ESTES
A SUBSIDIARY OF DAMON

ESTES INDUSTRIES
BOX 227
PENROSE, COLORADO

MODEL ROCKET ENGINE INSTRUCTIONS

WARNING — FLAMMABLE

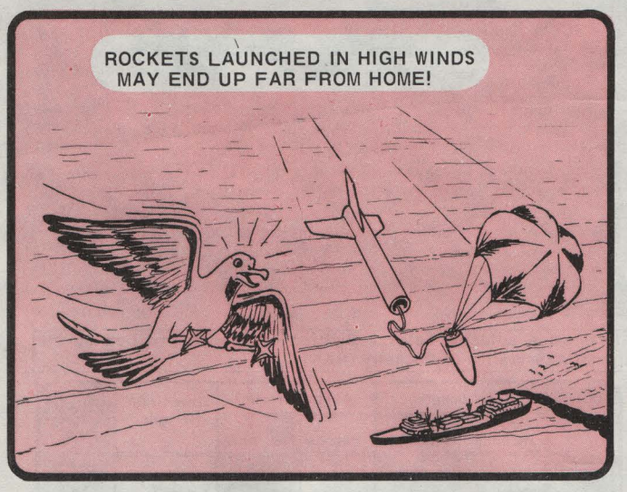
SAFETY RULES: These engines should be used only on devices which are specifically designed to perform properly with the type of engine being used. Engine mounts and materials surrounding the engine should be of non-metallic substances such as paper, plastic, wood, etc. Never launch a rocket which does not have a recovery system to break the aerodynamic stability of the model for the return flight. Always launch rockets in a vertical direction only, using a suitable launching system which will guide the rocket until it has enough speed to stabilize itself. Do not launch models in high winds, in the vicinity of flying aircraft, near tall buildings or trees.

Always store engines in a cool, dry place. Do not subject them to heat greater than 150 degrees F. Do not in any way tamper with or attempt to alter the engine casing, propellant, nozzle, etc., and do not use any engine which shows signs of damage. Never attempt to reload an expended engine casing. Care should be taken when hooking up igniters to keep fingers and body away from the nozzle. Under no circumstances should the nozzle be aimed toward the face. Stand at least 10 feet away from any rocket engine when it is being operated. Do not smoke near rocket engines and do not store them near highly combustible materials. Due to use, storage and other conditions beyond our control, no warranty is either made or implied as to the performance or reliability of these engines.

FIRST AID: For minor burns, use any first-aid burn ointment. For more severe burns, consult a physician. In case propellant is swallowed, induce vomiting and call a physician.

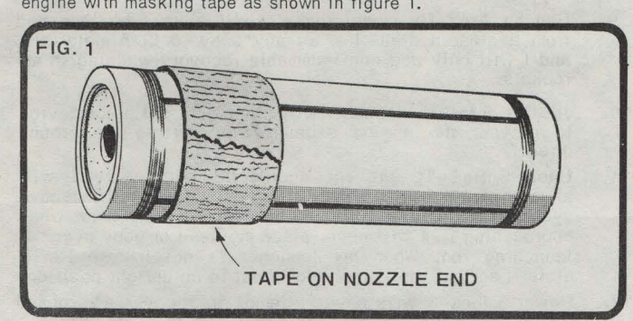
IN CASE OF FIRE: Fires near or among model rocket engines should be extinguished in a normal manner. Water or foam are recommended for preventing ignition of engines.

DISPOSAL: Damaged, defective or unwanted engines should be destroyed by soaking in water.



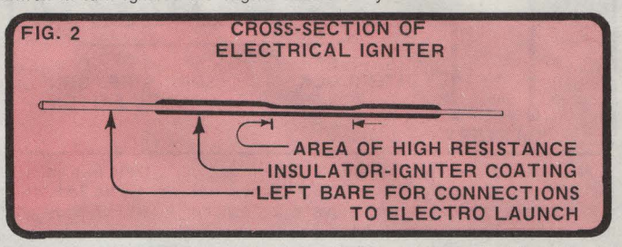
ROCKET ENGINE SELECTION: Rocket engines produced by Estes Industries are designed for flying recoverable, lightweight model rockets. For single-stage use, the primary engines are the A8-3, B6-4 and C6-5. For selecting special performance engines, and for additional design and technical data see the complete rocket engine selection chart in our current catalog.

SECURING THE ENGINE IN THE ROCKET: Different rockets are designed to hold their engines in various ways. Always follow the model manufacturer's recommendations when mounting the engine in the model. Parachute and streamer recovered models require special care in mounting the engine. When the ejection charge is activated, the inside of the model is pressurized. If the nose cone, parachute and wadding resist this pressure more than the engine does, the engine will be ejected, the parachute and nose cone will stay in place and the rocket will streamline in, probably damaging it. To prevent this, the engine must fit tightly. A good fit can be obtained by wrapping the engine with masking tape as shown in figure 1.

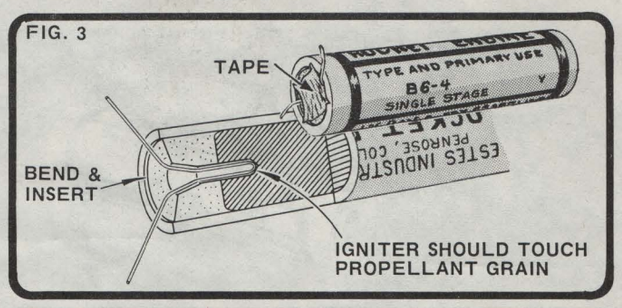


Always be sure the engine is mounted securely so its thrust will not move it forward in the rocket body. Extra care must be taken when mounting a Series II engine in the model. The engine block or engine holder must be securely glued in place. Be sure a force of ten pounds will not move the engine forward in the body. The engine should be positioned so its nozzle end is no more than 3/8" forward from the end of the body tube.

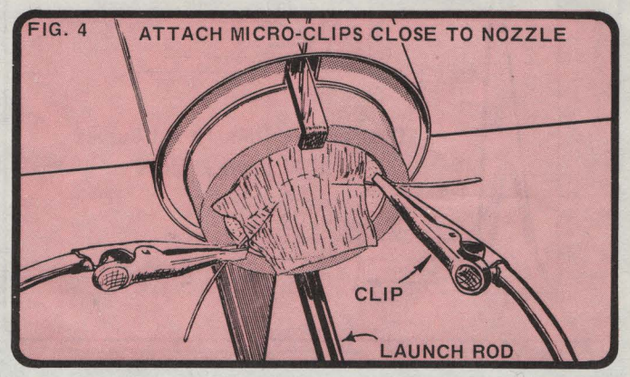
IGNITION: Model rockets are to be launched by electrical means only. Electrical igniters are supplied with all engines sold by Estes Industries. These igniters consist of a nichrome wire with an extra high resistance section in the middle. Surrounding the high resistance area and extending out slightly along the leads of the igniter is a plastic coating which serves as electrical insulation to prevent the igniter from touching itself and short circuiting. In addition, the coating will burn when it is heated to 1100° F. The igniter is installed in the model rocket engine so its coating touches the end of the propellant grain. When an electrical current of 2 amperes or more passes through the igniter the high resistance area heats to 1100°, igniting the coating which in turn ignites the engine immediately.



INSTALLING THE IGNITER: Estes igniters are supplied in strips of three. Cut the igniters apart (scissors will work) midway between the coated sections. Bend the igniter at the middle as shown in figure 3 and push it into the engine as far as it will go. To operate properly the igniter must touch the propellant grain. Spread the leads and apply a piece of masking tape to the nozzle and leads as shown. Be sure the igniter leads do not cross or touch each other. Press the tape firmly so it holds the igniter securely in place.



PREPARING FOR LAUNCHING: Always double-check the recovery system of your model before launching. Parachute and streamer recovered models should have enough wadding between the engine and recovery system to prevent scorching the parachute or streamer and assure positive ejection. Usually the wadding should fill the tube for a distance of at least 1½ body tube diameters.



Slip the model's launch lug over the launch rod and lower the rocket into position on the launcher. Make sure the micro-clips on the launcher are clean, then clip one to each lead of the igniter. The clips must not touch each other and the igniter leads must not cross. If necessary, the rocket may be supported with a scrap of wood or an empty engine casing to make it easier to attach the clips and to keep the clips from touching the metal blast deflector and short circuiting.

COUNTDOWN: For greater realism and safety a countdown should always be given before launching a rocket. First, arm the launch panel. Then begin counting; "5–4–3–2–1–Launch." Press the switch at "launch." If the batteries are in good condition the engine will ignite immediately. As the batteries get weak there will be a short delay between the time the button is pushed and the engine ignites. Disarm the panel as soon as the rocket takes off.

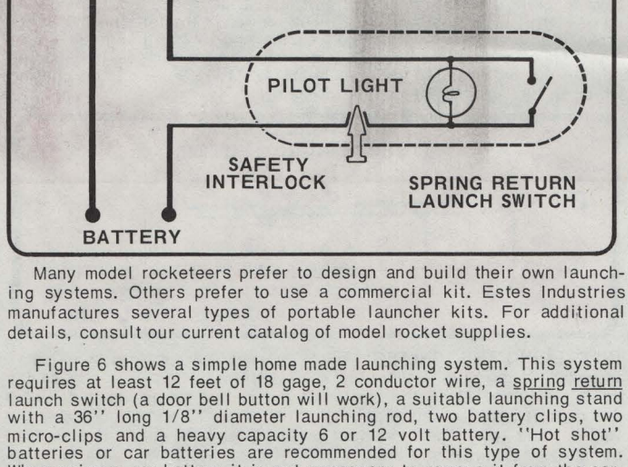
MISFIRES: Occasionally the igniter will heat and burn in two without igniting the engine. This is almost always caused by failure to install it correctly. If this occurs, disarm the launch panel, remove the model from the launcher, clean all pieces of igniter and tape from the nozzle and install a new igniter properly. Follow the normal launching procedure again.

If the launcher's electrical system is defective or the batteries are too weak the igniter may not get hot enough to operate. In this case, remove the model from the launcher, connect the clips to a 2" piece of #30 nichrome wire, arm the launch panel and press the switch. Check all contacts until the wire glows.

If all contacts check out and the launcher still does not deliver power, try fresh batteries. When the problem has been corrected replace the model on the launcher and try again. The power supply must be strong enough to force 2 amperes of current through the highly resistant igniter. When the current is low it will take the igniter several seconds to heat. A power supply that can force 6 to 12 amperes through will give the best results. The power supply should produce at least 6 volts to do the job quickly and efficiently

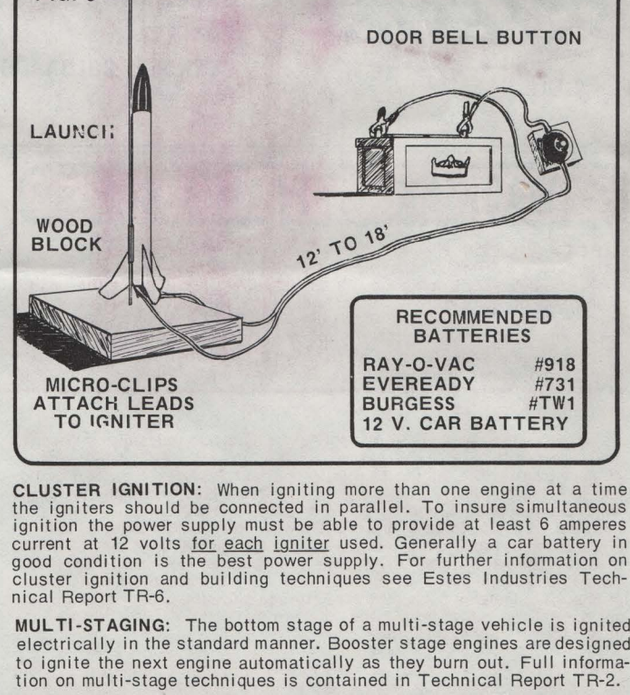
REMEMBER: Model Rocketry makes an excellent father-son activity.
Both enjoy it and the mature thinking of an adult will assure maximum safety and pleasure from your rocket activities.

TYPES OF LAUNCHERS: Figure 5 shows a typical launcher circuit. The system should be constructed so the control panel is at least 10 feet from the launcher. The interlock is provided to prevent accidental launching of the model. The pilot light is placed in the circuit so that when the interlock is closed the light will glow if there is a complete circuit through the igniter. If the light does not glow, the circuit is not complete and the engine will not ignite when the launch switch is pressed.



Many model rocketeers prefer to design and build their own launching systems. Others prefer to use a commercial kit. Estes Industries manufactures several types of portable launcher kits. For additional details, consult our current catalog of model rocket supplies.

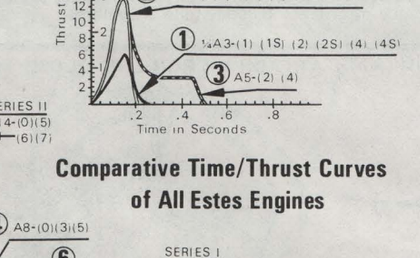
Figure 6 shows a simple home made launching system. This system requires at least 12 feet of 18 gage, 2 conductor wire, a spring return launch switch (a door bell button will work), a suitable launching stand with a 36" long 1/8" diameter launching rod, two battery clips, two micro-clips and a heavy capacity 6 or 12 volt battery. "Hot shot" batteries or car batteries are recommended for this type of system. When using a car battery it is not necessary to remove it from the car.



CLUSTER IGNITION: When igniting more than one engine at a time the igniters should be connected in parallel. To insure simultaneous ignition the power supply must be able to provide at least 6 amperes current at 12 volts for each igniter used. Generally a car battery in good condition is the best power supply. For further information on cluster ignition and building techniques see Estes Industries Technical Report TR-6.

MULTI-STAGING: The bottom stage of a multi-stage vehicle is ignited electrically in the standard manner. Booster stage engines are designed to ignite the next engine automatically as they burn out. Full information on multi-stage techniques is contained in Technical Report TR-2.

Engine Type & Classification



All engines sold by Estes Industries are stamped with a code designation which when understood will give the rocketeer important and useful data on the engine's performance capabilities. Here's how to read this coding: (refer to engine illustration at left.)

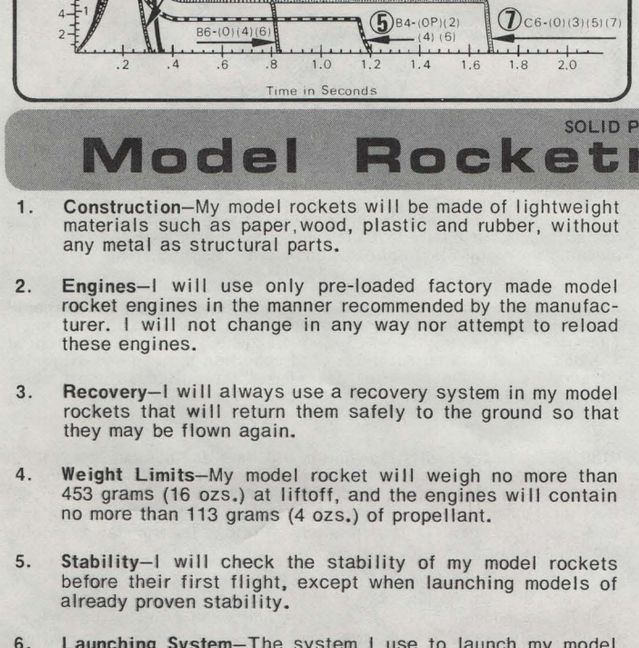
1 This portion indicates the "total impulse" or total power produced by the engine as shown in the chart below.

2 This portion is the engine's average thrust in newtons (1 newton equals 0.224 pounds). For normal flying an average thrust of 3 to 7 newtons is recommended (Series I and III). For lifting large payloads and for high acceleration studies high thrust (Series II) engines are recommended.

3 This number gives the delay in seconds between burnout and ejection charge activation. Engines with "0" have no delay charge, no ejection charge, and are for use in booster stages only.

Series III engines are identical in performance to the corresponding Series I engines. Series III engines are identified by the final "S" in the

The label color of all Estes engines indicates the recommended use of the engine. **GREEN** engines are for use in single stage models. **PURPLE** engines are for use in the top stages of a multi-stage rocket. **RED** engines are for use in all booster and intermediate stages of multi-stage models.



"All engines sold by Estes Industries have been certified by the National Association of Rocketry (NAR)."

Engine Type	Total Impulse		Average Thrust		Propellant Weight	Thrust Curve Number
	Pound-seconds	Newton seconds	Pounds	Newtons		
¼A3-	0.14	0.625	0.70	3.0	0.00172 lb.	1
½A6-	0.28	1.25	1.35	5.8	0.00344 lb.	2
A5-	0.56	2.50	1.12	4.9	0.00687 lb.	3
A8-	0.56	2.50	1.80	7.7	0.00918 lb.	4
B4-	1.12	5.00	0.90	4.15	0.01836 lb.	5
B6-	1.12	1.35	1.35	5.8	0.01374 lb.	6
B14-	1.12	5.00	3.15	14.0	0.01374 lb.	8
C6-	2.25	10.00	1.35	5.8	0.02748 lb.	7

SOLID PROPELLANT

Model Rocketry Safety Code

1. **Construction**—My model rockets will be made of lightweight materials such as paper, wood, plastic and rubber, without any metal as structural parts.

2. **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.

3. **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.

4. **Weight Limits**—My model rocket will weigh no more than 453 grams (16 ozs.) at liftoff, and the engines will contain no more than 113 grams (4 ozs.) of propellant.

5. **Stability**—I will check the stability of my model rockets before their first flight, except when launching models of already proven stability.

6. **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.

7. **Launch Safety**—I will not let anyone approach a model rocket on a launcher until I have made sure that either the safety interlock key has been removed or the battery has been disconnected from my launcher.

8. **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.

9. **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 non-flammable recovery wadding in my rockets.

10. **Jet Deflector**—My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly.

11. **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 store it so that the launch rod is **not** in an upright position.

12. **Power Lines**—I will never attempt to recover my rocket from a power line or other dangerous places.

13. **Launch Targets & 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 nor a payload that is intended to be flammable. My launching device will always be pointed within 30 degrees of vertical.

14. **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.

Revised 2/4/70

The Solid Propellant Model Rocketry Safety Code Is Approved by the National Association of Rocketry and the Hobby Industry Association of America.

(See the big Estes Catalog for complete descriptions of rocket kits, launchers, engines, etc. . .)