*** PLEASE OBSERVE THE FOLLOWING***

1.BE CAUTIOUS OF HIGH VOLTAGE POINTS use a discharge lead, that is ground HV before adjusting.

2.DO NOT POINT THE BEAM at anyone or anything that can reflect it where shouldn't go.

3.DO NOT USE in an electrical storm as 3371A may ionize a column of air in thedirection of a static charge, hence increasing the conductivity of the path for a potential lightning bolt.

INTRODUCTION TO YOUR NITROGEN LASER LN-1

The following plans show how to construct a laser device that can produce 100,000 watt pulses of UV energy at a rate of 120 pulses per second. The uniqueness of this device is that this energy is ultra-violet at a wave length of 3371A. The system is basically very simple and does not require complicated expensive mirrors for operating. Standard hardware and readily available parts are referenced and are available through INFORMATION UNLIMITED, INC.. The system. can be easily made portable. The device can be used for pumping dye laser in the visible range, ranging to objects such as clouds that bounce these energy waves back, (this distance can be miles away and easily measured with accuracies of several feet using echo ranging methods). It can induce photochemical reactions, fluorescence of materials at considerable distances, a radiation source for super-high speed photography and many other functions. Please, also note that this device is considered a high-powered device and must be treated with respect. Under no conditions should you look into the laser beam. Read carefully the enclosed safety literature. Alsc observe all safety rules pertaining to the high voltages used and the spark gap radiation. NEVER POINT THIS DEVICE AT ANYONE, OR ANYTHING THAT MAY REFLECT THE BEAM. NEVER USE DURING AN ELECTRICAL STORM.

The construction is divided into the following sections: I. A 20,000 volt power supply operating from 115 Vac. II. An aspirator type vacuum system. III.A nitrogen tank and optional cooler. IV. The laser section. V. The system in its entirety.

THEORY OF OPERATION

Coherent radiation of 3371A is pr oduced by a high current electric discharge through a relatively low pressure, flowing nitrogen gas. This radiation is in the ultra-violet region where most lenses and windows of glass are transparent. Action is started when a nitrogen molecule at room temperature absorbs energy by colliding with an electron and becomes unstable. This excited molecule usually falls to a lower state emitting a photon at 3371A. This emitted photon usuallv encounters an adjacent molecule of nitrogen, als excited, and stimulates a like amount of radiation in the form of an identic photon. This process further induces similar reactions in a syncronous fashion producing a large quantity of energy to be built up and creating laser action.

In order for this action to continue, the mount of excited nitrogen molecules must exceed the s ' pent absorL-ing ohes. Unfortunately, with nitrogen, this effect of the higher population excited molecules compared to the spent ones after being excited soon reverse with these excited molecules quickly returning to a lower energy state which is useless for laser action and actually now absorbs these waves of energy. This is a serious limiting factor of this type of device.

This deterioration of energy state ceases the laser action and occurs in about 100 nanoseconds thus producing very short energy pulses. It now is evident that to develop a device that will produce this energy via nitrogen gas, we must be able to excite these molecules almost instantaneously with tens of thousands of amperesthrough the gas. This is accomplished as illustrated and uses a method invented by a British electronics engineer, Alan Blumlein. The process is simple and the device is easy to construct. it is basically a flat capacitor with one plate split and acting as two capacitors with the unsplit plate being common to both.The two capacitors (split plates) are discharged through the gas as shown in Sketch "A". These two capacitors are connected together by a coil of wire that serves as an inductor (Ll). This inductor allows the two capacitors to charge up identically at the relatively slow rate of the power line voltage frequency; however, at discharge the rapid step of current cannot flow through the reactance of this inductor, hence a high potential is developed across it, sufficient for breaking down the nitrogen gas, and discharging the high current necessary for lasing. This step of current is produced when one of the adjacent capacitors (CB) is discharged via a park gap connected between it and the common plate. When this gap fires, this capacitor is electricallyconnected to the common plate. When this occurs, the second capacitor "CA" now discharges through the "Discharge GapAs this charge rushes to thespark gap, a potential difference now exists within the metal of the capacitor plate creating a circular wave receding from the spark gap. Basically what happens is this:The spark gan fires,casuing a voltage to occur at the center of the "discharge gap" and moving along to the ends in about.2 nanoseconds. This voltage develops to maximum in about one nanosecond and discharges across the gap. It is this discharge occuring in a flowing nitrogen gas atmosphere that excites the necessary molecules for producing laser action. This action exists for the next 10 nanoseconds and produces a pulse of light equal to about 25ma diameter by about 3 meters long (if we could see it) .

CONSTRUCTION STEPS FOR LASER SECTION

Dimensions are approximate and can be obtained from scale factors on sketche

1. Obtain a piece of circuit board (G10 or equivalent), copper cladded on both surfaces, and cut it approximately 12" x 18" x .15 thick. Identify bottom and remove a 3/4" strip around edges, (this surface is referred to as the "COMMON PLATE to CAPS CA & CB" in Sketch A). Identify Top and remove a 3/4" strip around edges - also remove a 2-1/8" strip down the middle along the width dimensions. These surfaces are referred to as "CA" and "CB" in Sketch A & B.

2. Fab two pieces of 1/4" Lucite - 12" x 2" mitre at a 20º to 30º angle as shown in Sketch "B" and "C", referred to as "TOP AND BOTTOM".

3. Fab four pieces of 1/4" lucite - 12" x 3/4" as shown in Sketch A,B & C. Referred to as "SIDES".

4.Attach "TOP" and two "SIDES" together using clear silicone adhesive. Jig and let cure. Use small screws for sturdier construction if desired. Repeat with "BOTTOM" and remaining two "SIDES" pieces. Note Sketch A,B, and C.

5. Clamp the two half boxes securely together and angle "SIDE" pieces to coincide with angle of mitred "TOP" and "BOTTOM" pieces. Use a belt sander or eauivalent remembering that final construction involves the placement of the plastic end pieces to these angled ends and must make an air tight seal. Note Sketch A, B, & C.

6. Clamp bottom half of box in place on circuit board temporarily. Cut two pieces of approximately .02" soft drawn copper sheet. 10-1/2", long by 3-1/4" wide. Form as shown and temporarily secure as shown in Sketch A, Note a lazy "S" configuration. These pieces are referred to as "Discharge Electrodes".

7.Leave Discharge Electrodes in place and remove lucite box to protect against heat. Solder along indicated strip shown in Sketch "B". Use torch or high wattage solder iron. Clean surfaces before soldering and use ample flux.

8.With two Discharge Electrodes soldered in ' Place and cooled off,slide the bottom half of the box in place and clamp.Adjust discharge gap to between .38 and .4" as shown in Sketch "A". Note that proper position of discharge gap must be coincidental with proper height of these copper pieces contacting the "SIDES" pieces of the bottom half of the box.

9. Again, carefully remove the bottom half of the box from under the discharge

electrode by a sliding action. Apply silicon adhesive to top surface liberally nut not sloppily. Carefully slide this section in place under the discharge electrodes while lightly holding them up with the finger until all is in place and releasing them comtacting the adhesive. Use finger to remove and smooth excessive adhesive along the inside of the box where possible.

10.Apply liberally but not sloppily, silicon adhesive along top of discharge electrodes and put top half of box in place as shown in skteches. Secure these in place and let set. It is important that everything is fitted properly before curing. Note Discharge Gap and Flushness of Angled ends At this point, the lucite box, discharge electrodes should all be in place and secured. Note Sketch A, B, & C. .

11. The next step is to fabricate the end pieces. Obtain two pieces of lucite 1/2 to 3/4" thick and cut pieces 2" x 2" square. Drill 3/4" hole in exact center use correct drills and speeds to prevent splitting. Drill and tap holes for hose fitting. Note Sketches "AA".

12. Obtain some thin glass such as that used for microscope slides and seal over 3/4" hole in end pieces using paraffin wax and heat lamp. This step allows these glass pieces to easily be removed when they get dirty

13. The end pieces should be attached to the discharge box with two small machine screws to hold in place along with the silicon adhesive. This allows more strength when attaching hoses, etc.

14. At this point, the discharge box enclosure should be checked for leaks.

15. Obtain a length of #18 solid wire and wind a 10 to 12 turn coil (inductor Ll) about 3/4" ID by 1" long. Connect as shown in Sketch "A" soldering to discharge electrodes.

16.Obtain a brass or copper strap of metal of about 1/8 to 1/4" thickness and 1" wide. Form and fabricate as shown in Sketch A (C shaped). Note tapped hole drilled for a 1/4-20 brass screw along with nuts. Gap fastened to bottom common plate via solder. Note piece of metal soldered to top plate "CB" directly opposite head of brass screw. STATIONARY ELECTRODE. This provides a heat dissipation and a lower conductive path for spark gap discharge. If device is to be continually fired, a protective shield should be placed around the gap to prevent unneceasary ultra-violet radiation.

17.Refer to Sketch "D" and locate the Laser section on a table or other convenient stand, etc. Observe the optical axis of the device and note that this is the path of the laser beam. Locate power supply, nitrogen and cooler and connect as shown. Nitrogen can be the same used by welders and does not have to be super pure. A regulator and low range pressure meter for tank pressure and line pressure are necessary.

To fire up system, it is assumed that the power supply, vacuum system, nitrogen source, cooler and laser section are properly functioning and positioned.

1.Power supply turned off, adjust spark gap to .2 to .3". Turn power on and allow gap to fire for a minute or so confirming that this part of system is working properly, Turn power supply off.

2. Turn on vacuum aspirator or pump and allow to pump down to limit. A mercurv U tube manometer is available through any scientific supply house and will help in this step.

3.Adjust nitrogen regulator very carefully and slowly for 100 torrs over system pressure noted on manometer. A torr = lmm of mercury and atmosphere pressure = about 760mm of mercury.

4.Turn on power supply and note output along optical axis. Allow a material that will fluorescess to intercept the beam. This material usually is anything bleached, certain plastics, psychedelic posters and the dye solutionused in dye lasers. A pronounced glowing should take place when this discharge gap fires through the nitrogen. If the laser is triggered by the line(120pps) it will be necessary to precool the nitrogen. This is accomplished by obtaining a regular polystyrene picnic cooler and carefully coiling about 50 to 60 feet of tubing and exiting this through the container sides. (Seal these points) . The cooler is then filled with preferably dry ice or ice water and the cover securely put in place. This method keeps the gas cool and allows laser pulse rate at 120pps maintaining good
efficiency. Further output can be obtained by placing a mirror at the opposite end and adjusting it to reinforce the beam in the direction of the optical axis.

A closed system allowing pulsing at one per second can be utilized by evacuating the system down to the limit, purging with nitrogen at 100 torrs and sealing this system at this pressure. Operation now requires only the laser section and the power supply but is only good for 1pps rep rates or lower. This is because the enclosed nitrogen when warmed up will not lase.

Final optimum output touch-up may result in a combination of spark gap setting, nitrogen pressure, temperature rep rate, etc. Note maximum adjustment points and record for future use.

Dyes used for dye lasers such as COUMARIN, FLUROL, RODAMINE OXAZINE, etc., will produce super irradiance intheir corresponding visible spectrum. The trick is to optically pump thesechemicals by focusing the UV in line at the surface of the dye with a cylindrical lens. Most of the time these dyes will lase superadiantly emitting a visible line along the direction of the UV pumping line. No mirrors are needed. This nitrogen laser makes an ideal pump for all dyes opening up the entire visible spectrum to the home builder for moderate cost and effort. If the required dyes are unavailable, DAY GLO plastic will sometimes lase under highly energetic UV pulses.

The nitrogenlaser can be scaled lower or higher for different levels of power. The lucite enclosure can be increased to about 3 feet with other proportionalincreases and can produce 1 megawatt pulses. To do this will involve repositioning the spark gap towards a corner of the laser. This is because the laser action terminates before the radiation has a chance to travel the full length of the discharge gap. When the gap is positioned at a corner of the laser, that end of the discharge gap will first receive the voltage wavethat will travel down the end of the discharge gap in coincidence to theradiation produced.

THIS IS A CLASS IV LASER DEVICE AND IT IS SUGGESTED THAT THE BUILDER CONSULT THE REGULATIONS PERTAINING TO 1040.10 and 1040.20 OF THE BRH 1968 SAFETY ACT. THE FOLLOWING CONSIDERATIONS REGARDING CONSTRUCTION SHOULD BE FOLLOWED:

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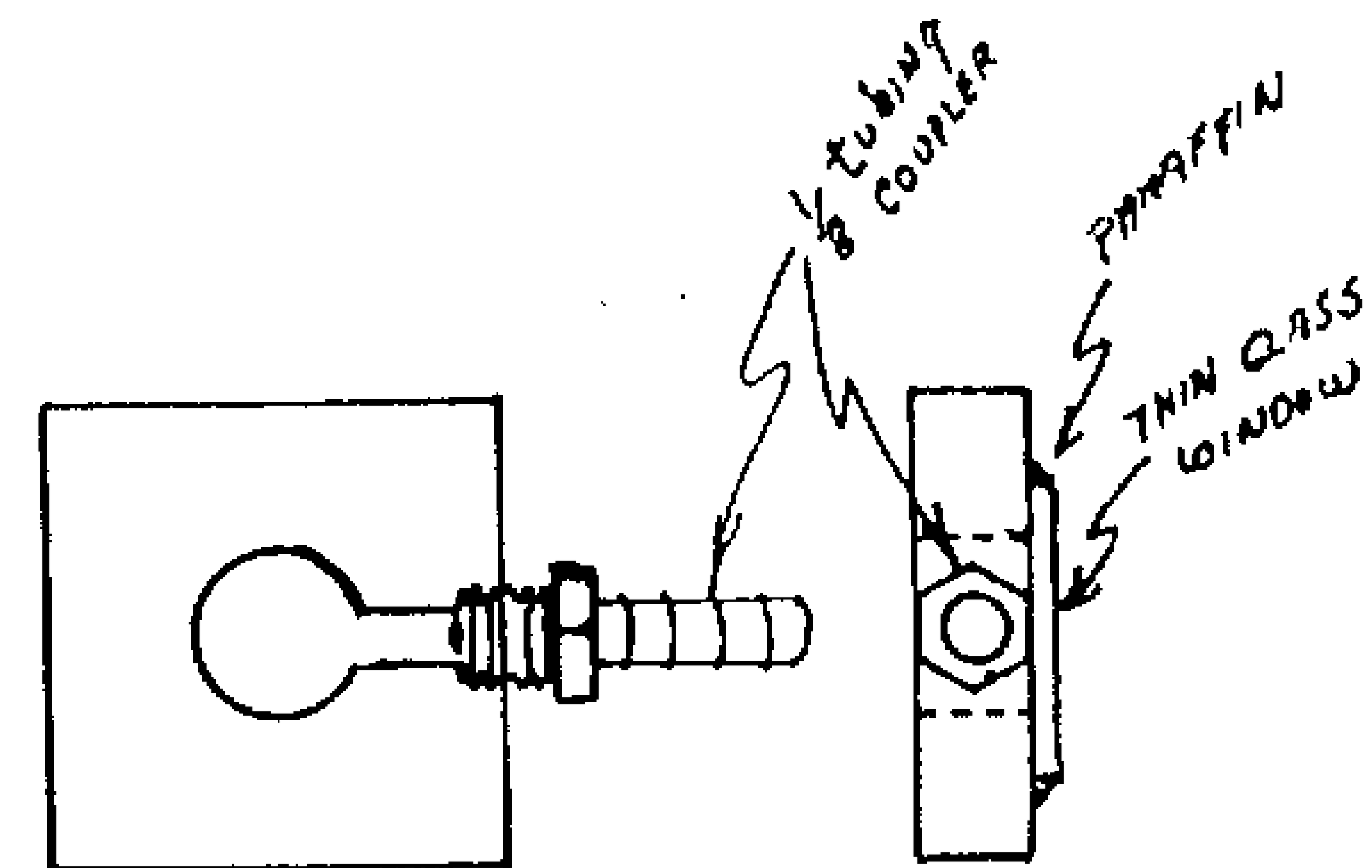
<table>
<tr><th>PERFORMANCE REQUIREMENTS</th><th colspan="2">LABELING</th><th>LITERATURE REQUIREMENTS</th></tr>
<tr><td>*PROTECTIVE HOUSING</td><td colspan="2">*CERTIFICATION</td><td>*LOGOTYPE ON BROCHURE</td></tr>
<tr><td>*SAFETY INTERLOCKS</td><td colspan="2">*IDENTIFICATION</td><td>*USER MANUAL</td></tr>
<tr><td>*EMISSION INDICATOR WITH EMISSION DELAY</td><td colspan="2">*LOGOTYPE:</td><td>*LABEL REPRODUCTIONS & LOCATIONS</td></tr>
<tr><td>*BEAM ATTENUATOR</td><td colspan="2"></td><td>*SPECIFICATIONS</td></tr>
<tr><td>*KEY CONTROL</td><td>111_a</td><td>111_b & IV</td><td>*INSTRUCTIONS TO AVOID EXPOSURE</td></tr>
<tr><td>*REMOTE CONTROL</td><td><u>CAUTION</u></td><td><u>DANGER</u></td><td>*LISTING OF CONTROLS & ADJUSTMENTS</td></tr>
<tr><td></td><td colspan="2">*LASER APERTURE</td><td>*SERVICE MANUAL- (ADJUSTMENT PROCEDURES RELATED TO LASER RADIATION SAFETY)</td></tr>
<tr><td></td><td colspan="2">*REMOVABLE PROTECTIVE HOUSING</td><td></td></tr>
</table>

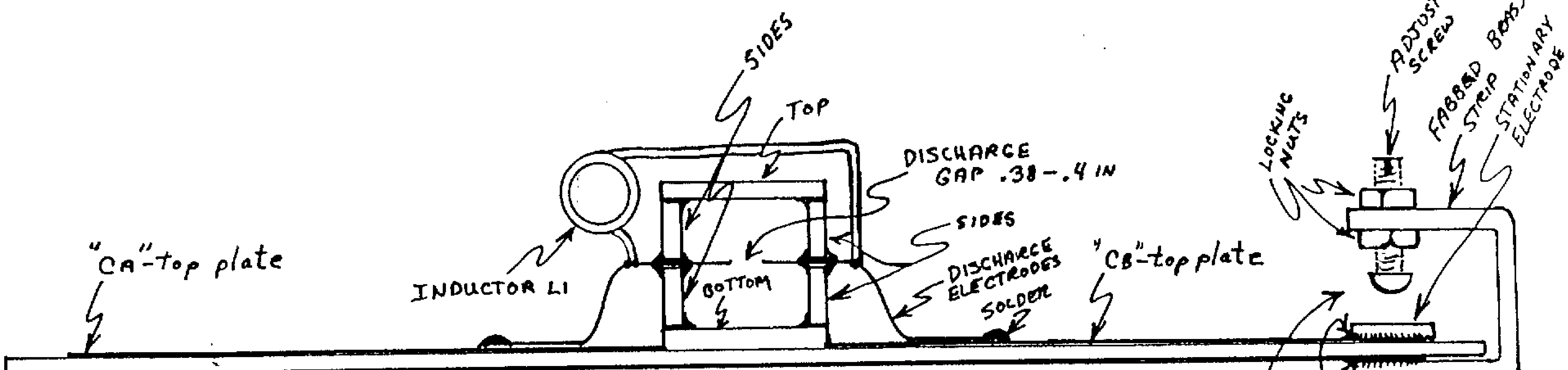
NOTE B To remove foil on circuit board, mask preserved surface with waterproof tape and etch with ferric chloride or dilute nitric acid.

NOTE C Note adhesive shown as black blotches in corners and along discharge electrodes.

NOTE E DISCHARGE GAP as referenced is not same as SPARK GAP.

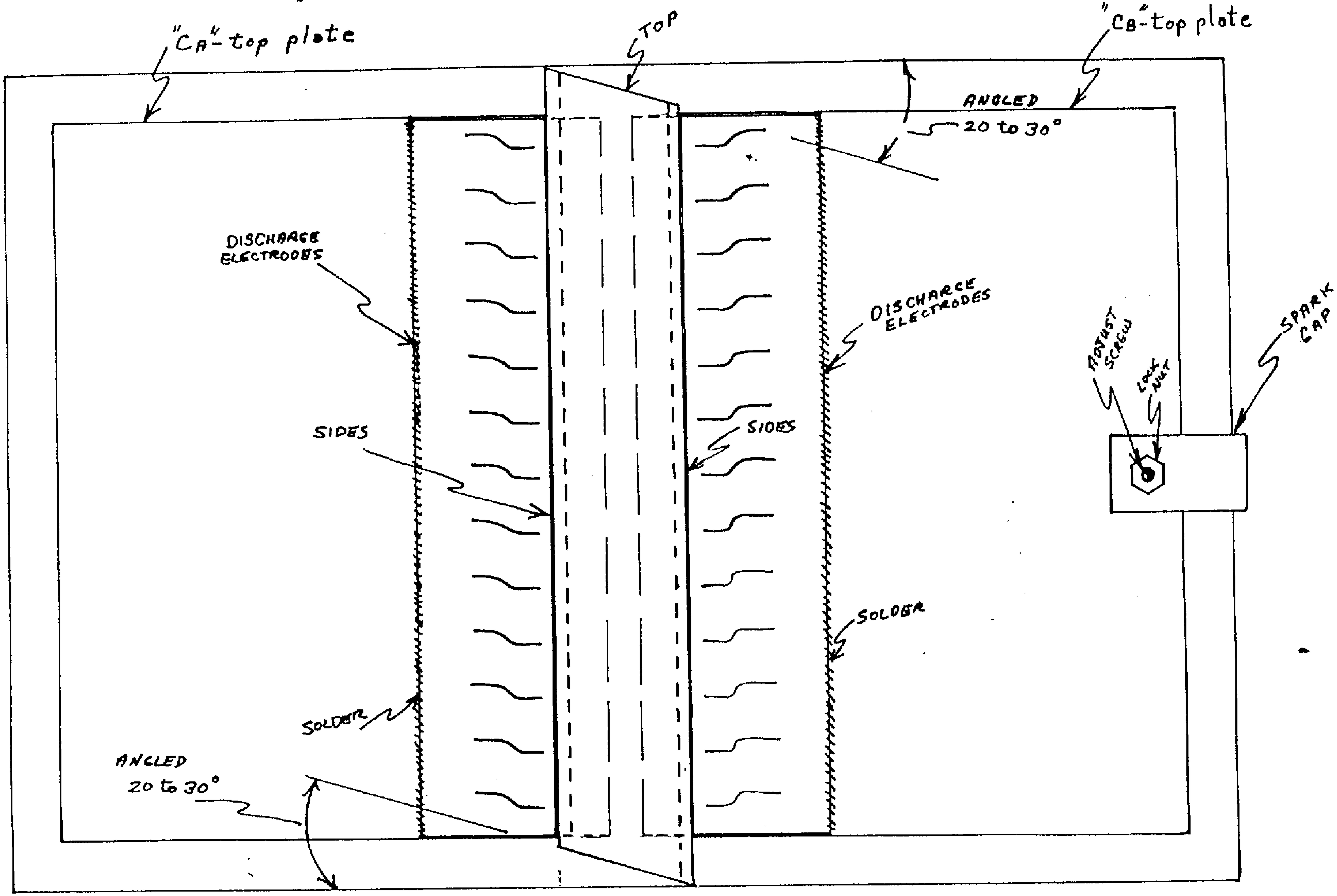


SKETCH AA
END PIECES — SIDE VIEW

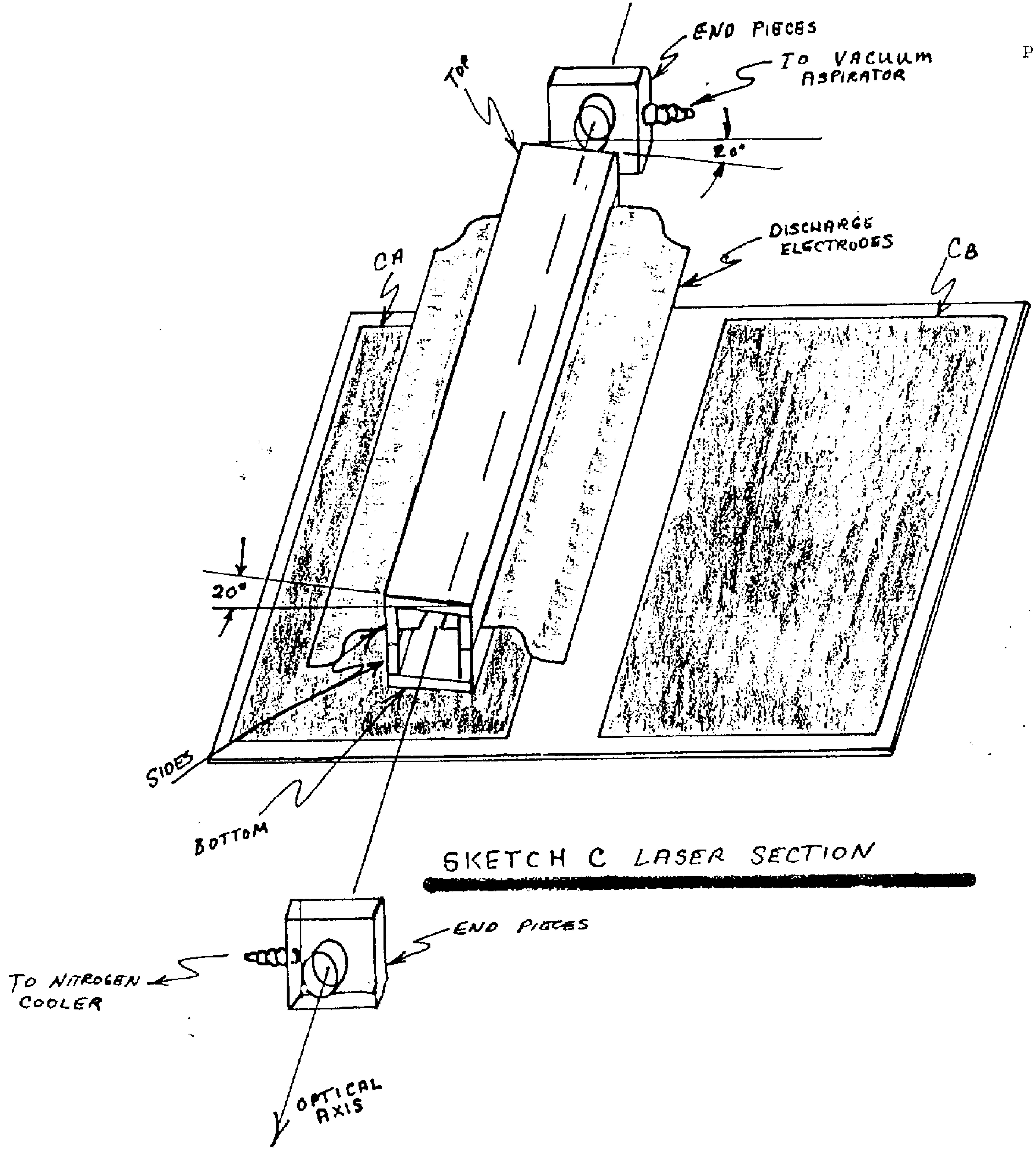


SKETCH A SIDE VIEW 1/2 SCALE

NOTE A Ends of enclosure angled to 20 to 30° to prevent back reflection into plasma via the glass windows.

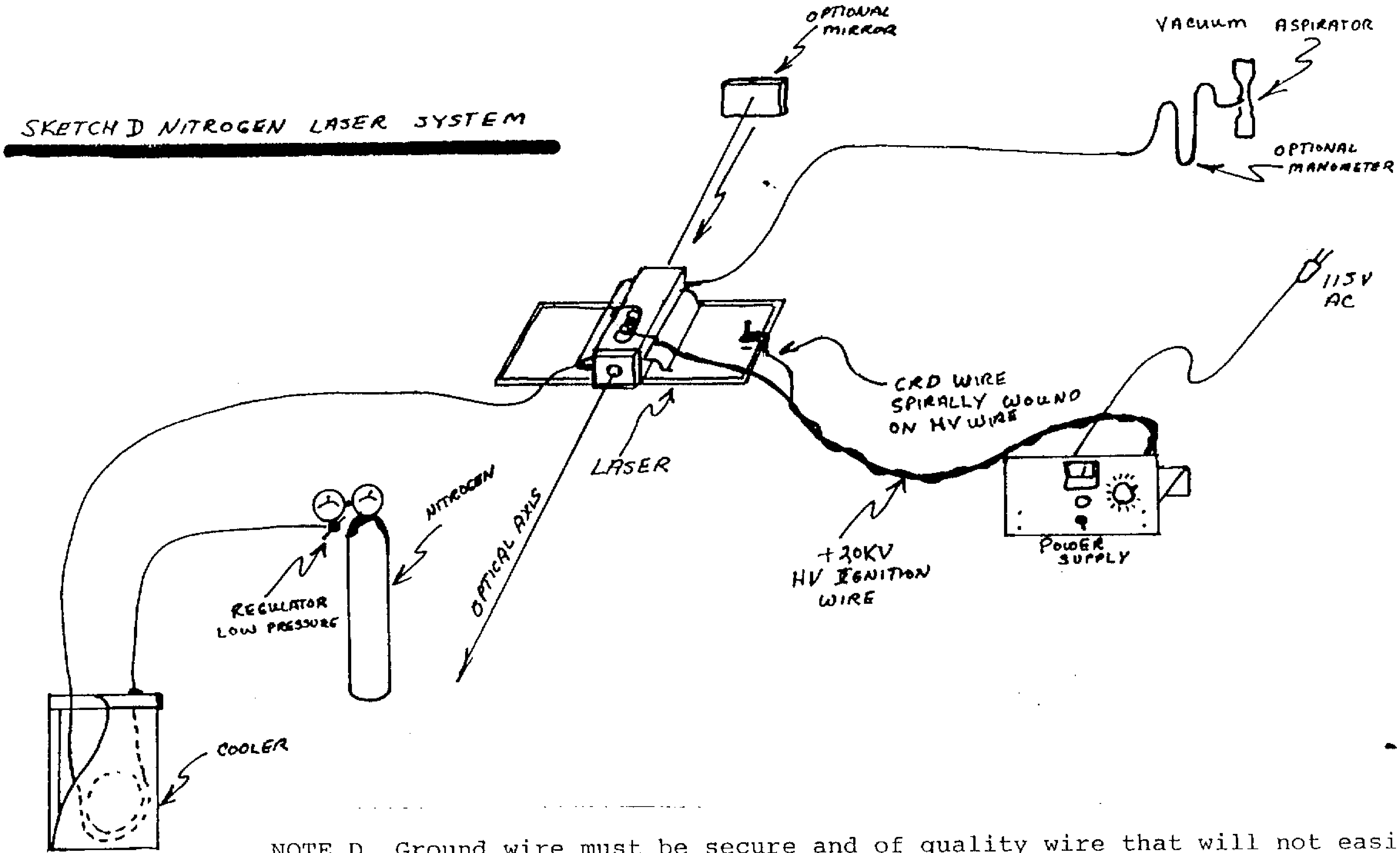


SKETCH B TOP VIEW 1/2 SCALE



SKETCH C LASER SECTION

SKETCH D NITROGEN LASER SYSTEM



NOTE D Ground wire must be secure and of quality wire that will not easily break or a potential dangerous HV situation will exist - Optionally ground common plate of laser to earth ground.

NOTE F Note, that unlike most lasers, there are no mirrors reflecting the beam back into the cavity. This is because of the large population of excited nitrogen atoms present for lasing. It should, however, be mentioned that output occurs at both ends reinforcing the already present beam. It also may help to improve efficiency by pre-cooling the nitrogen when using at moderate pulse rates.

POWER SUPPLY

CONSTRUCTION STEPS FOR NITROGEN LASER HV POWER SUPPLY-115VAC

Thefollowing plans show how to construct a variable voltage power supply producing 0-25000 volts at 4-15ma. The unit must be regarded as a potentially lethal device and consequently treated with extreme care, especially when using external capacitors.

1. Form chassis from 12" x 10" x 1/16" galvanized or thicker aluminum. Finished piece should measure approximately 10" x 8" x 2".

2.Drill holes for T1 transformer, PN1 Front Panel, C01 Power Cord, ST1 insulator standoffs (5), CL1 Cable Clamps, etc.

3.Form PN1 Front Panel from an 11" x 7" x 1/16" galvanized or thickeraluminum.Drill holes for S1 Switch, LA1 Indicator Lamp, Chassis Mounting holes, ME1 Meter, V1 Variable transformer, etc.

4. Fabricate 5 pieces of 2" long, 1/2 x 1/2 insulating standoff (ST1), from teflon, lucite, etc. Drill 3/8" holes in ends for mounting, etc.

5.Mechanically assemble as shown in Sketches.

6.Wire as per Schematic - keep primary leads near Front Panel and isolated from HighVoltage section.

7.Wire High Voltage Section - use round head screws and keep all wire leads with sharp points to a minimum. Note grounding of Di and C3 to ground lug under Insulator Standoff. Remove all burrs, sharp edges and coat connection points with anti-corona dope such as GC-50-2 by General Cement Company.

8.Determine length of High Voltage interconnecting cable CB1 and spirally wrap outside with stranded wire about one complete turn every 3 to 6". Tape for securing at various points. Clamp as shown via CL1 and connect.

9.Dotted lines show the placment of a plastic protective housing for enclosing the High Voltage Section, if desired.

10.A 25Kv meter should be used for testing, but is not necessary. Instead a spark gap can be placed between the junction of D4, C4 and Ground using a 20K-2 watt resistor spaced from 3/4 to 1" from the chassis. See Sketch shown in dashed lines.

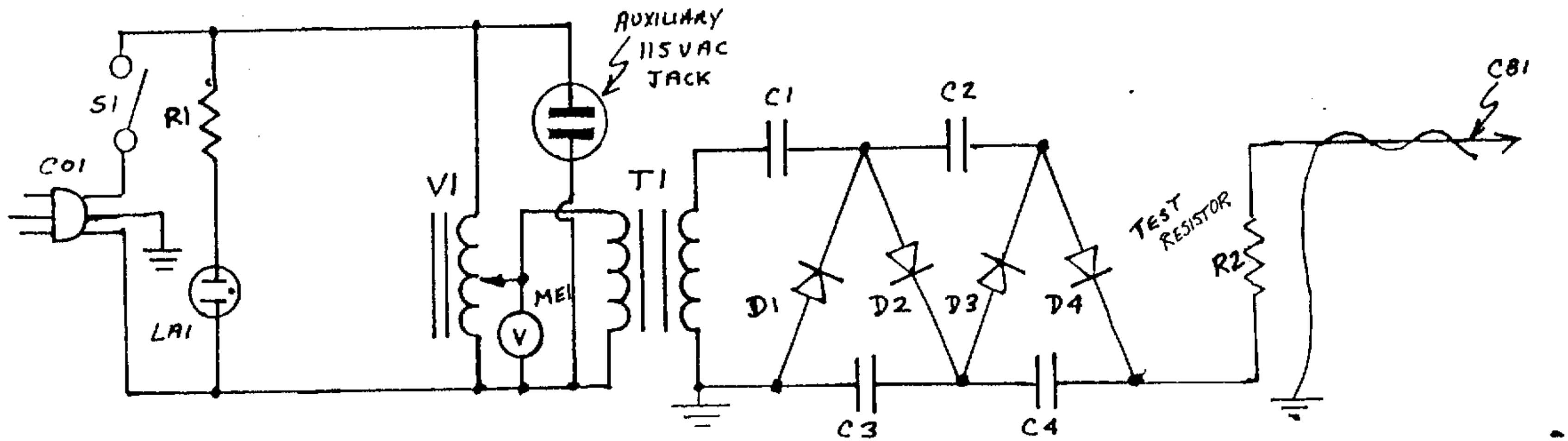
11.Turn V1 to minimum and plug unit into 115-V outlet. Turn on S1. LA1 should light and ME1 should read "0".

12. Slowly increase V1 until ME1 indicates about 25Vac. Shot end of spark gap resistor and note a small spark. Advance V1 to 115-Vac and note spark gap firing. Increase spark gap to no more than 1" and turn V1 to point that gap fires. Check for corona and other leakage with lights off or in low light.

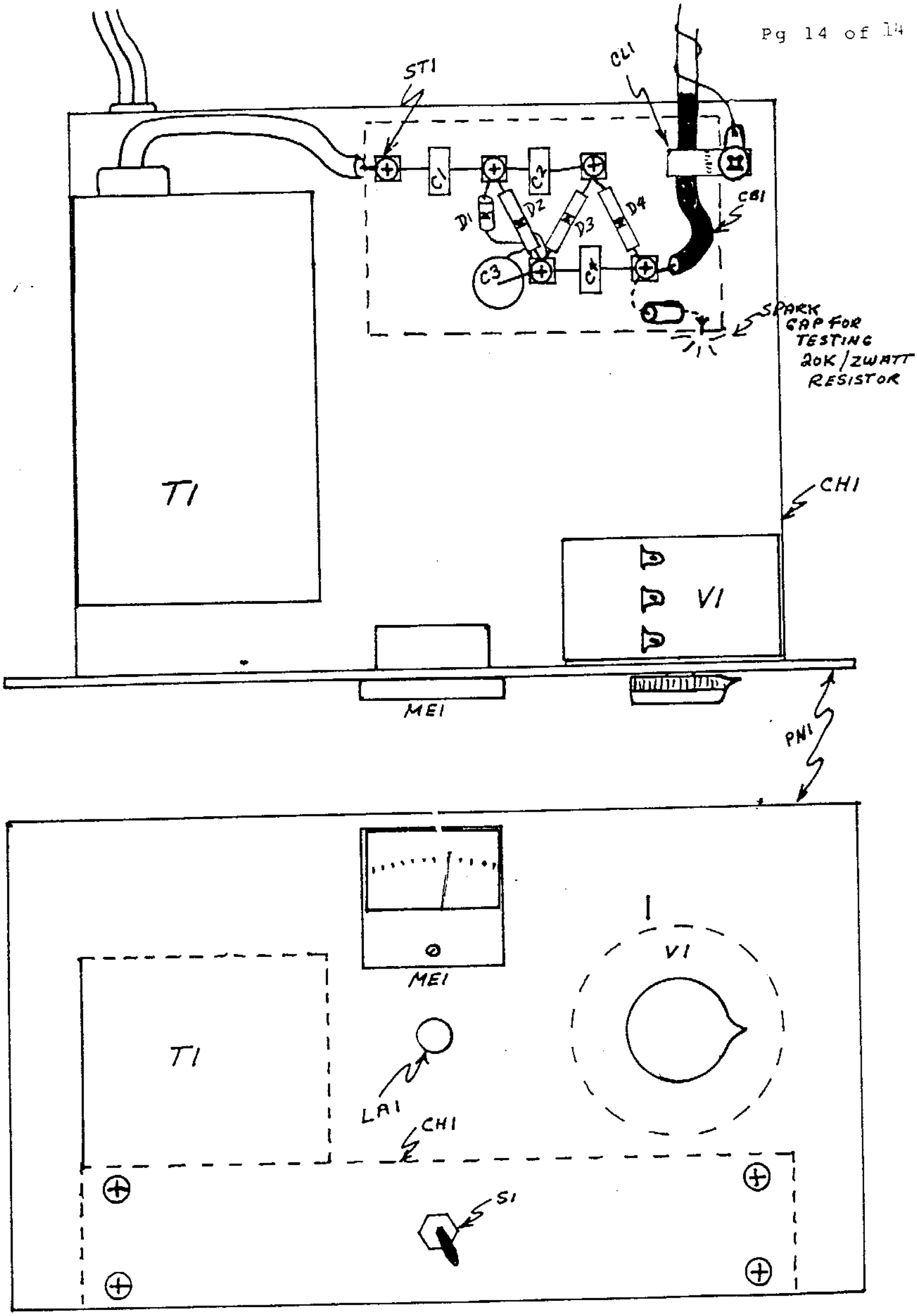
CAUTION- *Always discharge output before touching, as cap store a dangerous charge.* Use standard high voltage wiring and soldering thecniques.

PARTS LIST

*T1.	Jefferson Transformer 5000/.02 amps #112 (current limited)
V1	Variac 1.75 amps Staco #171
CH1.	8 x 10 x 2" chassis
PN1.	12" x 7" x 3/32" panel
ME1.	Meter 150V ac 2" panel
S1.	Switch SPST 3A/125V
LA1.	Light NE2
Lens.	Red
R1,	100K 1/4 Watt
C1,2,3,4.	.001mfd/15Kv ceramic with leads
D1,2,3,4.	10Kv 25ma High Voltage diodes
ST1,2,3,4.	Insulator Standoffs 2" long x 1/2 x 1/2 teflon
CB1.	High Voltage auto ignition cable wrapped with stranded ground wire.
Misc.	screws, nuts, washers, solder lugs, bushing.
R2	15K 1/4Watt



SCHEMATIC

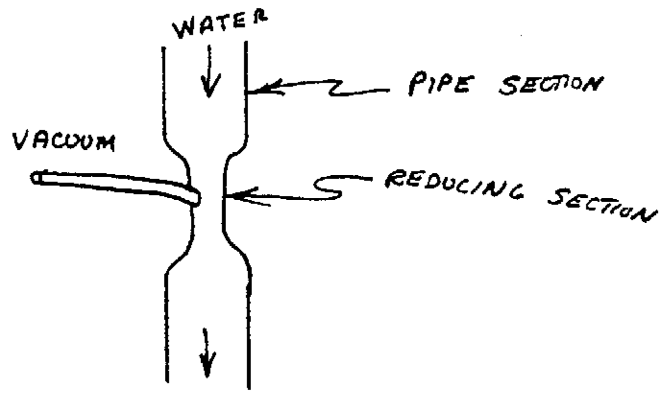


FRONT PANEL SCALE 1/2

LOW-COST VACUUM PUMP FOR NITROGEN LASER

Chemical and other industrial laboratories have a requirement for a cheap, ready source of powerful vacuum or suction. This type of-vacuum, less powerful than that produced by expensive mechanical pumps, is used for such routine procedures as suction filtration, evacuation of vacuum dessicators, routine low-pressure distillations and the drying of glassware. It can also be used in many non-chemical experiments such as the fabrication of glow tubes, particle accelerators ("Atom Smashers") and pressure gauges.

The principle involved is Bernoulli's Theorem. Basically stated, this theorem states that the pressure of a stream of tiuid (such as water) drops as the velocity increases. As pressure is exerted at right angles to the direction of fluid flow, this decrease in pressure can be applied to a pipe inserted at a right angle to a pipe carrying a flow of high pressure water. The basic design of such a device, called either an "aspirator" or a "water pump" is shown in Figure 1.



The lowered pressure in the vacuum line causes air to be drawn into and trapped by the water stream. The vacuum rapidly lowers to a limit which is the vapor pressure of the water. Figure 2 gives the vapor pressure of water at various normal temperatures (such as might be found in normal tap water).

Figure 2

TEMPERATURE (Centigrade°)	VAPOR PRESSURE (mm of mercury)
25°	23.8mm
20°	17.5mm
15° room temperature	12.8mm
10°	9.2mm
5°	6.5mm
0° ice water	4.6mm

While this type of pump can be assembled from common pipe parts. as shown in Figure 1, the cost and effort involved as well.as the availability of well-designed, efficient, low-cost plastic units (readily usable on home faucets) would hardly make the effort worthwhile.