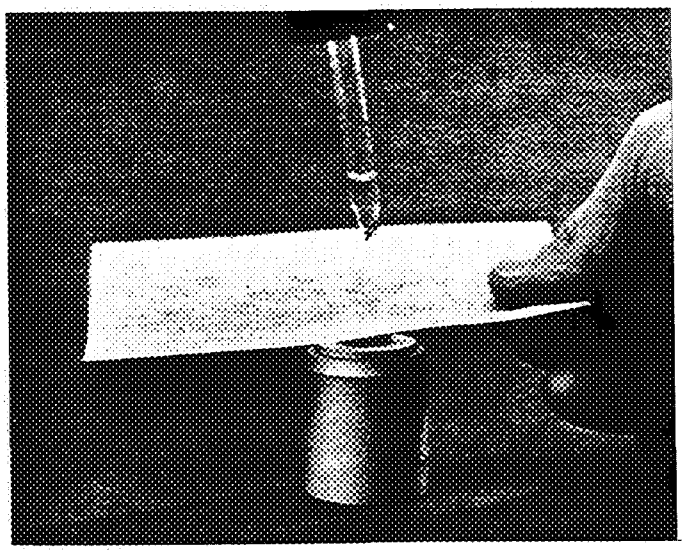


Figure 12

Reflector Cleaning, Step 1: Center clean lens tissue above reflector surface. Place a drop of methanol on tissue.

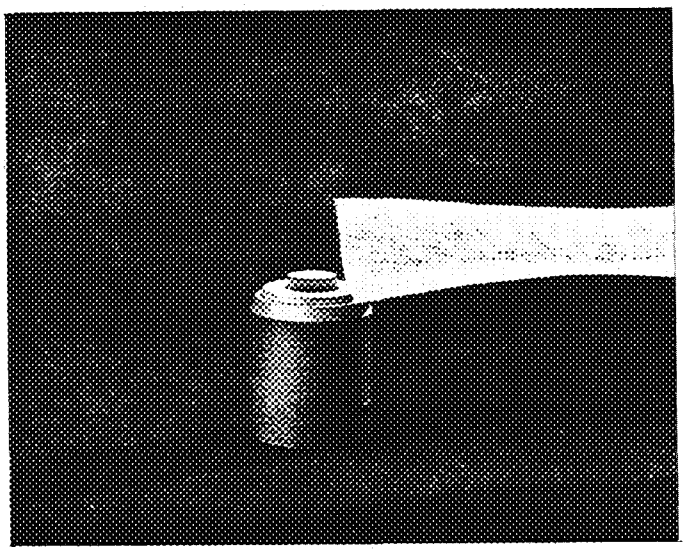


Figure 12a

Reflector Cleaning, Step 2: Lower moist lens tissue onto reflector surface and pull tissue across the surface - one stroke only.

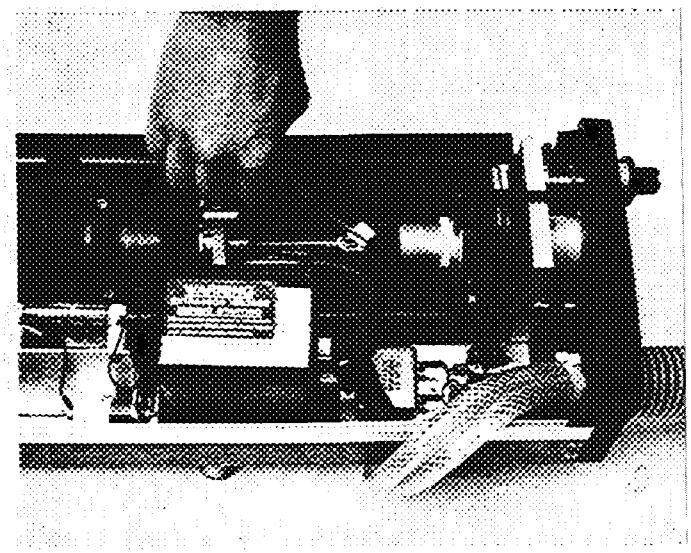


Figure 13

Brewster Windows: Clamp folded lens tissue in hemostat. Soak lens tissue in methanol. Shake off excess. Sweep across window with light pressure - one stroke only. (Water tubing disconnected for viewing purposes only.)

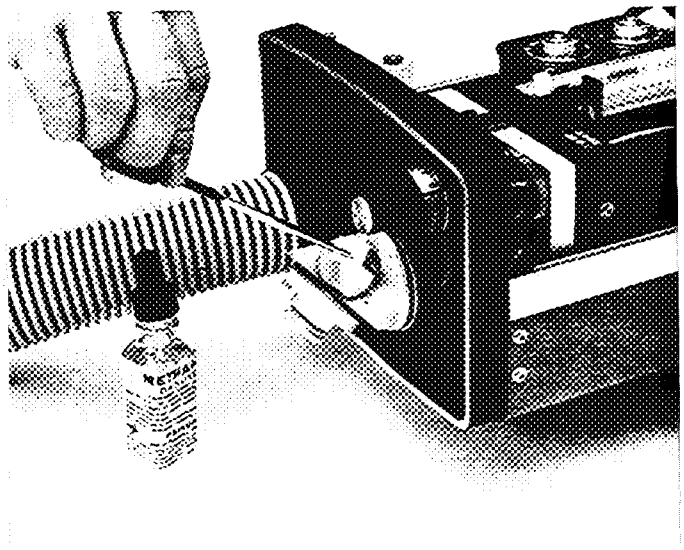


Figure 14

Prism: Use same procedure as for Brewster windows.
(Note size of tissue after folding.)

8.1.4 MODEL 54 PLASMA TUBE REMOVAL PROCEDURE

Step 1: Remove laser head cover.

Step 2: Blow out water lines. Wedge open check valves. Air hose can be used if available. If not, lines can be blown out by mouth.

Step 3: Remove clamps from two water lines. Hose with red band is the water input line. Fold water lines and tuck them out of the way

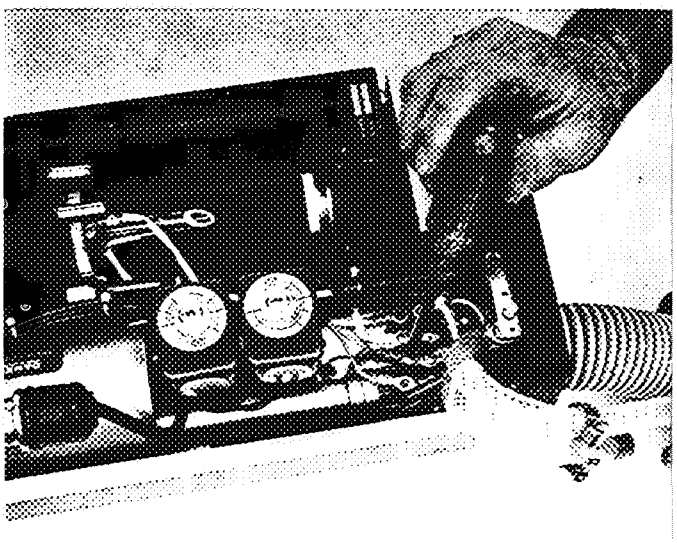


Figure 15

Step 4: Disconnect solenoid leads (two slot screws). Remove top leads only. Solenoid leads should be placed on top of solenoid shield for convenience.

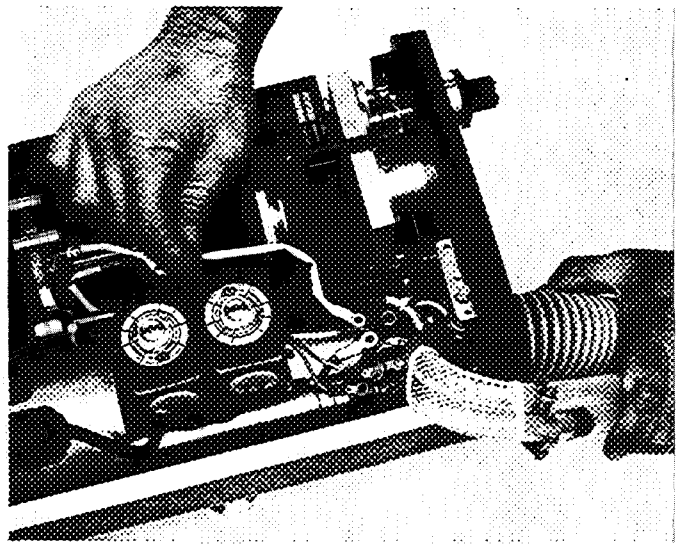


Figure 15a

Step 5: Remove anode lead from terminal strip.

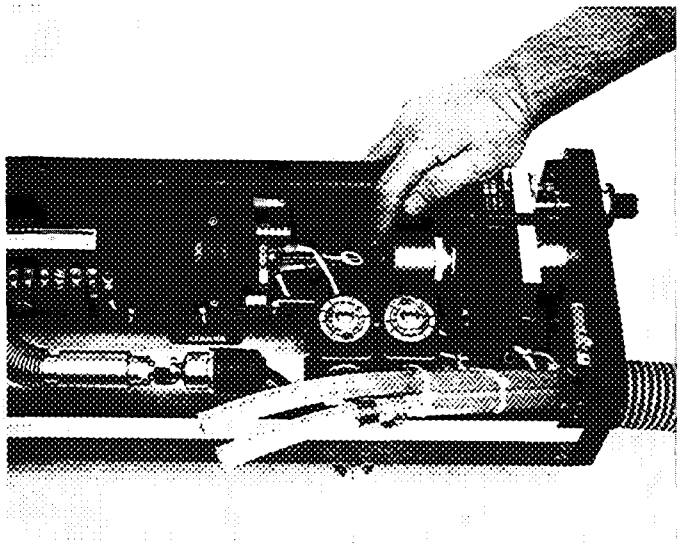


Figure 15b

Step 6: Loosen retaining nut on dust shield. Slide dust shield so that it clears Brewster window.

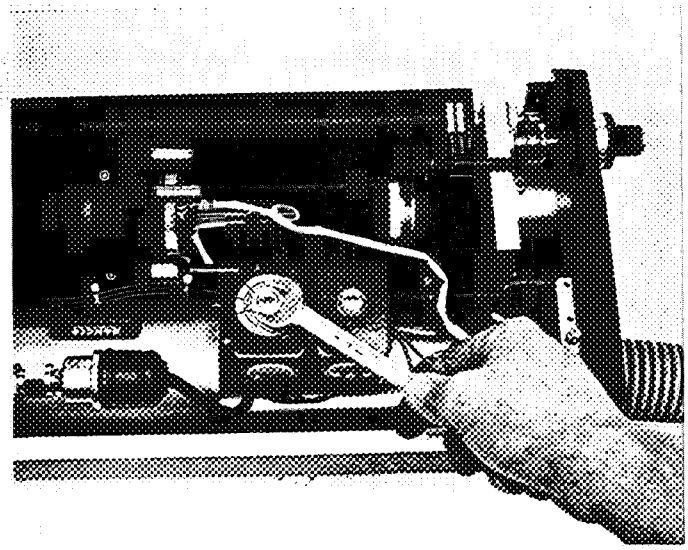


Figure 15c

Step 7: Remove 5/8" nuts and washers securing gas fill solenoids.

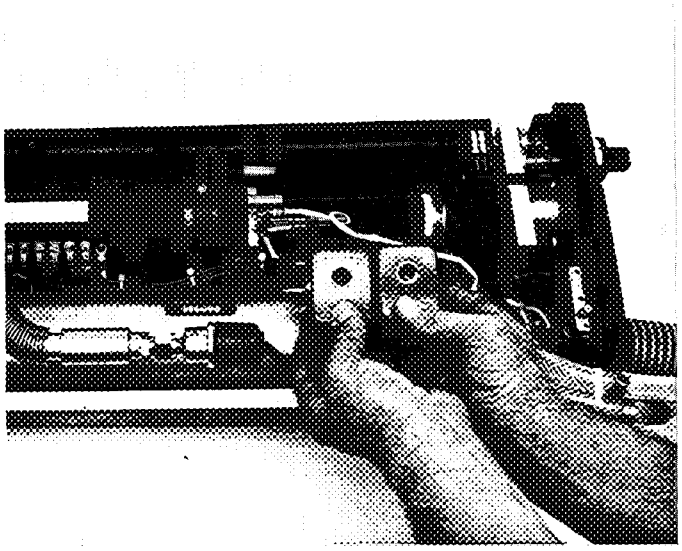


Figure 15d

Step 8: Remove both solenoids together.

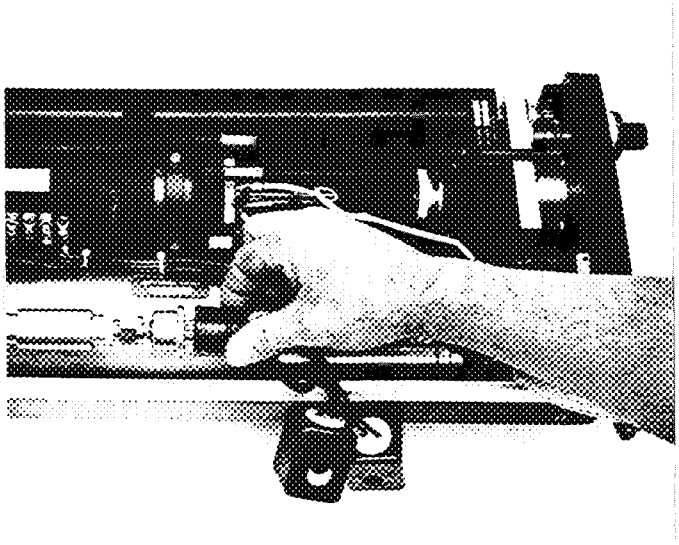


Figure 15e

Step 9: Drape solenoid valves over the side of laser. Remove thermocouple (TC) guage from end of connector pin.

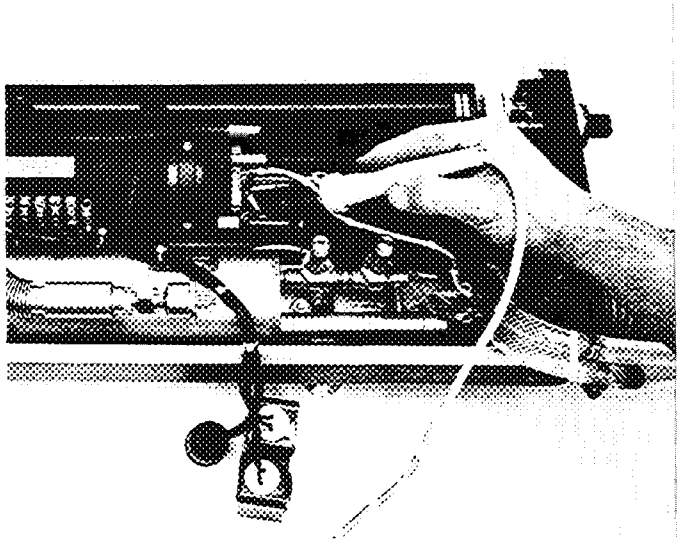


Figure 15f

Step 10: With razor blade remove shrink tubing exposing solder joint. Unsolder anode stinger wire. Remove resistor nut and unscrew stand-off and resistor together.

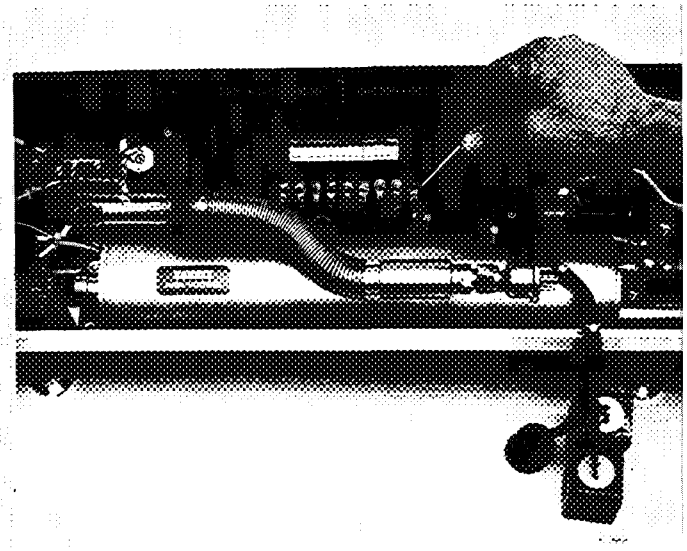


Figure 15g

Step 11: Using Allen wrench, remove terminal strip mounted on magnet assembly. Place solenoid wires so that they clear the tube.

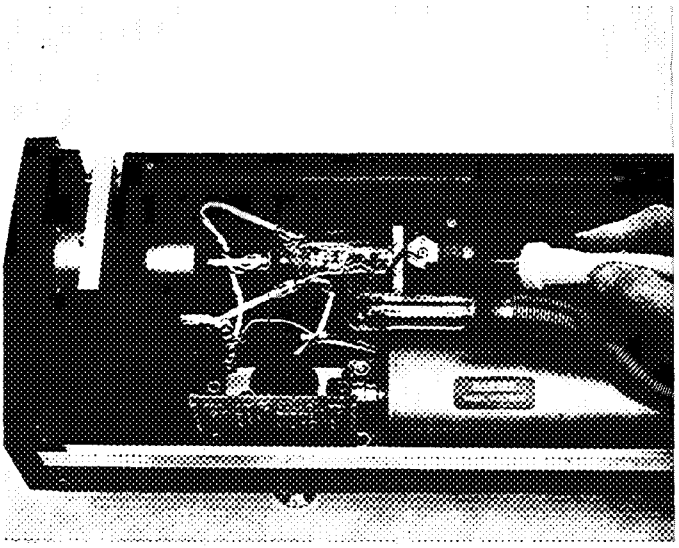


Figure 15h

Step 12: Unsolder two thermistor connections and remove leads.

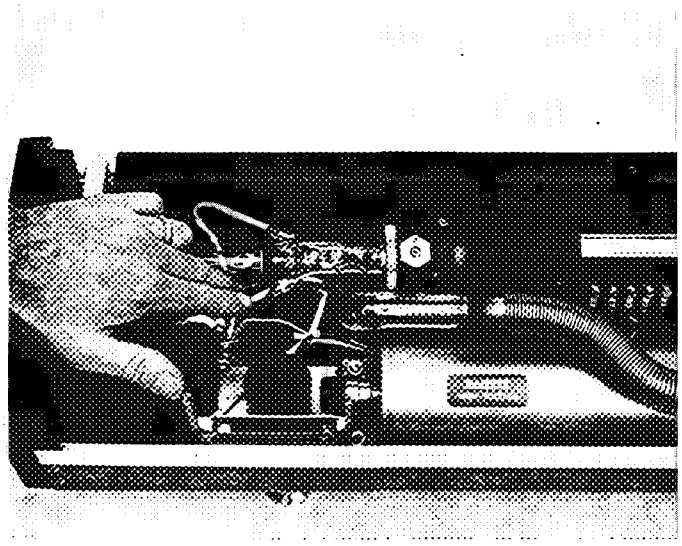


Figure 15i

Step 13: Remove P.C. board from socket. Remove starter coil wire from tube by pulling off.

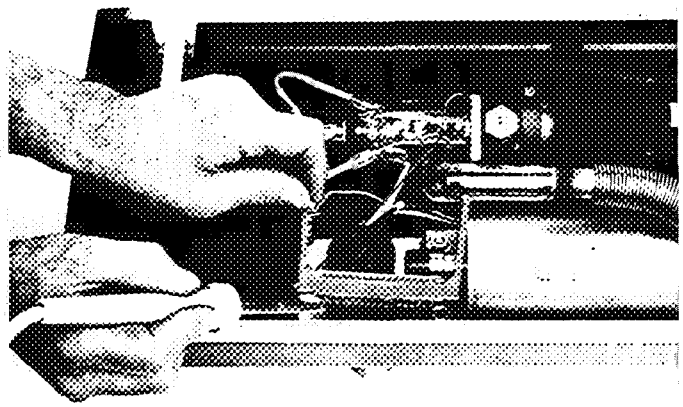


Figure 15j

Step 14: Unscrew P.C. board mounting screws (two) with Allen wrench. Lift mounting and unsolder cathode stinger lead.

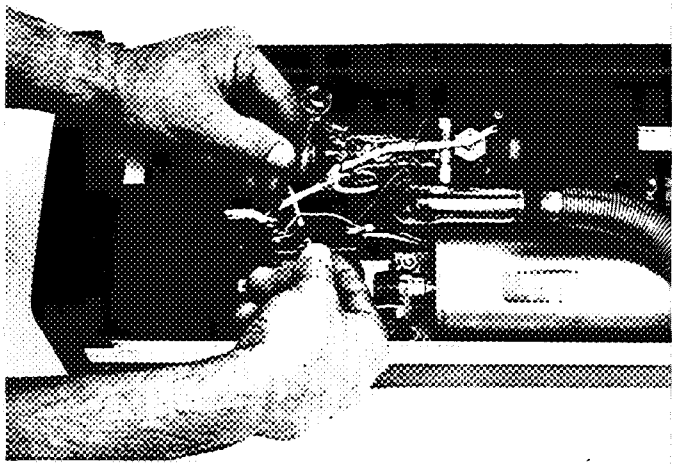


Figure 15k

Step 15: Remove 11/32" nuts securing leads to filament transformer. Use Allen wrench and 11/32" open end wrench. Disconnect leads. Use care in moving leads.

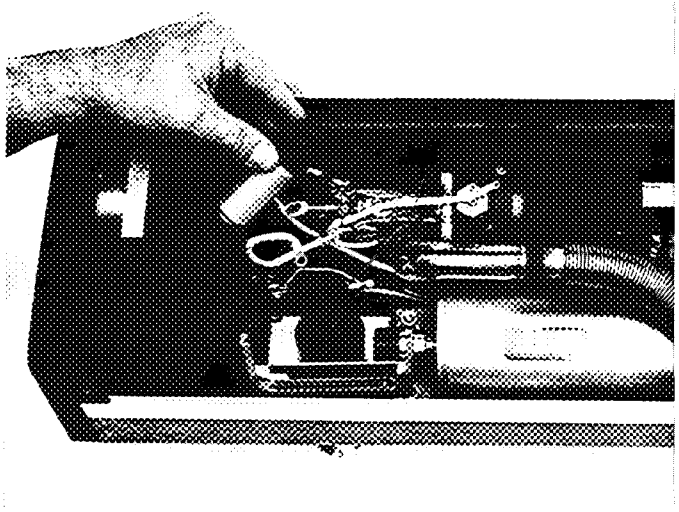


Figure 15m

Step 16: Loosen retaining collar and slide Brewster window dust shield clear of Brewster window and remove.

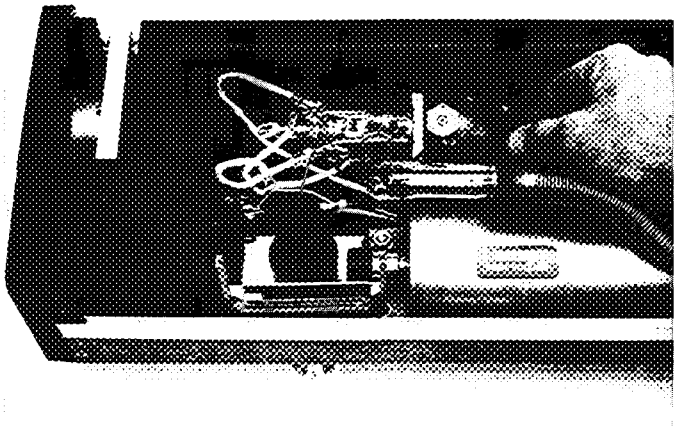


Figure 15n

Step 17: Loosen Allen screws and remove clamps holding solenoid in resonator.

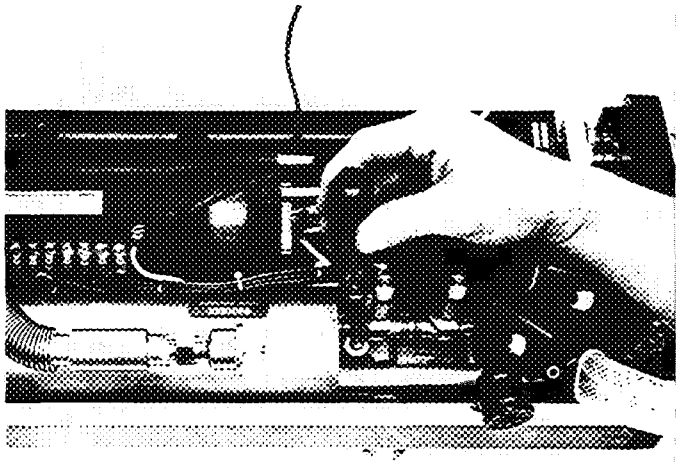


Figure 15o

Step 18: Remove nuts and lock washers (three) securing ballast tank to base plate. Use 7/16" socket wrench.

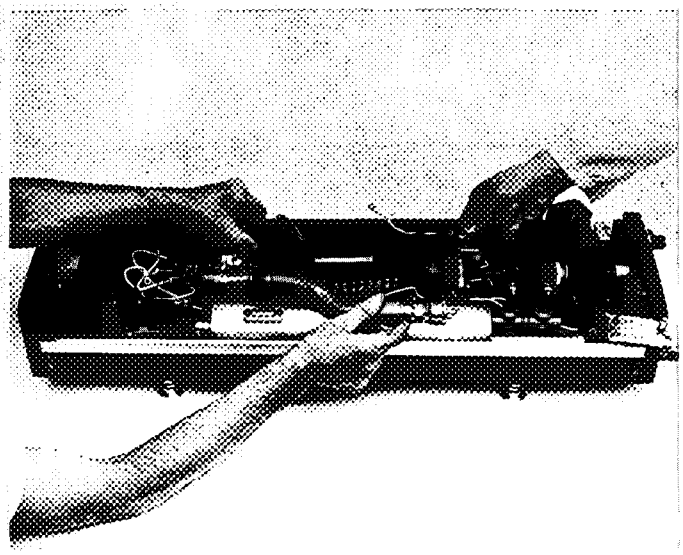


Figure 15p

Step 19: Remove plasma tube and solenoid together. Two men are required. CAUTION: Note position of hands. Lift components straight up. Take care to maintain the relative position of the ballast tank and plasma tube/solenoid assembly during lifting. Person at the cathode end should guide this operation.

NOTE: For new plasma tube installation, reverse steps 1 through 20. Take care to safeguard the Brewster windows during tube installation.

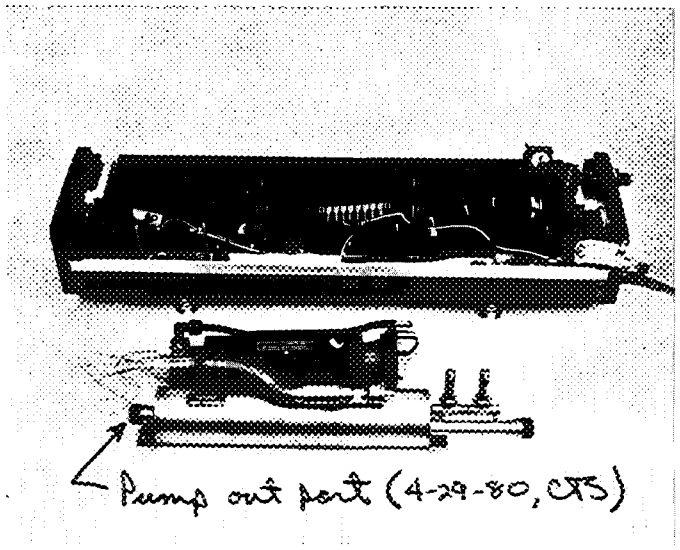


Figure 15q

Step 20: Set plasma tube and solenoid assembly aside. Maintain the relative position of the components.

8.2 Installing Optional Accessories

8.2.1 Model 421 Resonator Mode Selector

If the mode selector is factory installed, the etalon will be pre-aligned and it will only require adjusting as explained in paragraph 8.2.1b. If, however, it is not factory installed, follow the instructions and alignment procedures as described in the following paragraphs.

8.2.1a Installation (Refer to Figure 16)

Remove existing dust shield, both glass and metal part, and discard. Screw threaded adapter A into mirror holder plate. Unscrew parts B, C and glass dust shield from etalon housing and lay to one side. Slip main frame of housing, cocked at 45° over part A and press to secure. The vertical adjust D should clear the top of the resonator end plate and be located centrally. Now secure the etalon housing to the resonator end plate E with the two 8-32 screws supplied. Install etalon, check surfaces for cleanliness, into part B and screw B into the main housing. Slide glass dust shield into part C as far as it will go. Carefully slip glass dust shield and C over Brewster window, from below. When horizontal, telescope C back towards B. Screw C into B. The installation is now complete. Refer to Figures 17 through 17i for visual presentation of installation instructions.

8.2.1b Alignment

With the etalon in place, additional beams at an angle to the main resonator beam will be generated by multiple reflections within the etalon. These may be viewed in reflection from the anode Brewster window by holding a white target above the Brewster window and insuring that the dust cover is extended to a position where the reflection from the Brewster window passes through the glass tube. By inserting an Allen

driver (3/32) into the vertical angle adjustment D or the corresponding horizontal adjustment, the angular position of the etalon may be adjusted to bring all of the multiply reflected spots to coincide with the main reflected beam. When this position is reached, an increase in output power from the laser will generally be noted and the laser power output will become more critically dependent on the etalon angular tuning. This angular position of the etalon is used as a reference point only, since in this position the etalon does not act as a rejection filter but reflects directly back into the resonator. If an optical spectrum analyzer is available, the oscillating modes will generally appear very noisy in this position. From this point, vary the angle of the etalon by using the vertical adjust only. Single axial mode operation will result after slight tilting with the vertical adjust and can be observed with the scanning interferometer. Small subsidiary modes may appear on either or both sides of the main mode. These can be tuned out by further slight adjustment of the vertical and horizontal angular controls. Highest single mode power is achieved by operating at the smallest angular deviation from the initial position which produces single mode operation.

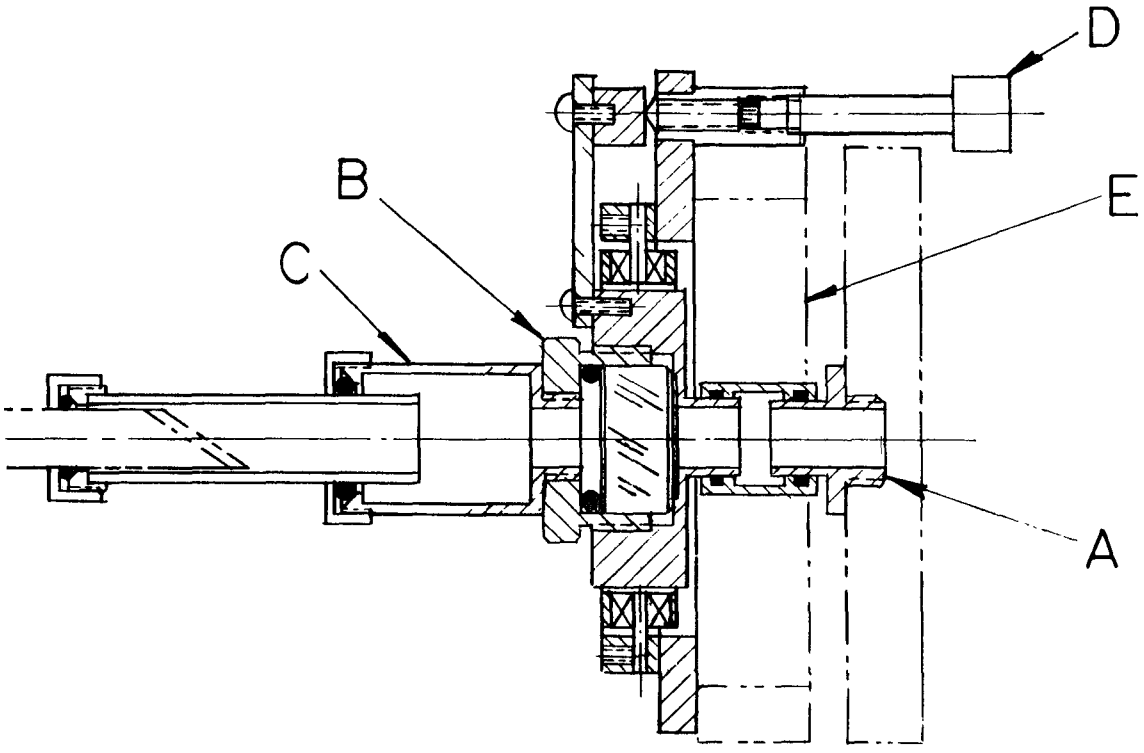


Figure 16
Model 421 Assembly Drawing

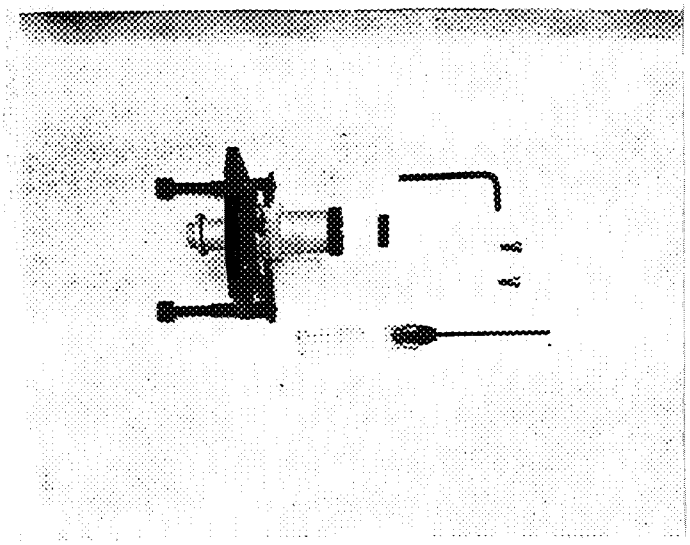


Figure 17

1. Parts List and Tools
   a. Etalon mount assembly with glass dust shield.
   b. 2 ea. 8-32 mounting screws.
   c. 9/64" Allen wrench.
   d. 3/32" adjustment Allen driver.

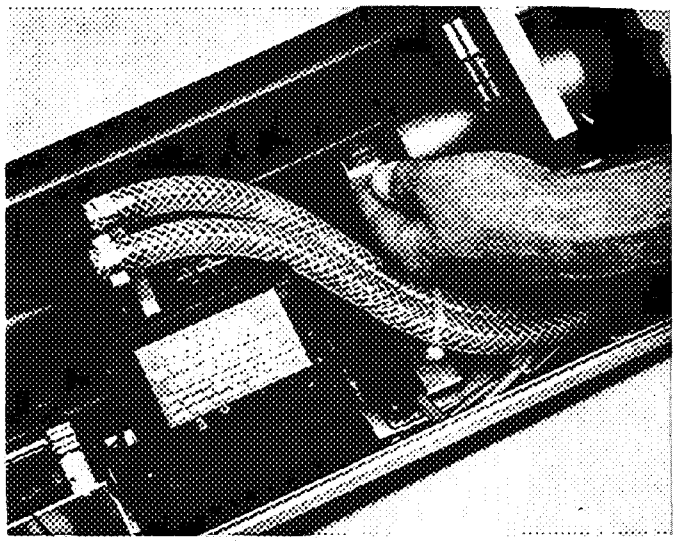


Figure 17a

2. Loosen Brewster window dust shield retaining collar and slide dust shield clear of rear Brewster window.

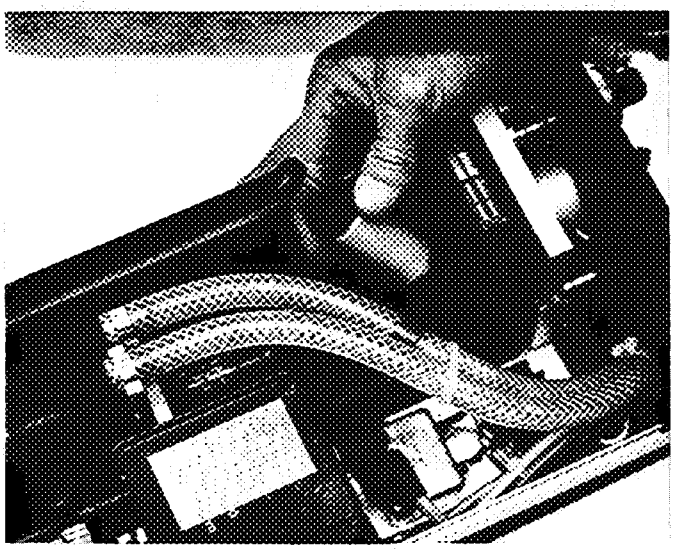


Figure 17b

3. Unscrew and remove dust shield assembly.

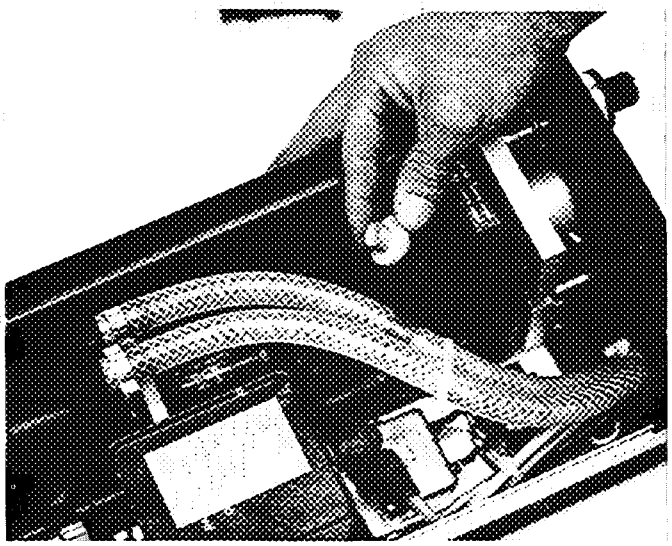


Figure 17c

4. Screw etalon adapter fixture into dust shield assembly mounting hole.

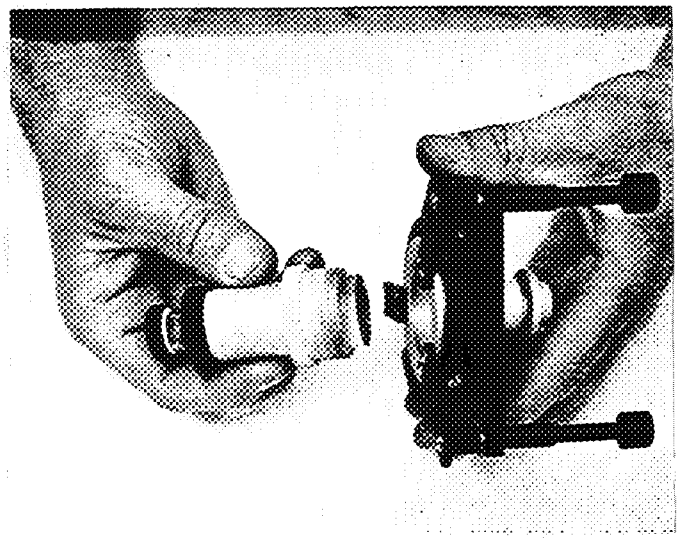


Figure 17d

Step 5: Unscrew and remove dust shield and etalon from etalon mount assembly.

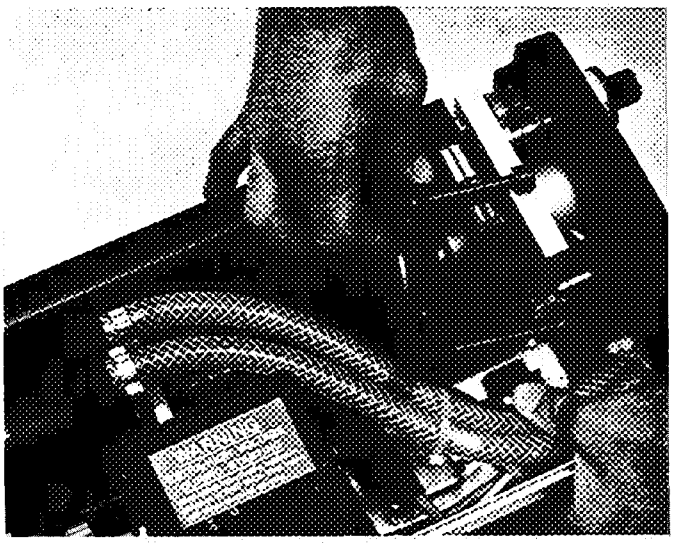


Figure 17e

Step 6: Install etalon adjustment assembly. Water hoses may be gently moved to the side to facilitate entry. Etalon adjustment assembly should be firmly pushed into etalon adapter.

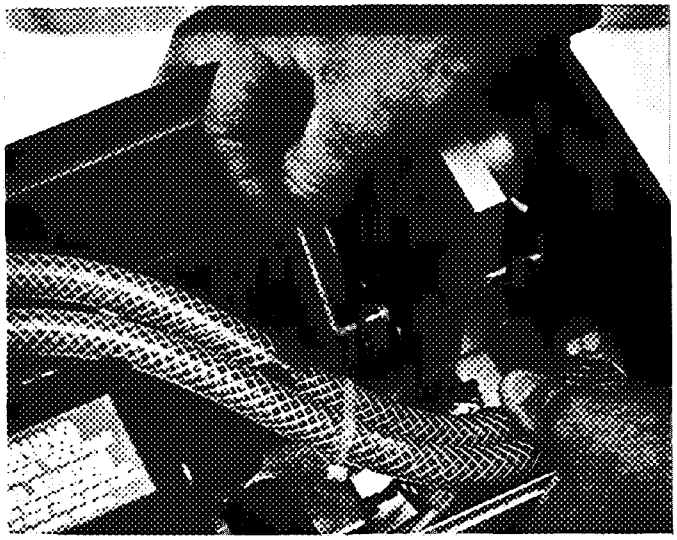


Figure 17f

Step 7: Secure etalon adjustment assembly with two 8-32 mounting screws.

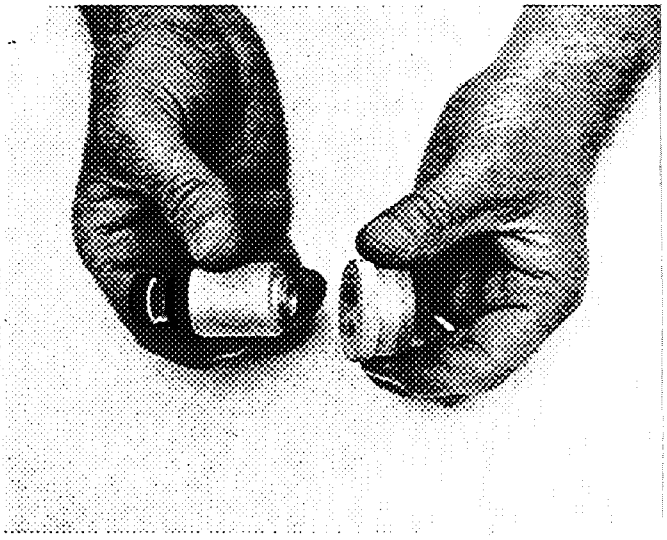


Figure 17g

Step 8: Separate dust shield from etalon mount.

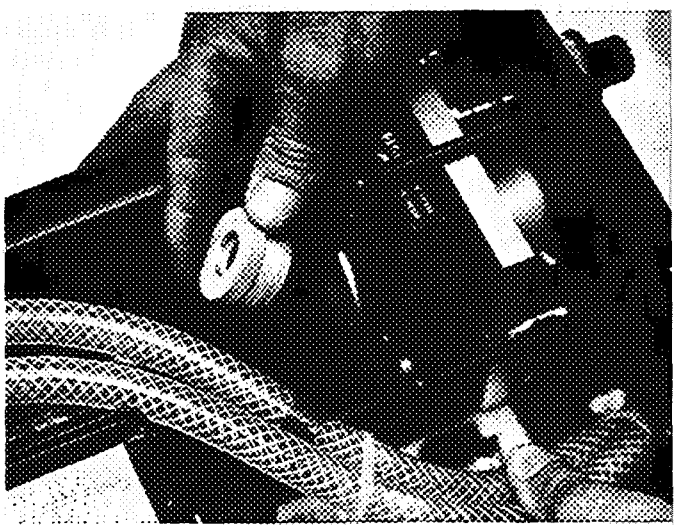


Figure 17h

Step 9: Install etalon and etalon mount in adjustment assembly.

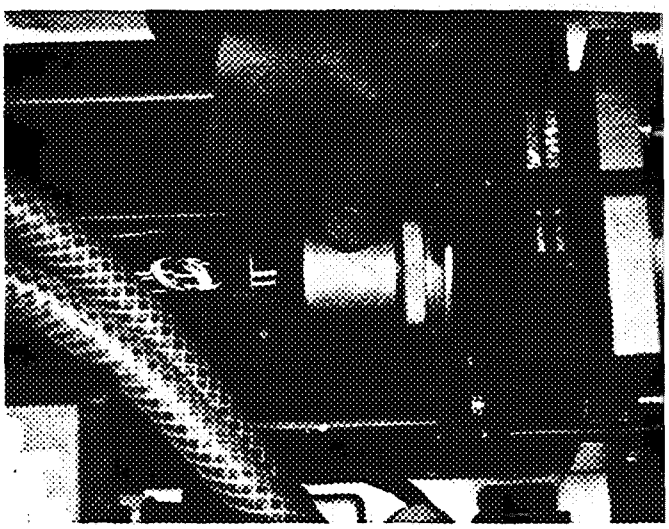


Figure 17j

Step 10: Screw dust shield into etalon mount. Slide dust shield over Brewster window and secure.

8.2.2 ETALON REMOVAL PROCEDURE

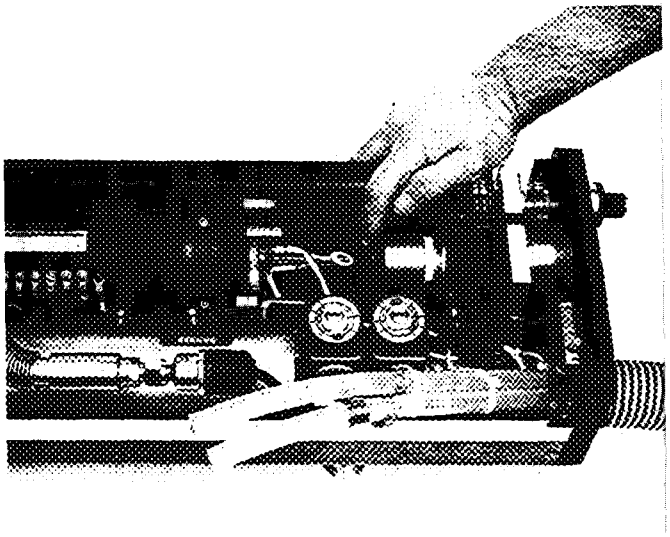


Figure 18

Step 1: Slide telescoping Brewster window dust shield back.

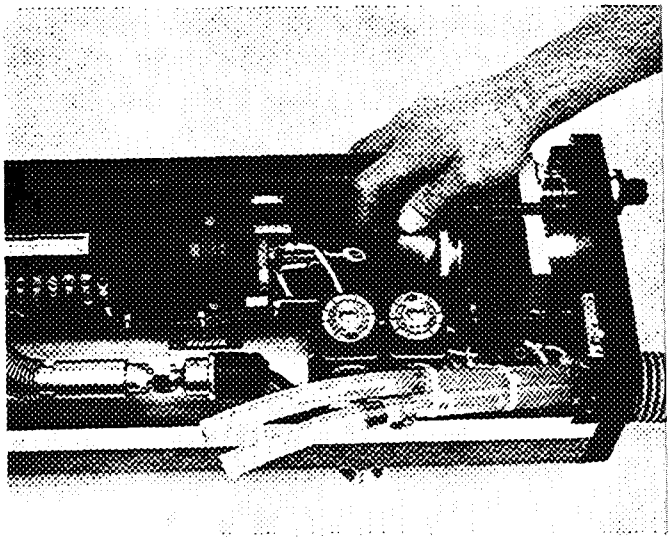


Figure 18a

Step 2: Unscrew and remove Etalon dust shield.

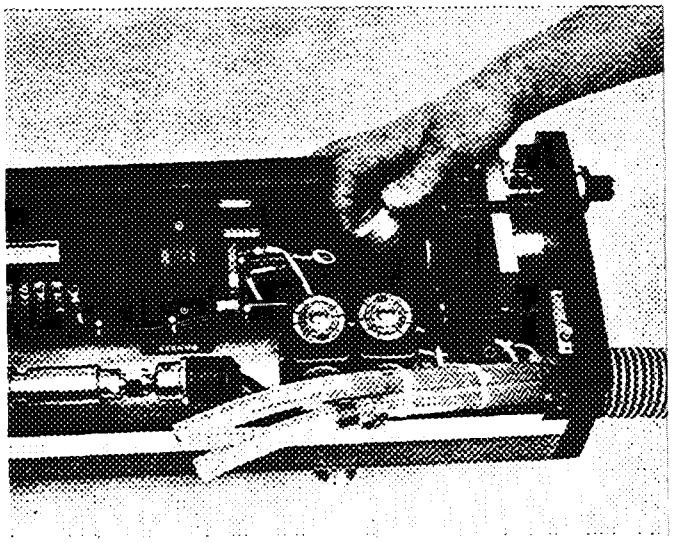


Figure 18b

Step 3: Unscrew Etalon holder and remove Etalon. Reverse procedure to install dust shields for operation without Etalon.

8.2.3 Model 431 Prism Wavelength Selector

The Model 431 Brewster prism assembly supplied as an accessory to the Model 54 Ion Laser System is designed to be interchangeable with the mirror holder assembly. Normally the assembly is supplied prealigned and ready for use. If not, initial alignment must be performed as follows.

8.2.3a Installing Wavelength Selector

Tune the laser for optimum power by the procedures described in Section 5.1.

Remove the laser top cover. Note the paths of the beams reflected from the Brewster windows. If these beams are obstructed by the dust shields, move the shields so that the beams pass through the glass tubes. If the water hose is in the way, it may be gently pushed to one side. Mark with a pencil the positions of the reflected beams A and B on the ceiling or other convenient surface above the head. From this point until the laser is in oscillation with the prism in place, the laser head and marked surface must not be moved.

Remove the rear mirror. Insert the prism wavelength selector into the rear mount. Remove the dust cover and the mirror holder from the prism selector assembly.

3.2.3b Alignment of Prism

Measure the distance CD between the front Brewster window C and the prism D. Mark a point E on the ceiling at a distance from A equal to CD. The reflection from the front surface of the prism should fall on E. With the room darkened so that the reflection of the plasma tube

fluorescence may be seen on the ceiling, rotate the prism until the reflected spot falls on E. To rotate the prism, loosen a small set screw just above and to the side of the prism. (Refer to Diagram A).

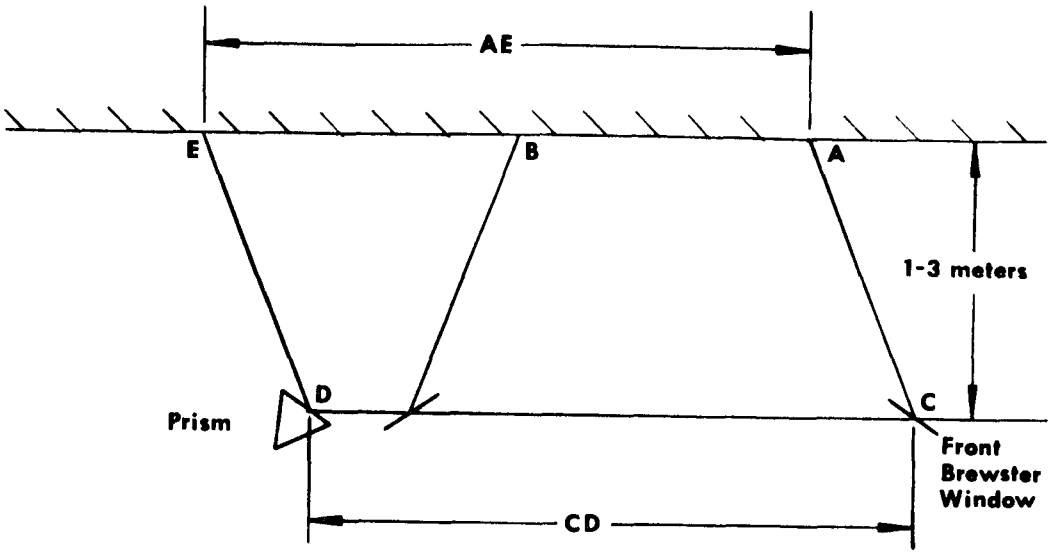


Diagram A

8.2.3c Alignment of Mirror

The totally reflecting mirror is now aligned as follows: Replace the mirror and mirror mount in selector assembly. The tilting of the mirror mount is accomplished by turning the screws 1 and 2 located on the flange. There is a pivot screw 3 which should not be touched. 1 is the vertical adjust screw and 2 is the horizontal adjust screw. These screws work against springs 4 and 5. The small locking screws 6 and 7 should be backed off for this adjustment. By adjustment of 1 and 2, position on spot B on the ceiling the plasma tube fluorescence which has

been reflected from the mirror and the rear Brewster. Oscillation (lasing) should occur during this procedure. By adjustment of screw 1 the prism may be set to obtain oscillation as previously set on the wavelength selector. In argon tubes, the green 514.5 output is easily recognized by its high power (700 milliwatts) and green color. After final slight adjustments to maximize the power, the locking screws should be tightened down. Replace the dust cover. The fine angular controls may now be used for final optimizing of the power.

8.2.3d Changing Wavelength

When the output has been optimized, the vertical adjust may be varied to verify oscillation on the other specified spectral lines. In varying over the full output spectrum, some retuning of the output using the rear horizontal fine control is generally necessary.

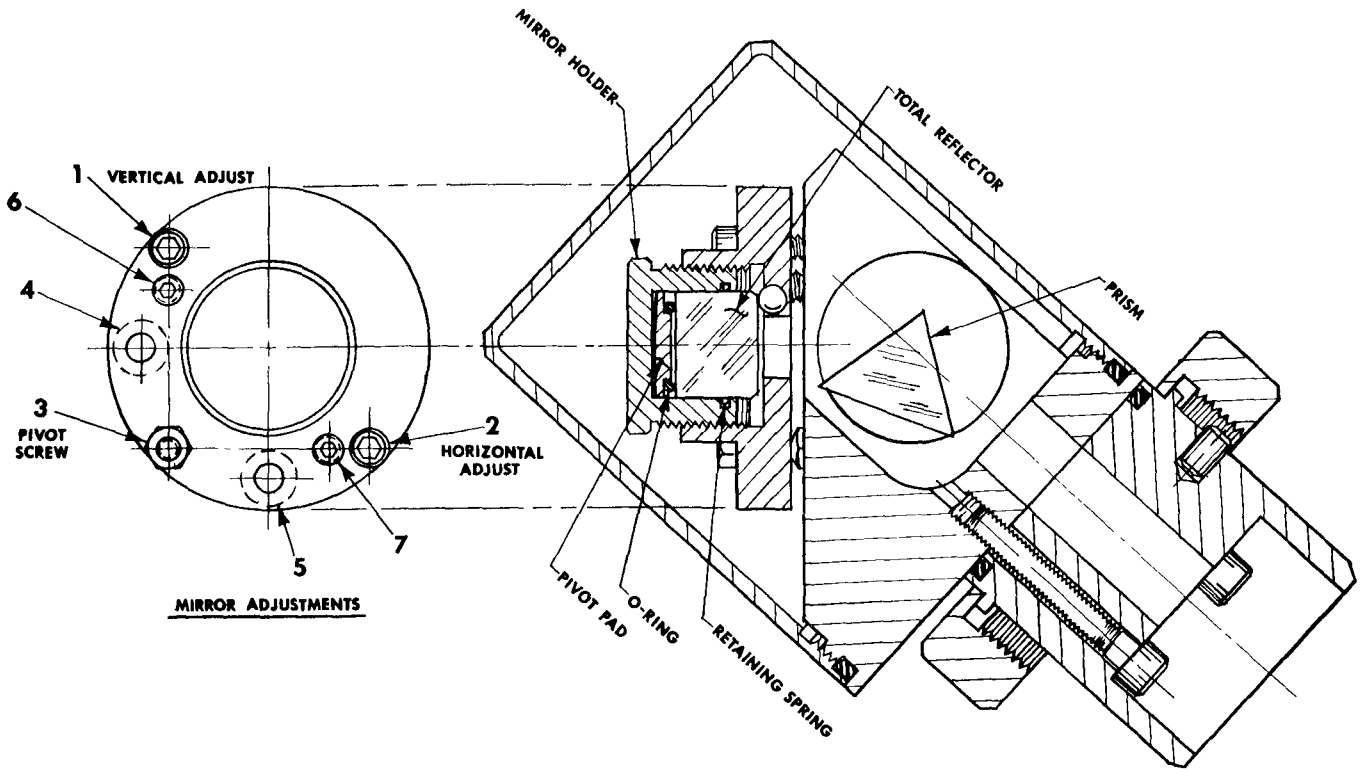


Figure 19
Model 431 Assembly Drawing

8.3 Adjustments

8.3.1 Prism Alignment

Refer to INSTALLING OPTIONAL ACCESSORIES, Section 8.2.2, for detailed information.

8.3.2 Mirror Alignment

The Model 54 Ion Laser contains two 4m mirrors: (1) the total reflector (or rear mirror) located at the umbilical end of the laser and (2) the coupling reflector (or output mirror) located at the output end of the laser. The total reflector is interchangeable with a prism wavelength selector (refer to Section 8.2.2).

The laser mirrors should be adjusted for maximum light output. Normal variations caused by shock in transportation or temperature change can be compensated by adjustment of the total reflector without the necessity of moving the output mirror. The adjustment can best be accomplished by using a laser power meter such as the COHERENT RADIATION Model 201 or 212.

The vertical and horizontal adjusting knobs should be tuned for maximum output. If power is still low, clean inside surfaces of both mirrors and outside surface of output mirror as well as the Brewster windows. (Refer to paragraph 8.1.3.)

WALKING: Only as a last resort should the output mirror be adjusted, in which case a walking procedure must be used. This consists of making a small change in the setting of either vertical or horizontal adjustment of the output mirror and then readjusting the corresponding adjusting knob on the total reflector for maximum output. If this maximum is larger than the maximum obtained before adjusting the output mirror, make another total reflector adjustment in the same direction. If it is smaller, adjust in the opposite direction. This procedure should be

followed first for the vertical axis and then for the horizontal axis.

The output mirror is carefully adjusted at the factory by this procedure and can be expected to remain in proper adjustment for the life of the equipment under normal conditions. Unless there is reason to believe that adjustment of the output mirror has been disturbed, it is best left alone.

8.3.3 Adjusting Mirror Mount

The mirror mount at the umbilical (or rear) end of the laser head may be adjusted if the laser beam is encountering any of the metal parts. Reference Figure 20 for an illustration of the mirror mount at the end of the laser.

Step 1: Support the mirror housing with one hand. With the other loosen the four screws one-half turn each, using an Allen wrench as illustrated. Note: One full turn of the mounting screws will cause the retaining nut to drop off onto the base plate.

Step 2: Move mount to correct position.

Step 3: Retighten screws.

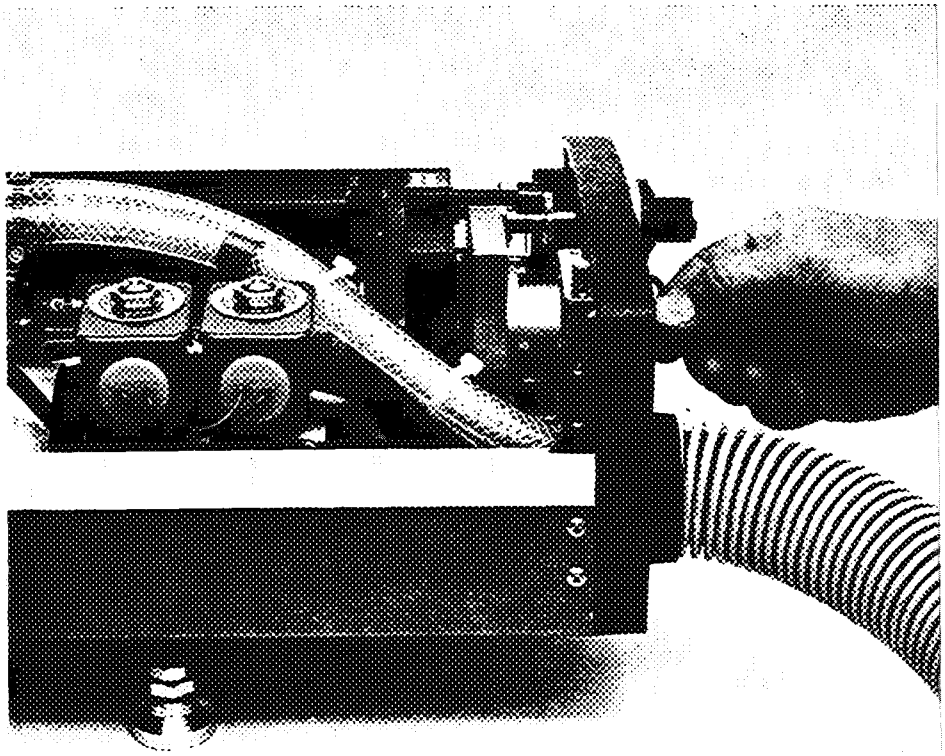


Figure 20.

Mirror Mount
Laser Head, Rear

8.3.4 Transformer Tap Adjustments

Because of power line voltage drop under load and variations in laser tube voltage drop, it may be necessary to change the connections of these taps after the laser has been tested.

Refer to paragraph 4.2.2, Steps 6 and 7, for tap adjustment values.

Observe the PASS TRANSISTOR VOLTAGE meter while adjusting the front panel OUTPUT CURRENT control. The PASS TRANSISTOR voltmeter should stay within the marked operating range of 10 to 20 volts over the current range of roughly 12 to 18 amperes. If the current cannot be brought up to 18 amperes or the voltmeter drops below 10-volts at this setting, the auto-transformer should be set for the next lower line voltage connection. If the current cannot be adjusted below 12 amperes

or the voltmeter indicates above 20-volts at 12 amperes, or if the laser current meter goes to full scale and the circuit breaker trips off when the laser is started, adjust the auto-transformer to the next higher line voltage setting.

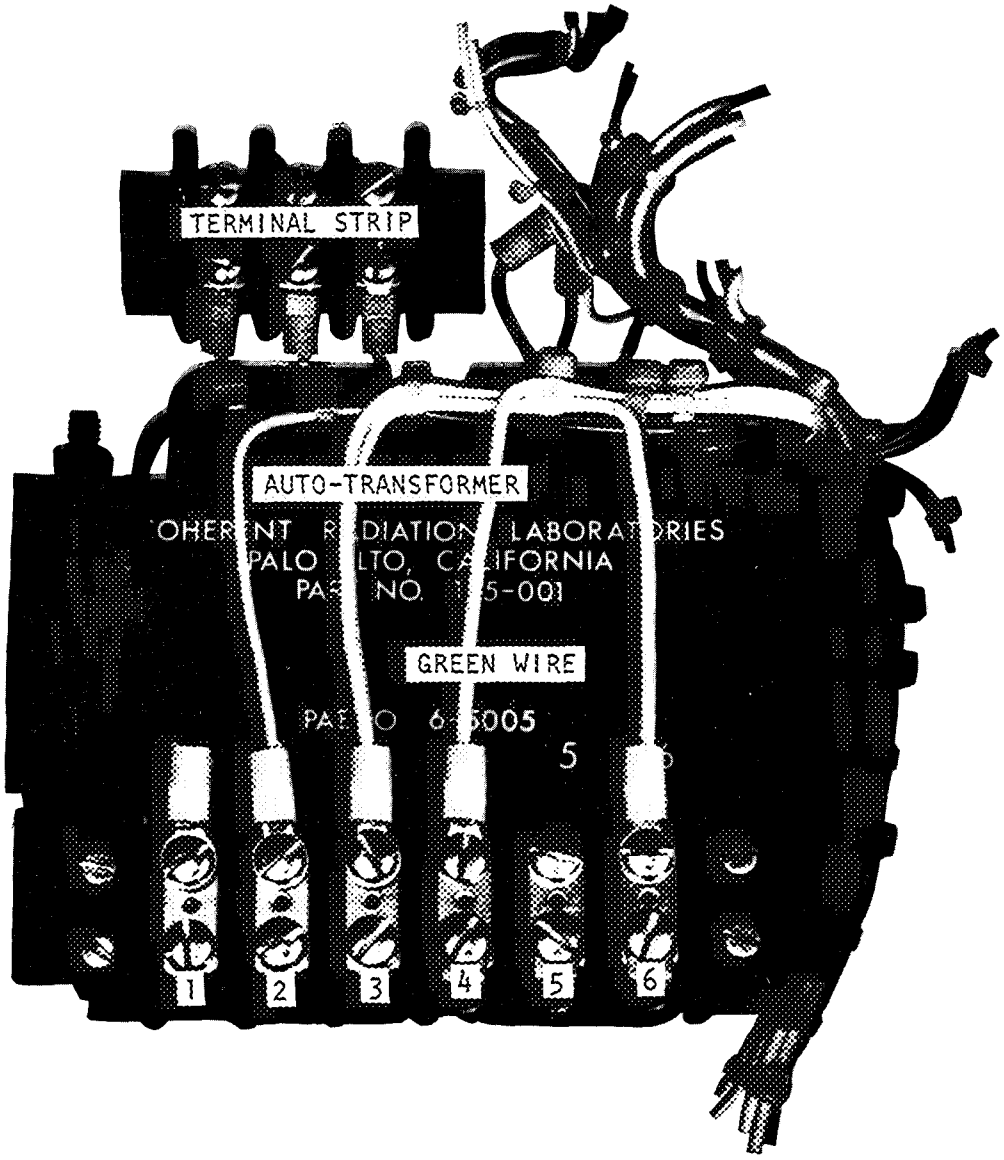


Figure 21; Transformer Tap Adjustments

8.3.5 Current Limit Adjustment

Refer to schematic, Figure 10, page 7-5, for the locations of potentiometers R149 (Current Trip) and R146 (Maximum Current Set).

Step 1: Turn the OUTPUT CONTROL to full clockwise position.

Step 2: Using a slot screwdriver, adjust R146 (right pot) counter-clockwise till current is up to 20 amperes.

Step 3: Adjust R149 (left pot) counter-clockwise till laser trips off.

Step 4: Re-adjust R146 counter-clockwise two (2) turns below the trip point and restart laser.

Step 5: When laser starts readjust R146 to 18 amperes.

8.4 Test Procedures

8.4.1 Test Procedure #1 - Locate Collector-Emitter or Three Electrode Short in Paralleled Power Transistors

Step 1: Disconnect the main power source.

Step 2: Connect equipment as shown in Figure 22. The test power supply must be current limiting or be used with a suitable resistance. Open circuit voltage should be 20-50 volts. Short circuit current should be 1-10 amperes.

Step 3: Measure voltage across 3 resistors. The one with the highest voltage is connected to the faulty transistor. For C - E short, the other resistors will measure '0' volts (no current). For 3 electrode short (the most common) the voltage difference is usually 0.5-0.7 volts, but may be less.

Step 4: Disconnect at least 2 connections to the suspected transistor. Measure collector voltage. It should be the open-circuit supply voltage. If not, repeat Step 3.

Step 5: If all voltages are equal within 0.2 volts, the fault is probably a collector-base short. Use Test Procedure #2.

8.4.2 Test Procedure #2 - Locate Collector-Base Short in Parallel Power Transistors

Step 1: Disconnect the main power source.

Step 2: Connect equipment as shown in Figure 23. The same power supply used in Test Procedure #1 may be used. A meter which will show a noticeable deflection with an input of about 3 millivolts is required. Many multimeters will do this on the

50 or 60 microamp scale. The power supply and meter must be connected at opposite ends of the base buss.

Step 3: Measure voltage between end of buss and each base, starting from the end nearest the meter positive connection. The first point at which the voltage is not zero is one transistor past the faulty one. Current from the faulty transistor causes a small voltage drop in the wire. The voltage drop will increase at each successive transistor because of increased wire length.

Step 4: Disconnect at least 2 connections to the suspected transistor. The collector voltage should rise to the open-circuit output voltage of the supply. If not, repeat Step 3.

8.4.3 Test Procedure #3 - Measuring Thermistor Resistance

Step 1: Using soldering iron, disconnect one lead of thermistor.

Step 2: With power off, measure resistance for a nominal value of 10,000 ohms.

Step 3: Minimum value is 2000 ohms below which unit will trip off.

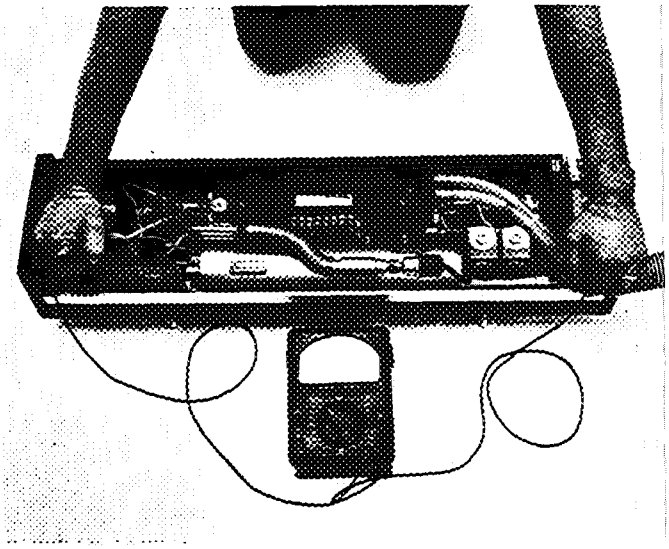


Figure 24.

Tube Voltage Measurement. DC tube voltage should be measured from center tap of filament transformer (cathode) to upper tap of starter transformer (anode). With tube current off, voltage should be approximately 250V. Caution: Avoid touching high voltage points.

Notes: 1. Collectors are mounted through mounting bolts.

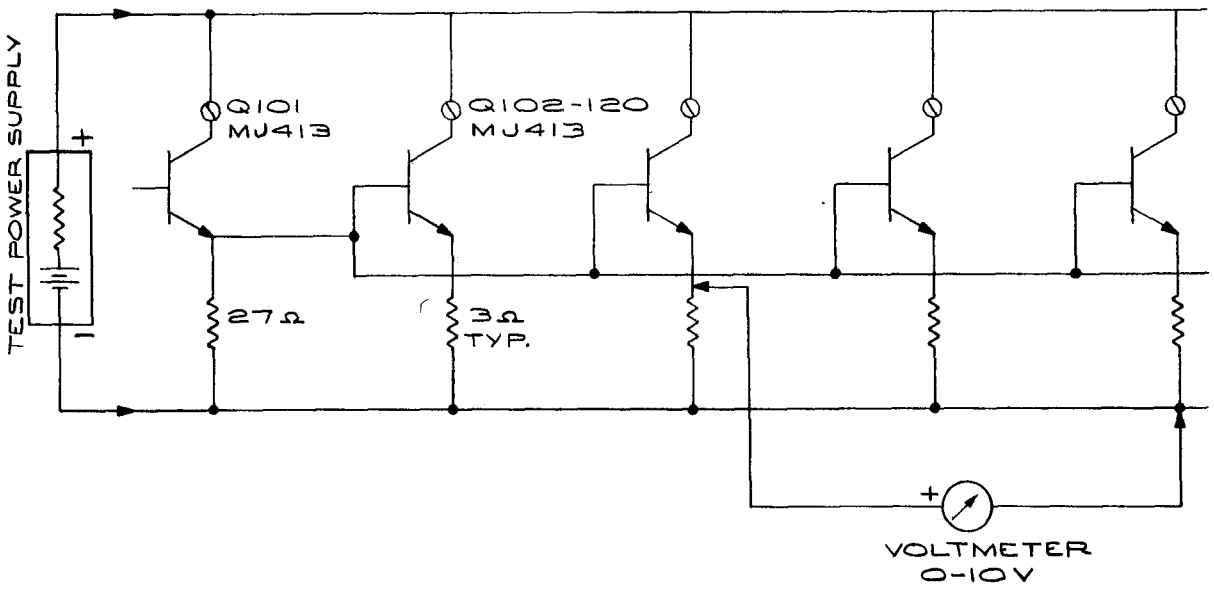


Figure 22; Test Procedure #1

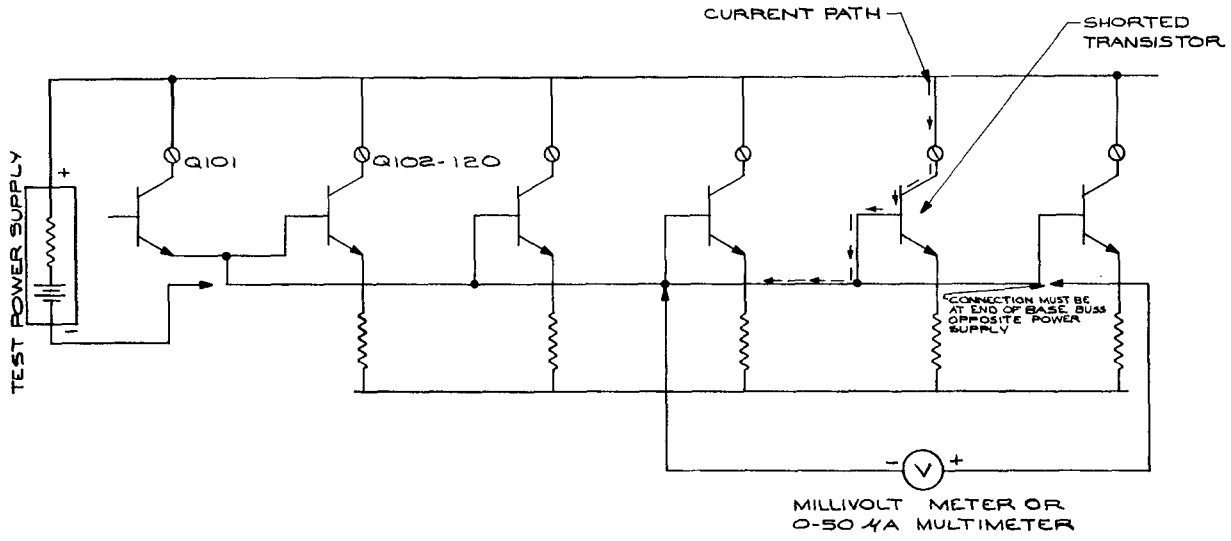
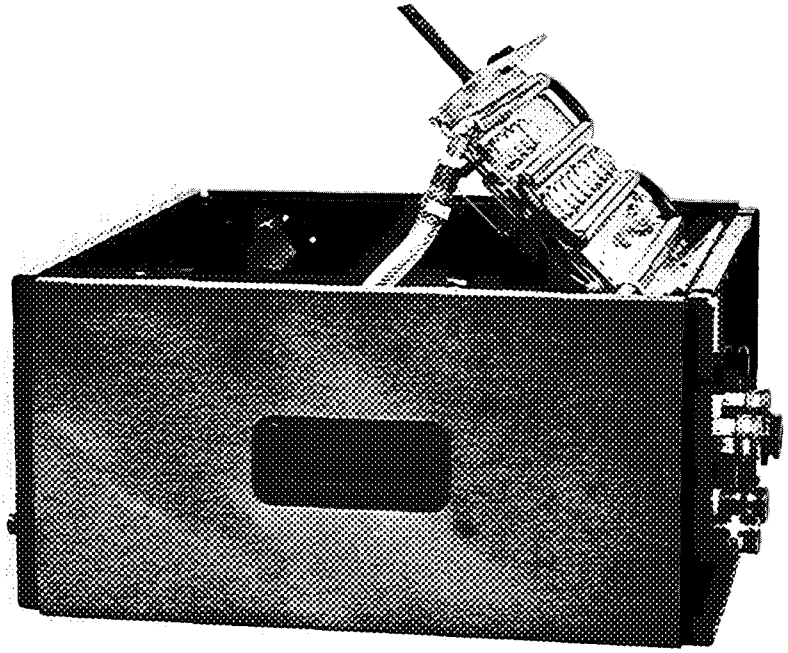
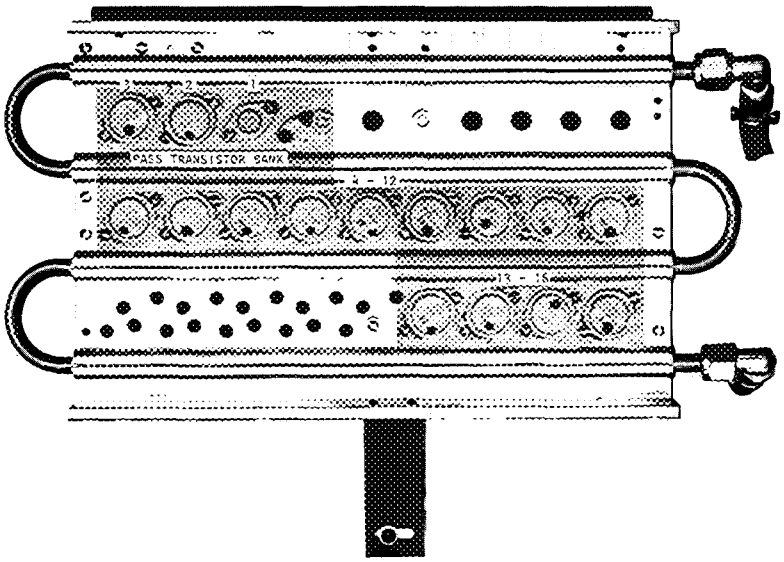


Figure 23; Test Procedure #2



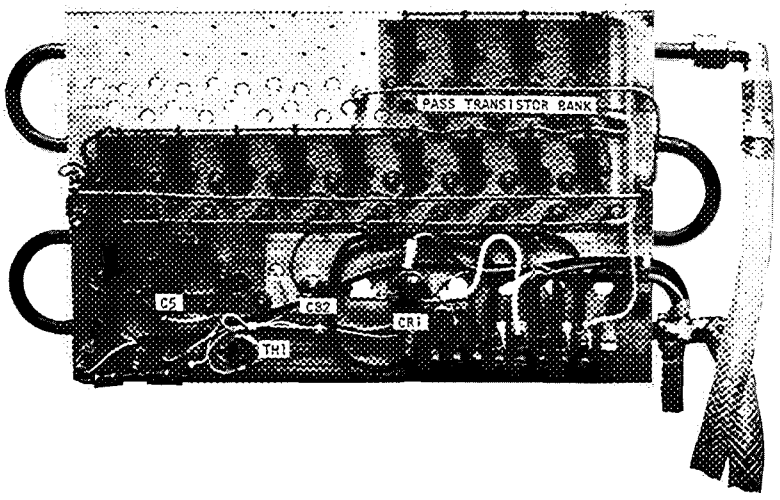
B

Heat Sink, Upright Position



C

Heat Sink, Top



D

Heat Sink, Bottom

A

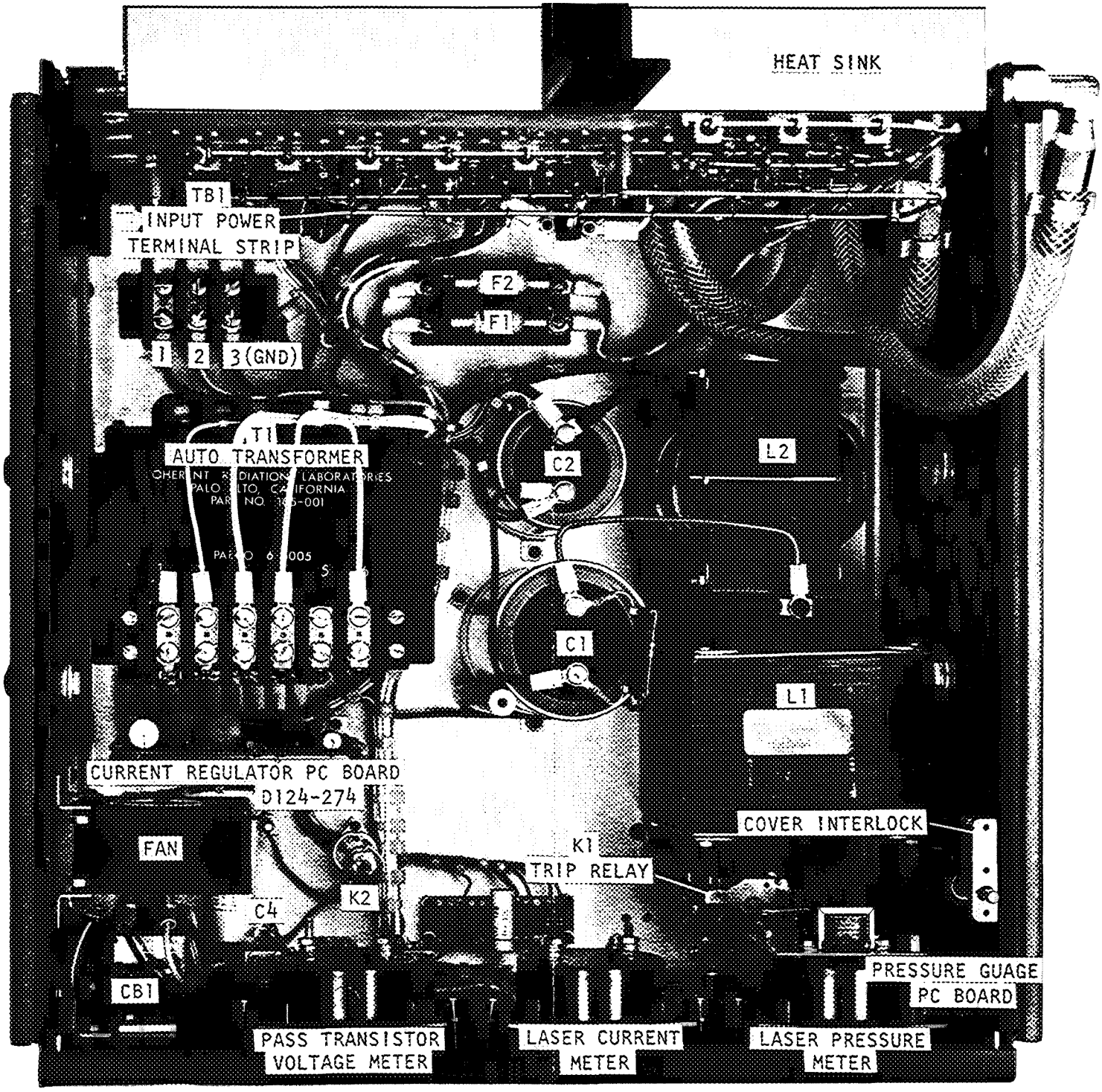


Figure 25; Power Supply,
Internal Components

8.5 Troubleshooting Guide

NOTE: When a fault occurs, a good deal of helpful information can be obtained by careful observation of the front panel controls and instruments. Additional tests can be conducted with a simple multimeter by opening the top cover of the power supply. If the supply is to be tested in the energized condition, the cover interlock plunger must be pulled out to override the interlock. The same is true for the laser head cover. Energized testing must be conducted cautiously as dangerous voltages and currents are present and the supply provides no isolation from the power line. The ground wire of test equipment must not be connected to any live portion of the circuit. Fuses can best be tested with an ohmmeter with the power disconnected. Use of isolated DC laboratory supplies is suggested for troubleshooting of the current regulator section.

SYMPTOMS	PROBABLE CAUSE	REMEDY
Laser current will not start.	1. Voltage too low.	1. Shift taps per paragraph 8.3.4.
	2. Fuses F101 and F102 blown.	2. Test and replace with same. (Note: Test fuses with an ohmmeter and with power disconnected.)
	3. No starter voltage.	3. a) Check line voltage between F103 and F104 for 120 VAC. b) Check glow in tube when start button is depressed - only one pulse per depression.
	4. Tube pressure too high.	4. Return to factory for rework.
	5. Tube pressure too low.	5. Follow gas fill procedure paragraph 5.1.6 with frequent attempts at starting. When started, run till warm. Add more gas if needed.

SYMPTOMS	PROBABLE CAUSE	REMEDY
Circuit breaker trips immediately.	1. Check if cover interlock is open.	1. a) Override interlocks on head and power supply or replace covers. b) R101 thermistor is less than 2000 ohms.
	2. Short circuit.	2. a) Test T1 and main rectifiers. b) Check for shorted solenoids. c) Check for shorts to ground.
Circuit breaker trips in 5 to 10 seconds.	1. No cooling water.	1. Follow procedure for turning on, Section 5.1.
Circuit breaker trips when laser starts.	1. Voltage too high.	1. Shift taps per Section 8.3.4.
	2. Fault on current regulator card.	2. Test and repair.
	3. Shorted pass bank transistor.	3. Test and repair per 8.4.1.
Circuit breaker trips after current level.	1. Trip point set incorrectly.	1. Set per paragraph 8.3.5.
	2. Fault in Current Regulator PC Board.	2. Isolate and replace.
Circuit breaker trips after laser starts	1. No coolant flow or insufficient flow. NOTE: DO NOT REACTIVATE LASER IMMEDIATELY IF TUBE HAS BEEN RUNNING HOT. ALLOW TUBE TO COOL TO ROOM TEMPERATURE BEFORE STARTING.	1. a) Check if water supply is turned on. b) Check if water filter is clogged, drain pressure high, water head pressure too low, kink in hose, or dirt in system.

SYMPTOMS	PROBABLE CAUSE	REMEDY
No control of current - pass transistor voltage 50.	1. Current Regulator PCB not plugged in. 2. Faulty component in current regulator.	1. Plug in printed circuit board. 2. Isolate and repair.
Restricted current range, pass transistor will not go above 10-20 VDC.	1. Shorted transistor in pass bank.	1. Isolate as per 8.4.1.
Low tube current, pass voltage less than 10 volts.	1. Taps set wrong. 2. Line voltage drops under load (soft line). 3. Tube pressure incorrect.	1. Readjust per 8.3.4. 2. Firm up voltage source. 3. Allow to run until extra gas is used up and send in to factory for pump out.
Low tube current, pass voltage greater than 10 volts.	1. Current limit incorrectly set. 2. Fault in current regulator.	1. Readjust per 8.3.5. 2. Isolate and replace.
Output power low - all lines.	1. Tube current low. 2. Dirty mirrors. 3. Defective mirrors. 4. Dirty Brewster windows. 5. Etalon dirty. 6. Out of alignment.	1. Refer above symptoms. 2. Clean as per 8.1.3. 3. Rotate to new spot if possible or replace. 4. Clean as per 8.1.3. 5. Remove for tests per 8.1.4. 6. Adjust rear mirror for peak power, and walk mirrors per 8.3.2.

SYMPTOMS	PROBABLE CAUSE	REMEDY
Single line power down but all line power okay.	1. Prism dirty. 2. Prism angle incorrect. 3. Beam hitting metal parts of wavelength selector.	1. Clean as per 8.1.3. 2. Set up as per 8.2.2. 3. Loosen screws (4) on mirr mount as per 8.3.3 and move as required.
Some lines missing with wavelength selector but are present when all lines are broken up externally.	1. Beam too close to metal on wavelength selector; other lines are hitting metal parts. 2. Prism assembly not vertical.	1. Loosen screws (4) as per 8.3.3 and adjust as required. 2. Loosen screws (4), rotate and test. (Only mirror adjustment of horizontal should be required line t line.)
No output with wavelength selector but okay on all lines.	1. Prism alignment. 2. Wavelength selector frame in optical path.	1. Adjust per 8.3.1. 2. Loosen screws (4) per 8.3.3 and adjust till plasma spot is centered on the mirror.
No output on all lines.	1. Plasma not on (nor adjusted to maximum current. 2. Rear mirror out of alignment. 3. Front mirror out of alignment. 4. Restriction in optical path.	1. Start and operate at full current as per Section 5. 2. Adjust as per 8.3.2. 3. Adjust per 8.3.2. 4. Check and correct condition as per 8.3.3.
Mirror does not adjust smoothly.	1. Loose or weak coil springs on mirror mounts. 2. Interference between bezel and mirror parts.	1. Tighten or replace. 2. Loosen screws on the bottom of the head in the rails; move base plate with respect to end bezel

8.6 Customer Service

COHERENT RADIATION provides a one year unconditional warranty with each purchase of a new unit. This warranty is limited to the repair or replacement of any defective part at either the factory or purchaser's place of business.

In many instances repairs can be made on site. Before making a shipment to the factory, the purchaser is advised to contact the Service Representative. A telephone call may aid in determining the extent of the repair, if a necessity for shipment to the factory exists and, if so, the most economical means to do so.

For further technical information or advice contact:

Service Department
COHERENT RADIATION
932 East Meadow Drive
Palo Alto, California 94303
Tel: (415) 328-1840

9.0 PARTS LISTS

LASER HEAD D105-054

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			REF.	Schematic, Elec.	C105-089	-
			REF.	Wiring Diagram	D105-053	-
			1	Mounting Plate	D105-015	1
			1	Resonator Assy	D105-012	2
			1	Tube, Plasma	D105-043	4
			1	Ballast Assy	D124-002	5
			1	Dust Shield Assy	A124-146	7
			4	Standoff	A124-054-1	15
			12	Standoff	A124-054-2	16
			4	Flexure Hinge	A124-055	17
			4	Spring Cap	A124-056	18
			4	Adj. Screw Stabilizer	A124-058	19
			4	Threaded Bushing	B124-059	20
			4	Nut	A124-061	21
			4	Adjusting Screw	A124-062	22
			2	Pivot	A124-063	23
			1	Pinion Shaft Bushing	C124-064	24
			1	Pinion Shaft	A124-065	25
			2	Spring Clip	A124-081	26
			2	Mirror Adjust Knob	B124-133	27
			2	Flexure Clamp	A124-029	30
			1	Flexure Mount	B124-030	31
			1	Flexure Plate	A124-031	32
			1	Flexure Mount	B124-039	33
			1	Suspension Plate	B124-033-1	34
			1	Suspension Plate	B124-033-2	35
			2	Clamp Mounting	B124-023	36
			1	Front Support	B124-032	37
			1	Bearing Mount	B124-040	38

LASER HEAD (Continued) D105-054

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			2	Retainer Cap	B105-019	42
			2	Retainer "O" Ring	A105-018	45
			1	Insulator, Ceramic	#NL633W01-004	46
			1	Screw,Set,Cup Point$oc.SST	#6-32x3/8"	47
			1	Screw, Rd. Hd., Slotted, Mach.	#6-32x2"	48
			2	Spring,Mirror Retainer	A120-095	50
			2	Mirror Holder	B124-071	51
			2	Nut Retainer	B124-072	52
			2	Bolt Ring	A124-069	53
			2	Housing, Mirror	C124-070	54
			1	Mirror Adj. Plate Rear	C124-068-1	55
			1	Mirror Adj. Plate-Front	C124-068-2	56
			2	Collet	B124-127	57
			2	Retainer Ring	B124-128	58
			2	Nut, Dust Shield	A124-141	59
			2	Compression Ring	A124-129	60
			1	Xfmr Mtg. Plate	B124-157	61
			1	Bracket, P.C. Bd. Mtg.	B105-082	62
			3	Rubber Mount	A105-081	63
			1	Head Interlock P.C. Bd.	D124-208	65
			2	Retainer Spring	A124-177	67
			2	Mirror Adapter	A124-073	68
			1	Mirror Reflector		70
			1	Mirror, Transmission		71
			1	Spur Gears	006-168	75
			1	Spherical Bearing	006-151	76
			1	Dowel Pin, Steel	009-011	77
			2	Dowel Pin, Steel	009-012	78
			1	Dowel Pin, Steel	009-010	79
			12	Ball, Chrome Moly	006-167	80
			4	Compression Spring	008-307	81

LASER HEAD (Continued) D105-054

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			2	Knob, Raytheon	006-063	82
			4	Leveling Pad, Modified	A124-147	83
			1	Wire, Ground	B105-097-1	87
			1	Wire, Ground	B105-097-2	88
			1	Trim Strip Marking	A105-095-2	89
			1	Bezel, Umbilical	B124-092	90
			1	Bezel, Front	D124-162	91
			1	Bezel, Rear	B124-134	92
			1	Cover, Top	B105-006	93
			1	Trim Strip Marking	A105-095-1	94
			2	Side Rail	B105-008	95
			1	Cover	D105-004	96
			2	"O" Ring, Parker #2-210	006-399	99
			4	"O" Ring, Parker #2-26	006-374	100
			2	Diaphram, Dust Shield	A124-226	101
			2	"O" Ring, Parker #2-22	Silicone	102
			2	"O" Ring, Parker #2-12	006-371	103
			2	"O" Ring, Parker #2-26	006-377	104
			1	Hose Connector	006-579	131
			1	Hose Connector Assy	A120-101	133
			2	Clamp "OETIKER"	006-303	134
			A/R	Tubing, Nylobrade	006-228	135
			1	Flex Hose Ductall Type U3	006-232	136
			16	Lockwasher, Internal Tooth	#8	143
			1	Flatwasher, St, Cad, Plated	#6	144
			4	Flatwasher,Stl, Cad. Plated	#10	145
			2	B.H.S.S., S. St.	6-32 x 1/4"	146
			5	Hex Nut, St.,Cad. Plated	1/4-20	147
			14	B.H.S.S., S. St.	#4-40x1/4"	148
			6	S.H.C.S., S. St.	1/4-20x3/4"	149

LASER HEAD (Continued) D105-054

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			8	S.H.C.S., S. St.	#6-32x7/8"	150
			4	S.H.C.S., S. St.	#8-32x1/2"	151
			4	B.H.S.S., S. St.	#8-32x3/8"	152
			4	B.H.S.S., S. St.	#10-32x1/2"	153
			24	B.H.S.S., S. St.	#8-32x1/2"	154
			4	S.H.C.S., S. St.	#8-32x1"	155
			4	S.H.C.S., S. St.	#8-32x3/8"	156
			4	S.H.C.S., S. St.	#6-32x1-1/4"	157
			4	F.H.S.S., S. St.	#8-32x5/8"	158
			3	Keps Nut	1/4-20	159
			8	S.H.C.S., S. St.	#6-32x1/2"	160
			4	B.H.S.S., S. St.	#8-32x1/4"	161
			2	Set Screw,Cup Point, Soc., S. St.	#6-32x1/8"	162
			2	Round Hd. Mach. Sc.Steel	#4-40x3/16"	163
			1	Fitting	006-466	167
			1	Fitting	006-460	168
			4	Rubber Grommet	006-355	169
			4	Standoff	A124-300	170
			2	Screw, Drive #0x1/4LG		171
			1	Plate, Identification	B900-003	172
			1	Bracket, P.C. Mtg.	124-2271-1	181
			1	Bracket, P.C. Mtg.	124-227-2	182
			1	Control Knob Assy	124-180-2	183
			2	Standoff	005-713	184
			1	Key, Polarizing	004-517	185
			1	Connector	004-505	186
			1	Connector	004-527	187
			1	Strip, Barrier	006-027	188
			1	Strip, Terminal	006-039	189

LASER HEAD (Continued) D105-054

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			2	"O" Ring, #2-115	006-368	190
			1	Tag, Serial No.	010-119	200
			1	Grommet	006-354	201
			1	Socket, Tube	003-301	202
			1	Connector (7 pin)	004-525	P101
			1	Connector (9 pin)	004-526	P102
			1	Connector,P.C. (18 pin)	004-548	J103
			1	Cap, Fxd., 1UF, 600V	001-547	C1
			1	Transformer	105-024	T1
			1	Transformer	005-825	T2
			1	Thermocouple Gauge Tube	006-780	TC1
			2	Solenoid Valve	006-609	K1, K2
			1	Cover Interlock	A124-178	S1
			1	Thermistor Assy	B124-159	R1
			1	Res.,Fxd.,30K,12W,±5%	000-558	R2
			1	Solenoid Assy	C105-037 C105-017	L1

POWER SUPPLY D105-055

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			REF.	Schematic, Elec.	D105-087	-
			REF.	Wiring Diagram	D105-076	-
			1	Current Regulator,P.C.Bd.	D124-274-1	1
			1	Pressure Gauge, P.C. Bd.	C124-221	2
			1	Front Panel	105-021	3
			1	Rear Panel	105-060	4
			4	Nut, Handle	124-094	5
			4	Standoff, Handle	124-095	6
			1	Tab, Locking	124-096	7
			4	Spacer	124-097	8
			6	Bracket, Front Panel	124-098	9
			4	Corner Section	124-099	10
			2	Side Panel	124-121	11
			2	Chassis, Side	124-122	12
			1	Top Cover	124-123	13
			1	Bottom Cover	124-124	14
			2	Clamp, Line Switch	124-126	15
			1	Heat Sink	124-138	16
			1	Standoff	124-143	17
			1	Hinge, Heat Sink	124-144	18
			8	Spacer, Modified	124-149	19
			1	Bracket, Heat Sink	124-163	20
			1	Terminal Board	150-021	21
			6	Standoff, #4-40 x 1/4	009-126	22
			1	Label	105-096	23
			4	Bracket, Angle	009-076	24
			2	Receptacle	004-494	25
			2	Retainer	004-495	26
			2	Stud, 1/4 turn	004-496	27
			4	Washer, flat, 1/2" I.D.		28

POWER SUPPLY (continued) D105-055

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			2	Handle	009-033	29
			4	Foot	006-356	30
			2	Fuse Holder	005-300	31
			2	Fuse Holder	005-301	32
			1	Identification Plate	900-003	33
			1	Label	900-006	34
			1	Tag	900-007	35
			2	Plug, Hole	006-651	36
			3	Bezel	005-652	37
			1	Socket, Tube (9 pin)	003-001	38
			2	Lampholder	003-519	39
			2	Bracket, PCB. Mtg.	124-227-1	40
			2	Bracket, PCB. Mtg.	124-227-2	41
			4	Nipple Assy	400-073	42
			2	Fitting, Hose Bib	006-460	43
			2	Fitting, Hose Bib	006-466	44
			1	Clamp, Cable	004-497	45
			1	Strain Relief	124-142	46
			2	Standoff 1"	009-136	47
			1	Label, Caution	010-222	48
			1	Label, Interlock	010-225	49
			1	Label, Danger	010-224	50
			1	Tag, Serial No.	010-119	51
			2	Terminal Strip	006-039	52
			5	Terminal Clip (jumper)	006-040	53
			1	Washer, Insulating	105-071	54
			1	Insulator	009-109	55
			18	Standoff	009-087	56
			2	Insulator	009-111	57
			2	Standoff	009-091	58

POWER SUPPLY (continued) D105-055

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			16	Washer, Mica	009-107	59
			32	Washer, Shoulder	009-106	60
			4	Spacer, Fan Mtg.	124-247	61
			1	Bracket, Fan Mtg.	124-248	62
			4	Grommet	006-350	63
			2	Elbow, Male	006-535	64
			2	Connector	006-574	65
			3	Bezel	003-605	66
			2	Bezel	003-607	67
			2	Lens, White	003-606	68
			3	Lens, Red	003-601	69
			6	Clamp	006-303	70
			1	Terminal Strip	006-024	71
			1	Transformer	105-001	T1
			1	Circuit Breaker	105-072	CB1
			1	Relay	004-004	K1
			1	Time Delay	004-005	K2
			1	Thermostat	409-070-2	TH1
			1	Switch, Interlock	124-178	S1
			3	Switch, Push	003-507	S2,S4,S5
			1	Switch, On/Off	000-517	S3
			2	Fuse (30 amp)	005-012	F1,F2
			2	Fuse (5 amp)	005-003	F3,F4
			2	Lamp, Neon (NE-84)	005-505	I1,I2
			1	Fan	006-139	B1
			1	Choke	005-849	L1
			1	Choke	005-852	L2
			1	Terminal Board	006-038	TB1
			2	Diode (IN457)	002-000	CR1, CR3
			1	Diode, Zener (IN2997)	002-021	CR2
			1	Diode, Bridge	002-029	CR4

POWER SUPPLY (continued) D105-055

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			1	Meter, current	124-075	M1
			1	Meter, voltage	124-077	M1
			1	Meter, pressure	124-076	M3
			1	Cap.,Fxd.,2500UF,350V	001-203	C1
			1	Cap.,Fxd.,1100UF,350V	001-204	C2
			1	Cap.,Fxd.,.47UF,100V	001-304	C3
			1	Cap.,Fxd.,1UF,600V	001-305	C4
			1	Cap.,Fxd.,.01UF,1000V	001-405	C5
			1	Res.,Fxd.,6K,12W,±5%	000-560	R1
			1	Res.,Fxd.,27K,1W,±10%	000-190	R2
			1	Res.,Fxd.,1Meg,1/4W,±5%	000-018	R3
			2	Res.,Fxd.,100K,1W,±10%	000-219	R4, R5
			1	Res., Fxd.,5K,10W,±3%	000-431	R6
			1	Res., Var.,1K	000-805	R7
			1	Res.,Fxd.,470Ω,2W,±10%	000-312	R8
			2	Res.,Fxd,27Ω,2W,±10%	000-308	R9, R39
			14	Res.,Fxd.,3Ω,10W,±1%	000-433	R10,R11,R12,R13, R14,R15,R16,R17, R18,R19,R20,R21, R22,R23
			14	Res.,Fxd.,1K,1/2W,±10%	000-104	R24,R25,R26,R27, R28,R29,R30,R31, R32,R33,R34,R35, R36,R37
			1	Res.,Fxd.,100Ω,2W,±10%	000-311	R38
			1	Transistor, NPN (2N3738)	002-316	Q1
			15	Transistor, NPN (MJ413) replacement part Delco 075-430	002-323	Q2,Q3,Q4,Q5,Q6, Q7,Q8,Q9,Q10,Q11 Q12,Q13,Q14,Q15, Q16
			1	Connector (7 pin)	004-521	J101
			1	Connector (9 pin)	004-920	J102
			1	Connector (22 pin)	004-507	J4

MODEL 54

PRESSURE GUAGE - P. C. BOARD ASSEMBLY — C124-219

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
			REF.	Schematic, Elec.	C105-094	-
			2	Screw #4-40		2
			2	Washer #4		3
			2	Nut #4-40		4
			1	Transformer	005-836	T1
			2	Diode, Zener (IN4733)	002-004	CR1 & CR2
			1	Res.,Fxd.,7.5K,5W,±5%	000-500	R1
			1	Res.,Var.,2K,.6W,±5%	000-808	R2
			1	Res.,Fxd.,3.3K,1W,±10%	000-216	R3

CURRENT REGULATOR - P. C. BOARD ASSEMBLY — D124-088

			REF.	Schematic, Elec.	D124-306-1	-
		REF.		Schematic, Elec.	D124-306-2	-
	2		2	Transistor, NPN (MPS6531)	002-310	Q122 & Q123
	1		1	Transistor, PNP(MPS6534)	002-311	Q124
	1		1	Diode, Zener (IN4747)	002-007	CR108
	3		3	Diode, (IN457)	002-000	CR111, CR114 & CR115
			1	Cap.,Fxd.,50UF,50V,±10%	001-004	C103
	2		2	Cap.,Fxd.,.01UF,1KV	001-405	C104 & C108
	1		1	Cap.,Fxd.,250UF,25V	001-308	C105
	1		1	Cap.,Fxd.,100UF,25V	001-309	C106
	1		1	Cap.,Fxd.,4.7UF,35V	001-018	C107
	1			Cap.,Fxd.,.01UF,1KV	001-405	C109
	1		1	Res.,Fxd.,4.7K,1/4W,±10%	000-011	R144
	1		1	Res.,Fxd.,2.2K,1/4W,±10%	000-008	R145
	1		1	Res.,Var.,1K,.6W,±5%	000-807	R146
	7		7	Res.,Fxd.,1K,1/4W,±10%	000-006	R148, R150, R151 R153, R154, R156 R158

CURRENT REGULATOR - P. C. BOARD ASSEMBLY (continued)

Qty per Mod. No. -4	-3	-2	-1	Description	Part No.	Symbol
		1	1	Res.,Var.,2K,.6W,±5%	000-806	R149
		1	1	Res.,Fxd.,10K,1/4W,±10%	000-021	R152
		1		Res.,Fxd.,47 ,1/4W,±10%	000-033	R157
		1	1	Res.,Fxd.,3.3K,1/4W,±10%	000-055	R159

HEAD INTERLOCK - P. C. BOARD ASSEMBLY D124-207

REF.	Schematic, Elec.	C105-091-1	-
A/R	Buss wire #22		2
A/R	Insulation		3
1	Transistor NPN(MPS6531)	002-310	Q1
1	Cap.,Fxd.,1UF,25V,±10%	001-313	C1
2	Cap.,Fxd.,2UF,450V,±10%	001-209	C2 & C3
1	Diode, Zener (IN4751)	002-008	CR1
1	Diode, Zener (IN4742)	002-034	CR2
2	Diode (IN4005)	002-011	CR3 & CR4
1	Res.,Fxd.,15K,10W,±10%	000-552	R1
1	Res.,Fxd.,2.7K,1/4W,±10%	000-009	R2
1	Res.,Fxd.,15K,1/4W,±10%	000-012	R3
1	Res.,Fxd.,10K,1/4W,±10%	000-021	R4
1	Res.,Fxd.,100Ω,2W,±10%	000-311	R5
1	Res.,Fxd.,50K,12W,±10%	000-557	R6