THE SS67B-3 LIQUID FUEL ROCKET

Construction manual

First Edition

From the leaders and innovators of practical liquid fuel rocket technology!

THE SS67B-3 LIQUID FUEL ROCKET
CONSTRUCTION MANUAL

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Note:

The instructions that you will be following are step by step procedures to building a rocket that is by modern military and aerospace standards, a toy. However, don't be fooled. The SS67B-3 is not a toy!

The SS67B-3 is the safest liquid fuel rocket engine ever designed. It uses materials and components that are specifically designed to perform a particular function. We urge you not to substitute components other than those recommended in this manual. To enjoy the safe features of the engine, do not deviate from the construction and launching procedures outlined in this manual.

Systeme Solaire takes no responsibility for any accidents or injury that may occur from the misuse or abuse of any one piece of equipment, combination or whole, or not following the explicit instructions outlined in this manual. We remind you that a rocket propels itself on the basis of what is in essence, a controlled explosion. Work cautiously and always work with patience. Don't take foolish chances.

We welcome your comments and are always ready to answer any questions you may have! We appreciate your business and are ready to help you!

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Section 1

How the engine works!

1.1 THRUST

The engine works on the principal (as all rockets do) on the basis of producing thrust by the expansion of hot combustion gases (ie. using thermal energy to do work). The thrust is accomplished by increasing the velocity of combustion gases through a special nozzle called a "convergent-divergent" nozzle. The nozzle allows gases that are traveling below the speed of sound to be increased to a speed in the supersonic range, often many times the nozzle inlet velocity.

The gases in the SS67B-3 are produced by the combustion of regular gasoline (high octane) and the oxidizer. The oxidizer used in the SS67B-3 is a little known solution that was first used in a more concentrated form in Germany's V2 rockets during the second world war. *The solution was concentrated hydrogen peroxide.* The SS67B-2 uses a solution of **50% hydrogen peroxide.**

1.2 LOADING & IGNITION

To operate the rocket, three ingredients are required; dry ice (ie.frozen CO_2) [dry ice is the recommended pressurizing substance] , the oxidizer and high octane gasoline. A chunk of dry ice is first broken up into a powdery consistency and poured into the pressure reservoir through the port at the bottom of the chamber and sealed. As the dry ice sublimes, it pressurizes the reservoir. The reservoir is held pressurized by a servo valve that only opens once voltage is supplied by the control box. The fuel is loaded next. High octane gasoline (200 ml or 0.0528 gallons) is poured into the fuel line. Next, the oxidizer (1.64 liters or 0.433 gallons) is poured into the tank. The pressure reservoir assembly is then mated to the rest of the engine. Wiring is then hooked up from the control box to the servo valve and ignition cartridge. Once the control box is activated, there is a 60 second time delay. Once this time has elapsed, the ignition cartridge is ignited. Three seconds later, the servo valve is opened allowing the pressure to force the fuel and oxidizer to enter the combustion chamber through a series of nozzles where the propellants are ignited. The combustion products are then forced through the rocket nozzle to produce the thrust.

1.3 LIFTOFF & RECOVERY

As the rocket begins to lift off, the pressure reservoir begins to lose pressure and the rocket gets lighter as fuel and oxidizer are burnt. As a result, the rocket increases its speed to a maximum of approximately Mach 0.75. At the end of the burn, the drag force on the rocket fins and upper collar is greater than that exerted on the nose cone. As a result, the nose cone separates from the rest of the assembly. The parachute is ejected as the force on the umbilical cord, exerted from the assembly, helps to remove the parachute from the nose cone.

There are alternatives to this type of ejection. We recommend you install a timing mechanism or an altimeter that will ignite a small charge of ignition powder similar to the type you will mix for the ignition cartridge. You may purchase this type of equipment from the following supplier;

Adept Rocketry, 2545 Overlook drive, Broomfield, CO 80020 (phone: 1-303-466-9605).

The parachute used in the recovery of the launch vehicle is one that you can make yourself. Details for its construction are on drawing SS-23. As an alternative, you may wish to purchase a parachute. See section 2.2 for supplier list.

Section 2

Parts, tools & materials

2.1 TOOLS & MATERIALS

Some other materials and tools that you will need for the general building of the SS67B-3 rocket are as follows ;

- 3/16" thick birch plywood
- Teflon tape pipe sealant
- 4 strand - 18 gauge instrument wire (50 feet minimum)
- 5 minute and 24 hour epoxy glue
- scotch tape
- Pliers, open end wrenches, pair of vise-grips
- Small balance (1/2 lbs or 200g minimum capacity)
- thin 26 or 28 gauge wire
- large glass jar
- tissue or bathroom paper
- 10' x 6' storage bag (optional)
- nylon fishing line (optional)
- 1/16"thick nylon braided rope (ie. kite twine)
- rubber bands
- mortar cement (optional)

You can find all the above in your local hardware, electronics, or drug store.

2.2 FABRICATED PARTS

The parachute is the only part that you may wish to construct from scratch.

Parachute - The material for the parachute is made out of 0.002" thick polyethylene plastic and is cut from a 10' x 6' storage bag. The ropes are cut from regular nylon fishing line that you could buy from your local sporting goods store. Follow the instructions on drawing SS-23 for construction. As an alternative, you may wish to purchase a parachute. To have the parachute manufactured, submit the dimensions on drawing number SS-23 to any of the suppliers below;

Parachute Suppliers

Top Flight Recovery, S12621 Donald Road, Spring Green, WI 53588 (phone 1-608-588-7204)
Catalog $1.00

Spherachutes, P.O. Box 621956, Littleton, CO 80123 (phone 1-303-798-2889)
Catalog $1.00

Nose Cone - If you are planning to use an ejection circuit as stipulated on page 4 (section 1.3), then modification to the nose cone is not required. If you are using drag induction, (ie. no timer or altimeter actuation) then you must drill holes in the nose cone as stipulated on drawing SS-24. The holes help to eliminate a suction force that tends to hold the nose cone on to the rocket at the end of the burn.

2.3 GENERAL INFORMATION ON CONNECTIONS

If you are aware of the differences between piping and tubing in industry, you can skip this section.

Tubing - In industry, tubing is usually a thin walled pipe that cannot be threaded. Tubing can be connected together in a number of ways, two of which are welding and brazing. A third way is to use special compression fittings. This last method is the one that will be used in the construction of the SS67B-3. Compression fittings that attach to tubing can convert end connections to threaded piping, tubing or even straight thread hydraulic fittings. The instructions for connecting tube fittings together are on the page to the right. You should familiarize yourself with the procedure before the assembly of any component.

A number of companies manufacture compression fittings but we chose Swagelok for their worldwide availability and quality construction.

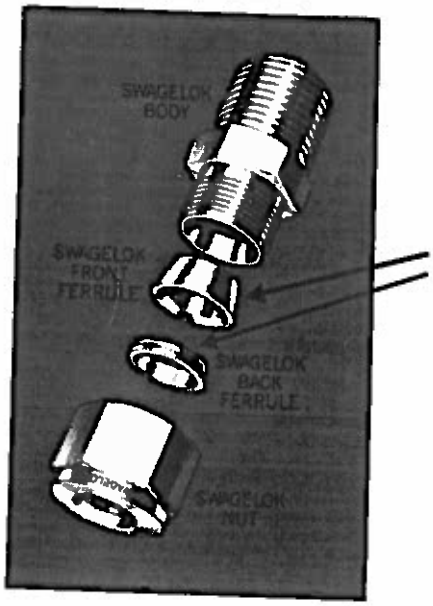
Piping - Standard piping in industry comes in two different wall thickness classes - Schedule 40 & Schedule 80 (the latter is more thicker). The type of threads in piping can be a variety of different types but we will be using a tapered type of thread. This means that the diameter of the threads start off small and become larger as you work toward the ends of the thread. There are numerous types of threads but the type we will be using are called "NPT" for national pipe thread. A problem with North American type threads is that there is no correlation dimensionally between actual pipe diameter and pipe specification. For example, a 1/8" I.P.S. pipe does not mean that the pipe is 1/8" in diameter. This can become confusing especially when you consider the fact that tubing, as discussed in the previous paragraph, is sized according to outside tube diameter (ie. 1/8" tubing means 1/8" diameter tubing).

To connect piping together, pipe fittings with internal tapered female threads are used. **To obtain leak proof connections in piping, the threads must be covered in either a tape or paste sealant.** (We will be using tape sealant.) To connect brass pipe fittings on the SS67B-3, the piping can be tightened until a good snug fit is achieved. When fitting pipe connections made of aluminum, greater care must be taken. Aluminum fittings require about two turns of teflon tape around threads and you should not tighten fittings beyond 1/4" of male entry into female hole. Otherwise, damage will occur to threads. The tape is made from teflon. It is available at any hardware or plumbing store.

2.4 O-RING LUBRICATION

To lubricate the O-rings, DO NOT use any other lubricant except the type that was included with the kit. The lubricant is compatible with both the gasoline and the oxidizer. Substituting another type of lubricant may cause a serious reaction with the 50% Hydrogen Peroxide.

LUBRICATE ALL O-RINGS BEFORE ASSEMBLY OF COMPONENTS.



Swagelok® tube fittings.

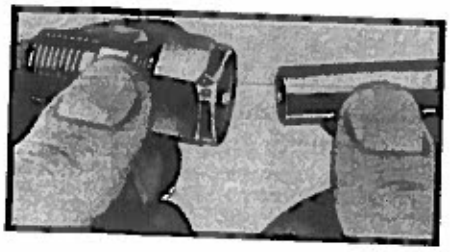
The SS67B-3 liquid fuel rocket engine uses Swagelok® tubing connectors.

Note the parts that make up the connector.

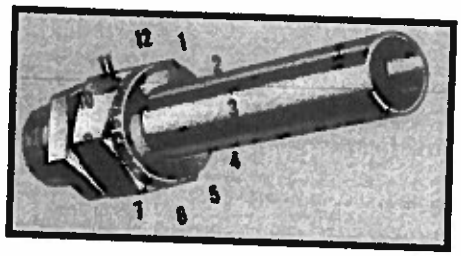
After the nut has been turned 1 and 1/4 turns past the finger tight setting, the front and back ferrules should be locked on the tubing.

Installation Instructions

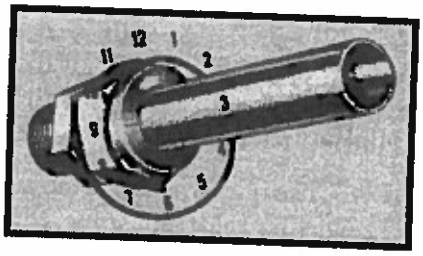
Tube fittings come to you completely assembled, finger-tight. They are ready for immediate use. Disassembly before use is unnecessary and can result in dirt or foreign material getting into fitting and causing leaks.



Step 1
Simply insert the tubing into the tube fitting. Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger-tight.



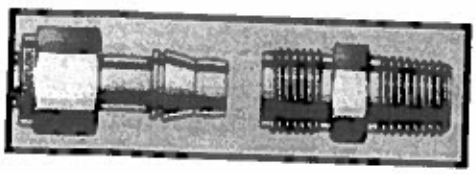
Step 2
Before tightening the swagelok nut, scribe the nut at the 6 o'clock position.



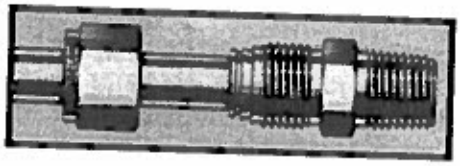
Step 3
Now, while holding the fitting body steady with a backup wrench, tighten the nut 1 & 1/4 turns. (Watch the scribe mark, make one complete revolution and continue to the 9 o'clock position.)

Re-tightening Instructions

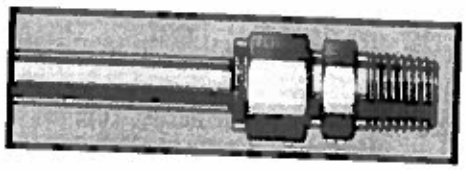
Connections can be disconnected and re-tightened many times. The same reliable, leak-proof seal can be obtained every time the connection is remade.



1. Fitting shown in disconnected position



2. Tubing with locked ferrules inserted into the fiting until front ferrule seats in fitting.



3. Tighten nut by hand. If required, rotate nut to original position with a wrench. Then tighten slowly 1/4 extra turn.

Section 3

Assembly

3.1 ASSEMBLIES

Before you begin assembly of any component, make sure that all components are clean. Any metal bits or debris caught in the fuel line, oxidizer reservoir, pressure reservoir etc. will clog valves and nozzles which will radically affect rocket performance.

3.1.1 COMBUSTION CHAMBER ASSEMBLY (drawing B3-1)

Warning! Before you begin assembly, separate all components used in Drawing B3-1 from the rest of the engine parts. Do not contaminate any parts other than those specified in the drawing. Find a work area (ie. garage) that will be used only for the assembly of the combustion chamber and the usage of $KMnO_4$. You should also use rubber gloves to avoid any contact with your hands. The chemical stains anything it touches to a purple color.

*NOTE - **NEVER** mix $KMnO_4$ with hydrogen peroxide. **There is a violent reaction when these two reagents come into contact with one another.**

Preparing parts

Coating - Sand the outside of the copper pipe with a rough grade sand paper (100 grit). Coat the copper pipe of the ignition cartridge with mortar (supplied with kit). This mortar is usually used to repair cracks in cement . It acts as an insulator against the heat created during combustion. Allow coating to dry.

Igniter - The igniter is the same kind that is used to launch small solid propellant rocket motors. Make a few igniters by soldering some 26 or 28 gauge wire on each end. Test one igniter with a large 12V source (ie, lantern, motorcycle or car battery). When voltage is applied, it should ignite within one second.

Ignition powder - The ignition powder is made from a mixture of 50% sugar and 50% KNO_3 (potassium nitrate). To mix the ingredients, make sure that both products are of a powdery consistency. Then mix equal amounts of sugar and potassium nitrate together by gently mixing them in a ziploc bag or a plastic container. DO NOT USE ANY METALLIC OBJECTS OR HOME APPLIANCES TO DO THIS! Any spark will ignite the mixture!

Once the above has been completed, you are ready to assemble the combustion chamber. Use drawing B3-1 as a reference.

1. Pack ignition powder into cartridge using a wooden or plastic utensil.
2. Insert igniter 1/4" deep into mixture.
3. Seal top with thin tissue paper. Use scotch tape only on the side of the cartridge to hold paper in place.- **Do not cover top of cartridge with tape.**
4. Lower ignition cartridge into chamber. Make sure wires exit out of nozzle.
5. Lower cylindrical shield over ignition cartridge and center it in chamber.
6. *$KMnO_4$ preparation* - $KMnO_4$ is a required catalyst. It helps to break down the peroxide into its fundamental components, one of which is oxygen. To prepare the $KMnO_4$ for introduction into the chamber, it must be watered down to a thick and flowable nature - a consistency similar to that of mud. Using a spoon, introduce the mixture between the shield and the chamber. Make sure that this boundary is

completely flooded with material. Continue this procedure right to the top level of the shield. The mixture must then be allowed to dry so that it hardens.

3.1.2 CASING and NOSE CONE (drawing B3-2 & B3-2a)

The casing assembly might take you a couple of days between coats of epoxy and sanding before all surfaces are smooth and the fins are glued solid.

1. Place casing on flat surface and draw 3 lines (120 degrees apart) 12 inches long on one end. Glue fins using five minute epoxy using drawn lines as a guide. Once glue has dried, reinforce fins with 24 epoxy glue.
2. Place 3/16" birch plywood (4.25" diameter) at location indicated on drawing B3-2 and glue with 24 hour epoxy.

The base of the nose cone requires some attachments for it to fit properly on the casing. Follow the instructions on drawing B3-2a.

3.1.3 UPPER ENGINE ASSEMBLY (drawing B3-3)

1. Gather parts as indicated on drawing B3-3.
2. Put one to two turns (two turns recommended) of teflon tape on all aluminum pipe threads.
3. Put two or more turns on all brass pipe threads.
4. Do not put teflon tape on the main fitting. It is not required. (ie. the main fitting contains the O-ring that mates with the pressure reservoir).
5. Assemble all threaded parts as indicated on drawing. Do not over tighten aluminum fittings. Make sure threads do not enter more than 1/4" after entering female hole. Brass fittings can go deeper.
6. Glue 1/4" machine screw with appropriate birch plywood plates at top of upper engine assembly.
7. Screw in main fitting that now contains all components.

3.1.4 LOWER ENGINE ASSEMBLY (drawing B3-4)

Oxidizer nozzle assembly

1. Remove the three oxidizer check valves from the kit.
2. Put two to three turns of teflon tape on brass threads.
3. Using a plier or similar tool, tighten the three check valves until a snug fit on appropriate end of supplied reducing bushings is achieved. Over tightening is not required.
4. Apply two to three turns of teflon tape on brass nozzles. Tighten until nozzles have entered into threads and a snug fit has been achieved on supplied reducing bushing (ie. oxidizer nozzle housing). Apply 2 turns of teflon tape to threads of oxidizer nozzle housing. Tighten assemblies into lower portion of oxidizer and fuel reservoir as shown using an open end wrench. **Make sure that nozzles are aligned so that top nozzle cut is perpendicular with distributor center (see right side of drawing B3-4).**

Fuel nozzle assembly

5. **Do not** place teflon on fuel nozzle threads. Tighten nozzle until there is good solid metal to metal contact with head of supplied and modified reducing bushing (fuel nozzle housing).
6. Place two to three turns of teflon tape on lower brass fuel line check valve. Insert into fuel nozzle housing until a snug fit is achieved.
7. Place one to two turns of teflon tape on fuel nozzle assembly housing. Install on lower portion of fuel and oxidizer reservoir with appropriate tooling.

Other fittings

1. Apply two turns of teflon tape to pipe nipple (left of drawing B3-4) . Using a small vise grip or pipe wrench, insert fitting until it has entered 13/64" to 1/4"" deep.
2. Apply two turns of teflon tape to threads on 1/4" tube swagelok fitting (left of drawing B3-4). Using a wrench, tighten into threads 13/64" to 1/4" deep.

3.1.5 UPPER AND LOWER MATING ASSEMBLY (drawing B3-5)

1. As indicated on the drawing, install fuel line check valve with tubing and mate assembly to connector.
3. Place large brass check valve between the appropriate pipe nipples. Align reservoirs so that they are in-- line. Also, check that all tubing seats properly and that there is no tubing that is either too short or too long.
4. Once you are satisfied that the alignment is good between all components, install all tubing connections as per instructions on page 7.

3.1.6 UPPER AND LOWER MATING DISASSEMBLY (drawing B3-6)

1. Disconnect tube connections where indicated on the drawing. If you have installed the tube fittings correctly, the ferrules (see page 7) should be locked on the tubing.

3.1.7 COMBUSTION CHAMBER INSTALLATION (drawing B3-7)

1. Install components as indicated on drawing.

Section 4

Pre-launch checks

4.1 PRESSURE TESTING

When you have finished construction you must pressure test the main pressure reservoir. You will need to make a soapy solution (ie. dishwashing liquid with water). You will also need to purchase a block of dry ice at a local supplier. (Dry ice is CO_2 gas in solid form). The cost of the dry ice should not cost you more than 60 cents a pound. Buy the minimum quantity which should be in the neighborhood of a 5 or 10 lb. block. You will only need about 2 lbs. for testing. When you get it, you should start conducting your testing right away. A 10 lb. block will not last more than 24 hours even if you put it in your freezer.

4.1.1 PRESSURE RESERVOIR

The only place where you might see leaks is the connection between the servo valve and the main fitting or at the pressure gauge connection. Start by manually closing the servo valve. The valve can be shut by hand by turning the stem clockwise. The valve is closed if you can't see through it. Next, crush up some dry ice by placing a small chunk of at least 100g (0.22 lbs.) into a ziploc bag and breaking up the ice into a chunky, powdery form. Next, with a regular piece of blank 8 1/2" x 11" paper, weigh out about 50g (0.11 lbs.) and pour it into the pressure vessel and cap with the servo assembly. (use drawing B3-9 as a reference). Wait until the pressure in the reservoir rises to about 100 psi. Begin applying the soapy solution you made to all threaded ports, joints and connections. The solution will bubble in areas where there are leaks. Apply 12 volts to valve to open it or turn by hand slowly. This will allow the gas trapped in the pressure reservoir to escape. Tighten any connections where leaks occurred. Continue this procedure until you have eliminated all leaks. As a final test, pour 70g (0.154 lbs.) of crushed CO_2 into the chamber and pressurize. Wait until the system reaches steady state about (150 psi). Observe the pressure. Wait 1 hour. Observe the pressure. If the pressure has not changed, then your connections are leaktight.

*NOTE- Values for CO_2 test weights could change from supplier to supplier depending on dry ice quality. Before introducing crushed ice into chambers, always use a small quantity for testing. Also, as a safety precaution, never pressure test any piece of equipment yourself beyond 150 psi. The only time this should occur is at the launch site and with you at a safe distance away.

Do not attempt to load more "dry ice" into pressure reservoir beyond recommended values. If your tank is not pressurizing to target values, the gauge is faulty. Although the gauge is high in quality, breakage can always occur.

If you use an air compressor or other air source for pressure testing, always use an additional gauge and relief device to insure the accuracy of the vessel pressure.

4.2 Storage

When storing 50% Hydrogen Peroxide, ensure the area is cool. (ie. garage). **Also ensure that sealing cap on container is not tightened during long term storage.** This will allow trapped oxygen gas to escape during the slow natural decomposition of the solution.

Never store "dry ice" in a sealed container such as a plastic bottle, glass jars, etc. **Storing "dry ice " in sealed containers that cannot withstand the pressure of the sublimed gas will cause an explosion!-**

Section 5

Launching!

5.1 SS67B-3 LAUNCH CONTROL

Before going into the field, make sure the launch circuit operates properly by conducting a test. You can simulate a launch sequence without fuel and oxidizer. Use an igniter and ignition powder wrapped in some tissue paper to simulate the ignition cartridge. You can also hook up the servo valve to the red and black connections at the top of the control box to make sure it functions.

Important: When activating the servo valve, always make sure it is closed before activating it. Verify that the steel cable attached from the servo to the valve is wrapped around the threads of the screws protruding underneath the plastic circular servo plate.

Before starting: When you have completed construction of the ignition control circuit, the delay-off relay start capacitor must be charged sufficiently for proper operation.

1. Energize the circuit. Connect only the 12V power supply (two 6V lantern batteries, motorcycle or car battery) and leave the arming switch on for two minutes.
2. To remove the charge from the circuit, remove all cables from the control box. With a voltmeter, allow charge in capacitor to dissipate to a level below 0.5 volt. Measure this voltage between the upper two red igniter jacks. YOU MUST DISCHARGE THE CAPACITOR FOR THE CIRCUIT TO OPERATE PROPERLY. THIS PROCEDURE MUST BE FOLLOWED BEFORE EVERY LAUNCH.
2. Re-connect two 6 volt lantern batteries in series or a small 12V motorcycle battery (recommended) to the terminals at the right of the control box.
3. Continue to follow instructions on Control Box.
4. Once the 60 second countdown is complete, the igniter should ignite the powder within 2 seconds. Don't stand too close to avoid hot combustion products from getting into your eyes or on your skin. WEAR EYE PROTECTION.
5. Once the powder ignites, the servo valve should open. It is important to make sure that the valve only opens after the powder has been ignited. This is imperative for proper ignition of the rocket. Once the valve has opened, immediately cut power from the circuit to the valve by closing the **ARMING** switch. This will help to avoid damage that can be caused to the gears in the servo motor.
6. To remove the charge from the circuit, complete step 2.

5.2 LAUNCH PAD

To launch the SS67B-3, we recommend you use some kind of launch pad with guide rails that will allow the rocket to take off on an upward straight flight path.

Ideally, you should have a platform that is elevated to about 12 inches off the ground with a center hole drilled or punched out for the rocket nozzle to come through. This will allow you to connect the igniter wires to those coming from the control box.

You may construct the pad in almost any material. Wood is the easiest building material and should withstand the relatively low temperatures of the combustion products coming from the engine.

5.3 WEATHER CONDITIONS

Weather conditions for launch must be ideal in order for the rocket to be stable in flight. Wind should not exceed 5 mph. Temperatures should be between 50 ^{o}F and 85 ^{o}F and no rain in the forecast.

5.4 LAUNCH SEQUENCE (drawings B3-8, B3-9, B3-10, B3-11, B3-12)

1- Place launch pad on flat surface.
2- Stand combustion chamber on launch pad and place rocket nozzle through hole of launch pad.
See drawing B3-8-
3A. Clean funnel and place it in the fuel line first (ie. swagelok connector). Measure approximately 200 ml (0.0528 gallons) of super unleaded gasoline and pour extremely slowly into fuel line.-
3B. Clean funnel thoroughly with water.
3C. Place funnel in oxidizer line (ie. pipe connector) and slowly pour 1.64 liters (0.433 gallons) into oxidizer reservoir.
See drawing B3-9-
4A. Pour approximately 250 grams (0.55 lbs) of broken powdered dry ice (ie. frozen CO_2) into pressure reservoir. *Before adding this amount, make sure that pressures correspond approximately to those stipulated in the pressure testing section (section 4.1.1).*
4B. Immediately mate servo valve assembly with pressure reservoir. Take note of the time. As a safety precaution, attempt to finish the remaining steps within 20 minutes.*
4C. **Slowly** turn assembly completely vertical to ensure that no dry ice enters the internal pipe of the reservoir and begin step five.
See drawing B3-10 *(Note: drawing has been drawn at an angle only to increase drawing size and clarity. The assembly should be put together in a vertical position).*
5. Lower assembly from step 4 - part C onto connections of lower assembly. Re-connect tubing as per instructions on lower portion of page 7. (ie. tighten nuts 1/4 turn past a finger tight position)
See drawing B3-11
6. Slide rocket casing down over engine until top 1/4" screw protrudes out of plate at top of casing. Secure casing to engine by using appropriate 1/4" nut.
See drawing B3-12
7. Insert nose cone with parachute into upper portion of casing. Attach parachute cord to top of the pressure reservoir with appropriate 1/4" nut. Ensure that nose cone cord is attached to parachute cord.
8. Install connections from the control box using 18 gauge wire. We recommend that the wires be approximately 50 feet long from the rocket in the event that you must disarm the system. Connect red plugs from top left side of the control box to the igniter wires protruding from the rocket nozzle. Connect plugs from the top right side of the control box to the servo valve. Make sure you connect the wires to the servo valve in a fashion as shown on the drawing. Also, make sure that bare wires do not touch the engine. If they do, a short circuit will occur causing damage to the control circuit.
9. Note the time. If 60 minutes has passed from the time you loaded the pressure reservoir with dry ice, you are ready to launch the rocket.
10. Follow instructions on Control box. You may abort at any time by removing any battery cable or closing arming switch to the "off " position (ie. downwards). After you have engaged the arming switch, move to a distance as far as possible from the launch pad behind a solid barrier. (500 feet recommended).

After successful launching and recovery, remove the combustion chamber. Be careful not to contaminate any area with $KMnO_4$ that normally comes into contact with the 50% hydrogen peroxide (ie. keep oxidizer tank and nozzle housing internals free of contaminants and $KMnO_4$).

Also remember to remove the timing charge in the circuit . Immediately go to step 1 of section 5.1.

***Although the burst pressure of the pressure reservoir is much higher than 500 psi, we do not recommend that you stay close to any cylinder while it is pressurizing past 150 psi.**

5.5 TROUBLE SHOOTING

It is not at all unlikely that you may encounter problems during launching. This should not discourage you. The best aerospace organizations in the world, including NASA, have encountered disaster. The following is a small list of problems which you may encounter attempting to fly the SS67B-3.

Problem: Rocket does not take-off, but there is a lot of smoke.
Possible cause: Bad ignition. Igniter bad.
Fuel has leaked entirely before ignition.
Servo valve has not opened fully.

Problem: Engine begins to fume well before time of ignition
Possible cause: Oxidizer check valves are leaking
Servo valve is leaking CO_2 gas.

Problem: Rocket lifts off initially and then drops before reaching target altitude.
Possible cause: Fuel or oxidizer nozzles partially blocked with debris.
Fuel has partially leaked before ignition.
CO_2 leak. Ruptured pipe or tube.
$KMnO_4$ has not fully dried

We realize that this is only a small list of possible bad scenarios. In the event that you come across a situation that seems impossible to solve, contact customer service. (see page 2)

5.6 COLLISIONS

As rocket enthusiasts, we all like to think that crashes won't and don't happen. Unfortunately, we all know that this is not true. Crashes are a part of amateur and sport rocketry. Fortunately, the SS67B-3 was designed to survive mild crashes of 200 ft. or less depending on the type of launch site. The ideal type of terrain is of a bushy nature to help cushion and slow down the fall of the vehicle. During impact, the SS67B-3 is designed to break apart at the coupling casings, minimizing damage to expensive components such as the oxidizer tank and pressure reservoir.

In the event of any crash, always inspect all parts for any signs of damage. In fact, we strongly suggest that you take the rocket completely apart and have the pressure reservoir pressure tested to 500 psi at your local machine shop or at a facility that can properly perform the test.

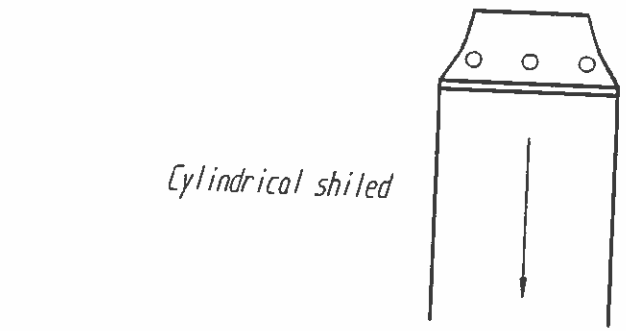
5.7 SUPPLIERS

When you purchase the chemicals required for the SS67B-3, always ensure you receive the MSDS sheets (ie. material safety data sheets) . They should be supplied with all chemicals that you purchase. These documents will inform you of the proper handling and safety precautions when using these substances. As we have said at the beginning of this manual, work cautiously and always work with patience. There is no substitute for common sense. If something seems wrong, then it probably is. Don't take foolish chances.

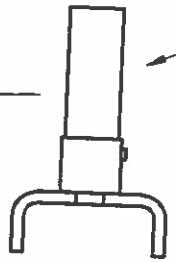
To obtain the necessary chemicals required for the SS67B-3, we strongly recommend that you find local suppliers in your area. If not, you may purchase the chemicals from the suppliers below. The "dry ice" may be purchased from distributors of Praxair Co. The Hydrogen Peroxide can be purchased from distributors of FMC and Dupont. The biggest distributor for Dupont is "Van Waters and Rogers".

1. Chemicals: Maillinckrodt Co. Phone: 1-314-654-2000
2. Chemicals: Aldrich Chemical Co. Phone: 1-414-273-3850
3. "Dry Ice": Praxair Co. Phone : 1-203-837-2000
4. 50% Hydrogen Peroxide: DuPont Co. Phone: 1-800-441-7515, Fax 1-302-774-7321
5. 50% Hydrogen Peroxide: FMC Co. Phone: 1-215-299-6000
6. 50% Hydrogen Peroxide: Van Water and Rogers Co. Phone: 1-520-247-8717

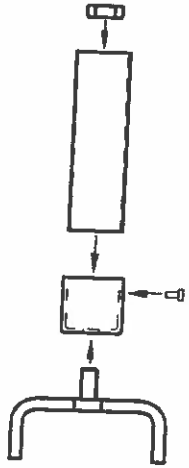
Assembly Drawings



Cylindrical shiled

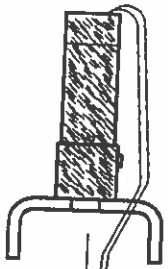


Load ignition powder into cartridge



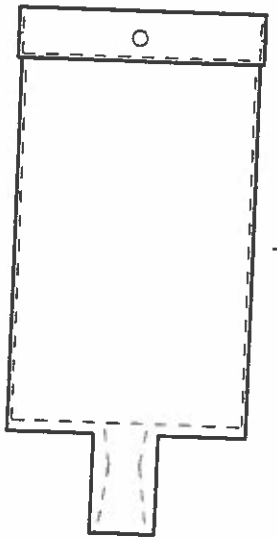
ossenble igntion cartridge

Coat pipe with supplied nortar. Place a coat about 1/16" to 1/8" thick.

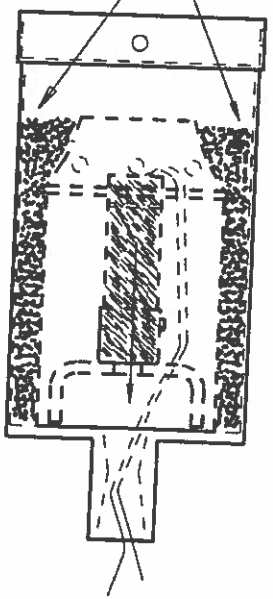


Solder 26 or 28 gouge wire to the igniter. Insert igniter head about 1/4" deep into mixture. Seal top with tissue poper and sone tape so that cartridge is fairly well sealed.

Lower igntion cartridge into conbustion chanber



load $KMnO_4$ here until top of shield



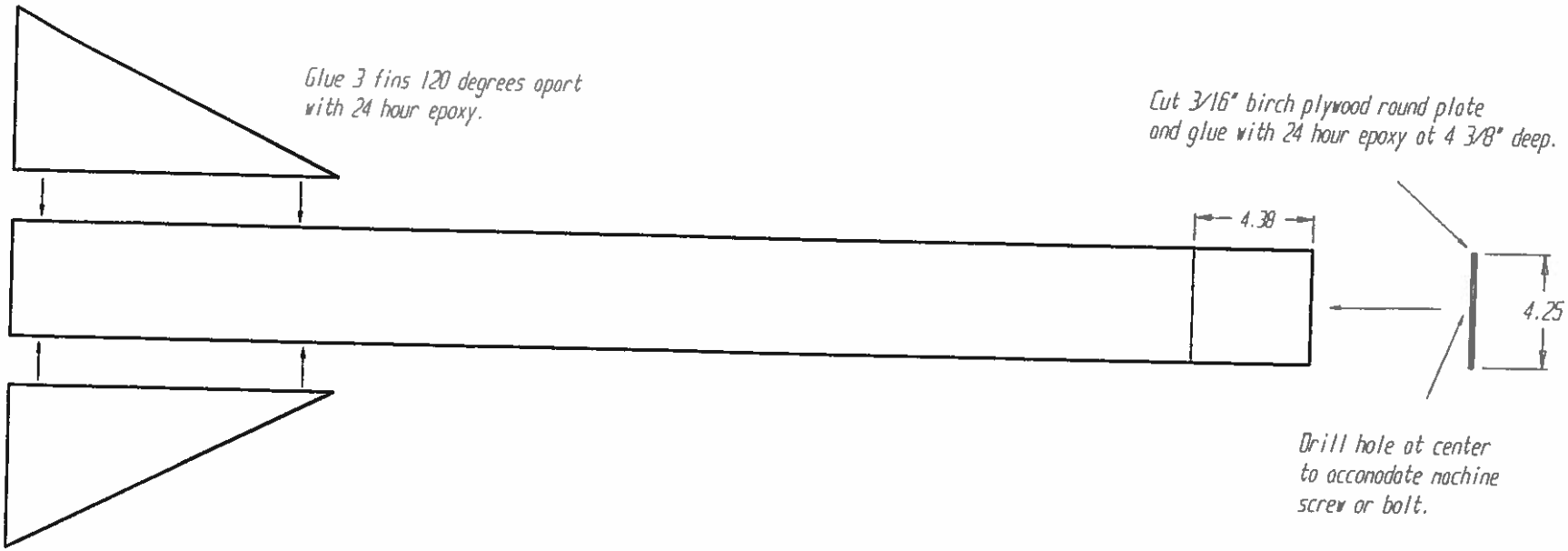
Completed Assembly

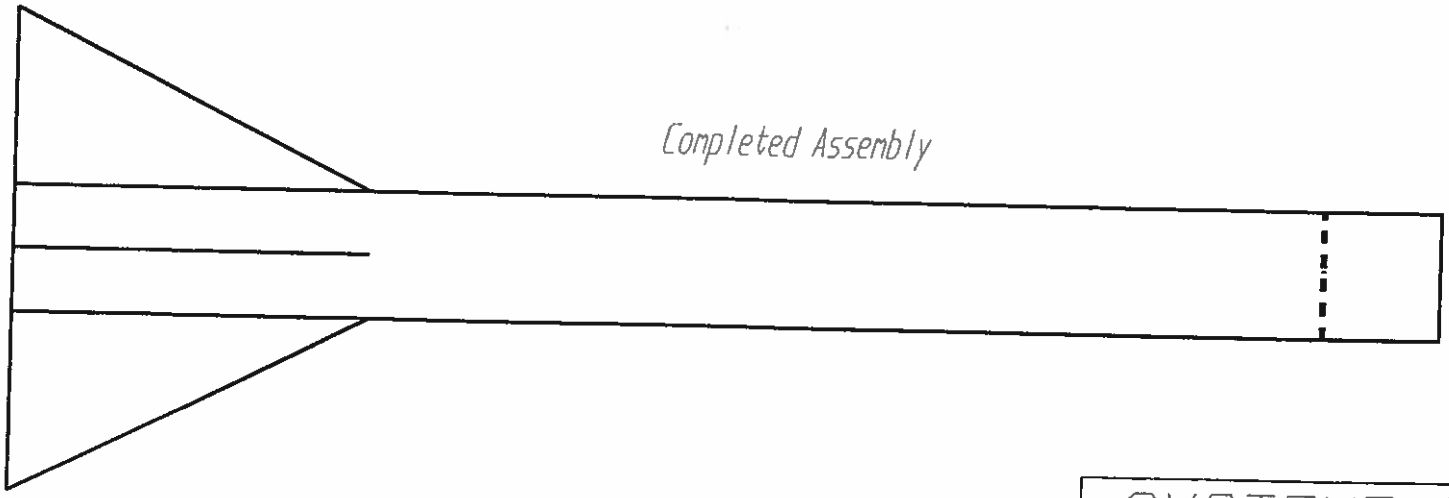
Allow $KMnO_4$ to dry.

SYSTEME SOLAIRE

Drawing #

B3-1





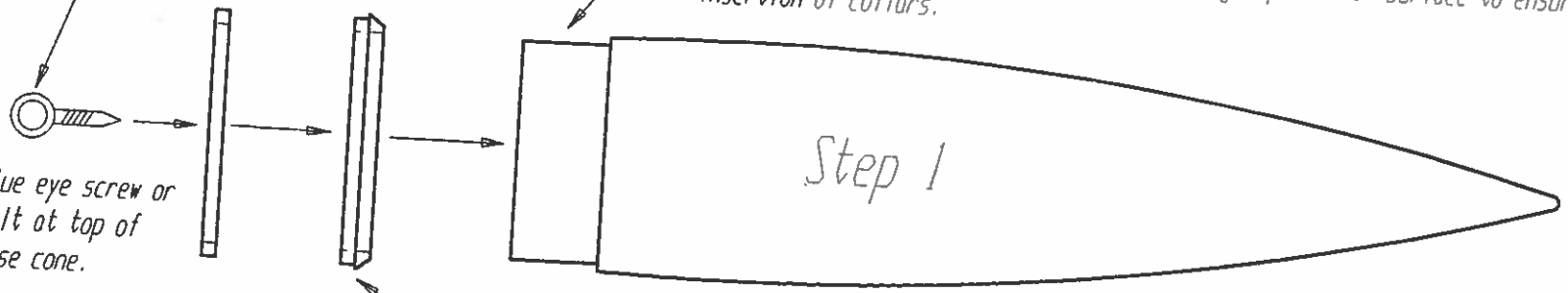
SYSTEME SOLAIRE

Drawing #

B3-2

Tie kite twine or cord of equivalent strength to eyebolt.

Ensure that surface is uniform. Remove any high spots from surface to ensure easy insertion of collars.



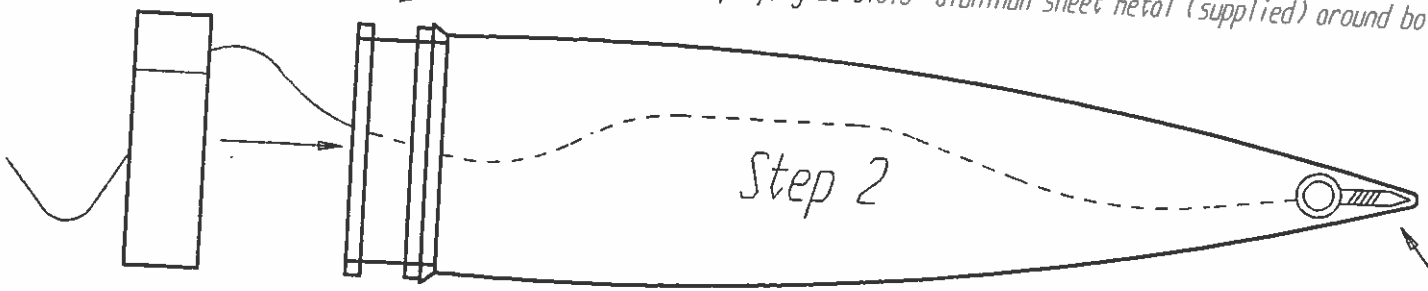
Glue eye screw or bolt at top of nose cone.

Using 24 hour epoxy, slide first collar until contact with the base of the nose cone occurs.

Using 24 hour epoxy, slide second collar until it is flush with the lower portion of the nose cone.

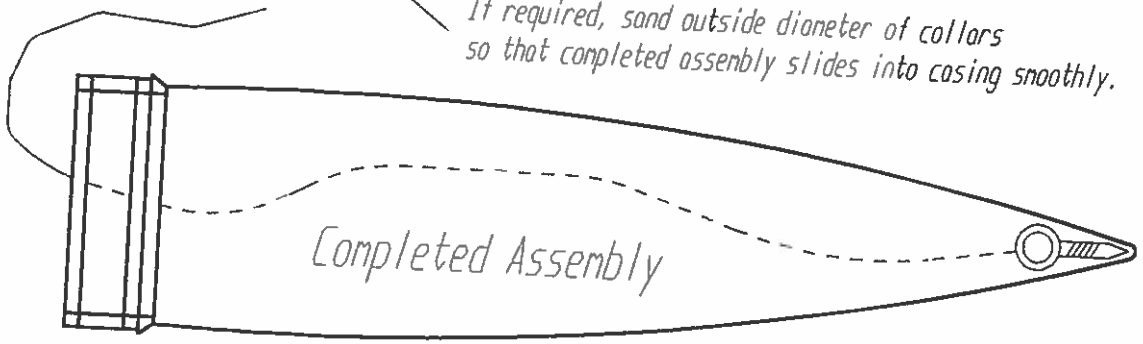
Curl supplied aluminum sheeting around collars.

Using 24 hour epoxy, glue 0.015" aluminum sheet metal (supplied) around both collars.



Note eyebolt

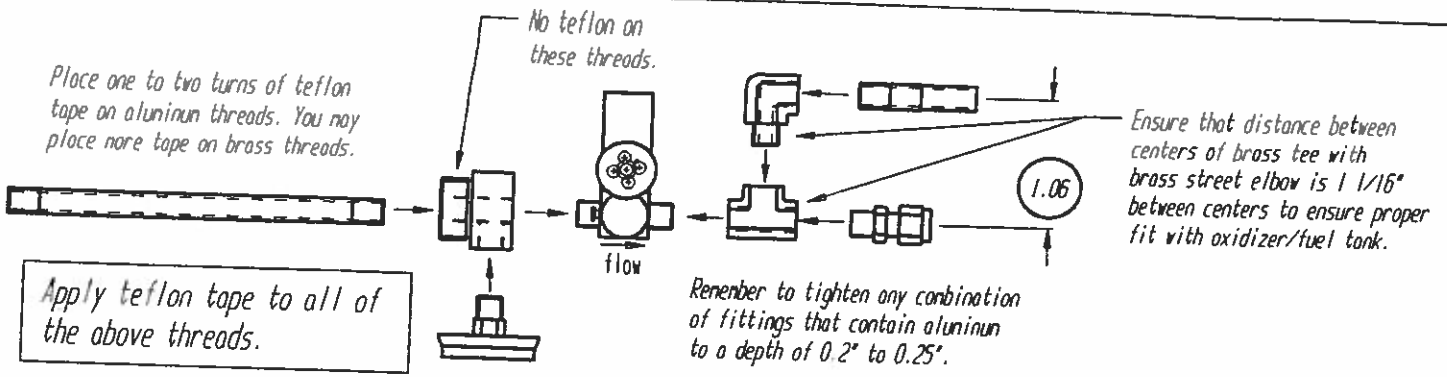
If required, sand outside diameter of collars so that completed assembly slides into casing smoothly.

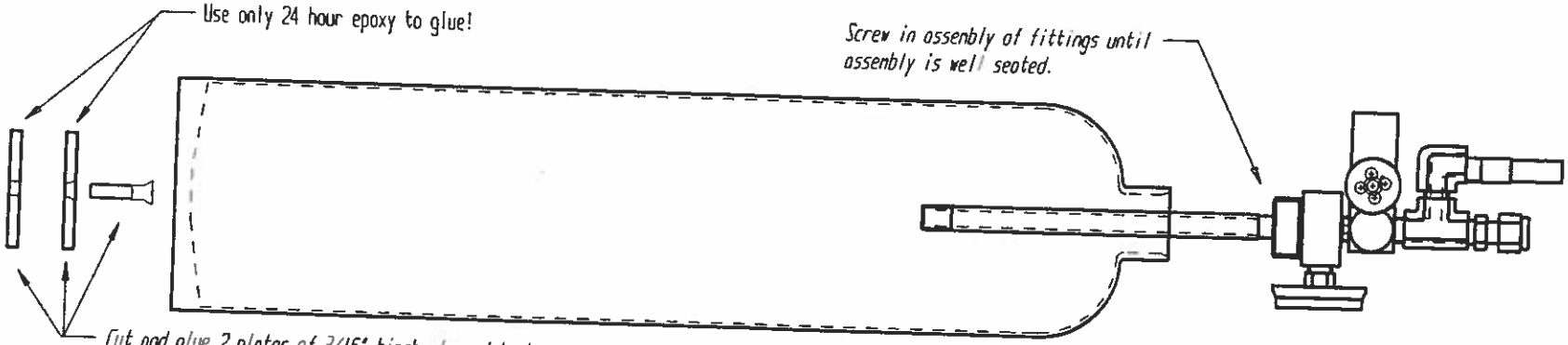


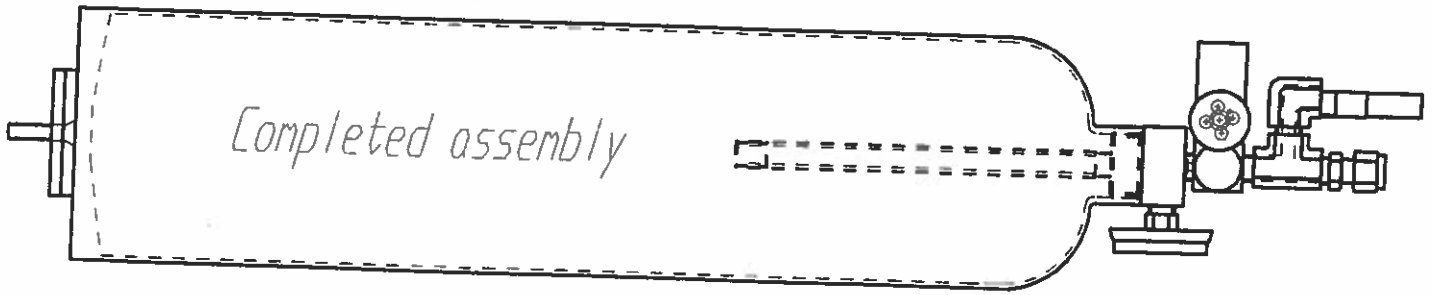
Some internal lines are solid for clarity. (ie. eyebolt)

SYSTEME SOLAIRE

Drawing # B3-2a



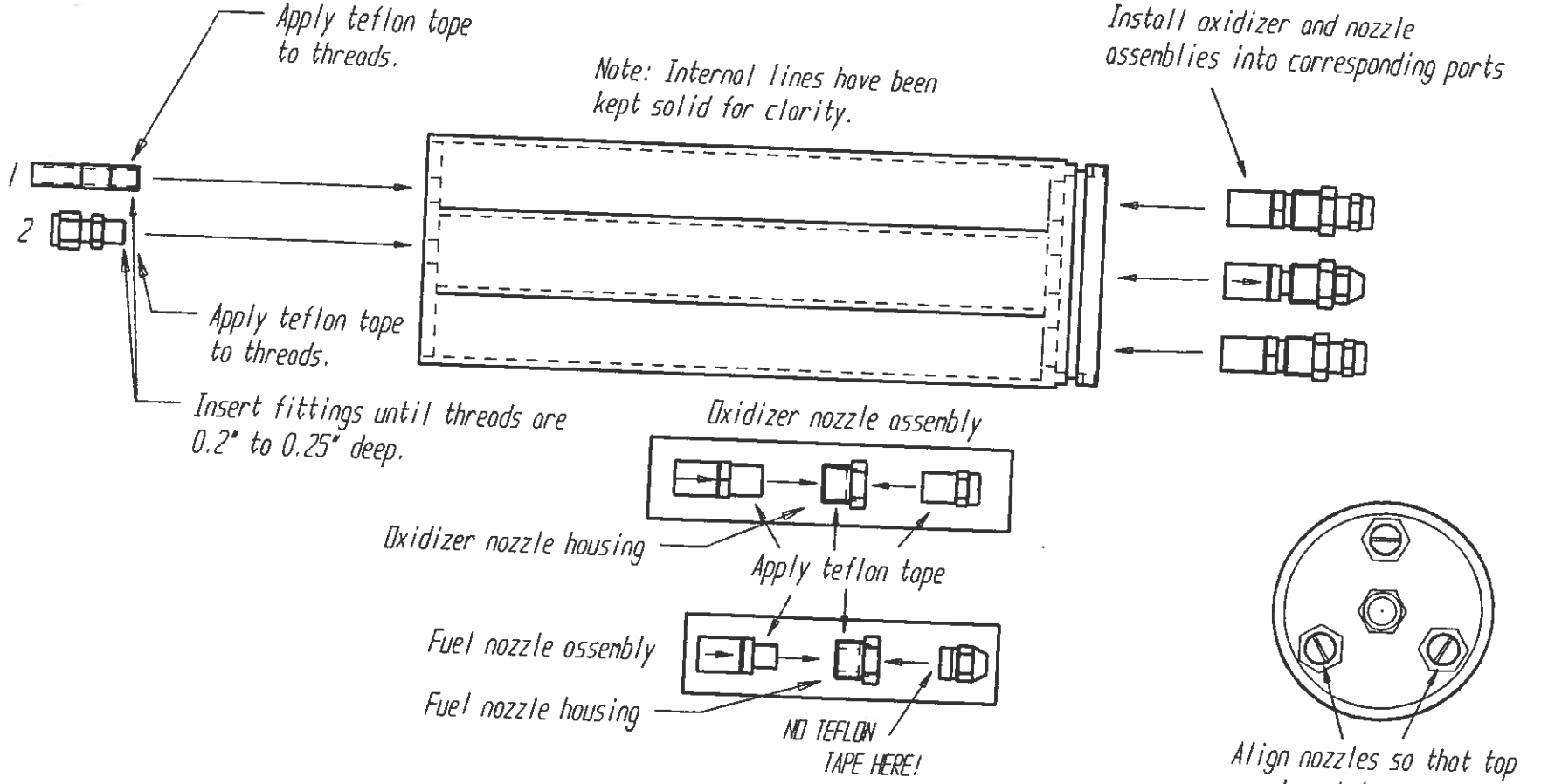


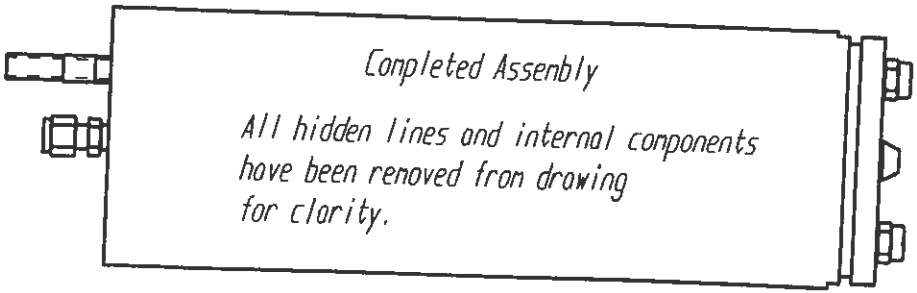


SYSTEME SOLAIRE

Drawing #

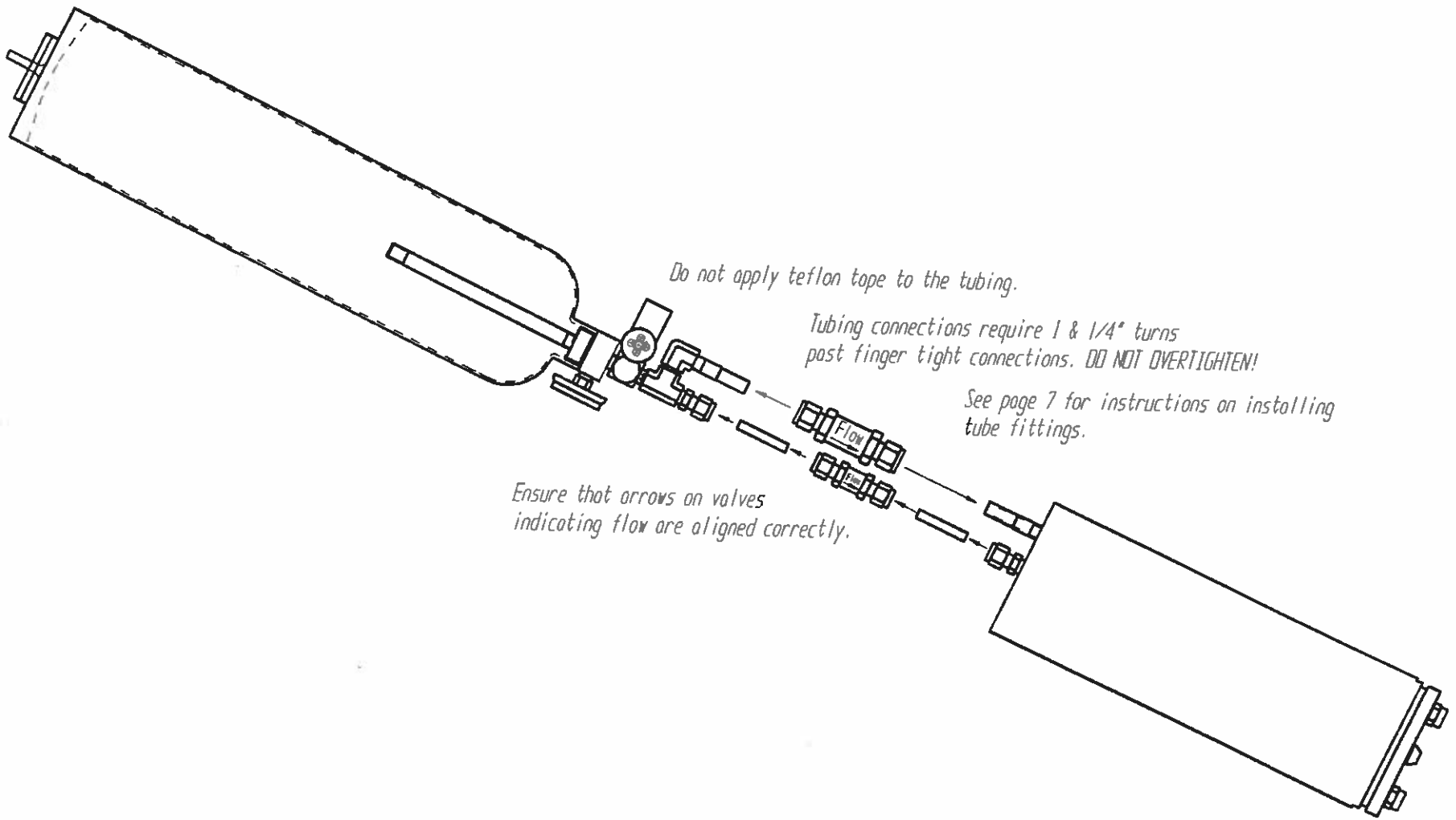
B3-3





SYSTEME SOLAIRE

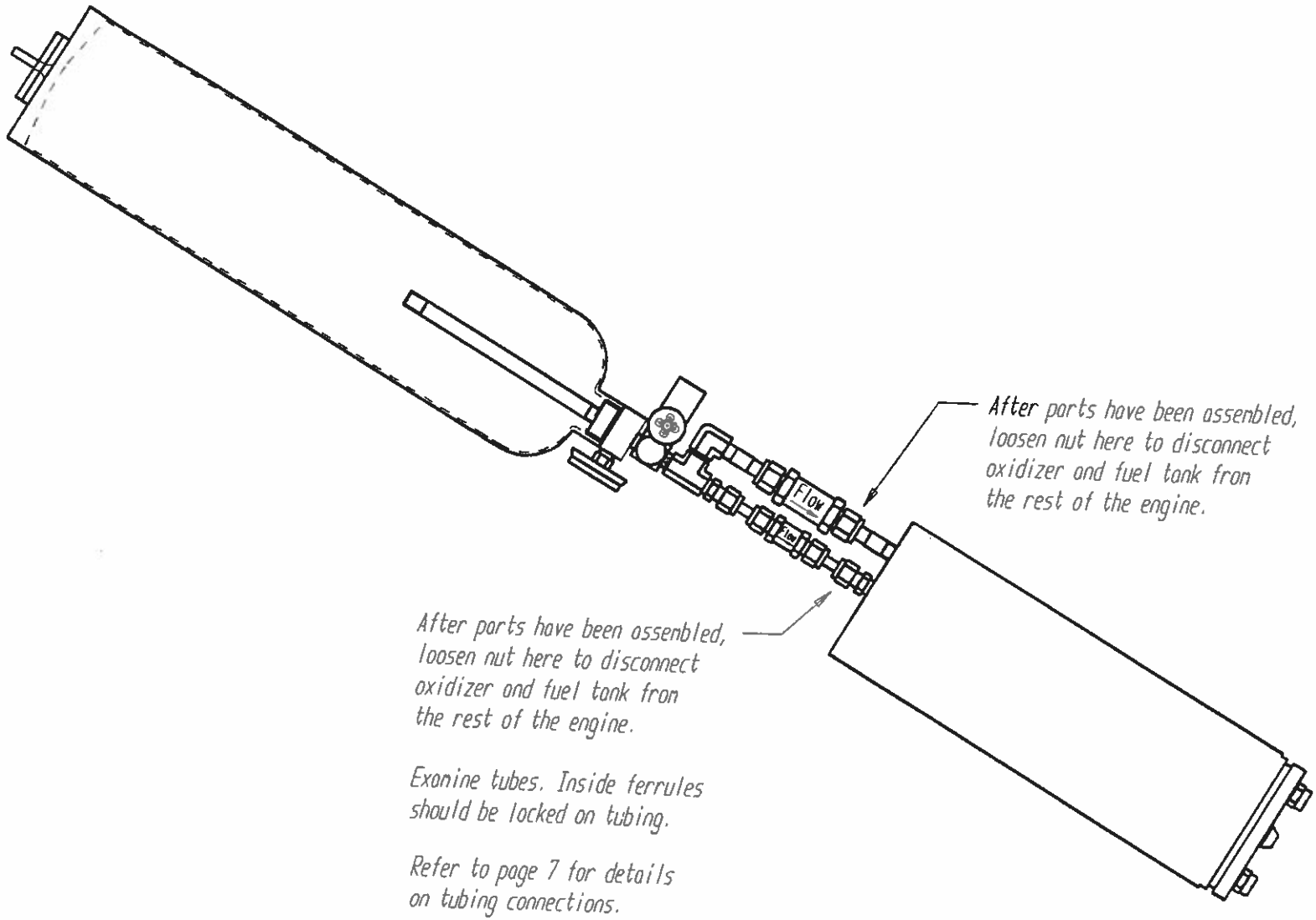
Drawing # B3-4



SYSTEME SOLAIRE

Drawing #

B3-5



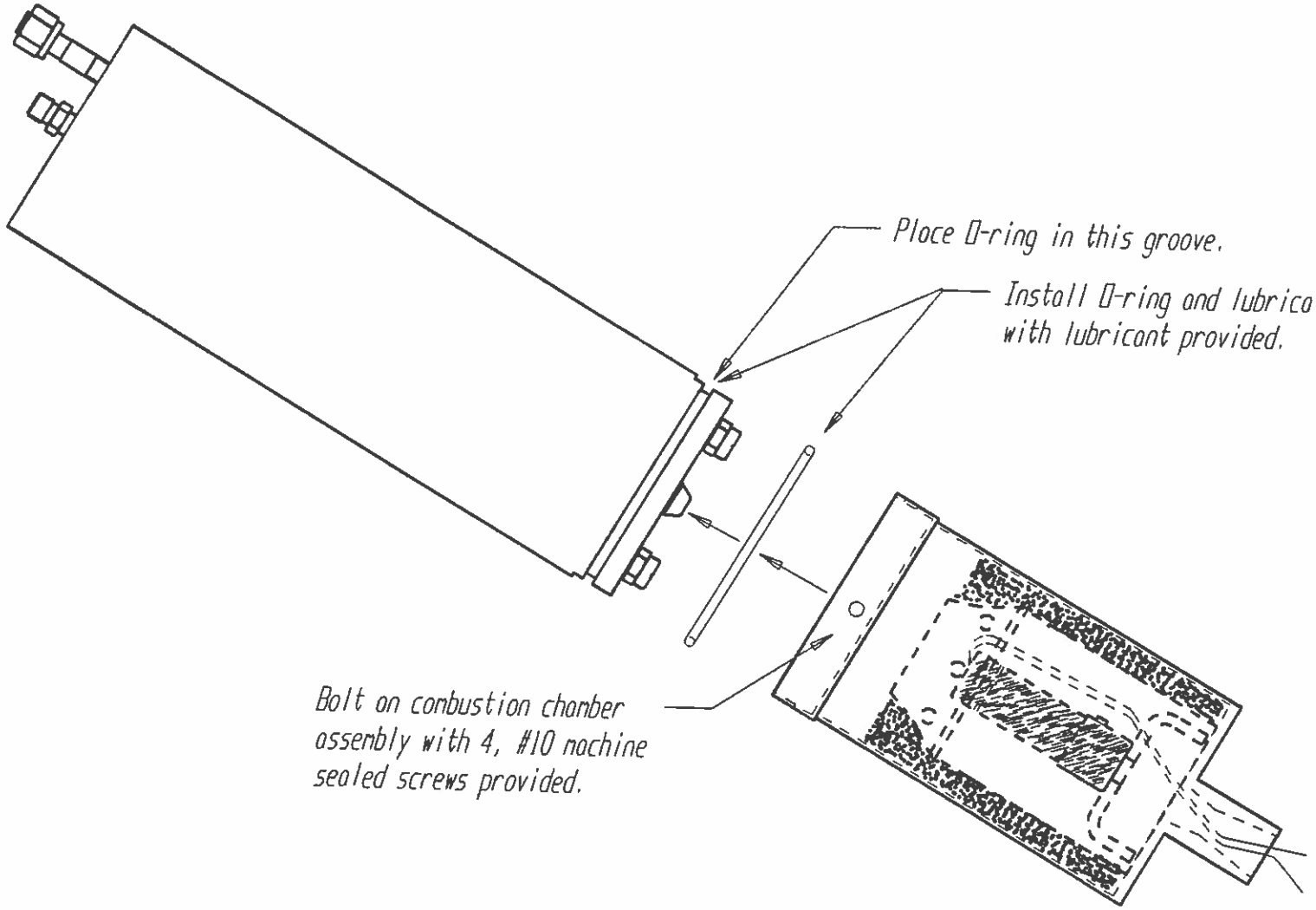
Exonine tubes. Inside ferrules should be locked on tubing.

Refer to page 7 for details on tubing connections.

SYSTEME SOLAIRE

Drawing #

B3-6

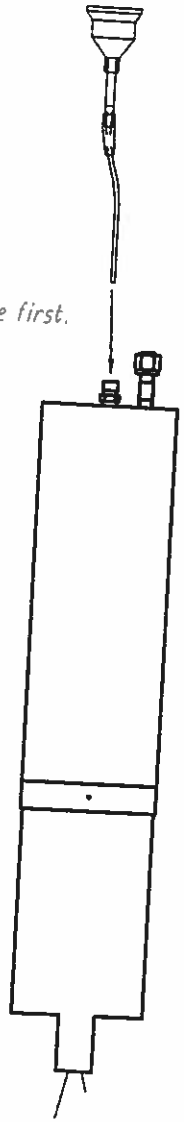


SYSTEME SOLAIRE

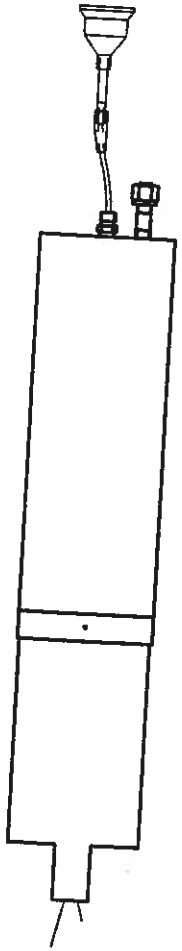
Drawing #

B3-7

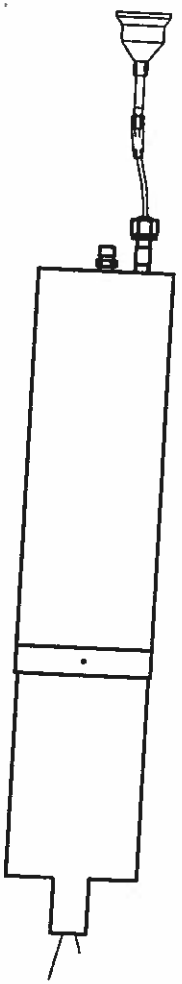
Place funnel in fuel line first.



Using funnel provided, slowly pour in approxinately 200 ml (0.0528 gallons) of super unleaded gasoline or 138 grans (0.304 lbs.)



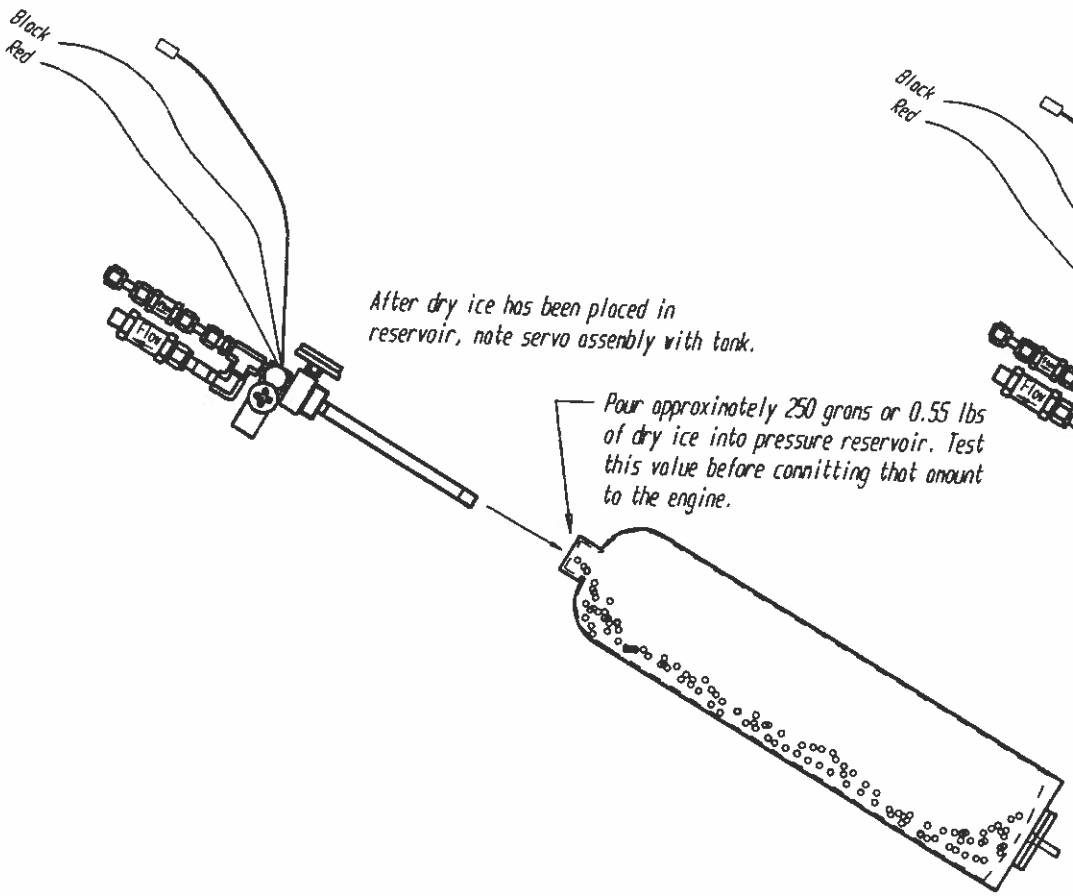
Clean funnel thoroughly with water. Pour 1.64 litres (0.433 gallons) or 1.97 kg (4.334 lbs) into oxidizer reservoir.

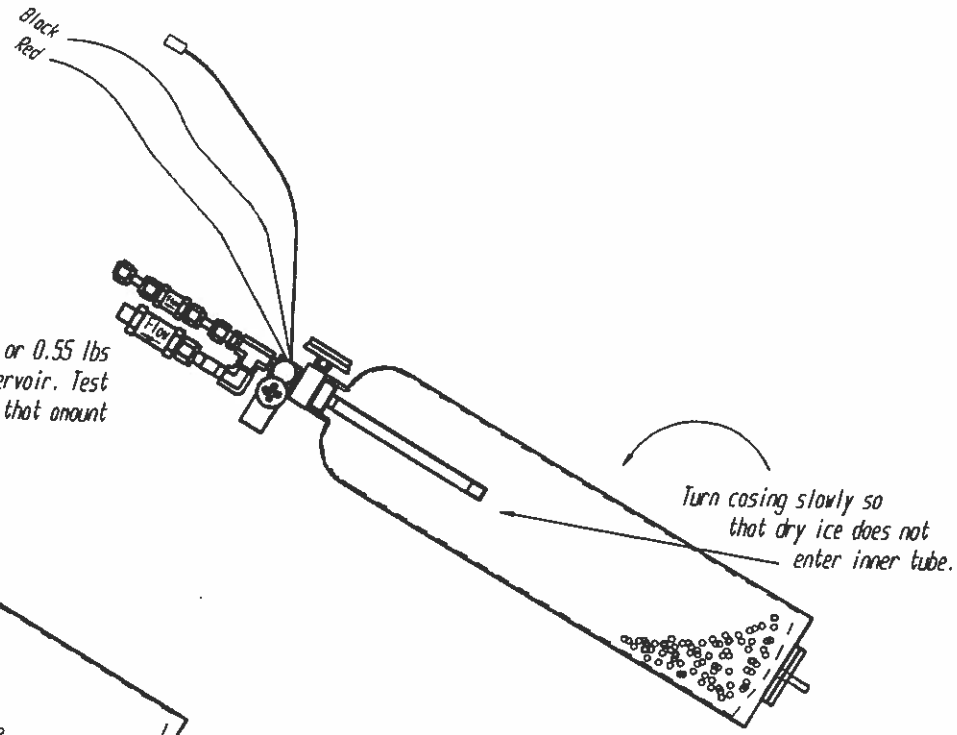


SYSTEME SOLAIRE

Drawing #

B3-8

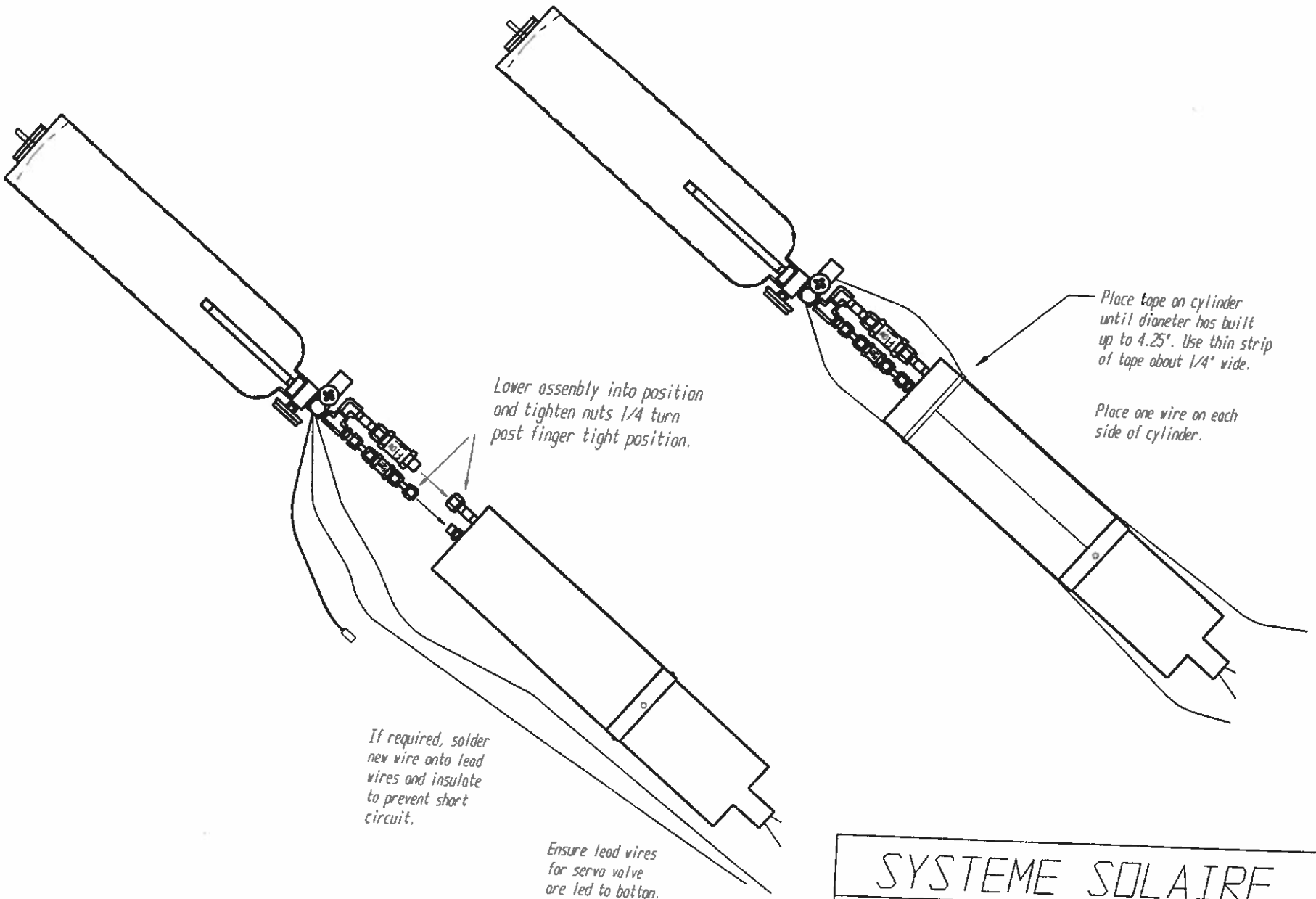




SYSTEME SOLAIRE

Drawing #

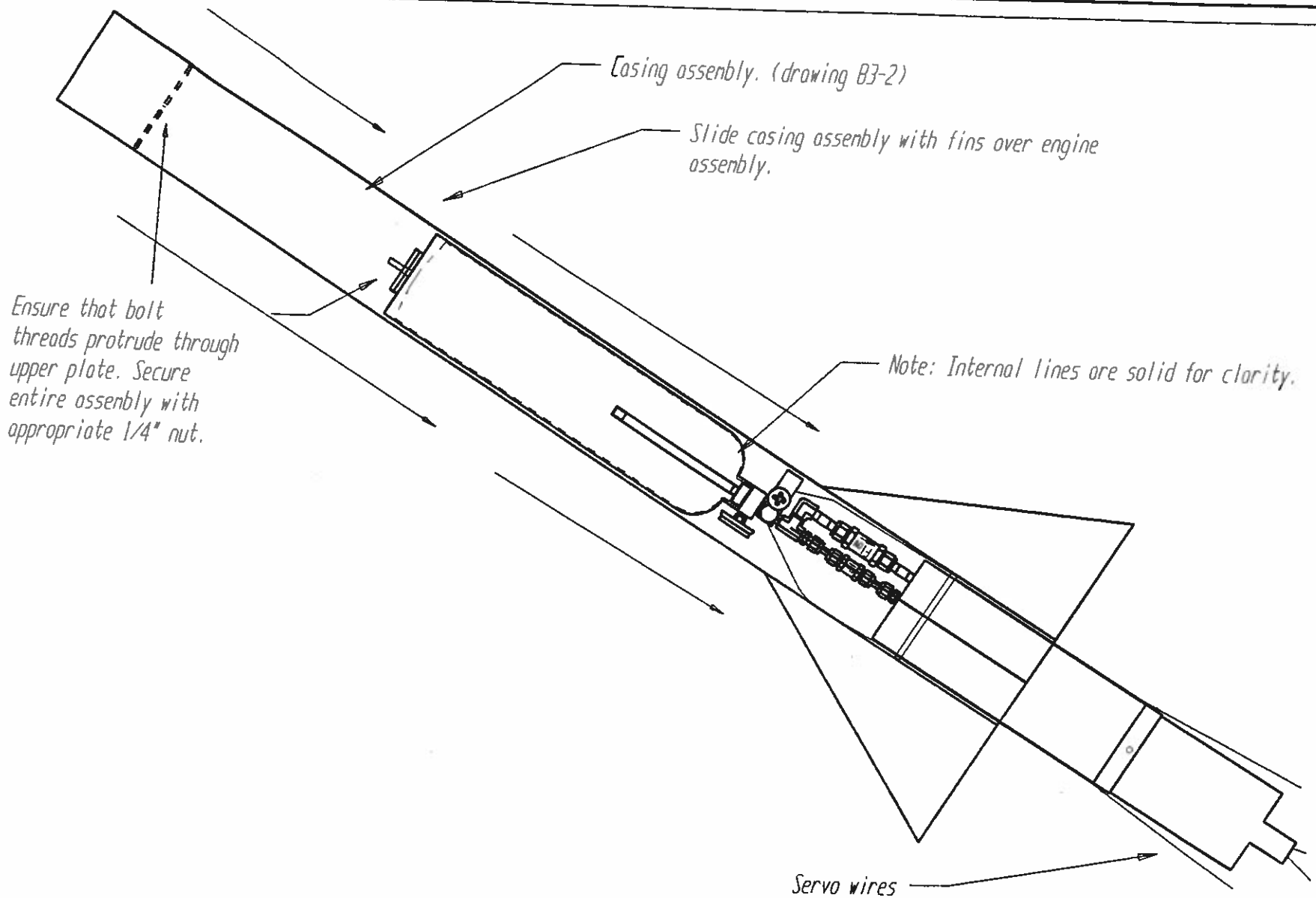
B3-9



SYSTEME SOLAIRE

Drawing #

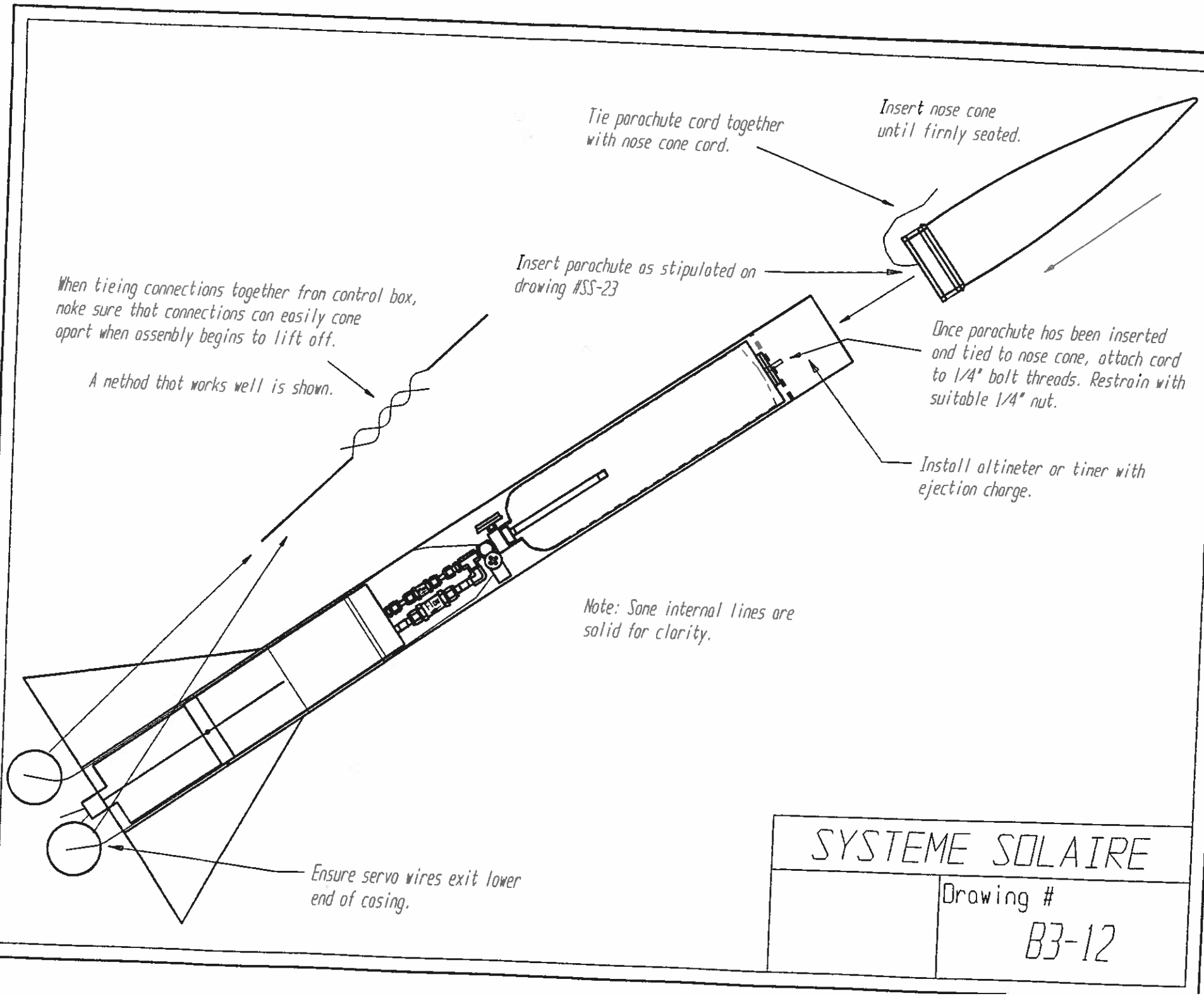
B3-10



SYSTEME SOLAIRE

Drawing #

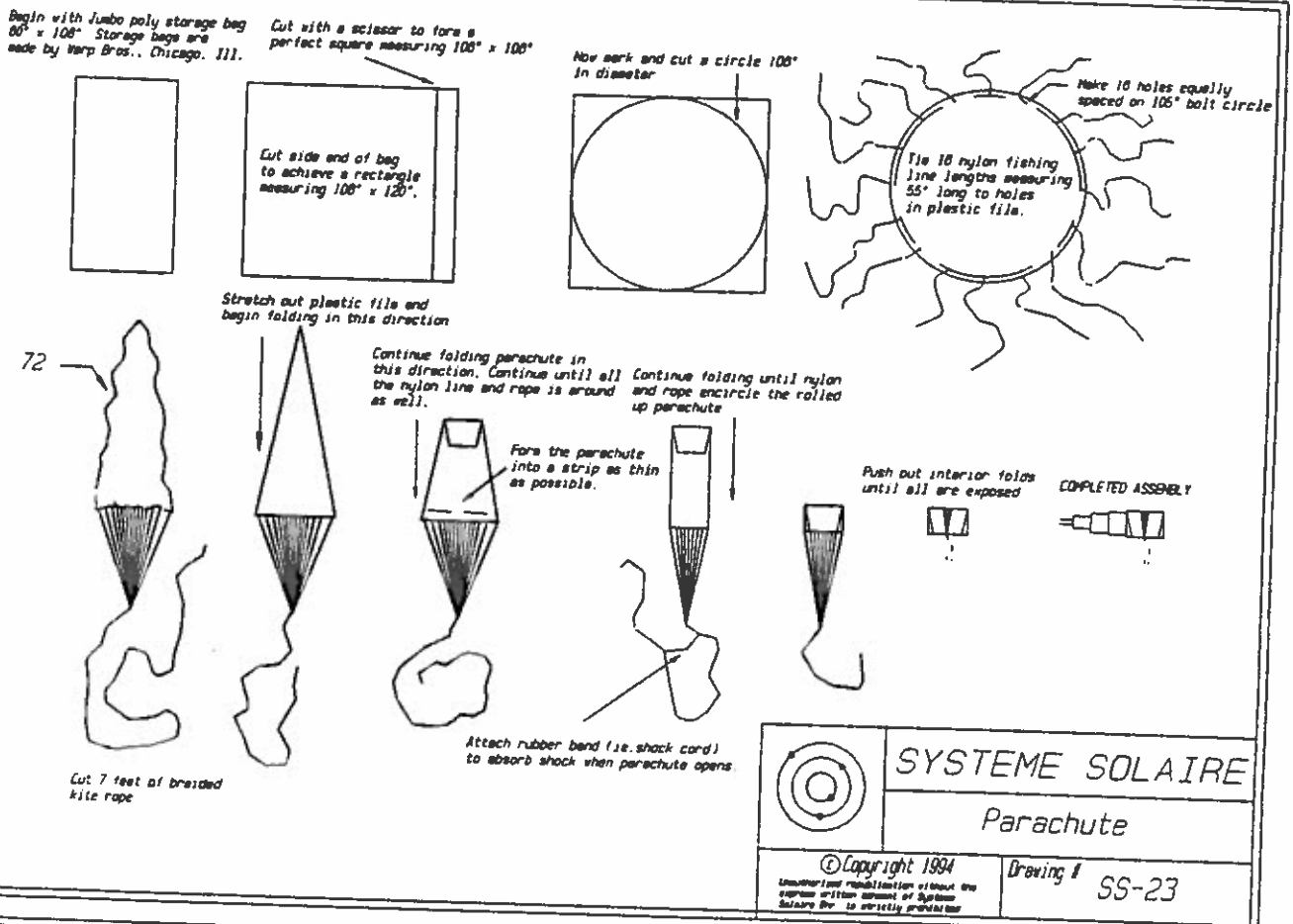
B3-11



SYSTEME SOLAIRE

Drawing #

B3-12


Begin with jumbo poly storage bag 80" x 108" Storage bags are made by Warp Bros., Chicago, Ill.
Cut with a scissor to form a perfect square measuring 108" x 108"
Now mark and cut a circle 108" in diameter
Make 16 holes equally spaced on 106" bolt circle
Cut side end of bag to achieve a rectangle measuring 108" x 120".
Tie 16 nylon fishing line lengths measuring 55" long to holes in plastic film.
Stretch out plastic film and begin folding in this direction
72
Continue folding parachute in this direction. Continue until all the nylon line and rope is around as well.
Continue folding until nylon and rope encircle the rolled up parachute
Form the parachute into a strip as thin as possible.
Push out interior folds until all are exposed
COMPLETED ASSEMBLY
Attach rubber band (ie. shock cord) to absorb shock when parachute opens.
Cut 7 feet of braided kite rope
SYSTEME SOLAIRE
Parachute
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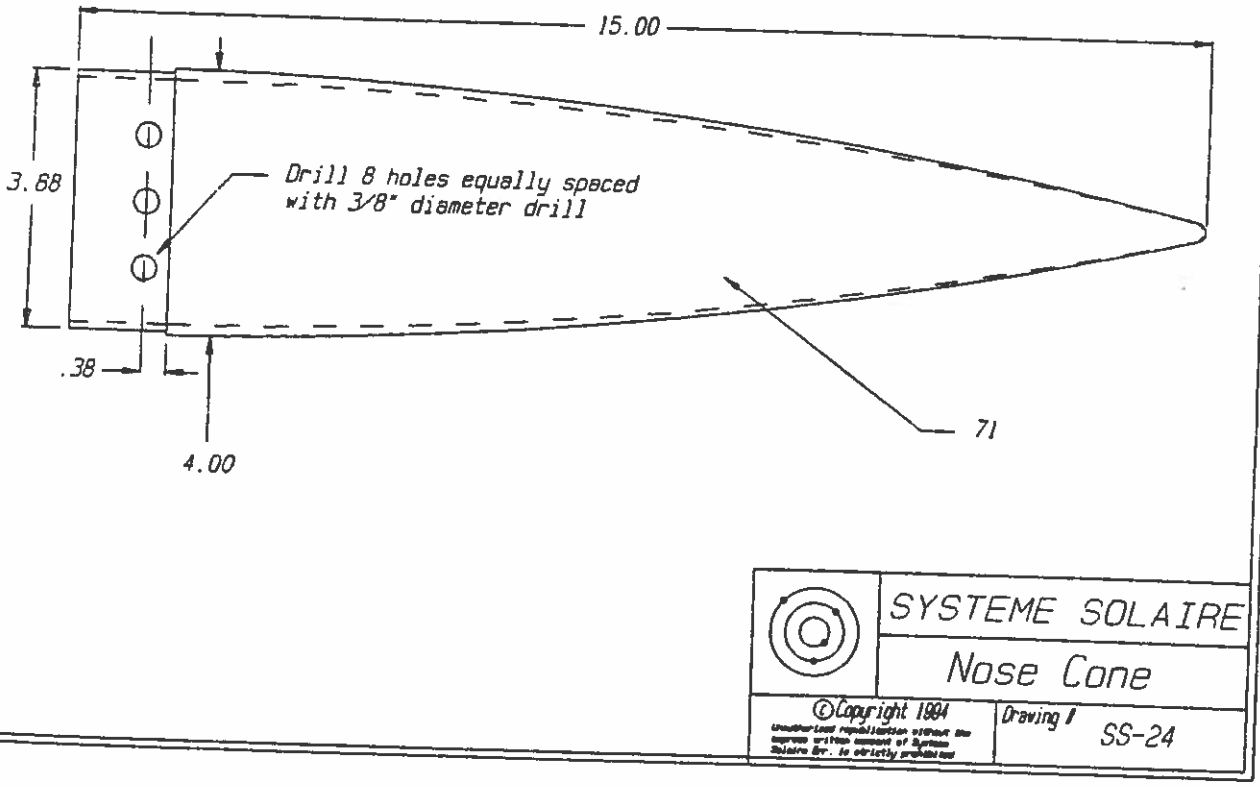
Drawing # SS-23


15.00
3.68
Drill 8 holes equally spaced with 3/8" diameter drill
.38
4.00
71
SYSTEME SOLAIRE
Nose Cone
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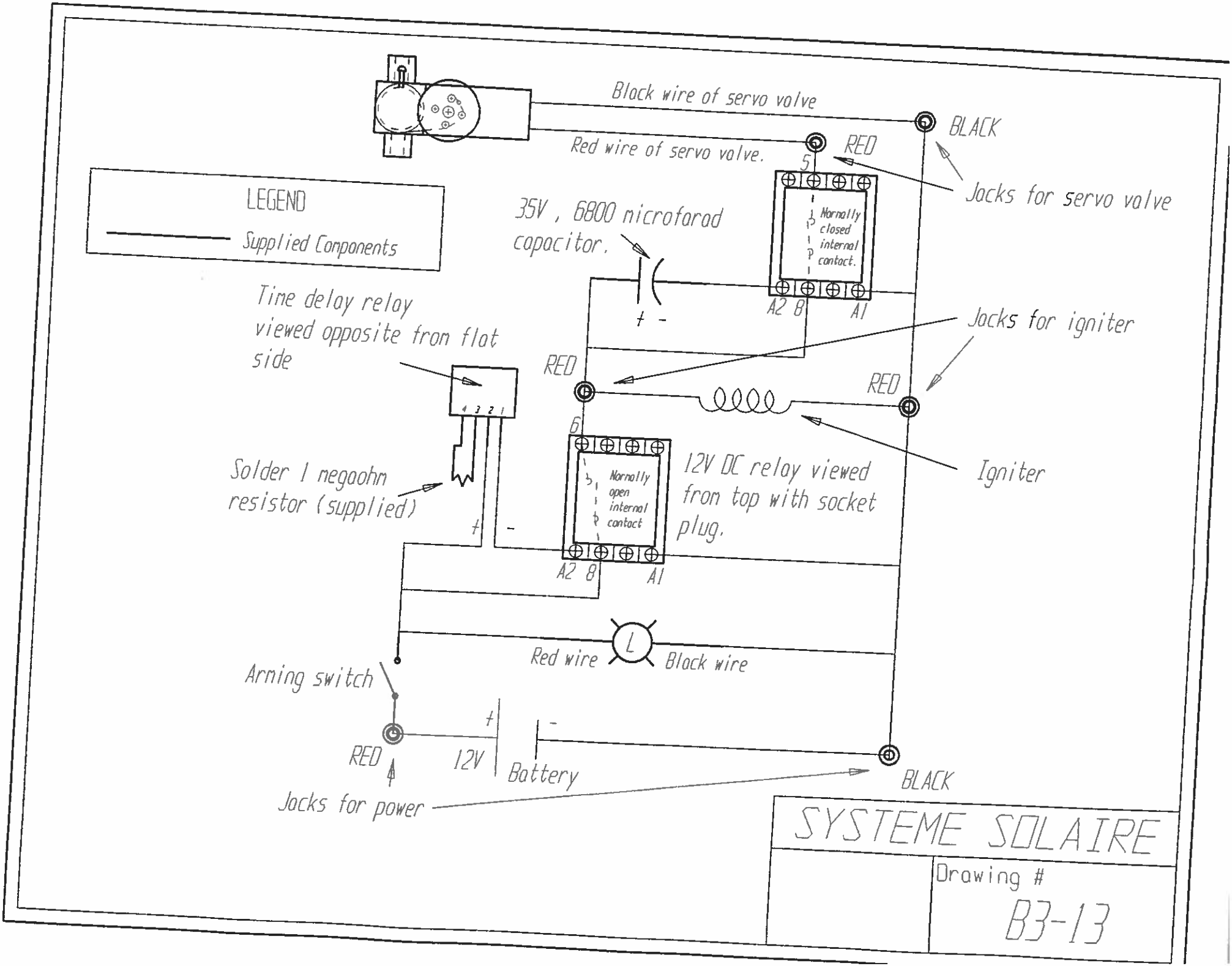
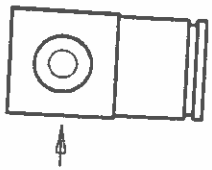
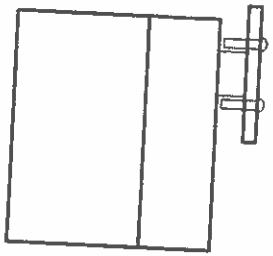
Drawing # SS-24

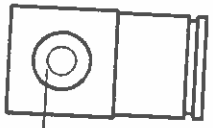

Black wire of servo volve
BLACK
Red wire of servo volve.
RED
5
Jacks for servo volve
LEGEND
Supplied Components
35V , 6800 microforad capacitor.
Normally closed internal contact.
A2 B A1
+ -
Jacks for igniter
Tine delay relay viewed opposite from flat side
RED
RED
4 3 2 1
6
Igniter
Solder 1 megaohm resistor (supplied)
Normally open internal contact
12V DC relay viewed from top with socket plug.
+
-
A2 B A1
L
Red wire
Black wire
Arming switch
+
-
RED
12V
Battery
BLACK
Jacks for power
SYSTEME SOLAIRE
Drawing #
B3-13

Servo Valve Assembly Instructions

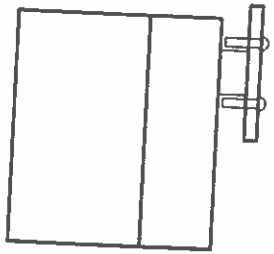


Sand contact surfaces with 200 grit sandpaper and glue with 24 hour epoxy glue.



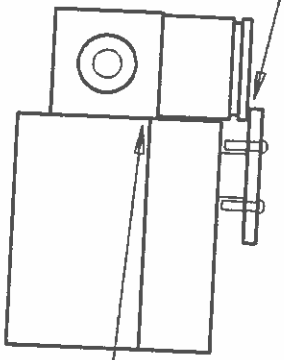


Apply 24 hour epoxy glue to surfaces.



Allow glue to dry for 24 hours.

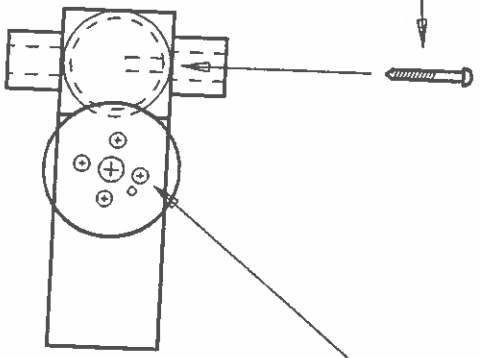
Bring valve to 1/64" from head servo motor plate.



Ensure that glue does not touch rotating green center.

Coat screw threads with 24 hour epoxy glue and place in side hole.

Flow



Turn servo motor plate completely clockwise. Remove center phillips screw and position plate to orientation as shown. Note tie screw at a position to the right. Re-install phillips screw.

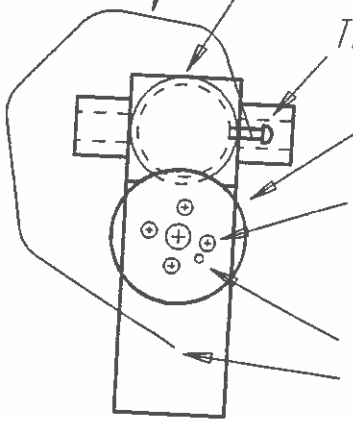
Ensure cable enters guide track on green stem.

Tie cable around protruding screw.

Servo motor plate

Once cable has passed upwards through hole, tie to head of screw.

Pass end of servo cable under plate. Pass cable through plate upwards at hole indicated.



If required, loosen center screw holding servo motor plate and turn counterclockwise to tighten cable.

Pass cable underneath plate. Ensure that cable contacts screws protruding underneath plate.