rev1099

PLASMA FIRE SABER

SABDON

Electrical Science Project Kit Demonstrating High Frequency Electricity

Note it is possible to receive an annoying pin prick burn if contact is directly made to output connection by actual finger or other body part. This project is recommended for ages of 10 to 16.

Why does the light travel up the tube without a connection wire on the other end?

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Your *Plasma Saber science project* kit demonstrates several important scientific princples as well as being a fun product for both young and old. It utilizes a patented lighting display effect* where a column of plasma (being an electrically ignited gas giving off visible light) is varied in length and brightness. This gives the effect of a controllable length of light emitting from the handle and flowing out into space. Total control of this display effect is accomplished by simple grip contact to the saber's handle. The uniqueness of the flowing light can be utilized to provide an indication of direction such as turn signals for vehicles, semaphore signaling, pointing devices or an excellent safety device for night time jogging or walking. *The concept also produces the effect of the Star Wars™ Light Saber.*

(Our *Patent #4,742,278 and 5,089,745)

EXPERIMENTS AND DEMONSTRATIONS Shown in detail on page 7 .

■ The ability to power light sources from a distance without wires opens up many interesting possibilities and is shown in our ***Wireless Energy*** experiment.

■ The surface properties of this energy can be clearly demonstrated in our ***Magic Man*** experiment.

■ The action of the finished device appears to defy all reason in that current flows into empty space and is shown in our ***Electrical Field Capacity*** experiment.

■ Flashes of light are clearly visible in dark conditions without any external power demonstrating the energy from our ***Static Charge*** experiment.

■ Wireless control of our interactive sound module demonstrates and explains the operation of several electronic circuits combined in a unique system that changes in tone as the finished operating saber is moved to and fro. This is covered in our ***Saber Sound Module*** expereiment requiring this optional project kit.

■ A ***Fun Trick*** that demonstrates the skin effect of high frequency electricity can fake out your pals. The trick is to firmly grab a metal object such as a screwdriver and contact the output pin drawing a visible electrical arc. Pretend you are in pain as you perform this daring feat-of course you do not feel a thing as the high frequency energy flows on the surface of your skin!

CIRCUIT THEORY REF FIG 1

The system utilizes a high frequency, high voltage plasma power source that connects to only one electrode of the display tube. This eliminates the return connections required in conventional systems. Ignition of the plasma discharge now appears to occur extending outwardly into space without a return connection. In actuality high frequency electrical currents are flowing thru the capacitive reactance of the plasma tube with the surroundings where the glass enclosure acts as the dielectric between the two. The user, by hand contact to the control pads, forms the other plate of this virtual capacitor.

The circuit consists of transistor **(Q3)** connected as a Hartly type oscillator where its collector is in series with the primary (PR1) of transformer **(T1)** and is energized by batteries **(B1,2)**. Drive signal to its base is obtained by a “feedback” (FB) winding properly phased to allow oscillation to take place. Base current is limited by resistor **(R4)** and biased into conduction by resistor **(R3)**. The oscillations produced are at a frequency of approximately 100 KHZ being stepped up to the necessary voltage by the turns ratio of the secondary to primary windings of T1. This frequency is determined by the parallel combination of the resultant primary inductance and capacity of **(C4)**. Resistor **(R5)** is necessary to stabilize the oscillator from parasitics.
The current thru **Q2** hence the power to **Q3** is controlled by the DC ramp amplifier **Q1. Q1** transistor is now controlled when base current flows thru resistor **R2**. This occurs when the users fingers bridge two external pad contacts and biases **Q1** to a point dependent on the users contact resistance. *This effect produces the variable current ramp that controls the current thru pass transistor **Q2** hence controlling the output of **Q3**. No off/on switch is necessary since total power is controlled by the users finger contact, A capacitor **C1** bypasses any external signals that may cause premature operation while **R1** controls the sensitivity range of the necessary contact resistance for full ignition as well as linearity. Power is via 2 standard 9 volt alkaline batteries providing a total “on time” of many hours.

*A dry hand may require a tighter grip where a damp hand requires only light touch to achieve full plasma ignition.

BASIC CONSTRUCTION

Construction is shown in two parts consisting of the *handle* and *display tube*. The display tube is now easily changed for selection of other colors, lengths or should blade become damaged.

The display tube section of the device can vary from a 12 to 36”" length of small diameter neon or other gas tube. This internal gas tube is centered into a plastic shroud on rubber shock washers that help prevent breakage. The display tube assembly is simply screwed into the handle section where it contacts a *spring loaded plunger pin*.

CONSTRUCTION STEPS CHECK LIST

1. ( ) If you are a beginner it is suggested to read the enclosed pamphlet titled GENERAL CONSTRUCTION PRACTICES AND TECHNIQUES *available thru Information Unlimited order#GCAT1.* Proceed by identifying all part bags with the parts list. Verify the values of the electronic parts to the color charts in rear of the pamphlet. Place the parts by bag in dishes or bowls to prevent loss and yet easy access.

2. ( ) Identify the PC (printed circuit) board and insert the resistors starting with R5. Note the other resistors are mounted vertically and will help to have leads prepared as shown in the sketch inset on Fig 2. Carefully solder these components into place.

3. ( ) Identify the capacitors C1 thru C4 inserting and soldering as above. Note that C2 has a + sign on it indicating polarity and must be positioned as shown.

4. ( ) Assemble HS1 heatsink bracket onto transistor Q3 using screws and nuts SW1/NU1. Note this is shown more clearly on isometric drawing Fig 3.

5. ( ) Identify transistors Q1 and Q2 noting that Q2 is a PN2222 and Q1 is a PN2907. Note the flat side of the case as they are inserted into the PC board. Allow a 1/8” spacing between the body and board surface as shown on inset drawing Fig 2.

6. ( ) Insert and solder switch S1 as shown. Note elevated legs.

7. ( ) Insert Q3 and heatsink bracket assembly as in step and solder in place.

8. ( ) Assemble the contact assembly using the hardware as shown on Fig 2 ,3. Note position of spring and contact plunger as it is the point that makes contact with the display tube. Plunger must freely move against the spring and return for proper operation.

9. ( ) Solder in T1 transformer-Note angled mounting scheme.

10. ( ) Solder in LEAD2 as as shown. Note that this lead must be electrically attached to the CONTACT BRACKET ASSEMBLY. You may solder directly to main body of these brackets or attempt to sandwich lead under one of the screws SW2. Either way must be a secure connection for proper operation.

11. ( ) Solder in two leads for LEAD1 noting the position of the black lead as this is an external ground reference point. The orange lead is the floating contact probe lead. Note that these two leads will eventually connect to the metal touch probes located on the opposite handle halve.

12. ( ) Solder in LEAD3 and the two battery clips CL1 and CL2. It is a good idea to put a dab of glue or silicon rubber to keep the battery clip leads from fraying, eventually breaking from handling.

13. ( ) This completes the board assembly. It is suggested to double check your work for correct components, positioning, intergrity of solder joints, solder bridges and shorts on printed circuit board.

You are now ready to test your work. If you have done your homework and Murphy’s fundamental law of “what can go wrong, will go wrong” does not rear its ugly head, your circuit will work like a charm!

14. ( ) Position the above assembly board so that the plunger pin is making contact with the center connection point of the DISPLAY BLADE. Use modeling clay and your own ingenuity in performing this temporary step.

15 ( ) Push switch slide forward and join the black and orange leads from step 10. Quickly contact the correct pins on a 9 volt battery to one of the battery clipc noting DISPLAY BLADE fully lighting. *Those with test equipment may wish to compare readings as noted on Fig1*

16. ( ) Disconnect joined leads and position slide switch to rear noting display shutting down. Wet fingers ang contact both free leads noting light moving to end of display tube. Recheck action of switch noting total control of display.

If your assembly board works as above you now can perform the experiments and demonstrations as noted on page 7 before assembling into the completed SABER.

17. ( ) Identify the handle halves as shown Fig 4. Screw in the completed ASSEMBLY BOARD using the four screws SW3.

18. ( ) Snap in the CONTACT PROBE STRIPS into the other halve handle piece. Solder the black and orange leads from the ASSEMBLY BOARD to these strips. Note a dab of glue is suggested to secure in place.

19. ( ) Slide on SLIDE SWITCH ACTUATOR PIECE. Note a small piece of masking tape can be used for shimming if to loose.

20. ( ) Snap the two handle halves together being careful not to pinch any wires. Verifying a positive fitting with no spaces in between the sections. *Do not glue at this time!* Screw the rear cap on and screw the hilt sections together using the black sheet metal screws SW4.

21. ( ) Wrap handle with tape or another temporary method to hold together. Screw in the BLADE ASSEMBLY until it bottoms out. This point should be about 1/4” below the lower extremity of the hilt as noted on Fig 5 inset. ***The BLADE ASSEMBLY is supplied enclosed in its protective shroud with the mating fittings and contact mechanism. Other colors and sizes are available for your kit***

22. ( ) Make sure rear of handle is wrapped to keep it together as you must unscrew the cap to install the two 9 volt Radio Shack alkaline batteries. Slide switch to “off”. Failure to do this may cause handle to prematurely separate.

23. ( ) Verify proper operation where tube easily fully lights when you bridge TOUCH PROBES and actuate slide switch. Check for control of display length by touch probe pressure. You should be able to start display at bottom and smoothly control it to extend the full length of the tube. Note that saber may only power up part way if you do not hold the handle. This is because operation depends on your body capacity as the other electrode for the high frequency to flow to from the saber blade.

24. ( ) You can now glue the handle halves together using a good plastics glue. Make sure you keep the handle pieces clamped together or the glue will not properly set.

You now can **“go forth and lite up the world”**

PARTS IDENTIFICATION **Note contents in bags may vary slightly**

To simplify construction for beginners we have individually packed the components as used in the various steps of assembly. Components functions are briefly explained for those who desire to understsand the circuit operation.

BAG #1..... *Contains hardware, heatsink and contact assembly brackets*

SW1 #3 Machine screw and **NU1** #3 Hex nut for attaching *HS1* heatsink to *Q3*
HS1 Heatsink aluminum angle bracket with hole-keeps *Q3* running cool.
SW2 (4) #2 Machine screws **NU2** (4) #2 Hex nuts-use for attaching *Brackets* to *PC Board*
BRACKET (2) Fabbed as shown Fig 2,3-For retaining spring and plunger assembly See fig 2,3
PLUNGER (1) Small brass pin as shown.
SPRING (1) Small spring as shown
SW3 (4) #2 Sheet metal screws for attaching board assembly to *handle halve.*
SW4 *(4) #*3 Black sheet metal screws for securing *handles halves together.*

BAG#2.*.....Cintains Resistors, Capacitors, Semiconductors*

R1 (1) 5.6M 1/4 Watt carbon resistor with ***grn-blue-grn*** color bands
R2 (1) 1K 1/4 Watt carbon resistor with ***brn-blk-red*** color bands
R3 (1) 2.2K 1/4 Watt carbon resistor with ***red-red-red*** color bands
R4 (1) 330ohms 1/4 Watt carbon resistor with ***or-or-brn*** color bands
R5 (1) 39ohms 1/4 Watt carbon resistor with ***brn-wht-blk*** color bands

FUNCTIONS (Resistors)

R1 Sets sensitivity of display tube length to finger resistance by biasing Q1 slightly but positively “on” Lowering this value will desensitize the touch probes requiring more positive contact for full length operation. This may be desirable if skin resistance is real low or moist.
R2 Prevents catastrophic base current flow should touch probes be shorted.
R3 Sets the bias voltage of Q3 to start conducting.
R4 Sets the base current of Q3 providing saturation yet not overdrive.
R5 Provides stable operation of Q3 at higher frequency when TI is fully loaded.

C1 (1) .01mfd at 50 volts green mylar capacitor marked 2A103J
C2 (1) 10mfd at 50 volts vertical mounted blue electrolytic capacitor marked 10ufd 50 V
C3 (1) .022mfd at 50 volts green mylar capacitor marked 2A223J
C4 (1) .1mfd at 400 volts red metal film capacitor marked 104K 400V

FUNCTIONS (Capacitors)

C1 Bypasses any AC signals thatcould cause the circuit to erroneously turn on.
C2 Bypasses oscillation signal of Q3 to ground and decouples it from Q2.
C3 Speeds up the switching of Q3 by removing base charge.
C4 Resonates with primary inductance of T1 providing a reasonable smooth half sine wave of approx 3 times the battery voltage (Vc).

Q1 PN2907 PNP Plastic transistor as marked
Q2 PN2222 NPN Plastic transistor as marked
Q3 MJE182 NPN Plastic power transistor as marked
S1 Heavy duty slide switch

FUNCTIONS

Q1 Conductance amplifier controls base current to Q2
Q2 Linear pass transistor controls voltage to oscillator via base current from Q1
Q3 Oscillator transistor generates controlled high frequeny pulses to step up transformer T1
S1 Turns saber "on" bypassing the contact probes. Intended for those wearing gloves etc.

BAG#3..... Wire jumps and battery clips.

LEAD1 (2) 5" Lengths of one black and one orange stripped and tinned leads
LEAD2 (1) 2" Length of red stripped and tinned lead
LEAD3 (1) 3" Length of purple stripped and tinned lead
CL1,2 (2) 9 Volt battery clips
T1 (1) Transformer
PC Printed Circuit Board
Contact Probe Strips (2)
Switch Extension

Test Lead (2) Red and Black for experiments page 7 (Builder supplies)
Mini Neon Lamp for experiments page 7 (Available thru Radio Shack)

FUNCTIONS

LEAD1 (2) For interconnection to contact probes strips inserted into handle half. Orange and black.
LEAD2 For interconnection of output of T1 to contact plunger brackets
LEAD3 For board jump connecting arm of S1 and V+ point.
CL1,2 For power connection to 9 volt batteries
T1 Steps up voltage to energize neon tube in BLADE ASSEMBLY.

Miscellaneous parts

Construction Plans
Handles Halves and Rear Screw on Cap
Blade Assembly 36" 24" or 15" Color Choice of *Red, Green, Blue, Purple or Yellow*

EXPERIMENTS AND DEMONSTRATION PROCEDURES

WIRELESS ENERGY You should obtain a household fluorescent lamp but can use the display blade of the saber or the mini neon lamp. Using the black test lead, connect the black lead from the assembly board to a grounded or large metallic object. *Note the socket plate screw of most outlets is a good ground.* Connect the red test lead to the plunger pin and extend upwards like an antenna. Turn slide switch on and bring a lamp near the output lead noting it glowing in the proximity but yet not requiring physical contact. **Uses setup A on page 13**

MAGIC MAN Using the above setup, contact the plunger pin firmly holding a metal object. Grab one of the above lamps with the other hand and note it glowing. This demonstrates the ability of the body to pass high frequency electricity without any noticeable feeling. It also is a neat magic trick!!

FUN TRICK Similiar in setup of above MAGICMAN but now you draw an arc to the plunger pin. Fake out your pals that this energy is going thru your body causing intense pain!!

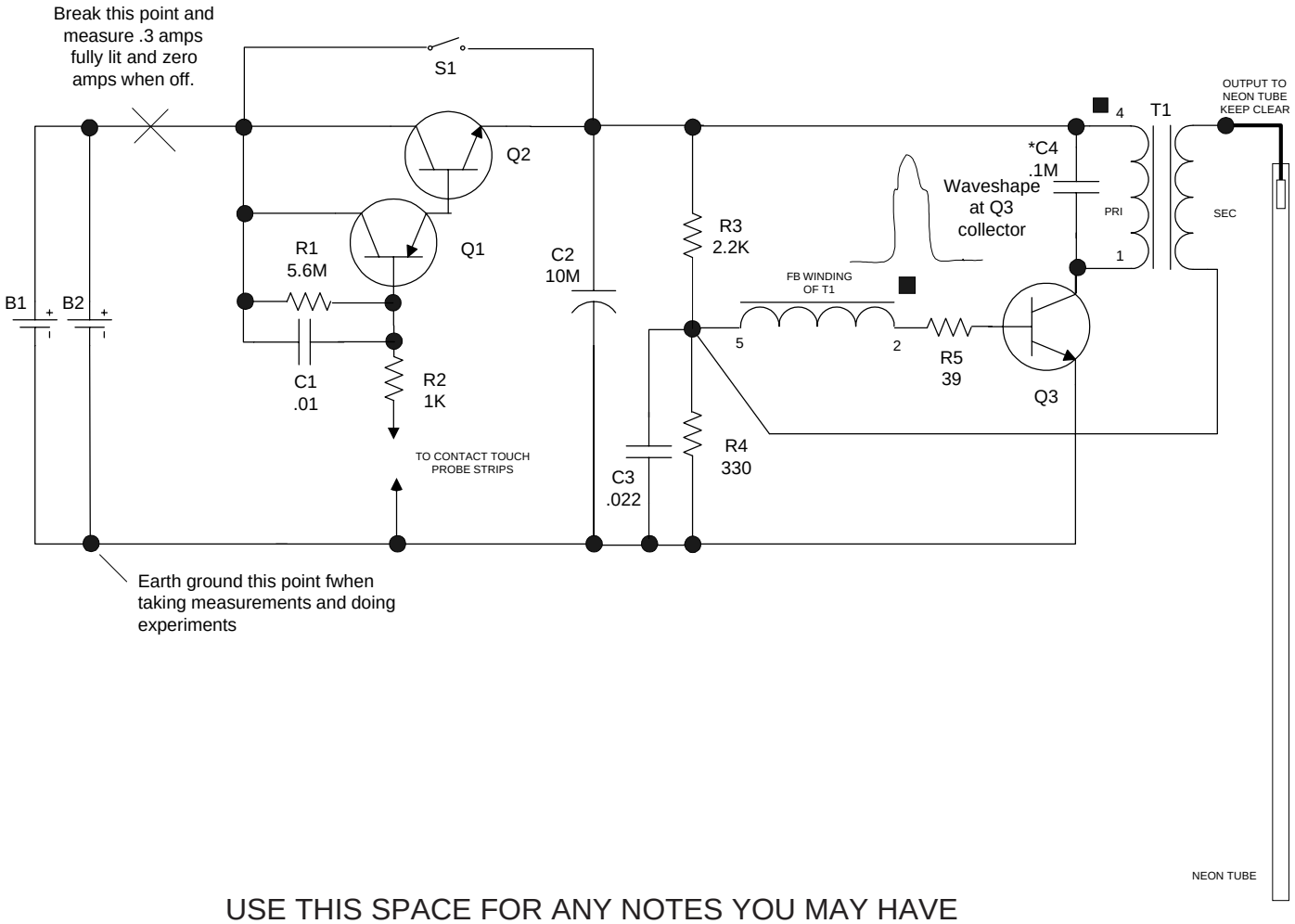
ELECTRICAL FIELD CAPACITY Using the above setup connect the plunger pin to one end of a long fluorescent tube. Note it lighting without any contact to the other end. Grasp the other end with your hand noting display getting brighter. This is due the capacity of your hand or other objects being able to pass high frequency electrical currents without a direct contact.

STATIC CHARGE You must wait until night and your eyes become accustomed to the dark. Grab the display blade and rub it with a cloth noting minutes flashes occuring in the display. Experiment with different materials for the rubbing medium and do not forget the cat!! This experiment clearly shows the gas within the tube breaking down as the result of the static charge occuring on the plastic shroud. Note that the neon requires almost 100 volts to break down!!

SABER SOUND MODULE (pat pend) This experiment requires our electronic sound module #SABSOUND as an optional product. Final assemble the saber as shown. Place the sound module on a table and turn “on” setting volume at 1/2 throttle. Extend antenna about 12” and energize saber noting sound module coming to life and changing tone as saber is moved “to and fro” Experiment at various distances with antenna settings and note range of control. See if you are as creative as our design group and attempt to figure how we do the tone changing without dissecting the circuit.

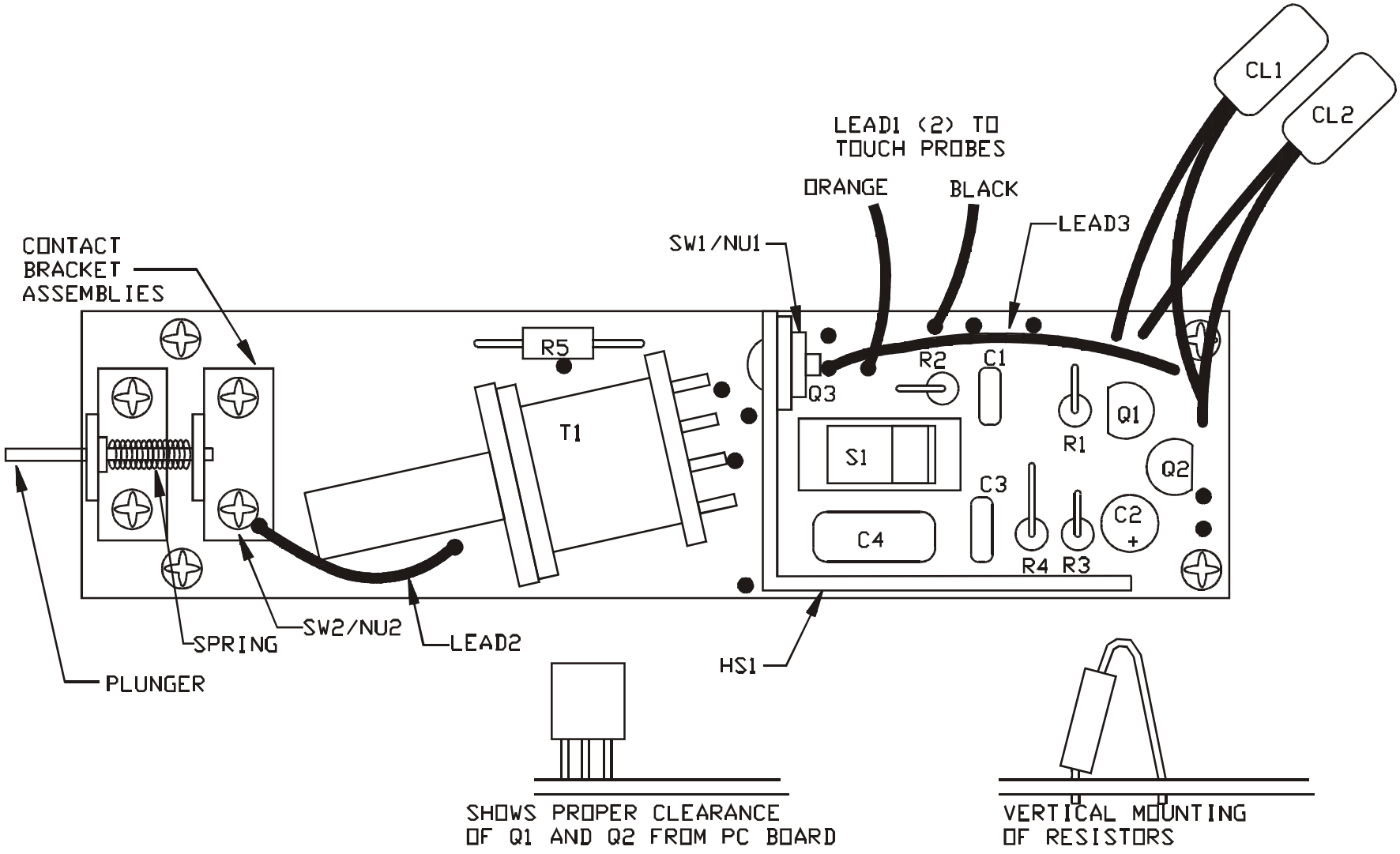
SABERSCH

FIG 1 PLASMA FIRE SABER SCHEMATIC



USE THIS SPACE FOR ANY NOTES YOU MAY HAVE

FIG 2 ASSEMBLY BOARD



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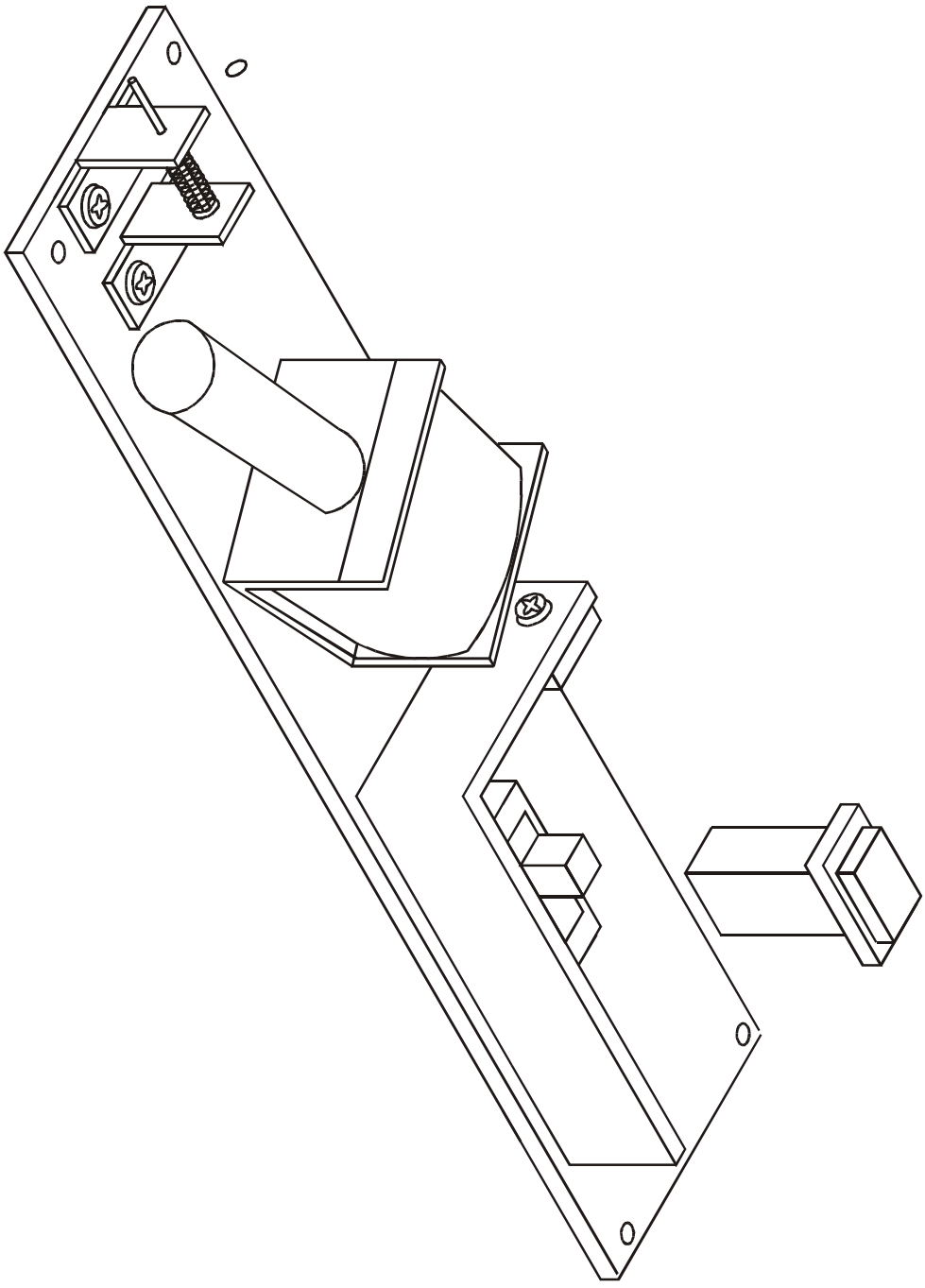


FIG 4 ISOMETRIC OF SABER BOARD LAYOUT

SABERBRD

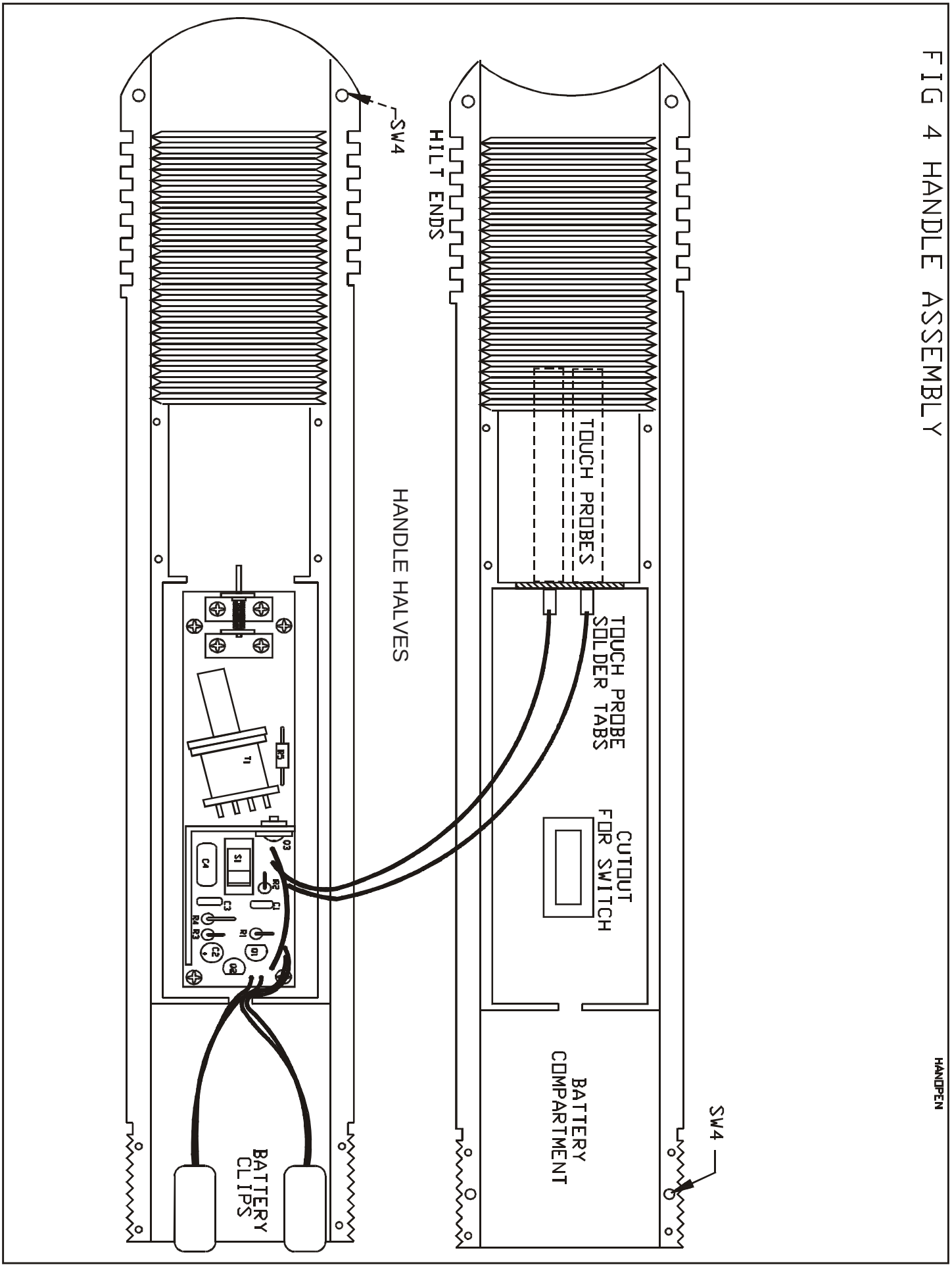


FIG 4 HANDLE ASSEMBLY

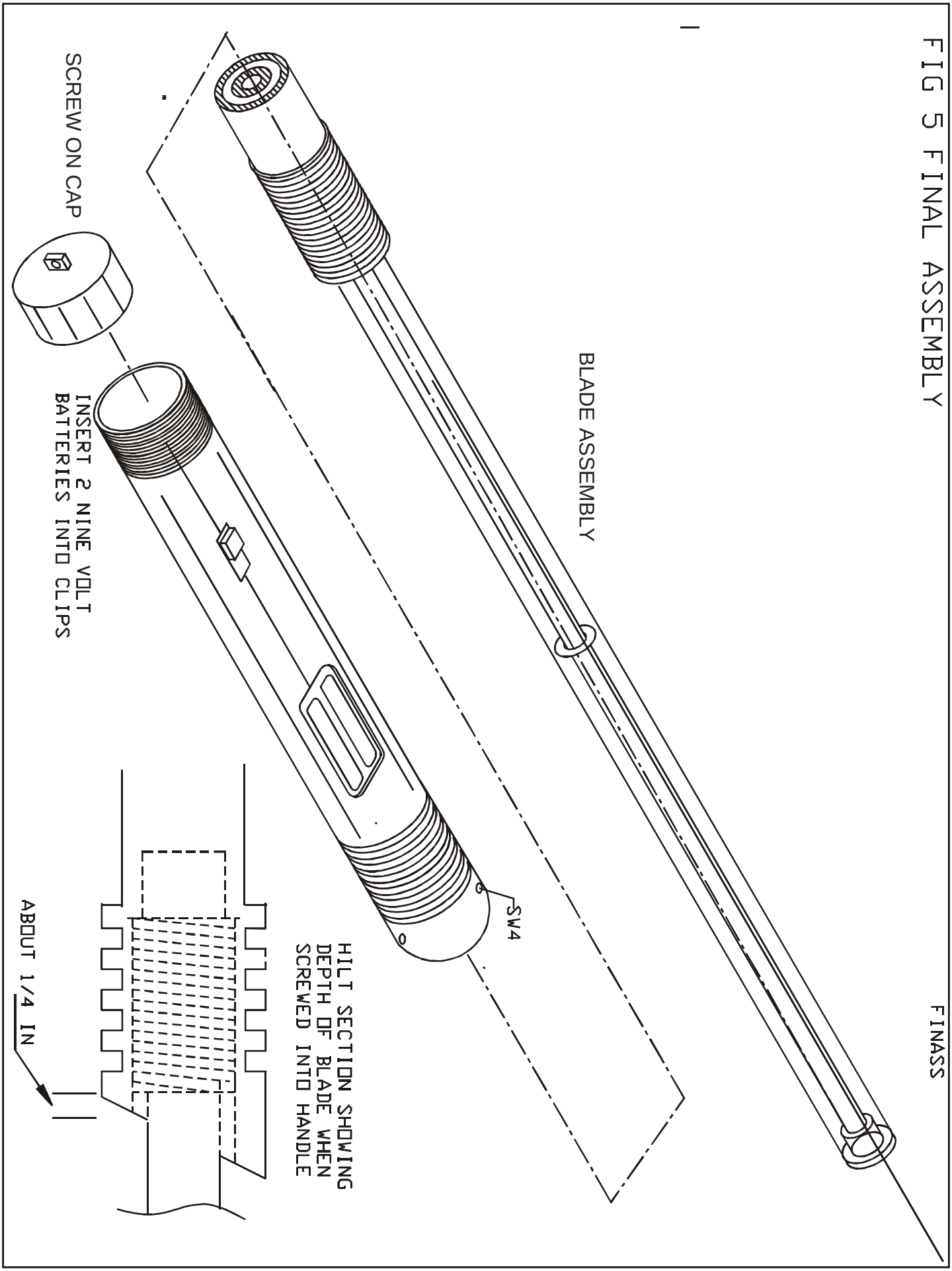
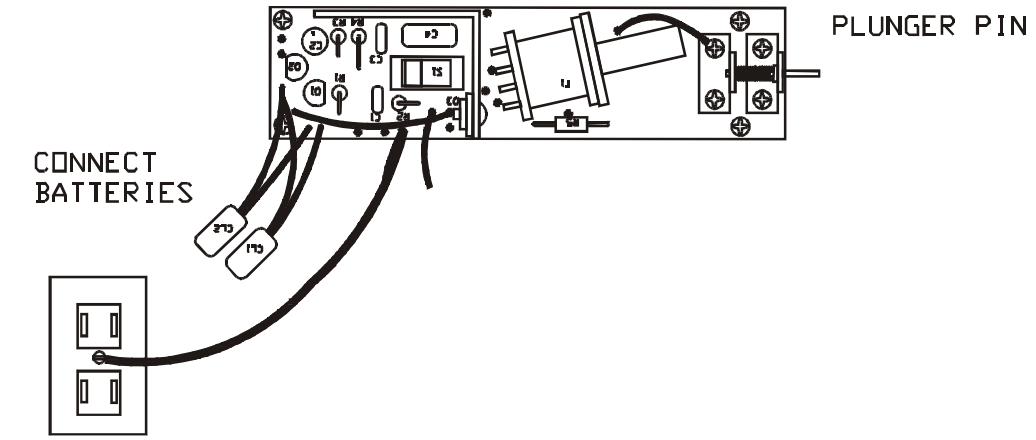


FIG 5 FINAL ASSEMBLY
FINASS
BLADE ASSEMBLY
SCREW ON CAP
INSERT 2 NINE VOLT
BATTERIES INTO CLIPS
SW4
HILT SECTION SHOWING
DEPTH OF BLADE WHEN
SCREWED INTO HANDLE
ABOUT 1/4 IN

EXPERIMENTS

SETUP A



GROUNDING SCHEME USING SOCKET PLATE SCREW

SETUP B

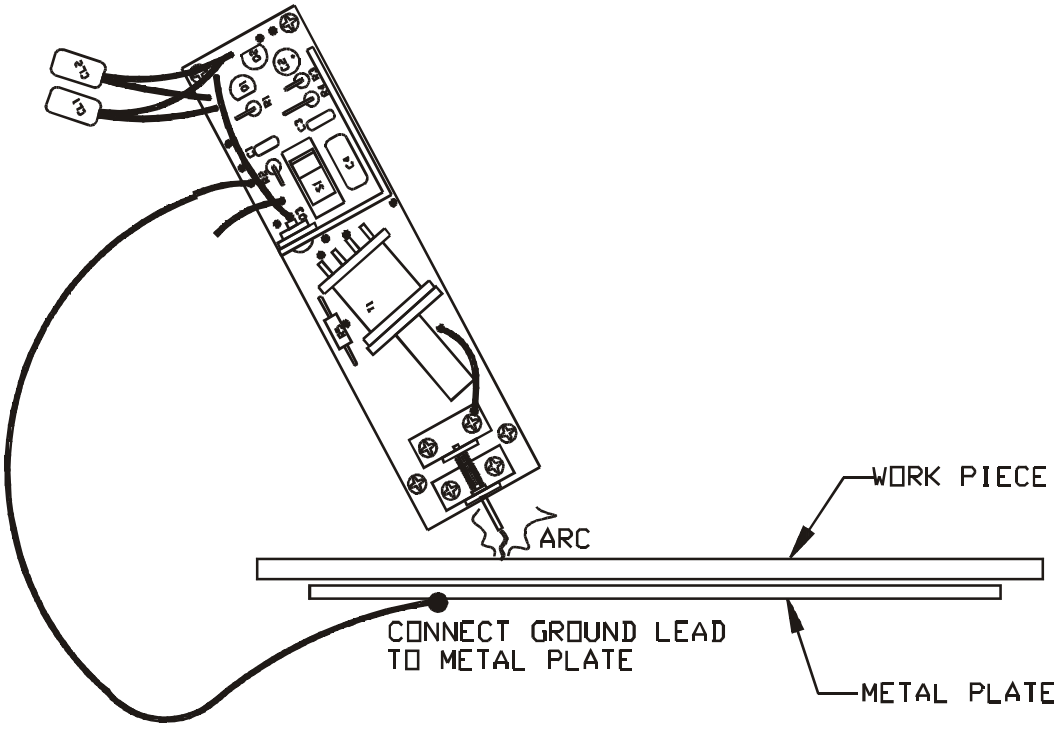


PLATE SETUP FOR PLASMA ETCHING