Magnetic Impulse Pistol

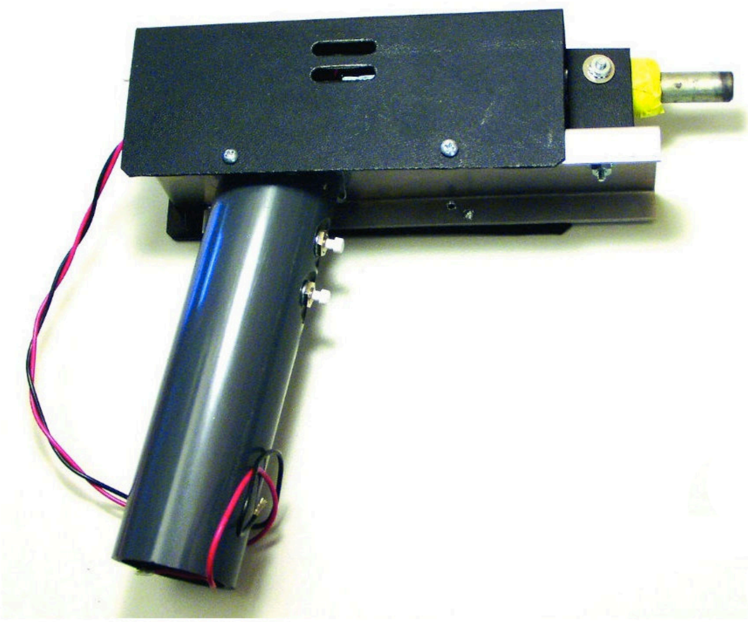


Fig 1 Photograph Coil Gun Pistol

The unit operates from a low-voltage source of 12 *volts direct current* (vdc) or a battery (see Figure 2). The circuit produces 72 joules of capacitive energy exrage at 600 volts. This is labeled as a dangerous wectrical device if the protective cover is removed. The unit must not be aimed or pointed in the direction of personal or breakable objects. Projectiles can reach a reasonably high velocity.

Basic Theory

Your electrokinetic accelerator demonstrates two methods of electrokinetic acceleration.

First and Preferred Method

A flat, pancake-shaped accelerator coil is structured to match the dimensions of a circular aluminum ring that serves as the launch vehicle. This closed ring now becomes a shorted secondary winding of a pulse transformer that is as closely coupled to the primary windings as possible. A current pulse is produced in the secondary that is the aluminum ring induced by the current pulse in the primary. The result is opposing magnetic fields that cause a mechanical repulsion pulse propelling the nonmagnetic aluminum ring. If the ring were magnetic, it would be attracted to the coil and completely counteract the repulsive force. It is the current flowing in the aluminum ring that causes the repulsive magnetic field (Lenz's law).

The design of the accelerator coil must minimize the leakage inductance of the coil assembly and limit the impedance in the primary discharge circuit. A disadvantage of this type of kinetic system is that the acceleration event occurs over a short distance interval. Therefore, the resulting peak forces must be very high to achieve a high velocity. The repulsive forces will vary as the inverse of the square of the separation distance between the accelerator coil and the moving projectile.

Second Method

This method uses a solenoid coil with a pitch equal to its diameter. This coil uses a magnetic pulse that attracts a small ball or rod-shaped projectile made from a magnetic material. The ball is accelerated into and along the coil axis, exiting with a velocity. The initial positioning of the ball is critical to obtain the maximum exit velocity. The inner diameter of the coil should only be large enough to allow unobstructed movement of the projectile ball. Again, magnetic leakage and pulse width plays an important part in achieving optimum results.

Circuit Description

A single-ended inverter circuit is shown in Figure 2 consisting of a self-oscillating transistor (Q1) resonantly switches the primary of the voltage step up transformer (T1) and tuning capacitor (C3). The input power is 12 vdc at 1 amp and is controlled by the charging switch (S1).

The base drive to Q1 is provided by the *feedback winding* (FB) of the T1 that must be properly phased. The bias for Q1 is provided by the resistor (R2). The capacitor (C2) speeds up the switching by providing a low-impedance path for the feedback signal. The resistor (R1) provides the starting bias for turning on Q1. The capacitor (C1) bypasses the switching frequency to ground by providing a low-impedance path. A charging choke (L1) is necessary to limit the switching current during the initial charging cycle of the storage capacitors.

The high-voltage/frequency output of the secondary winding of T1 is rectified by the diode (D1) charging storage capacitors (C5, C6) through the low-impedance winding of the accelerator coil (L2). Resistors (R7, R8) help to balance the voltage charge across the two individual capacitors. The charge across these capacitors is applied to L2 by the switching function of the SCR switch. This energy exchange generates the magnetic pulse necessary to launch the projectile. The SCR switch is controlled by the trigger switch (S2) applying a voltage to the gate of the SCR when ready to fire the device.

Board Assembly Steps

To assemble the board, follow these steps:

1. Lay out and identify all parts and pieces. Verify them with the parts list, and separate the resistors as they have a color code to determine their value. Colors are noted on the parts list. If you are a beginner, it is suggested to review the #GCAT1 General Construction Practices and Techniques section available free on our website. This informative literature explains basic practices that are necessary in the proper construction of electromechanical kits.

2. Create a piece of .1-inch x .1-inch grid perforated board at 5 3/8 X 3 3/8 inches. Locate and cut out sections for pins of T1 as shown in Figure 3.

3. If you are building from a perforated board, insert components starting in the lower left-hand corner, as shown in Figure 3. Pay attention to polarity of capacitors with polarity signs and all semiconductors. Route the leads of the components as shown and solder as you go, cutting away unused wires. Attempt to use certain leads as the wire runs. Follow the dashed lines on the assembly drawing as these indicate connection runs on the underside of the assembly board. The heavy dashed lines indicate the use of thicker #18 bus wire, as this is a high-current discharge path.

Note that the Q1 transistor must be mounted so that it mounts flush to its mounting surface at a right angle. This step is important for proper heat sinking and mechanical stability.

4. Secure large storage capacitors, C5 and C6, to the board using silicon rubber cement (RTV) or tape in place, as shown in Figure 3.

5. Wire in SCR1 using short pieces of bus wires for extensions through the holes of the board.

6. Attach the following leads, as shown in Figure 4 (the lengths noted are for best fit, and do not have an effect on EM interference):

Three 3-inch leads of #20 (WR20) connected to S1 and S2
Two 5-inch leads of #20 (WR20) for connected to NE1
One 3-inch jump between D2 and «pls» of C5

7. Double-check the accuracy of the wiring and the quality of the solder joints. Avoid wire bridges, shorts, and close proximity to other circuit components. If a wire bridge is necessary, sleeve some insulation onto the lead to avoid any potential shorts.

Fabrication

1. Fabricate the chassis as shown in Figure 5. Be sure to make a trial fit and check the sizes of the panel components before actually making holes. Kits will usually contain a predrilled piece that will mate to the included parts.

2. Fabricate a BK1 bracket, a MAND1 mandrel, and a FLY1 flyway, as shown in Figure 6.

3. Add the cover as shown in Figure 7. Note to mate the clearance holes for screws with holes in the chassis section for the (SW4) #6 sheet metal screws.

4. Wind the L1 accelerator coil, as shown in Figure 6. Sleeve in 1/4-inch section of MAND1 mandrel into the FLY1. Drill small holes for the start and finish of the winding into the side of the bobbin as shown. The measured coil inductance should read 90 to 100 microhenries without the projectile, dropping down to 50 to 60 with the projectile in place. Connect in the coil leads as shown in Fig 4.

Note that the objective is to get the projectile body as close to the windings as physically possible. This provides maximum magnetic coupling, and consequently optimum performance.

5. The final assembly is shown in Figure 7. Note the proper mounting of Q1 using a mica washer, shown in Figure 4.

Electrical Pretest

1. Connect a 1000-voltmeter across «pls»C5 and «min» of C6. If you have a scope, you can check the wave shape on the collector of Q1 and verify it, as in Figure 2.

Slide the PROJ1 projectile onto the mandrel and point the unit away from people or breakable objects. For maximum velocity, the projectile must be evenly positioned onto the accelerator coil.

Connect 12 volts to the input and push switch S1. Note the voltmeter reading increases in value as long as the switch is held. A current meter on the 12-volt supply will indicate around an ampere of current and will vary through the charging cycle.

Allow the charging to reach 600 volts. Push switch S2 simultaneously while still holding S1and note the projectile shooting off the mandrel.

The indicator lamp NE1 should light when the intended charge voltage level is reached. This is a maximum of 700 volts and should not be exceeded. The resistor divider, consisting of R9,10 and R11 sets this point. You may have to vary the value of R11 to get the desired indication at the charge voltage level you want. Without this lamp, you must time the charging cycle and coordinate it with an external meter to obtain the charging time or always use the meter.

Note that the velocity will increase after the first several shots.
This is due to the capacitors polarizing their electrolyte.

Obtaining More Velocity (Under no condition point or shoot towards a person)

Increase the mandrel diameter to 23/32 and wind 40 turns of # 22 magnet wire in six to eight even wound layers on our .75 inch diameter x .312 wide nylon bobbin #BOBTHER . The measured inductance should be 120 - 150 microhenries.

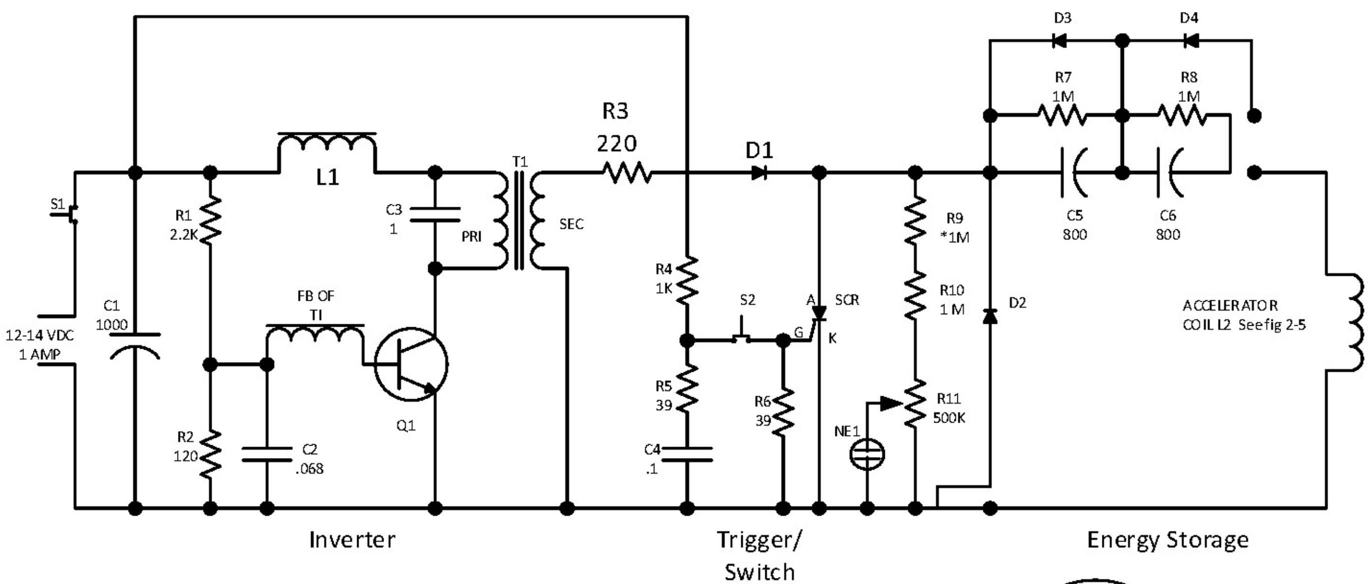
The objective here is to get the body of the projectile as close to all the copper windings as physically possible. This will reduce the reluctance and increase coupling.

Further velocity increase can be obtained by removing several turns on the accelerator coil until the current reversing diodes start to blow. Our laboratory unit got down to 50 microhenries obtaining a very dangerous velocity.

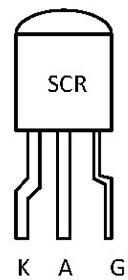
EML30 BILL OF MATERIALS

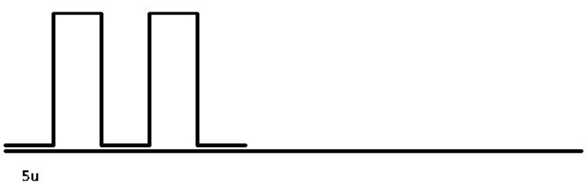
R1			2.2K 1/4 WATT [RED-RED-RED]	
R2			120 1 WATT [BR-RED-BLK]	
R3			220 1/4 WATT [RED-RED BR]	
R4			1K 1/4 WATT [BR-BLK-RED]	
R5,6	2		39 1/4 WATT [OR-WH-BLK]	
R7,8,9,10	4		1 M 1/4 WATT [BR-BLK-GRN]	
R11			500K TRIMPOT	
C1			1000 M / 25 VOLTS VERTICAL ELECT CAPACITOR	
C2			.068 M / 50 VOLTS PLASTIC CAPACITOR	
C3			1 M / 250 VOLTS METAL POLYPROPYLENE CAPACITOR [MPP]	
C4			.1 M / 50 VOLTS PLASTIC CAPACITOR	
C5,6	2		800 M /360 VOLTS PHOTO FLASH CAPACITOR	
L1			3.6 UH 1.5 AMP INDUCTOR [OR-BL-BLK]	
T1			INVERTER TRANSFORMER INFO 28K074	#28K074
S1,2	2		PUSH BUTTON SWITCHES	
D1			6 KV 10 MA HV FAST RECOVERY RECTIFIER	
D2,3,4	3		1 KV 3 AMP DIODE 1N5408	#8070
SCR1			80 AMP SCR INFO 8070	
NE1			NEON INDICATOR LAMP	
Q1			MJE3055T NPN TO220 TRANSISTOR	
PB1			.1 GRID PERFORATED CIRCUIT BOARD CUT TO 2.5 X 6''	
WR18B	6''		#18 BUSS WIRE FOR DISCHARGE PATH SEE FIG 3	
WR20B	12''		#20 BUSS WIRE FOR LONG LEADS ON BOTTOM OF BOARD	
WR20B	48''		#20 VINYL HOOK UP WIRE FOR HOOK UP OF EXTERNAL PARTS	
WR22M	10'		#22 MAGNET WIRE FOR WINDING ACCELERATOR COIL	
SW1			6-32 X 1/2 '' NYLON SCREW FOR MOUNTING Q1	
SW2			6-32 X 1/2 '' SCREW FOR MOUNTING BRACKET	
SW3			6-32 X 1.5'' SCREW FOR MTG FLYWAY TO BRACKET FIG 8	
SW4	4		#6 X 1/4'' SCREWS FOR ATTACHING COVER TO CHASSIS	
NUT			6-32 HEX NUTS	
MICA			MICA INSULATION WASHER BETWEEN Q1 AND CHASSIS FIG 4	
CHASSIS			FAB FROM 1/16'' ALUMINUM AS SHOWN FIG 5	
COVER			FAB FROM THIN PLASTIC OR ALUMINUM AS SHOWN FIG 8	
MAND1			11/16'' X 2'' COLD ROLL. MUST SLEEVE INTO FLYWAY	#MAND1116
BK1			FAB BRACKET FIG 6 FROM A 1 X 4 X 1/16'' AL OR PLASTIC	
FLYWAY			2 X 5/8'' OD X 1/16 WALL PLASTIC TUBE	
PROJ			1'' OD X 3/4'' X 1/8'' WALL ALUMINUM TUBE CUT 1/8" SECTIONS	
PLATE			2.5 X 6'' PLASTIC PLATE TO INSULATE BOARD FROM CHASSIS	
BOBBIN			.75" IDX 1.5" ODX .312 WIDTH NYLON BOBBIN	DB#BOBBIN
BH8AA			8 AA CELL BATTERY HOLDER FIG 9	
HA1			6 3/8" X 1 7/8" SKED 40 PREY PVC TUBE FIG 9	
CAP1			1 7/8" PLASTIC SLIP ON CAP FIG 9	
CL1			BATTERY SNAP CLIP FIG 9	
BU1			BUSHING FOR NEON LAMP NE1	
ADAPTR			12 VOLT .8 AMP ADAPTER	12DC/.8

Fig 2 Low power electro-kinetic gun



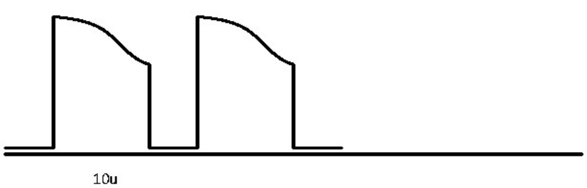
Note R11 is adjusted for NE1 igniting
when voltage reaches 600 volts.





Wave shape Q1
beginning of charging cycle

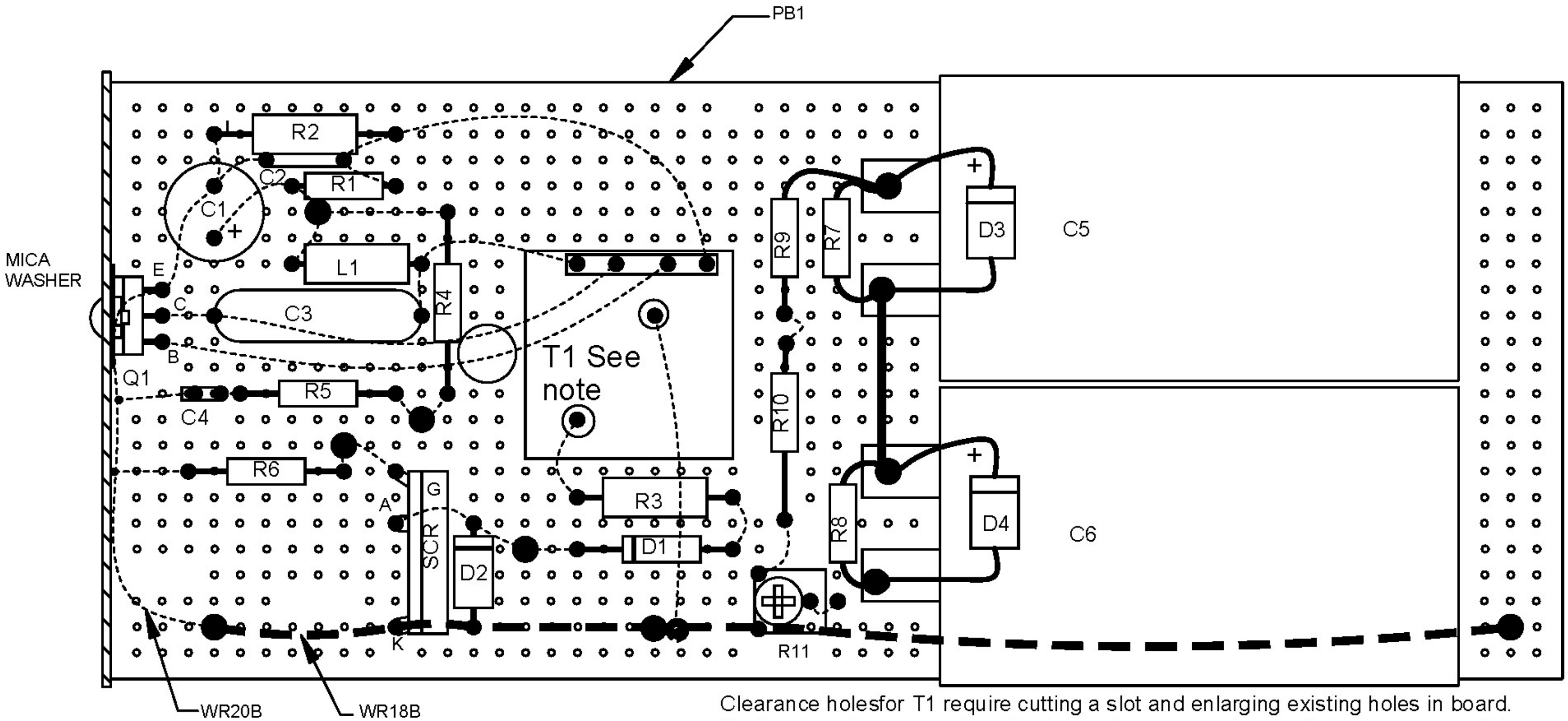
Diode D3,4 are necessary when using the photoflash electrolytic capacitors to keep the voltage from reversing. Unfortunately these diodes also remove the repulsive energy of the negative reversing current from further accelerating the projectile. Higher quality pulse discharge capacitors could be used without the diodes but would be larger and more costly.



Wave shape Q1
end of charging cycle

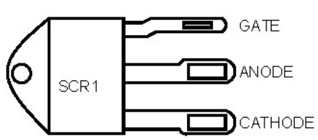
Note the schematic shows the output indicator lamp NE1 connected across a trimpot R11. This scheme allows easy adjustment of the indication level avoiding having to select and solder in fixed resistors.

Fig 3 Assembly board showing under board wiring and part identification



Clearance holesfor T1 require cutting a slot and enlarging existing holes in board.
Caution transformer must easily clear holes as any stress will damage connectiobs.

Drawing shows top view with pin locations.



Shows position for soldering into circuit

- Large black dots are for external lead connections.
- Medium black dots are holes used for mounting components.
- Small black dots are for solder points on bare wire runs.

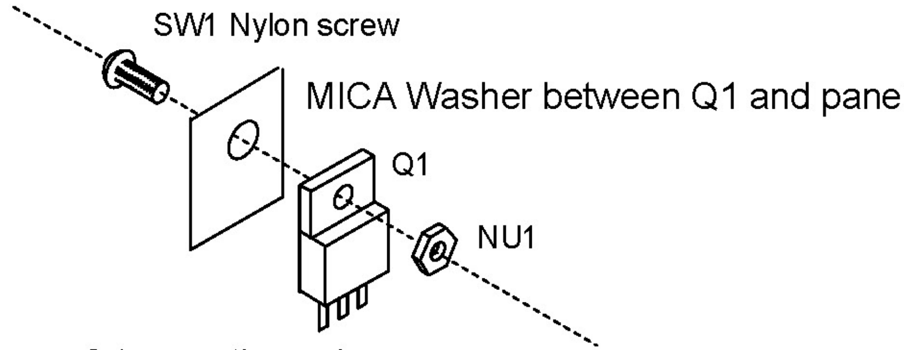
You may use insulated leads for two wire runs from Q1 to T1

You may use short pieces of bare wire to wire in pins of SCR1 or drill holes for actual pins

Thin dashed lines are #20 bare buss wire and leads of components to make the underboard wire runs and connections.

Thick dashed line is a piece of #18 buss wire to carry high discharge current.

Fig 4 Assembly board showing exernal wiring



Q1 mounting scheme
for insulating from panel

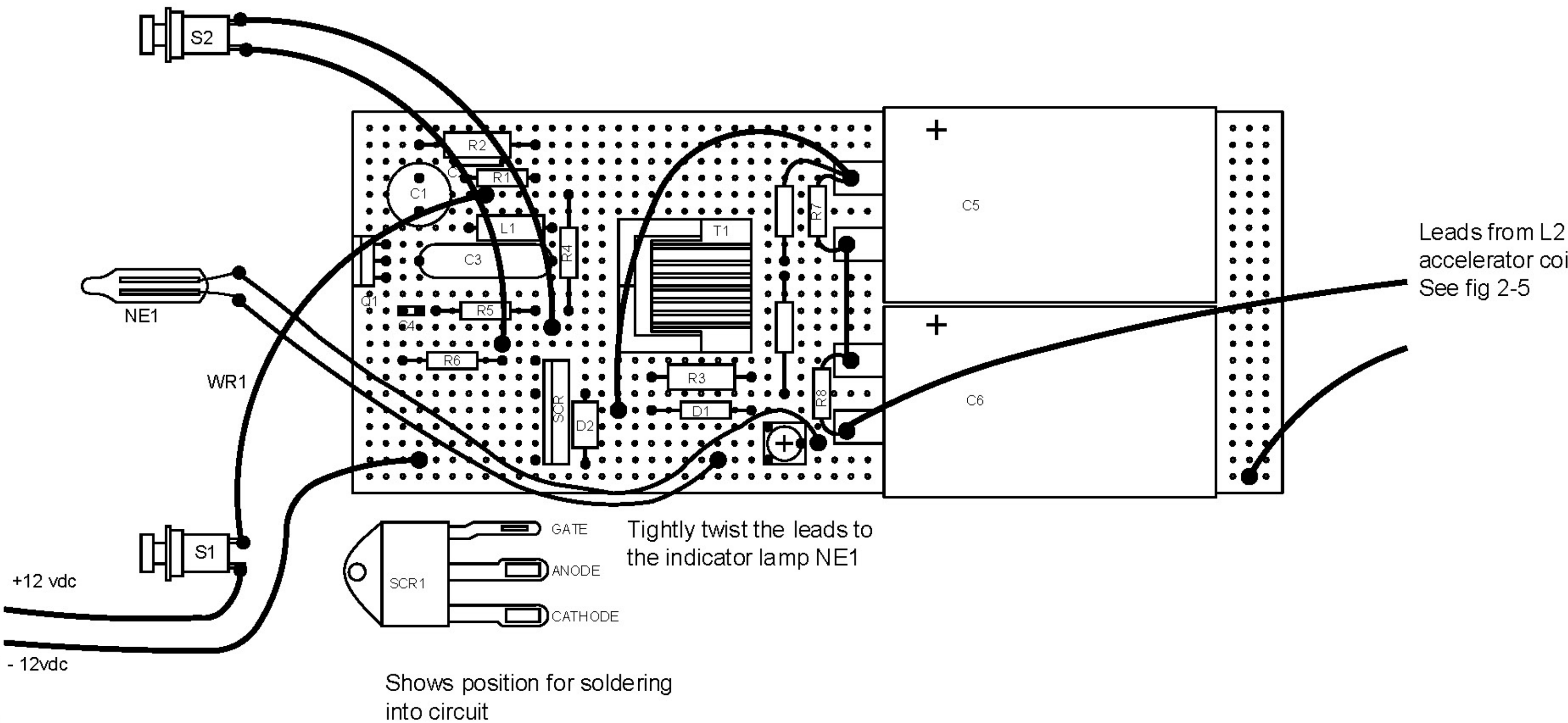


Fig 5 Chassis fabrication

Fabricate from .063 aluminum as shown. Trial fit and verify diameters of components for mounting before fabbing in the holes.

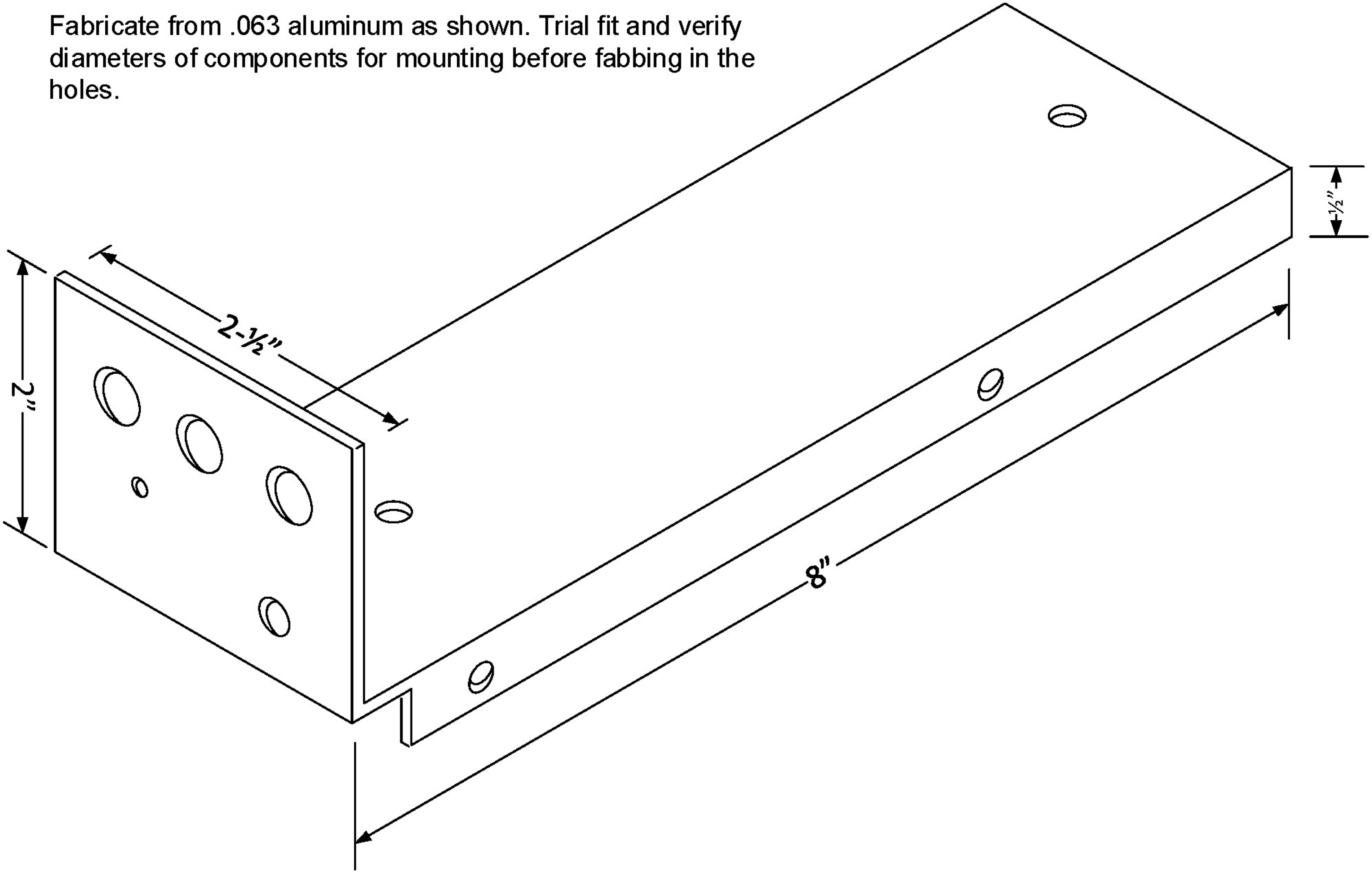
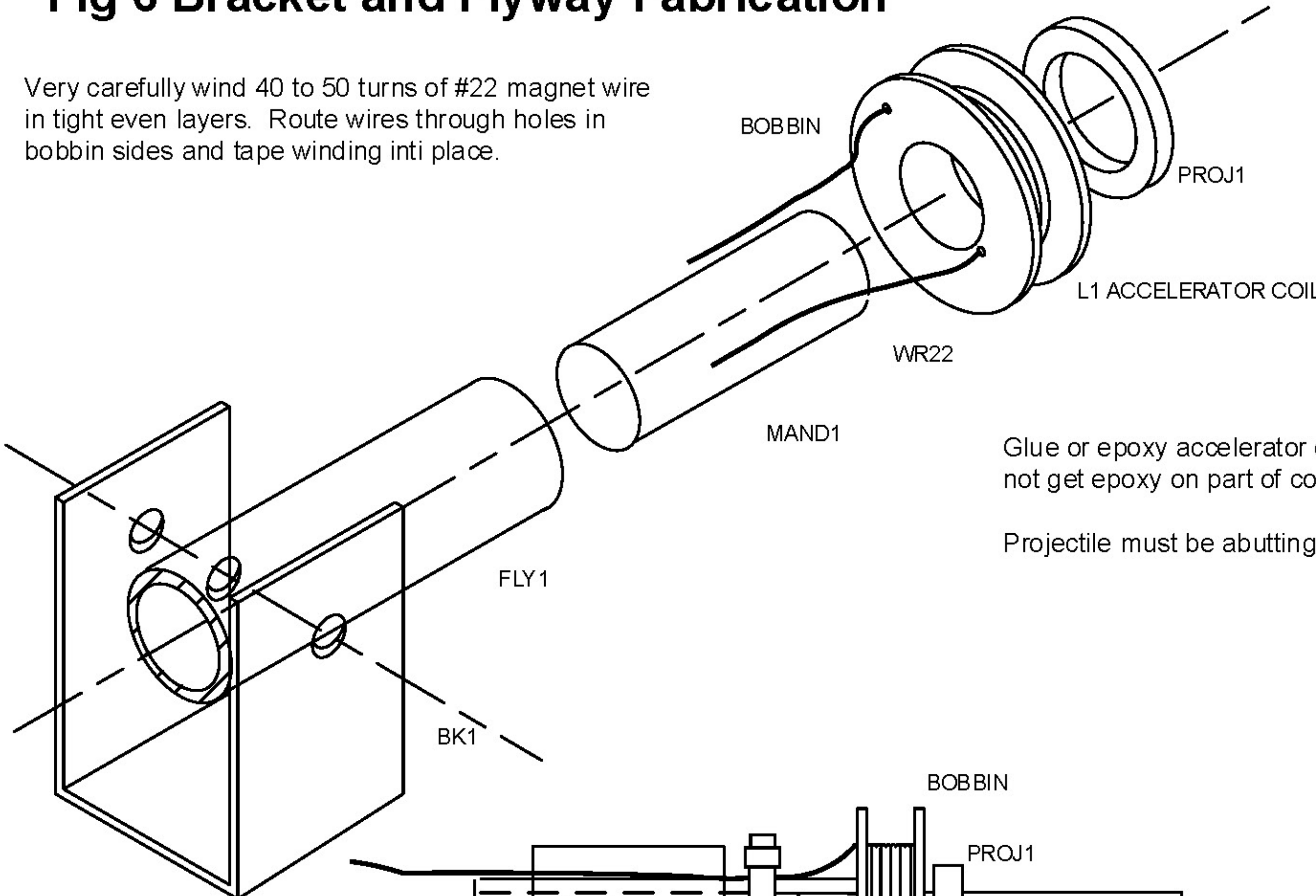


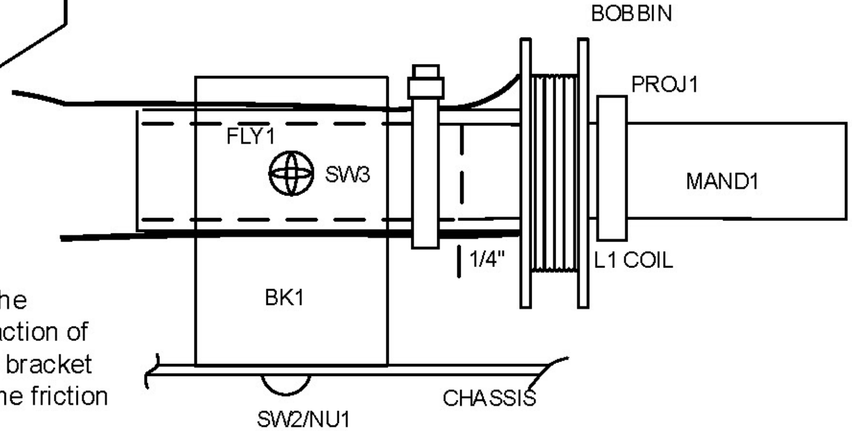
Fig 6 Bracket and Flyway Fabrication

Very carefully wind 40 to 50 turns of #22 magnet wire in tight even layers. Route wires through holes in bobbin sides and tape winding inti place.



Glue or epoxy accelerator coil to mandrell and flyway tube. Do not get epoxy on part of coil where projectile rests.

Projectile must be abutting to coil for maximum velocity.



Note that you can adjust the elevation by the pivoting action of the flyway attached to the bracket with a long screw and some friction washers in between.

Fig 7 Final assembly isometric view

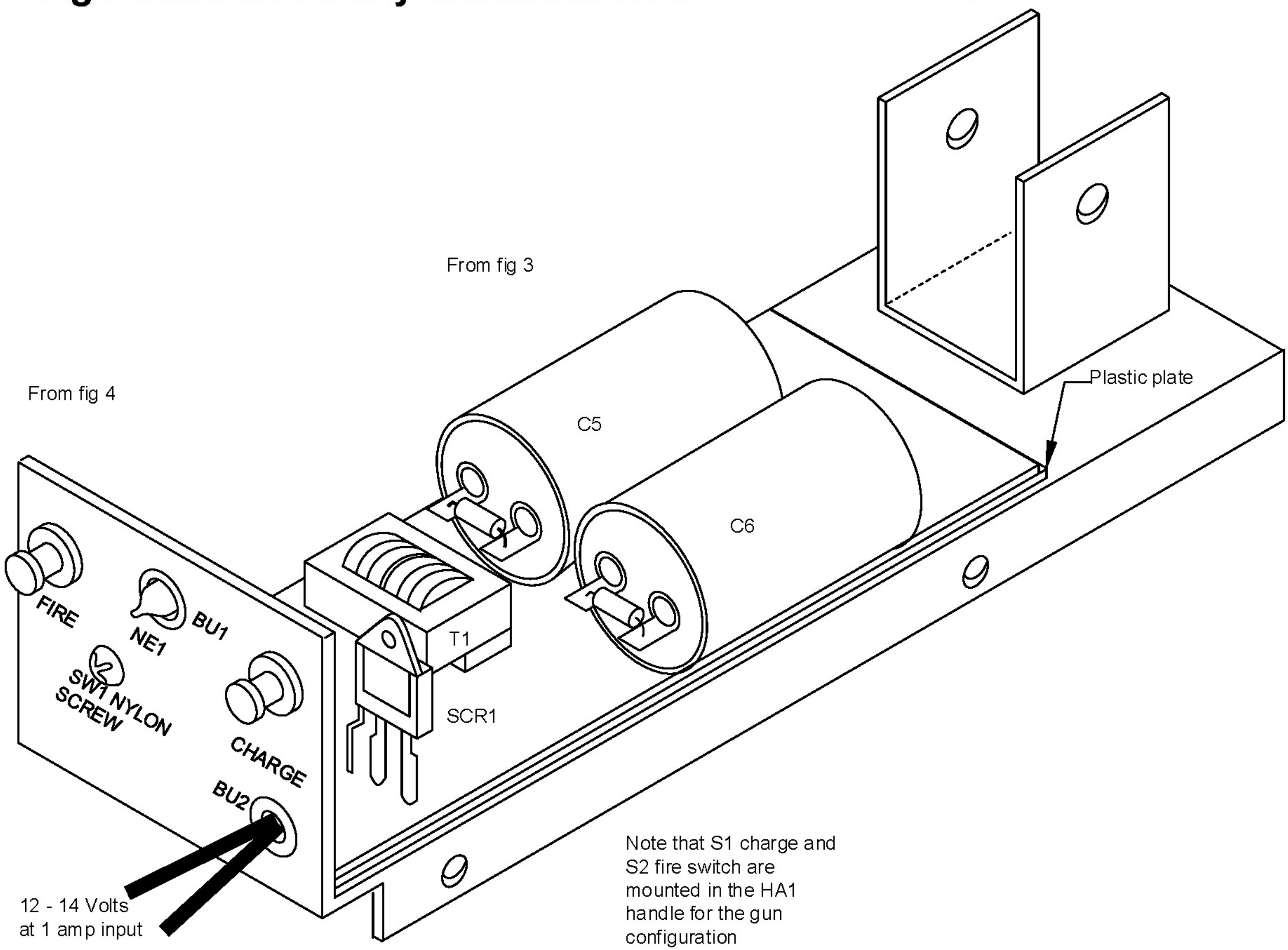


Fig 8 Final assembly isometric showing launcher configuration

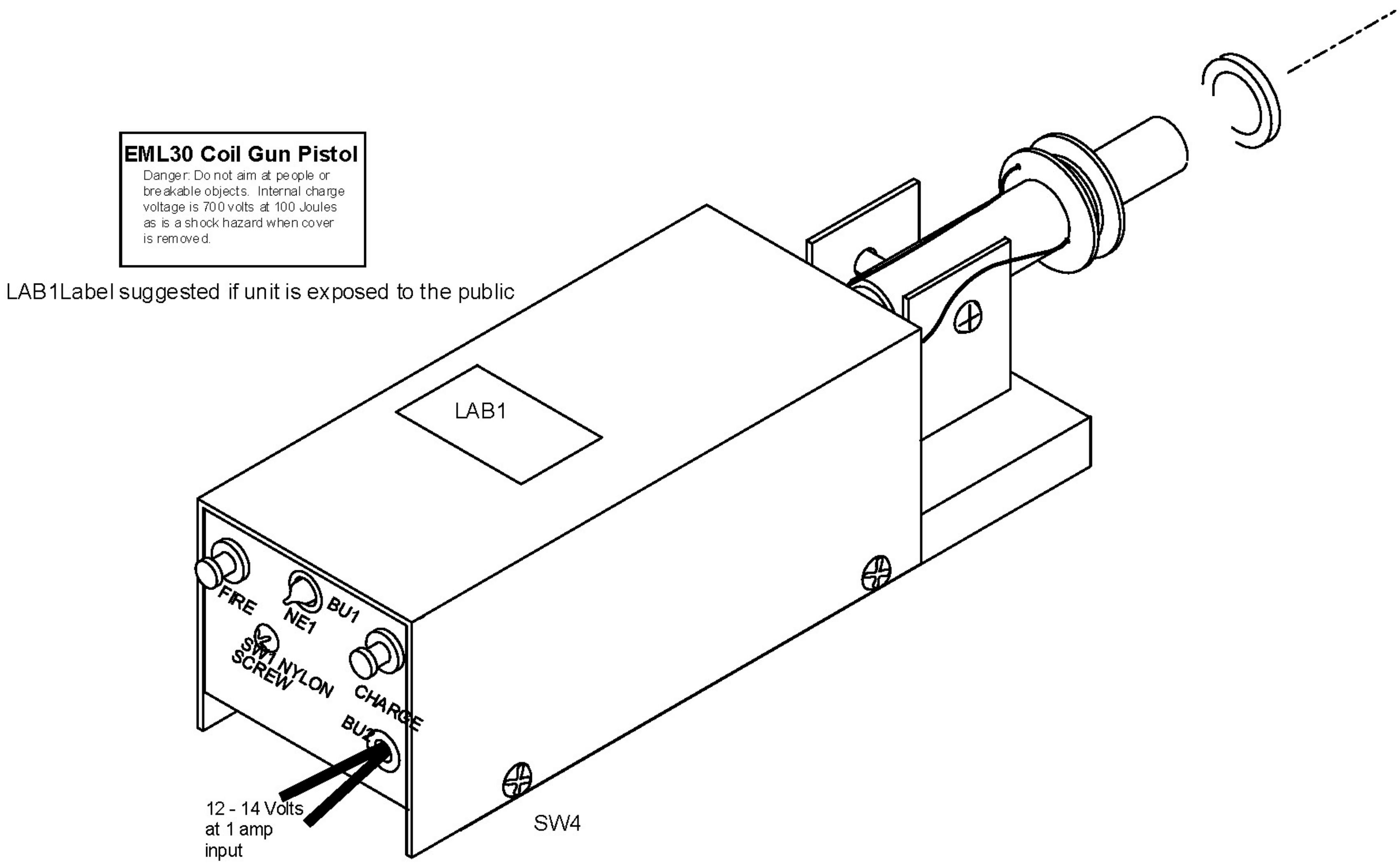
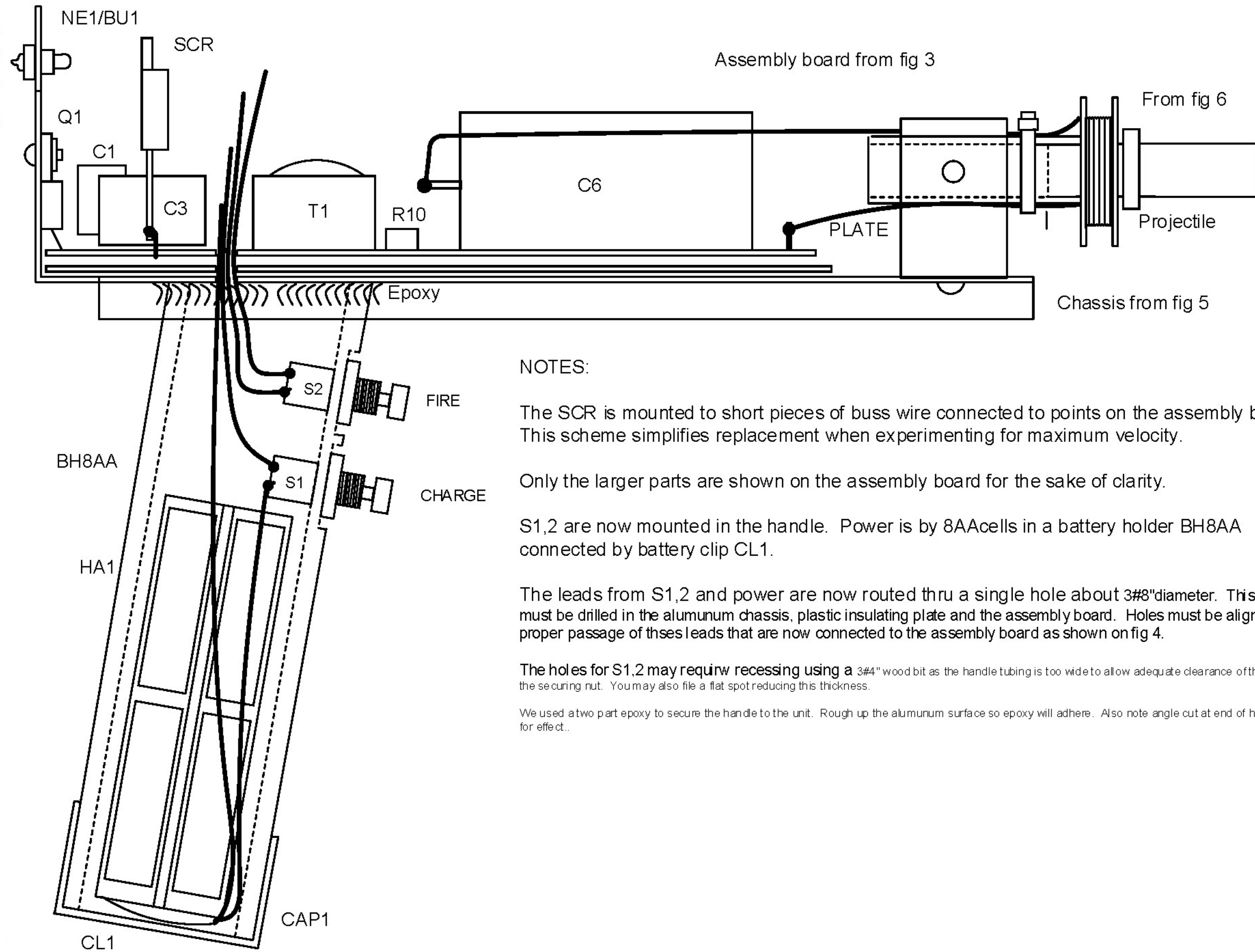


Fig 9 X-ray View of assembly showing pistol configuration



NOTES:

The SCR is mounted to short pieces of buss wire connected to points on the assembly board. This scheme simplifies replacement when experimenting for maximum velocity.

Only the larger parts are shown on the assembly board for the sake of clarity.

S1,2 are now mounted in the handle. Power is by 8AAcells in a battery holder BH8AA connected by battery clip CL1.

The leads from S1,2 and power are now routed thru a single hole about 3#8"diameter. This hole must be drilled in the alumunum chassis, plastic insulating plate and the assembly board. Holes must be aligned for proper passage of thses leads that are now connected to the assembly board as shown on fig 4.

The holes for S1,2 may requirw recessing using a 3#4" wood bit as the handle tubing is too wide to allow adequate clearance of the shaft for the securing nut. You may also file a flat spot reducing this thickness.

We used a two part epoxy to secure the handle to the unit. Rough up the alumunum surface so epoxy will adhere. Also note angle cut at end of handle piece for effect..