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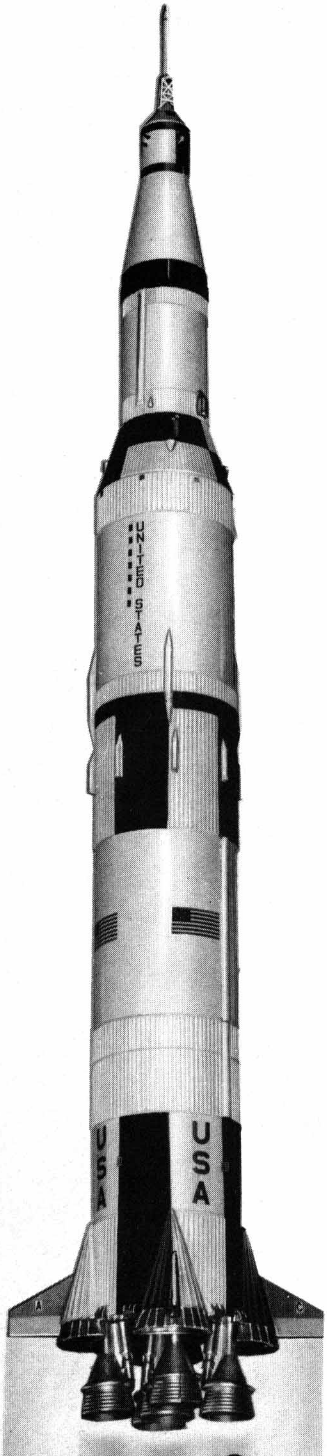
Centuri

model rocket designers MANUAL

Step-by-step instructions on how to design and build model rockets



Centuri

Design Manual

introduction

Centuri publishes numerous technical reports which deal, in depth, with specific aspects of model rocketry. Upon being initiated into the hobby, we're certain you will wish to further explore these fascinating subject areas. In the meantime, this Design Manual is offered to help you get started in model rocketry. Written in layman's terms, this booklet will instruct you in basic design and construction techniques and will provide groundwork for your future ventures into the area of custom building.

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Centuri

CENTURI ENGINEERING COMPANY

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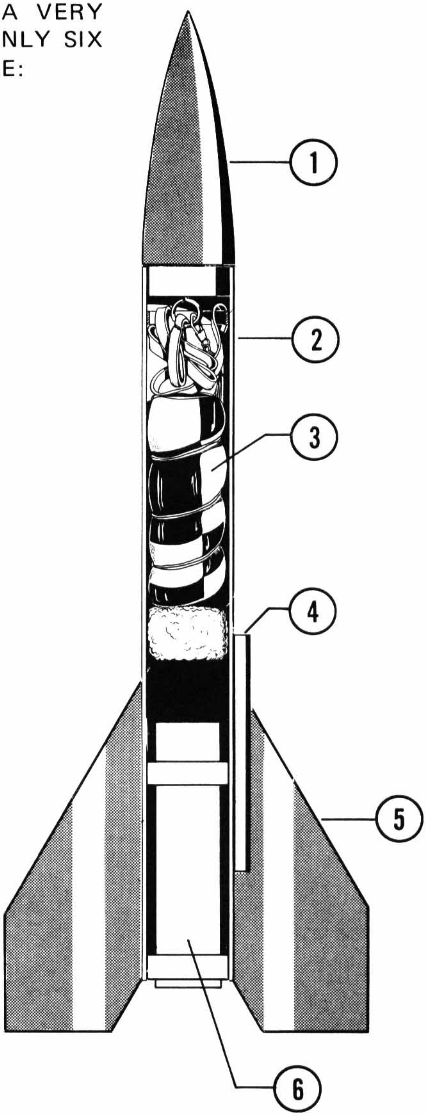
Chapter 1:
The Model Rocket

A MODEL ROCKET IS ACTUALLY A VERY SIMPLE VEHICLE, CONSISTING OF ONLY SIX BASIC COMPONENTS. THEY ARE:



(1) NOSE CONE

A cap for the forward end of the body, it is designed to direct the airflow smoothly around the rocket.

(2) BODY TUBE

Basic rocket airframe. All other parts of the rocket are either attached to it or are carried inside it.

(3) RECOVERY

Usually consists of a parachute attached to the body and nose cone by means of an elastic shock cord. Ejected at the peak altitude of the rocket's flight, the recovery system lowers the rocket slowly and safely to the ground.

(4) LAUNCH LUG

Guides the rocket along the launching rod until sufficient speed is produced to allow the fins to provide flight stability.

(5) FINS

Located at the aft end of the rocket, they serve to guide the rocket in a straight flight path.

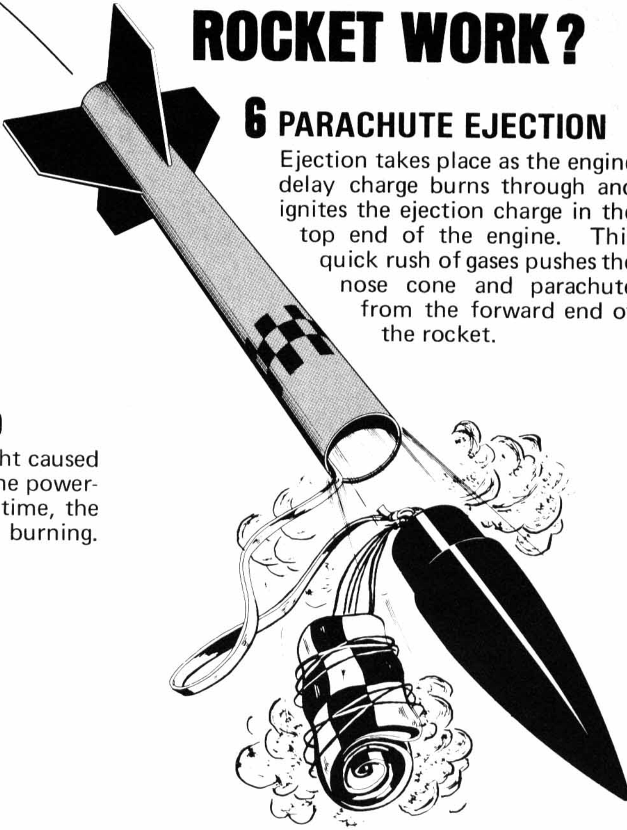
(6) ENGINE MOUNT

Designed to center and hold the engine in the body tube. Also transmits engine thrust to the airframe.

HOW DOES A MODEL ROCKET WORK?

5 APOGEE

Apogee as the rocket reaches peak altitude and begins descent.



6 PARACHUTE EJECTION

Ejection takes place as the engine delay charge burns through and ignites the ejection charge in the top end of the engine. This quick rush of gases pushes the nose cone and parachute from the forward end of the rocket.

4 COASTING PERIOD

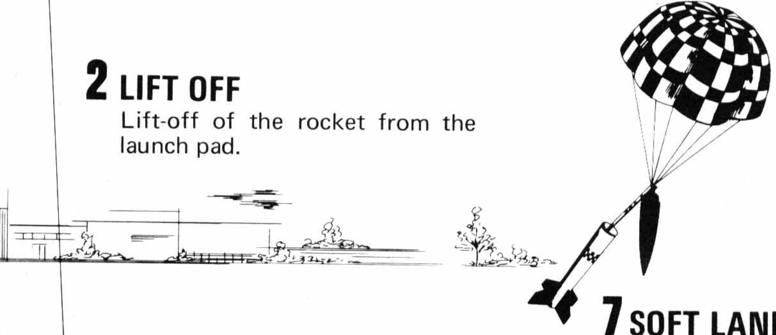
Coast period of the flight caused by thrust produced in the powered phase. During this time, the engine delay charge is burning.

3 BURNOUT

Burn out of the powered flight portion of the rocket engine.

2 LIFT OFF

Lift-off of the rocket from the launch pad.



7 SOFT LANDING

Slowly descending rocket lands safely, undamaged and ready for another thrilling flight.

1 IGNITION

Ignition of the rocket engine by remote electrical means.

Chapter 2: Model Rocket Engines

Model rocket engines accomplish two main purposes: 1—they provide power for boosting a model rocket to peak altitude, and 2—after a pre-determined delay time, they provide the ejection force which activates the rocket's recovery system. The standard ½A through C category of model rocket engines consists of the following basic components:

1. ENGINE CASING:

Made of strong, lightweight rolled paper, the casing houses the engine components safely and effectively.

2. NOZZLE:

Formed from a special clay, the nozzle is designed to produce the maximum amount of thrust from the propellant.

3. PROPELLANT:

Carefully controlled mixtures of solid propellant components are pressed under very high pressures into the casing to provide a safe, yet powerful thrust level.

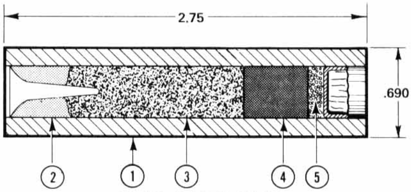
4. DELAY CHARGE: *

Made of an extremely even burning material, the delay charge dictates the amount of time that will elapse between the end of the powered phase of flight and the firing of the ejection charge.

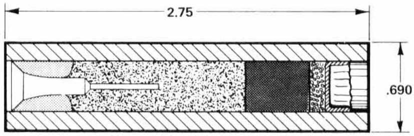
*Booster type engines do not contain a delay charge or ejection charge. See "Delay Times" in this chapter.

5. EJECTION CHARGE: *

A loose granular charge secured by a paper cap. This charge, ignited from the "burn through" of the delay material, creates a gas powerful enough to force the nose cone and recovery system from the top of the body tube.



END BURNING



PORT BURNING

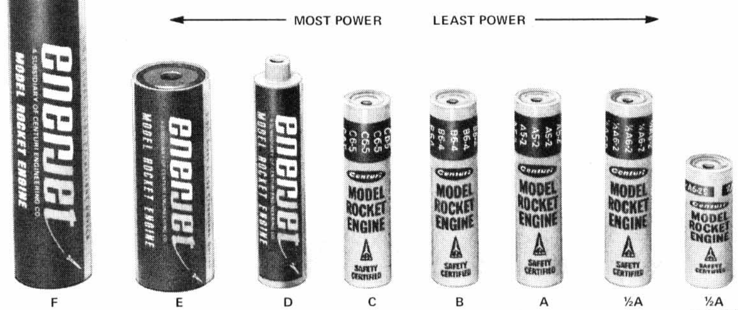
WHICH ENGINE?

Model rocket engines are divided into categories based upon the total impulse they produce in the measurement of Newton-seconds. (Refer to chart below). These categories, determined by the National Association of Rocketry, are standardized for all manufacturers in the model rocket industry. The categories are divided by the letter designations of ½A, A, B, C, D, E, and F. Of primary concern here are the ½A through D categories. (E and F engines and their use are discussed in Chapter 10). The engine with the lowest rating is the ½A class. From there, each succeeding letter class has more power, with the F class being the most powerful engine available in the model rocketry field.

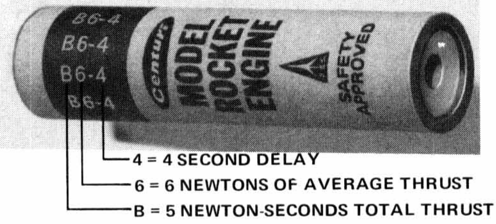
CODED TOTAL IMPULSE CHART

ENGINE TYPE	TOTAL IMPULSE IN NEWTON-SECONDS	TOTAL IMPULSE IN POUND-SECONDS
½A	0.626 to 1.25	0.15 to 0.28
A	1.26 to 2.50	0.29 to 0.56
B	2.51 to 5.00	0.57 to 1.12
C	5.01 to 10.00	1.13 to 2.24

MODEL ROCKET ENGINE CLASS POWER RATINGS



ENGINE LABEL CODING



Further category division of engines is based upon the average thrust of the engine during its burn time and is designated by a number. This category can best be explained with the following example: An A-8 engine has an average thrust of 8 Newtons* while an A-5 engine has an average thrust of only 5 Newtons. Since the engines are both of the 'A' category (total impulse of 2½ Newton-seconds), how can the average thrust differ? Simple, the A-8 engine has a high thrust level, but burns for only 1/3 second. The A-5 engine, while it has a lower thrust level, burns for 1/2 second. In other words, the higher numbered A-8 engine has more "push", but less "push time" than the slower burning A-5 engine.

Another example which shows more of a variance is in the 'B' category. A B-14 engine has more than twice as much average thrust as a B-4 engine. The B-4 engine, however, burns almost 4 times as long as the hotter B-14. Both engines come out with the same amount of total impulse; 5 Newton-seconds. The reason that several different power ratings are offered is because the power requirements of different rockets will vary depending upon the desired altitude, weight and frontal area of the rocket, etc.

The fact that a particular type engine will work better in one rocket than in another is not really a subject for discussion here. Later on, if you wish to delve into this subject in depth, read Centuri's technical report TIR-100. For the present, just remember that the varying power requirements do exist. The recommended engines for Centuri kits are shown in the catalog and on every Centuri rocket kit package.

DELAY TIMES:

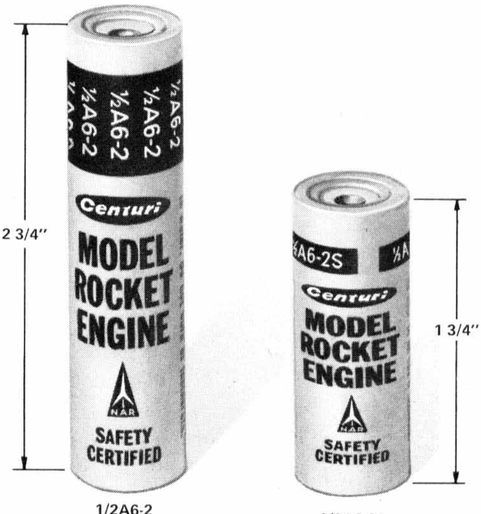
The third numeral in a rocket engine number has nothing to do with the power of that engine. This number indicates, in seconds, the delay time between burn out and ejection. Each Centuri engine is available in 3 or 4 different delay times. The reason for the different delay times is quite simple:

*A "Newton" is the metric unit of force, or, in the case of a rocket motor – "thrust".

You want the parachute to eject just when the rocket reaches the peak of its flight (apogee). If the parachute were to eject while the rocket was still climbing at a high rate of speed, the chute and shock cord might be torn from the rocket and, of course, you would be cheated of additional altitude. If the rocket were descending, the same situation (to a lesser degree) might exist. Therefore, each engine is offered in several different delays to best match the ejection with the apogee of the various rockets in the Centuri line. You will note that six engines in the catalog carry a '0' delay number. These engines have no delay or ejection charge and are intended to be used strictly as booster engines in multi-stage models (see Chapter 8). NEVER USE A BOOSTER ENGINE IN A SINGLE STAGE ROCKET.

'S' ENGINES:

You will note that 3 engines in the Centuri line carry an 'S' after the engine number. The 'S' designates this is an engine with a "short" casing (1¾" long as opposed to 2¾" standard length). These "short" engines are intended to be used with two models in the present Centuri line, the Lil' Hercules and the Firefly. Many more uses are found when you begin to design your own custom rockets.

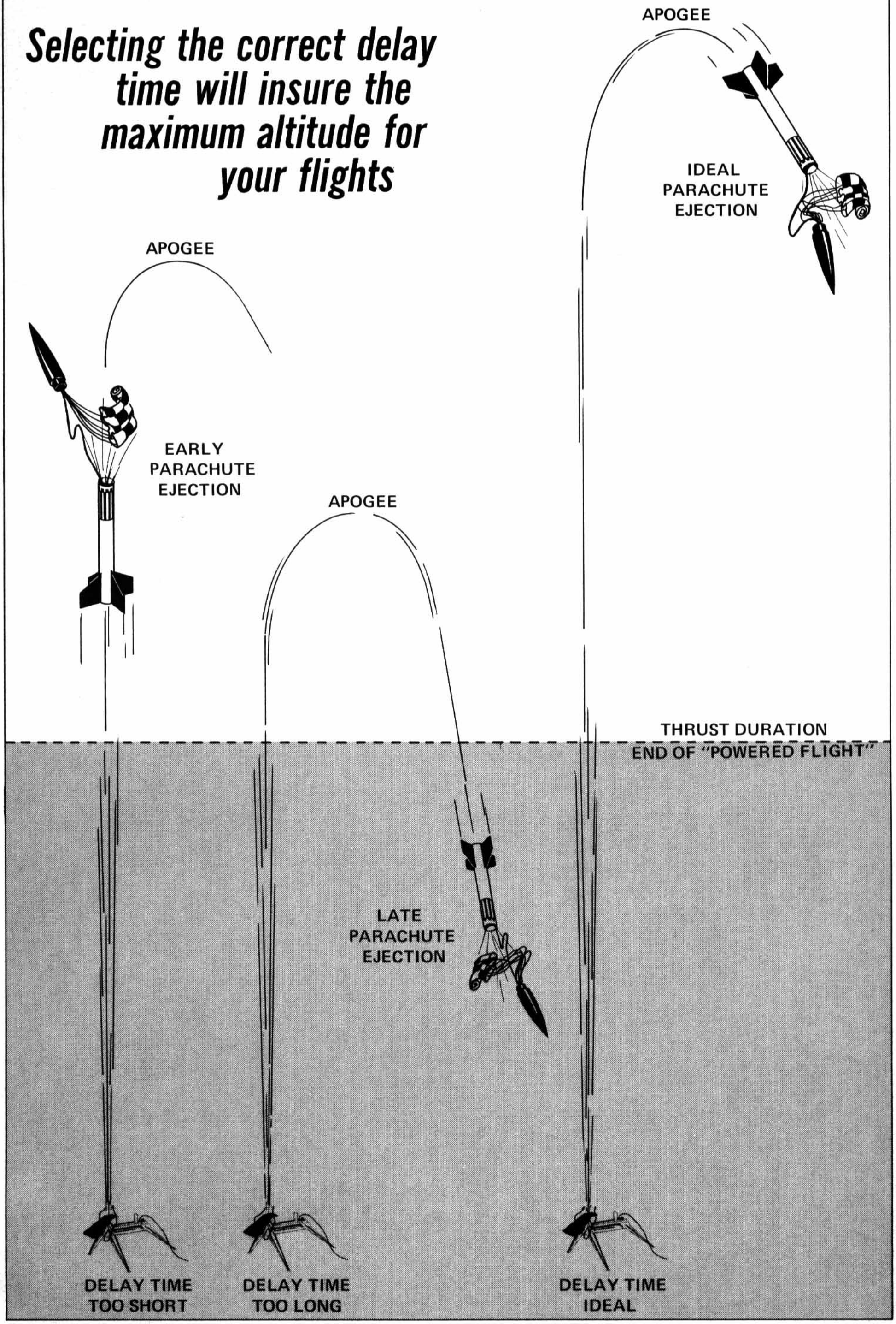


1/2A6-2 (REGULAR)

1/2A6-2S (SHORT)

SAME POWER – DIFFERENT LENGTH

Selecting the correct delay time will insure the maximum altitude for your flights



1 ENERJET "D" ENGINE EQUALS 4 "B" type engines

These are the most powerful engines available for the standard line of rocket kits. The Enerjet D's are constructed like the "Large Scale" E and F type engines. They use a plastic bound, high energy composite fuel which is encased in a filament reinforced plastic casing and feature a specially engineered expansion nozzle. These engines are twice as powerful as the 'C' engine. The Enerjet D engine is the same diameter as the ½A through C engines, but it is ¼" longer. It will fit in any standard rocket with the exception that it cannot be held in place with an engine lock. This is no real problem since it may be friction fitted into the rocket with masking tape (many kits, because of construction, do not feature an engine lock). Because of the D engine weight difference, several of the standard rockets need modification in the form of additional nose weight only in order to effect stable flight (see Chapter 3). The D engine is not recommended for small rockets such as the Javelin. The thrust of this engine is so high that a small rocket would go out of sight and you would probably never see it again. The 'D' engine will, however, provide beautiful flights in larger rockets such as the Nike Smoke, Orion, etc. It is recommended that you do not fire a 'D' engine until you have built and flown several kits using lower powered engines. Once you have a little experience, slip an Enerjet 'D' into that favorite larger size rocket and watch it go. You'll be amazed at the power and efficiency produced by such a small package.