4-H Kids- please read pgs 1-3 BEFORE class #1 April 11.

ADVENTURE I - A SAFE AND SANE HOBBY

1. TYPES OF ROCKETEERS

   A. MODEL ROCKETEERS - You, as a model rocketeer, are part of a "club" of one million individuals around the world who are active in this great hobby. Model rocketeers use lightweight materials such as balsa wood, cardboard, commercially produced rocket engines and adult supervision.

   B. AMATEUR ROCKETEERS - Amateur rocketeers are better known as basement bombers, as they make their own fuels, use unsafe equipment and their chances are 1 in 7 of being injured or killed. It just is not worth being an amateur rocketeer, because you do not have the training, experience or safety equipment.

   C. PROFESSIONAL ROCKETEERS - Professional rocketeers have a good technical education and extensive experience. Many specialties such as electrical engineering, chemical engineering and mechanical engineering are needed by NASA. Professional rocketeers use elaborate safety equipment when mixing propellant.

2. WHY MODEL ROCKETRY?

Four major factors responsible for creating model rocketry were: 1) a desire to build and launch rockets, 2) dangerous materials, 3) little information on the dangers involved and 4) safe materials for rocketry were not available.

Model rocketry was started as an alternative to the "basement bombers." A second reason was to initiate an educational program to alert the potential rocketeer of the dangers of becoming a "basement bomber". A third reason was to guide the imaginative rocketeer with safe and tested equipment. And the fourth reason was to provide the rocketeer with the technical information to have a safe and sane hobby.

3. BRIEF HISTORY OF ROCKETRY

The earliest recorded use of rockets took place in 1252 A.D., at a military siege in China. In the 15th century they were mainly used as a device for setting fire to the rigging of enemy ships. William Congreve was the first to use rockets of any size. They had a range of about 3,000 yards, used a sheet-iron case carrying a 7 pound charge, were 15 feet long and weighed 32 pounds. William Hale, British inventor, developed a rocket which was spin-stabilized, eliminating the heavy guidestick. Rockets were used in the War of 1812, Mexican War and American Civil War. By 1880 whaling rockets were developed. Goddard had improved rocket design by use of smokeless powder. Clarence Hickman invented the anti-tank rocket, better known as the bazooka. Rocketry has evolved to a thrust of 7 million pounds or more. Liquid propellant rockets began about 1920 and were mainly used as guided missiles. Rockets have many uses; as distress signals, to carry cables across rivers, carry scientific instruments and other applications too numerous to name. Model rocketry basically had its beginning about 1958 after the launch of Sputnik in 1957.

4. MODEL ROCKET SAFETY CODE

The following rules have been set down to conduct model rocketry in a safe and sane manner and have been accepted worldwide.

A. CONSTRUCTION - My model rockets will be made of lightweight materials such as paper, wood, plastic and rubber, without any metal as structural parts.

B. ENGINES - I will use only pre-loaded, factory-made model rocket engines in the manner recommended by the manufacturer. I will not change in any way nor attempt to reload these engines.

C. RECOVERY - I will always use a recovery system in my model rockets that will return them safely to the ground so that they may be flown again.

D. WEIGHT LIMITS - My model rocket, fully loaded, will weigh no more than 453 grams (16 ounces) at lift-off, and the engines will contain no more than 113 grams (4 ounces) of propellant.

E. STABILITY - I will check the stability of my model rockets before their first flight, except when launching models of already proven stability.

F. LAUNCHING SYSTEM - The system I use to launch my model rockets must be remotely controlled and electrically operated and will contain a switch that will return to "off" when released. I will remain at least 10 feet away from any rocket that is being launched.

G. LAUNCH SAFETY - I will not let anyone approach a model rocket on a launcher unless the safety cap, with safety key attached, is in place on the top of the launch rod, or until I have made sure that either the safety interlock key has been removed or the battery has been disconnected from my launcher.

H. FLYING CONDITIONS - I will not launch my model rocket in high winds, near buildings, power lines, tall trees, low-flying aircraft or under any conditions which might be dangerous to people or property.

I. LAUNCH AREA - My model rockets will always be launched from a cleared area, free of any easy to burn materials and I will only use nonflammable recovery wadding in my rockets.

J. JET DEFLECTOR - My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly.

K. LAUNCH ROD - To prevent accidental eye injury I will always place the launcher so the end of the rod is above eye level or cap the end of the rod with my hand when approaching it. I will never place my head or body over the launching rod. When my launcher is not in use, I will always store it so the launch rod is not in an upright position.

L. POWER LINES - I will never attempt to recover my rocket from a power line or other dangerous place.

M. LAUNCH TARGETS AND ANGLE - I will not launch rockets so their flight path will carry them against targets on the ground and will never use an explosive warhead or a payload that is intended to be flammable. My launching device will always be pointed within 30 degrees of vertical.

N. PRE-LAUNCH TEST - When conducting research activities with unproven designs or methods, I will, when possible, determine their reliability through pre-launch tests. I will conduct launchings of unproven designs in complete isolation from persons not participating in the actual launching.

Please complete questions for Adventure I found on page 27.

*Please Read Pgs. 3-5 Before April 25 Class #2

ADVENTURE II - WHAT IS A COMPLETE ROCKET SYSTEM?

5. BASIC PARTS OF A MODEL ROCKET

A. BODY TUBE - 2.75 inches or more in length.

B. NOSE CONE - There are nearly 32 sizes and shapes.

C. SCREW EYE - There are three sizes; large, small and extra small. Recovery system attaches to it.

D. SNAP SWIVELS - Used for quick changes and reduces tangling in recovery systems.

E. LAUNCH LUG - Length and sizes vary with size of rocket and launch rod.

F. ENGINE MOUNT - Centers and holds engine in place in body tube. There are three basic sizes according to engine being used.

G. FINS - Normally at rear of rocket, they are used to guide and stabilize flight of rockets.

H. ENGINE HOOK - Used to keep engine from going through body tube.

6. RECOVERY PARTS OF A MODEL ROCKET

A. SHROUD LINES - Connect to swivel and screw eye.

B. TAPE STRIPS - Connect shroud lines to parachute.

C. PARACHUTE - Varies according to size of model rocket, 10 inches to 36 inches in diameter.

D. WADDING - Flameproof tissue used to keep parachute from melting or burning.

E. SHOCK CORD - Connects to body tube, swivel and screw eye. Comes in 1/8 inch and 1/4 inch widths.

7. LAUNCHING EQUIPMENT OR PARTS OF A MODEL ROCKET

A. ENGINE - There are mini-engines, single stage, upper stage and booster engines (A-B-C-D example C6-3, and C6-0). Mini-engines come in A series only.

B. IGNITERS - Used to ignite the rocket engine(s). There are two types; Astron and Solar igniters.

C. LAUNCH CONTROL SYSTEM - Comes with safety interlock key, arming lamp, ignition button, micro-clips, heavy duty battery clips and 20 feet of launch cable.

D. BATTERY - Use at least a 6-volt battery, preferably a 12-volt system for reliability.

E. LAUNCH PAD - Includes launch rod, jet deflector and launch base.

Figure 1

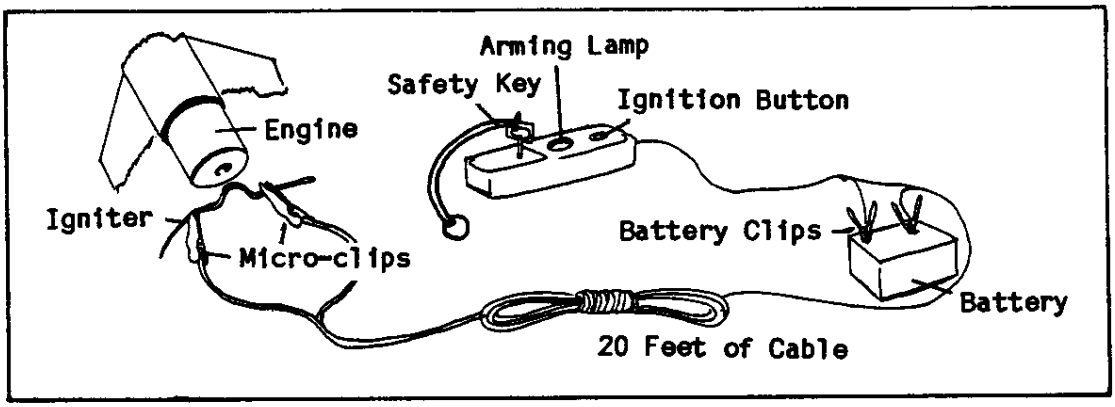
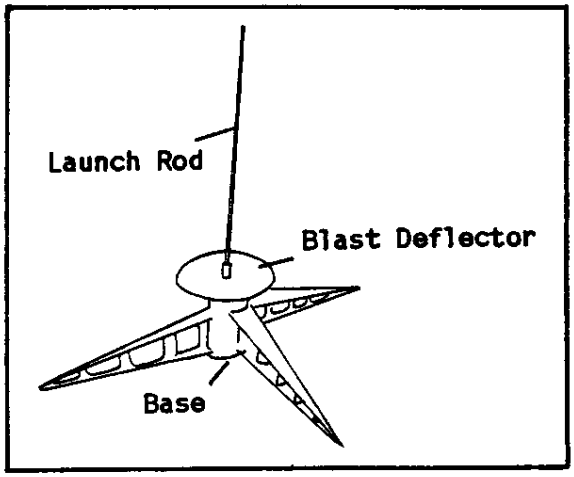


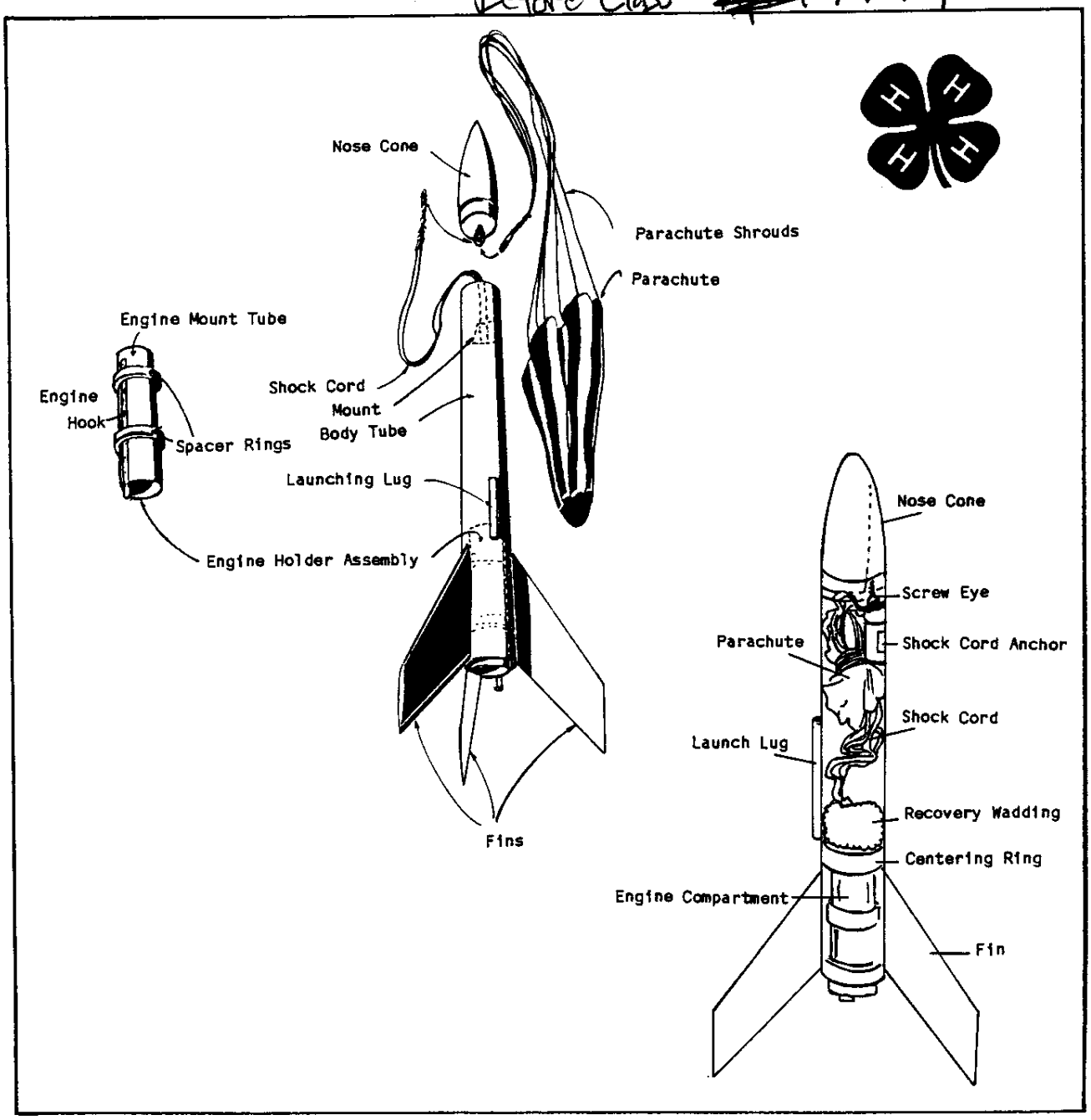
Figure 2



F. SAFETY CAP AND KEY - which is placed on top of launching rod while rocketeer is preparing for launch. Safety cap and safety key are tied together so that while cap is on rod launching cannot take place.

Please complete questions for Adventure II found on page 28.

Figure 3 Please Read pgs 5-11 Before Class - ~~April~~ May 9



ADVENTURE III - TOOLS, KITS, AND CONSTRUCTION

8. TOOLS NEEDED.

   A. HOBBY KNIFE - Exacto knife is preferred for safety reasons as it has a retractable blade.

   B. SAND PAPER - Fine and extra fine are preferred due to the softness of balsa wood.

   C. SANDING SEALER - For covering holes created by sanding and other causes.

   D. PAINTS - Dope is used for all parts except plastic; enamel is used for all parts including plastic. Do not mix the two.

   E. BRUSHES - Large, medium and small for all types of areas including detail work on your rocket.

   F. THINNER - For cleaning paint brushes.

   G. GLUE - To put parts together on rocket that require it.

   H. SCISSORS - For cutting out patterns, decals, etc., as needed.

   I. TWEEZERS - For parts that are too small to be readily picked up with your fingers.

   J. PENCIL OR PEN - For marking lines on body tube, tracing around patterns, etc.

9. ROCKET KITS TO BUILD

   Select and complete a rocket from skill level one. Then you may select and complete a rocket from skill level two.

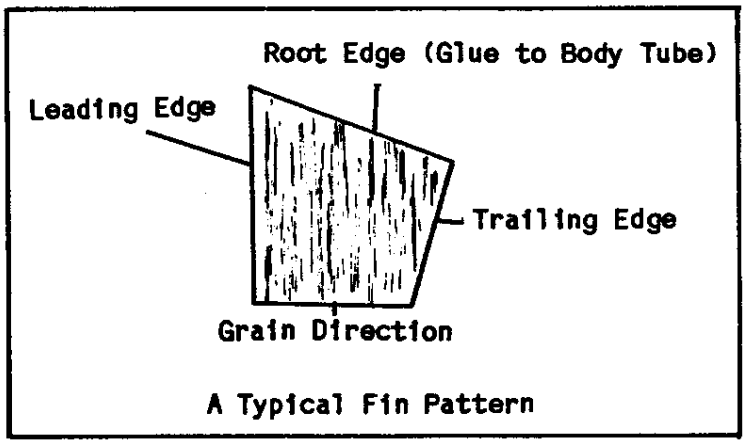
10. CONSTRUCTION BEGINS

   A. Check parts list and read instructions.

   B. Cut out fin pattern(s).

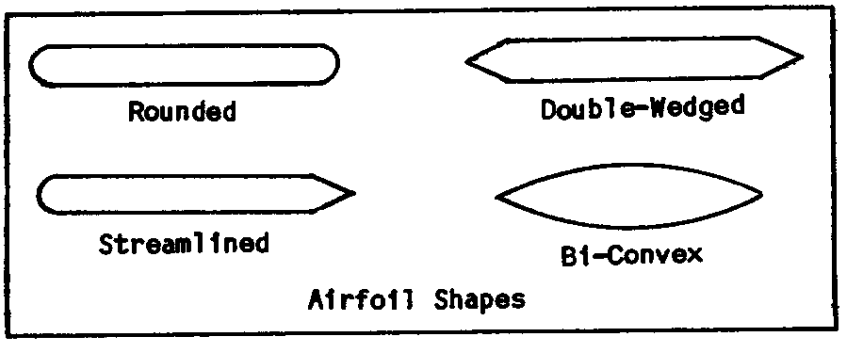
   C. Use fin pattern to trace on balsa wood, with grain going in the same directon as on the pattern.

Figure 4



D. After fins have been cut, the next step is sanding the fins. Each fin has to be done separately. If you use clamps or straight pins to hold them together, you will cause holes which cannot be repaired. Such holes cause an unstable guidance or flight pattern due to aerodynamic flow of air past the fins. Sand flat surface of fin with grain of wood so as not to form undue ridges. Then round edges of fins. This is known as airfoiling. One edge (called the root edge) should never be rounded as it will fit on the body tube.

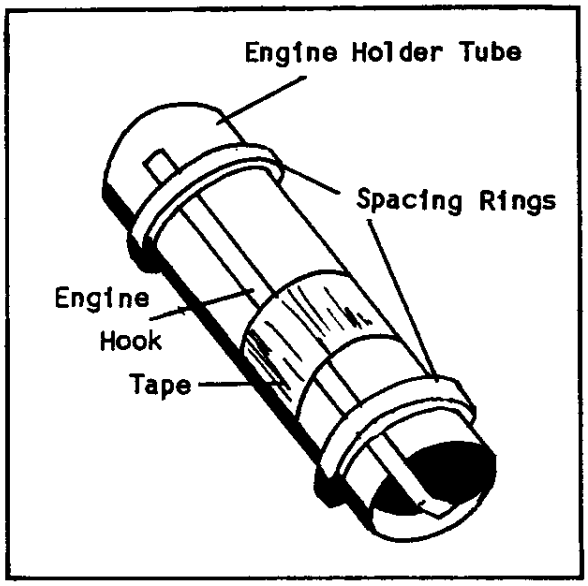
Figure 5



E. Sanding of body tube and nose cone is necessary so that the dope or enamel will have a surface to which it can stick or adhere. Nose cone should be sanded very lightly to prepare for sanding sealer. The surface of the nose cone that fits inside the body tube should be sanded so you can pull it out easily, but it still will not flop around in the body tube. This is very important for the ejection of the recovery system. Now you are ready for assembly of the rocket.

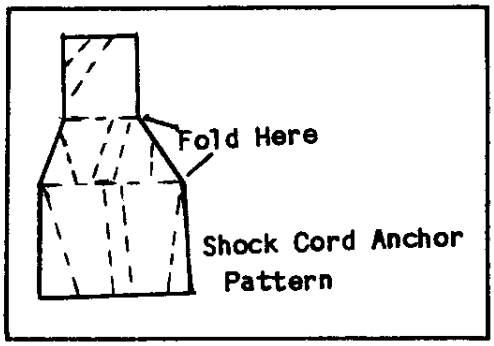
F. ENGINE MOUNT ASSEMBLY - Cut a 1/8 inch slot 1/4 inch from the top of engine holder. Next, place engine hook in slot and glue. Use tape around the engine hook and engine holder three times. This helps to hold engine hook in place. Install spacing rings on each end and glue in place, flush or even with ends. Be sure the bottom spacing ring has 1/8 inch slot cut and matched to engine hook. Install mount in body tube by putting glue on the spacing rings and sliding into place, flush with end of body tube.

Figure 6



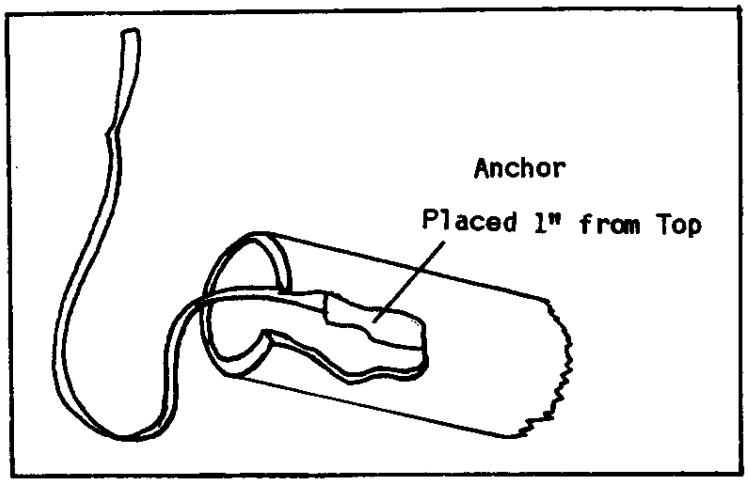
G. SHOCK CORD AND MOUNT - Assemble the cord and its anchor, (anchor is cut from pattern sheet).

Figure 7



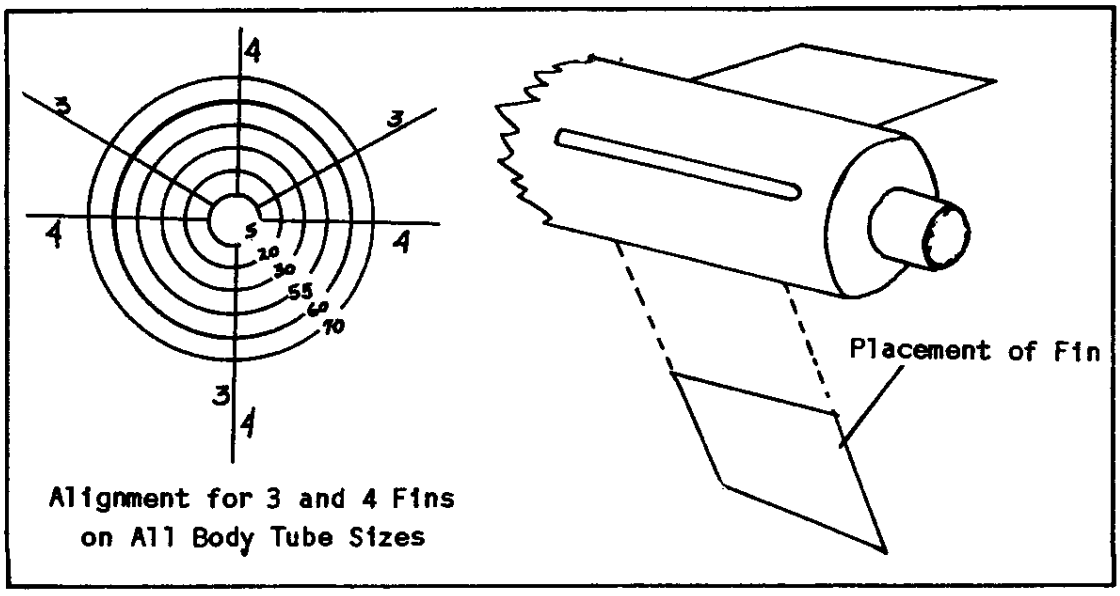
Spread glue on anchor, attach cord and repeat process; hold anchor with fingers or clamp until glue sets for a few minutes. Then spread a film of glue on the inside of tube wall (1 inch from end). Place the anchor so its forward edge is at least 1 inch from end.

Figure 8



H. FIN ATTACHMENT - Draw guide line for fins so as not to interfere with engine hook. Apply glue to base of one fin and place it on one of the guide lines. The rear edge of fin is even with rear of body tube if instructons indicate. Make sure that they are on straight (straight means vertically). Repeat this action for each fin.

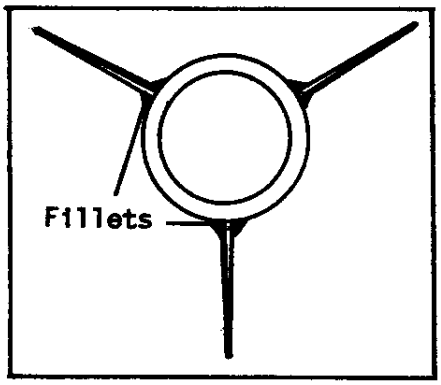
Figure 9



Alignment for 3 and 4 Fins
on All Body Tube Sizes

Fillet the joints. A fillet is a smooth joint built up between body and fin or lug by applying a line of glue along the joint of fin or lug, then smoothing out the glue with a finger.

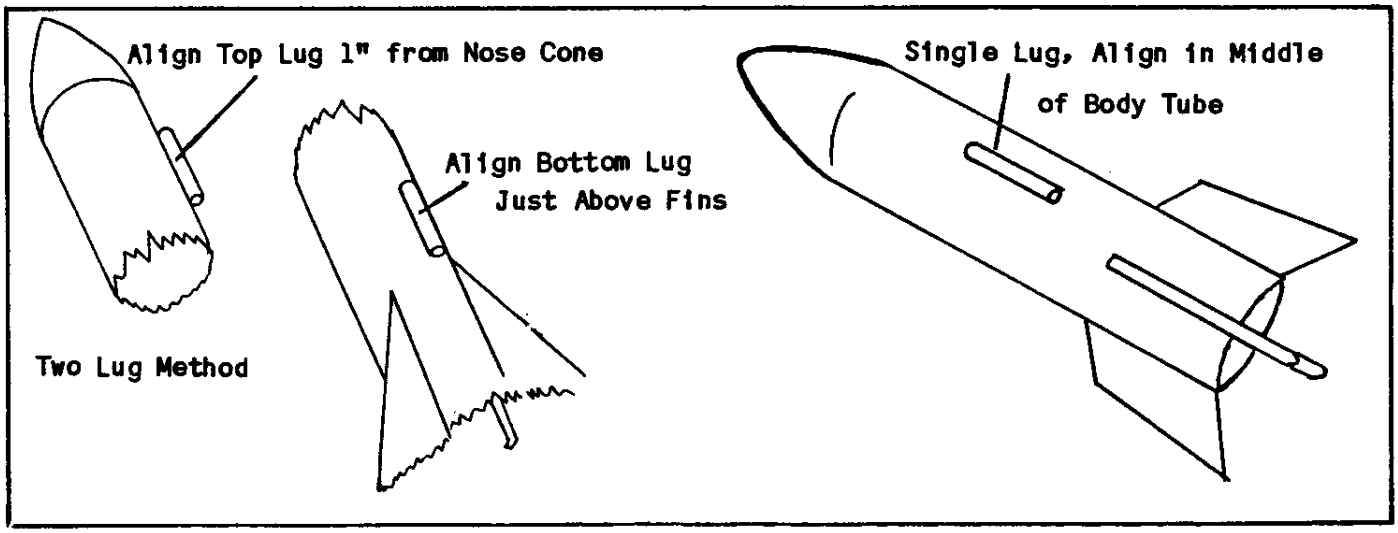
Figure 10



I. ATTACHING LAUNCH LUG(S)

The best method is to cut the 1 1/4 inch lug in two pieces of 5/8 inch each. Align bottom lug over engine hook and glue in place. Sight through bottom lug or use ruler or yard stick depending on size of body tube to align top lug.

Figure 11



J. PARACHUTE - Cut shroud line according to instruction provided in kit(s) and attach to chute with tape strips which are marked on chute, attach to snap swivel.

K. ATTACHING RECOVERY PARTS - Attach screw eye to the base of nose cone. Make a hole by inserting and removing the eye, squirt glue into the hole and replace eye, then attach snap swivel and shock cord to screw eye.

L. PAINTING AND APPLYING DECALS - Make sure all parts have sanding sealer applied to fins, nose cone and body tube. Paint work consists of a white base coat over everything, then you are ready to paint whatever color you desire and apply decals after paints have dried.

Please complete questions for Adventure III found on page 29.

Please Read pgs. 11-14 Before Class on May 23

ADVENTURE IV - A BRIEF SUMMARY OF TECHNICAL REPORTS

11. TYPES OF ROCKETS

A. SINGLE ENGINE ROCKETS - contain only one engine.

B. CLUSTER ROCKETS - have two or more engines, all engines are fired at the same time.

C. MULTI-STAGE ROCKETS - have two or more engines taped or coupled together on top of each other. This type of rocket uses series firing method, booster, intermediate and finally the upper stage.

D. COLDPOWER ROCKETS - use reusable metal engine and a liquid propellant which turns into a gas when released from the can.

12. TYPES OF RECOVERY SYSTEMS

A. PARACHUTE - The most common method of recovery used to bring your rocket down safely.

B. STREAMER - Long narrow strips of crepe paper or plastic to help break the fall of the rocket.

C. FEATHERWEIGHT - Small, lightweight rockets that more or less float back to earth.

D. TUMBLE - Similar to featherweight except it uses tumbling motion to help break its fall.

E. HELICOPTER - A revolving or spinning motion to help break its fall.

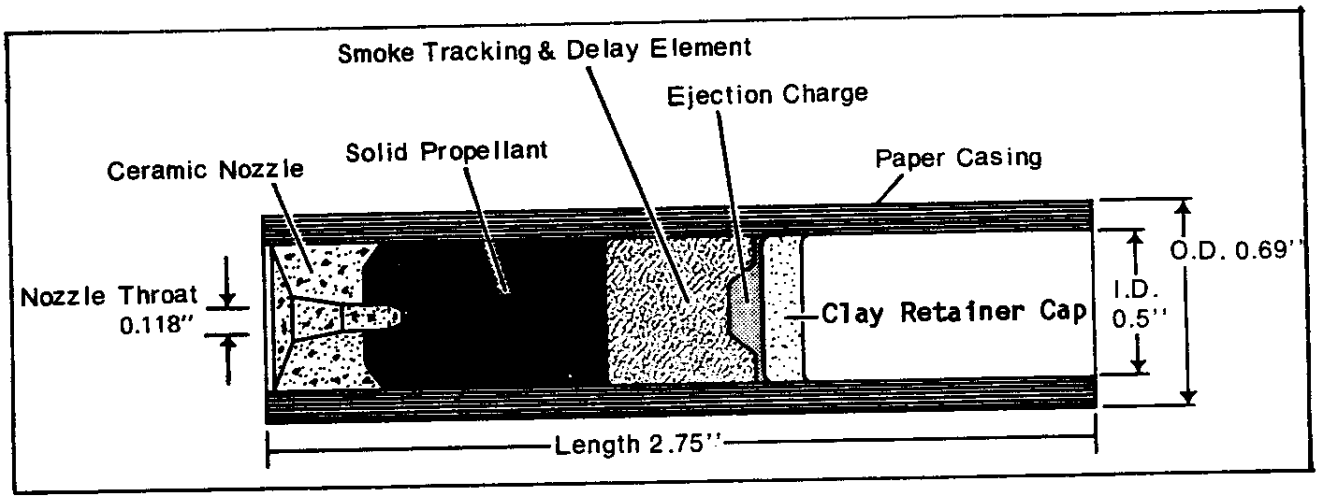
F. GLIDER - After the main rocket reaches its peak altitude, it starts a circular glide pattern until it reaches the ground.

13. ROCKET FUEL

THE FOLLOWING IS A LIST OF PARTS OF A SOLID-PROPELLANT ENGINE

1. paper casing
2. ceramic nozzle with nozzle throat
3. solid propellant
4. smoke tracking and delay element
5. ejection charge
6. clay retainer cap.

Figure 12



Courtesy of Estes Industries

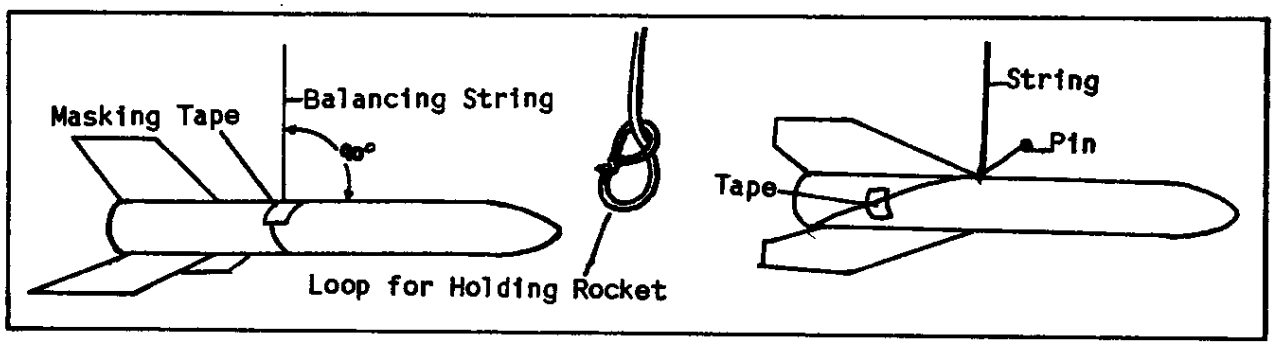
14. ROCKET STABILITY

A. UNDERSTANDING STABILITY - If, for any reason, a force is applied to a stable flying rocket that causes it to rotate, the rotation will always be around its center of gravity.

B. TEST OF STABILITY - The center of gravity is always determined with the engine in place. The rocket to be tested (with the engine in flight position) is suspended from a string, as illustrated. The string is attached around the rocket body using a loop. Slide the loop to the proper position so the rocket is balanced, hanging perpendicular to the string. Apply a small piece of tape to hold the string in place. If the rocket's center of gravity (balance point)

falls in the fin area, it may be balanced by hooking the string diagonally around the fins and body tube. A common straight pin may be necessary at the forward edge of the fins to hold the string in place.

Figure 13



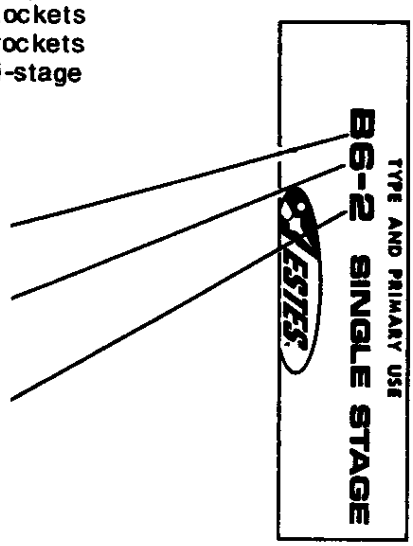
15. ENGINES

A. CLASSIFICATION - Engines are stamped with a designation which gives important data on the engines performance capabilities. Read the coding according to information given in box.

ENGINE CODING FOR QUICK-N-EASY IDENTIFICATION

1. **Label color indicates recommended use of the engine.**
   a. GREEN . . . . . Single Stage Rockets
   b. PURPLE & BLUE-Top stage and multi-stage rockets
   c. RED-Booster and intermediate stages of multi-stage models
2. **Code designation stamped on the engine gives useful and important information on its performance capabilities.**
   a. This portion indicates total impulse or total power produced by the engine.
   b. This portion shows the engine's average thrust in newtons and helps you choose the right engine for your rocket's flight.
   c. This number gives you the delay in seconds between burnout and ejection charge. Lets you choose the engine with the delay time you want for any flight.

Igniters and complete instructions are included with Estes engines.



Courtesy of Estes Industries

B. Dimensions of the mini engine are 1.75 inches (4.45 CM) long and 0.500 inches (1.27 CM) in diameter.

C. Dimensions of Series 11 engines are 2.75 inches (6.99 CM) long and 0.690 inches (1.75 CM) in diameter.

D. Dimensions of "D" engines are 2.75 inches (6.99 CM) long and 0.945 inches (2.40 CM) in diameter.

Please complete questions for Adventure IV found on page 30.

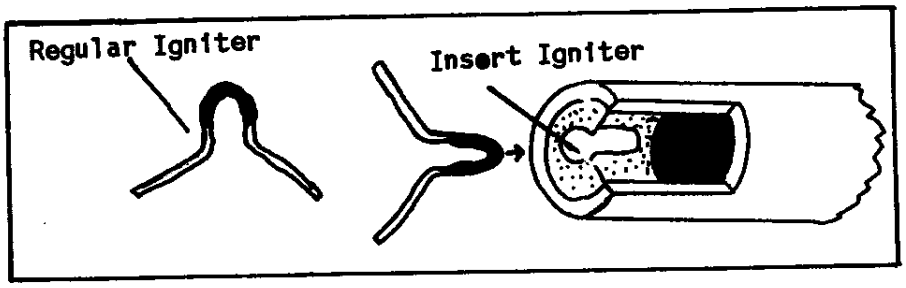
ADVENTURE V - IGNITER, LAUNCH, AND TRACKING

Please Read Before Class on June 6 pgs. 14-18

16. HOW TO PROPERLY INSTALL AN IGNITER

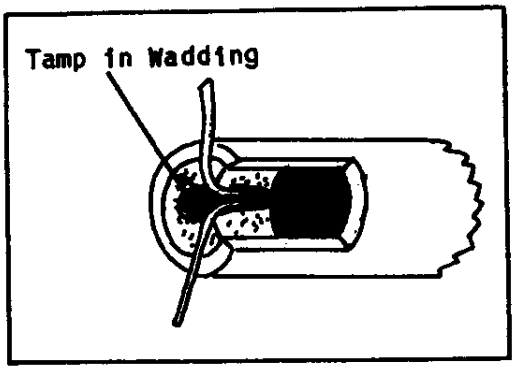
A. Electrical igniters are supplied in strips. Cut the igniters apart with scissors midway between the coated sections. Bend the igniter at the middle into a "U" shape and push it into the engine as far as it will go. Then separate the leads.

Figure 14



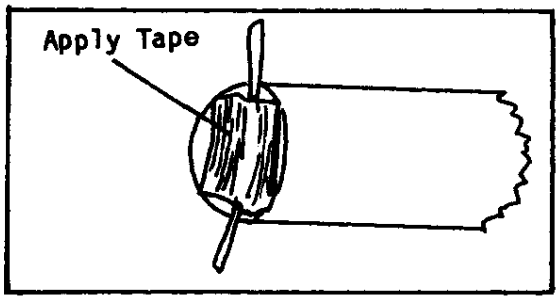
Take a small piece of wadding and stuff it between the leads first with your fingers. Use a pencil or ball point pen to pack the wadding into the nozzle as far as it will go.

Figure 15



Use a piece of masking tape to make doubly sure it stays in.

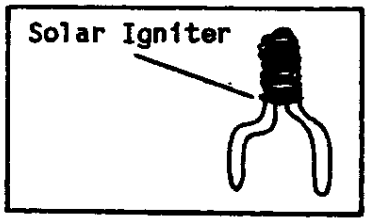
Figure 16



The weight of the micro-clips and wiring has a tendency to pull the igniters out.

B. Solar igniters are basically the same as the Astron igniters. However, they have one advantage over the regular igniter. The advantage of the solar igniter is that you do not need to carry a heavy battery because it works with the solar launch system.

Figure 17



17. LAUNCHING

A. COUNT DOWN READINESS OR CHECKLIST

1. Pack flameproof recovery wadding into body tube from the top. The wadding should fill the tube for a distance of about 1 1/2 times the diameter of the body tube.

2. Hold the parachute between fingers at its center and pass the other hand down to it to form a "spike" shape and fold in half. Push the parachute down in the tube and pack shroud lines and shock cord in on top of the chute. Slide the nose cone into place.

3. Install an igniter in engine as previously mentioned.

4. Insert the engine.

5. Remove safety interlock or key.

6. Place rocket on launcher. Replace safety cap with safety key back on top of launch rod. Attach micro-clips to igniter.

7. Clear the launch area.

8. Check for low-flying aircraft and for persons not allowed in the area.

9. Remove safety cap from launch rod and arm launch control system.

10. Start your count down, 5-4-3-2-1, push button; blast off and you have launched your first rocket.

B. RULES FOR LAUNCH AREA(S)

1. No one enters the launch area unless the person is in the process of preparing to launch a model.

2. Never cut through a launch area. Always approach a launch area from the firing point side.

3. In the event of a misfire, remove safety key and disconnect the launcher at once and then remove rocket.

4. Always follow the Model Rocketry Safety Code.

5. Limit your engine size according to the size of area you are in.

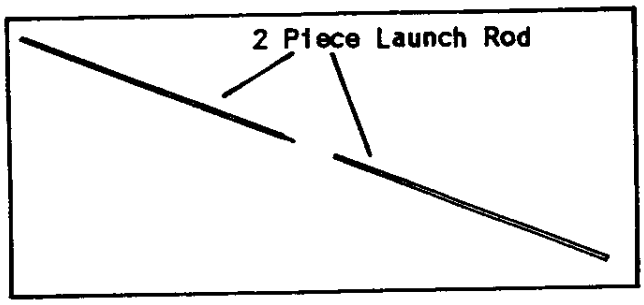
6. Never attempt to fly by yourself.

C. LAUNCH PAD

A launch pad consists of three parts.

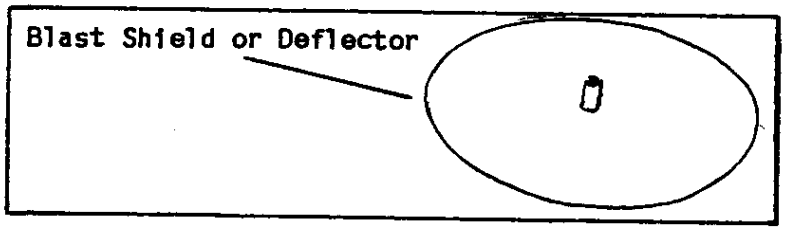
1. Launch rod guides the rocket within the first few feet. It should be a minimum of 1/8 inch diameter and 3 feet in length or longer.

Figure 18



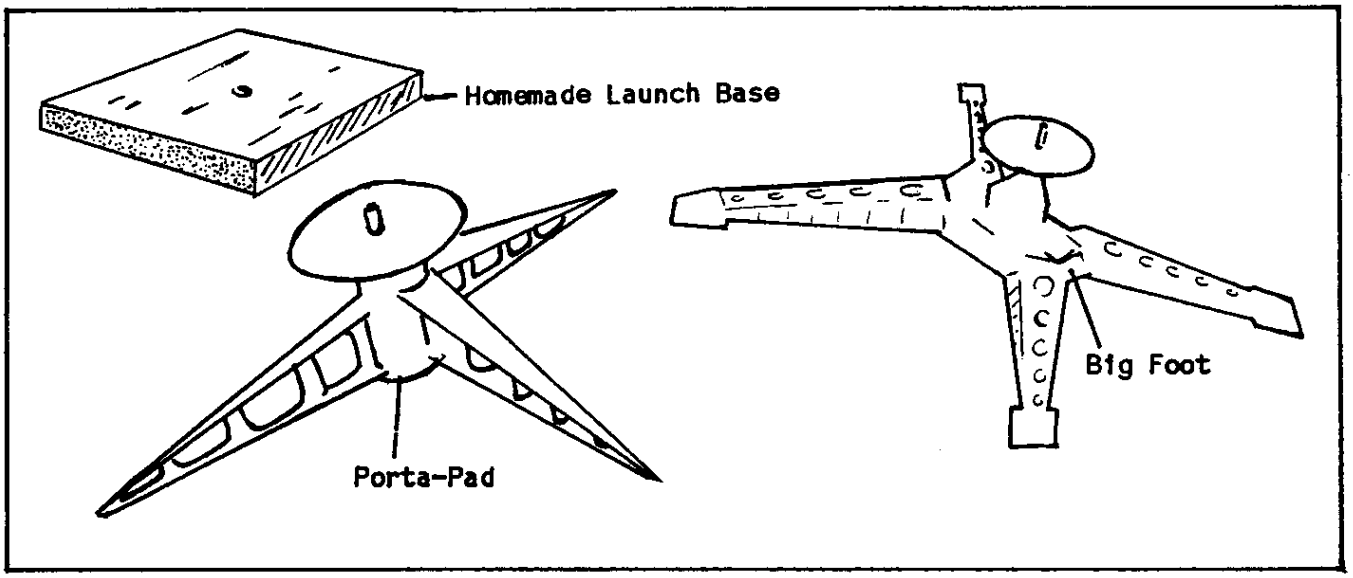
2. Blast shield or deflector comes in a kit or it can be homemade from steel or tin can lid.

Figure 19



3. Launch base can be homemade of 3/4 inch plywood or 1 inch hardwood such as oak, maple, etc. Other pads come in kit form. Examples of these are Porta-pad and Big foot.

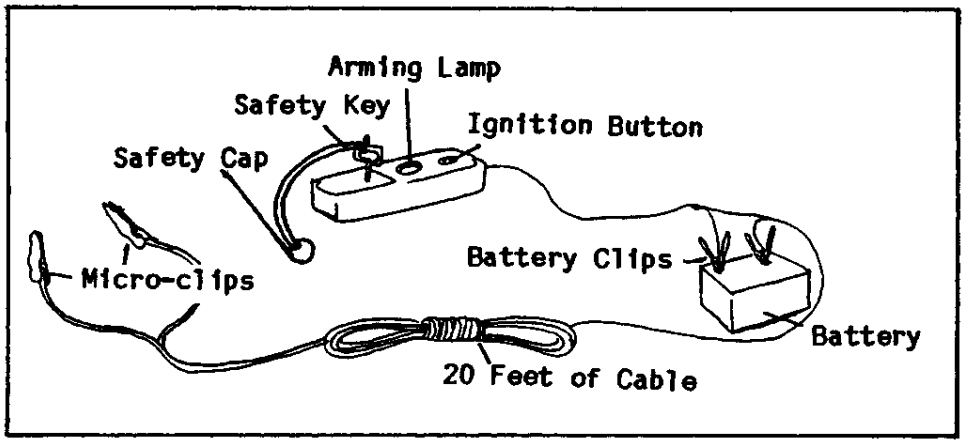
Figure 20



D. ELECTRICAL LAUNCH SYSTEMS

1. Standard system consists of two micro-clips which connect to the igniter; two battery clips that attach to the battery; safety switch that has a bulb which lights up when a safety key is inserted; a button which is pushed after key has been inserted; and a plastic housing unit. Wiring which is at least 20 to 25 feet long and of 18-gauge wire stranded and separated at each end for ease of use.

Figure 21



2. Solar systems consist of basically the same except they carry their own power supply, which consists of either pen light or Polapulse batteries. They are used with solar igniters.

Figure 22