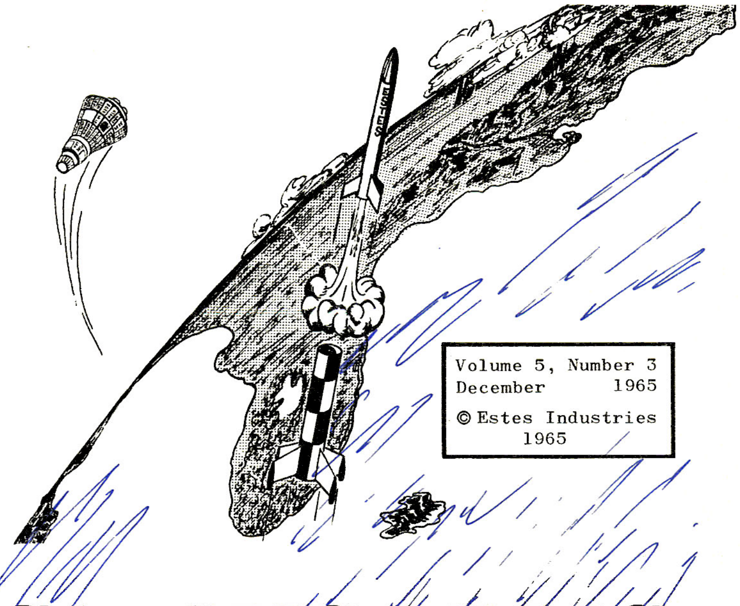
MODEL ROCKET NEWS

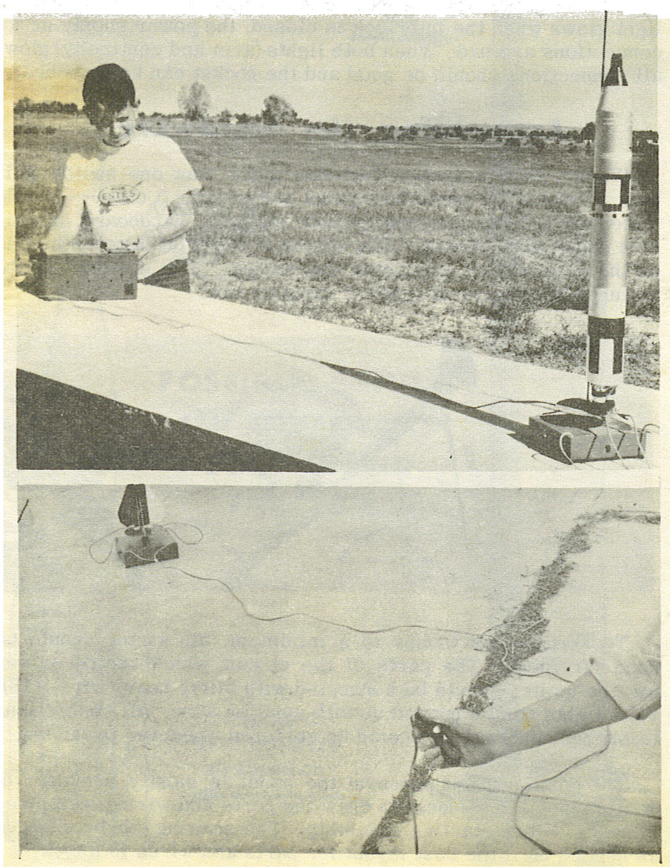


Volume 5, Number 3
December 1965

LAUNCHING SYSTEMS

You've spent hours building and painting your model. You've packed the recovery system and installed the engine and igniter. Now you place it on the launch rod, step back and wait—and wait. Nothing happens.

For some strange reason, an igniter can't read minds and start the engine at the right moment all by itself. Yet some rocketeers approach the problem of ignition as though they expected the igniter to do all this. If the igniter is going to do its job, it has to be connected to an electrical launching system that will do <u>its</u> job.



To understand the type of work a launcher must do, let's look at some fundamentals of electricity. When electricity flows in any normal conductor it produces heat. The problem in rocket launching is to develop enough heat in one particular conductor—the igniter—to bring it to its ignition temperature of 1100° F.

In any electrical circuit there are three factors which affect the flow of electricity. These are electromotive force, current and resistance. Electromotive force, the potential work to be done by the electricity, is measured in volts. Current, the rate of flow of the electricity, is measured in amperes. Resistance, which is present in all normal conductors, is an obstruction to electric flow that requires the electricity to work to get through it. Resistance is measured in ohms.

Current in any electric circuit is equal to the voltage divided by the resistance:

$$I = \frac{E}{R}$$

Where: I = amperes of current
E = electromotive force in volts
R = resistance in ohms (Ohm's Law)

When a source of electromotive force of 6 volts acts through a resistance of 1-1/2 ohms, the current in the circuit is 4 amperes ($\frac{6 \text{ volts}}{1\text{-}1/2 \text{ ohms}} = 4$ amperes). Six volts through a resistance of 2 ohms will give a current of 3 amperes ($\frac{6}{2} = 3$).

The amount of heat produced in the igniter is determined by the amount of current passing through it.* At least 2 amperes must be flowing to heat it to the ignition point. But since the amount of current flowing depends on the voltage and resistance of the circuit, we should keep all three factors in mind when we design the launch system.

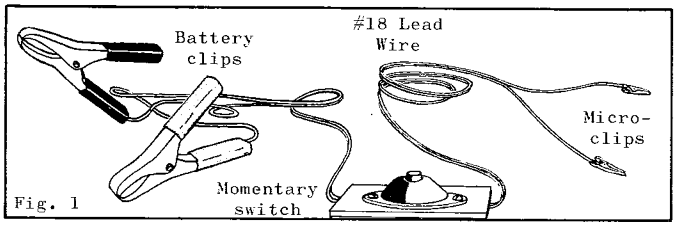
TABLE I RESISTANCES

Material	Resistance
Igniter (#NWI-1)	1.00 ohm each
#32 Nichrome Wire	0.88 ohm per inch
#30 Nichrome Wire	0.56 ohm per inch
#16 Copper Wire	0.006 ohm per foot
#18 Copper Wire	0.010 ohm per foot
#20 Copper Wire	0.016 ohm per foot
#51 Pilot Bulb (6 volt)	30 ohms each
#53 Pilot Bulb (12 volt)	120 ohms each

*Joule's Law: The heat generated in a conductor by an electric current is proportional to the resistance of the conductor, the time during which the current flows, and the square of the strength of the current.

Calories per second = ohms x amperes^2 x seconds x 0.24

Figure 1 shows a very simple launcher circuit. It consists of two clips to attach it to the battery, a length of wire, a switch and two clips to attach to the igniter. Looking at table 1, we find the resistance of #18-2 wire (0.01 ohms per foot per conductor).



Although the wire is 12 feet long, current has to go through both conductors (24 feet). Multiplying the length by the resistance per foot, we find that the total resistance of the wire is 0.24 ohms. Igniter resistance is 1 ohm, giving a total of 1.24 ohms.

TABLE II

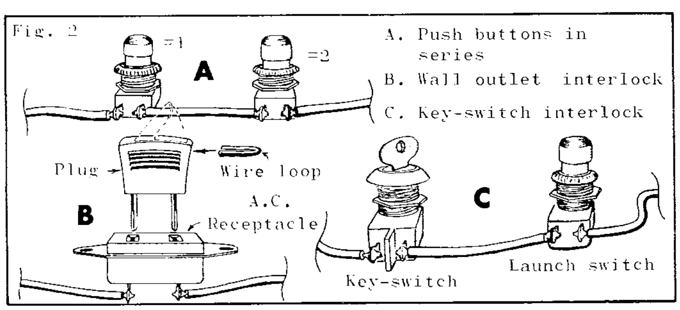
TYPICAL BATTERY CHARACTERISTICS (FRESH)		
Type	Voltage	Internal Resistance
"D" Flashlight (Eveready #950)	1.5	0.38 ohm
Lantern (4 "F" Cells) (Eveready #509)	6.0	0.86 ohm
"D" Photoflash (Ray-O-Vac #210)	1.5	0.18 ohm
6 volt Car Battery	6.0	0.02 ohm
12 volt Car Battery	12.0	0.04 ohm

Table 2 shows characteristics of some types of batteries. Using a single size "D" flashlight cell, we add the battery's internal resistance of 0.38 ohms to the circuit resistance of 1.24 ohms (totaling 1.62 ohms). Following the formula—$\frac{1.5}{1.62} = 0.93$ amperes—not enough. The lantern battery has an internal resistance of 0.86 ohms, so $1.24 + 0.86 = 2.10$, $\frac{6}{2.1} = 2.86$. This is adequate for ignition. (However, even when fresh, it will take about one second for the igniter to heat.)

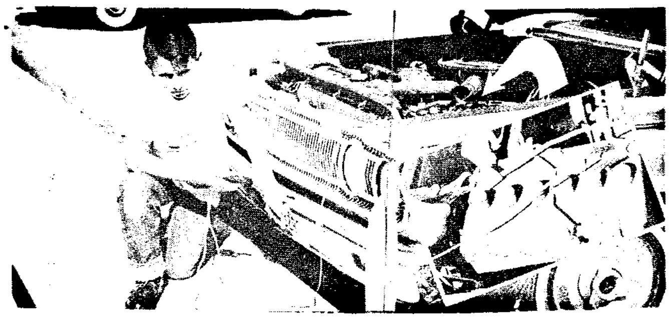
Using four size "D" photoflash cells, we might connect them end to end as shown. This gives $1.24 + (4 \times 0.18) = 1.96$ ohms; $\frac{6}{1.96} = 3.06$ amperes, which is better since it results in faster heating, less battery drain and longer life. The same method is used to evaluate other power supplies and lengths of wire.

Adding to the System

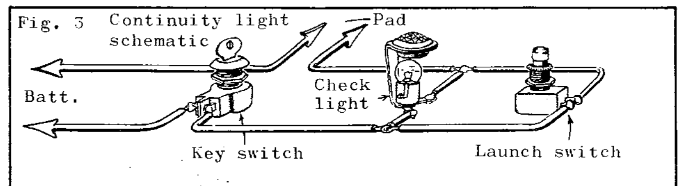
One of the most valuable additions to a launcher system is a safety interlock to prevent accidental ignition of the engine. This feature can be added in any of several ways. A second push button switch can be placed between the launch switch and the power supply. An ordinary wall outlet connected in as shown and a plug with the prongs wired together will provide a more reliable interlock. For maximum reliability and neat appearance, a key switch is recommended—when the key is out the switch cannot be turned on and the rocket cannot be launched.

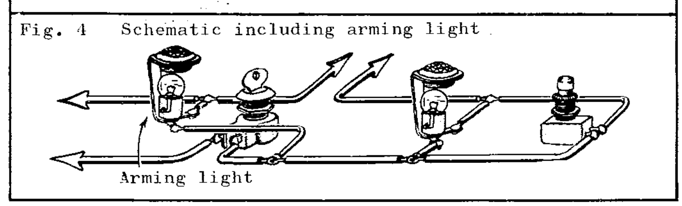


The next feature to consider is a continuity check. This addition can save a lot of effort and can help eliminate the embarrassment of pushing the button and watching the rocket sit. The easiest system to make uses a #51 or #53 pilot bulb (depending on the voltage of the circuit) wired in parallel with the launch switch. Since the resistance of the bulb is relatively high, current flowing through it cannot set off the igniter (try Ohm's Law and see). If the clips are dirty or the batteries are bad, the bulb will not light when the interlock is closed. When the bulb glows at full brilliance, the circuit is good.



An extra arm light can also be useful. When a bulb of the right voltage is wired in parallel with the battery and interlock, it will normally light when the interlock is closed, indicating that the panel is armed. If the interlock is closed and the arm





light alone glows, the connection to the igniter is bad. If neither light glows when the interlock is closed, the power supply or its connections are bad. When both lights (arm and continuity) glow, all connections should be good and the rocket can be launched.

Assembling the Hardware

When a launch system includes more than one switch it is best to mount the parts on a panel and provide a case. Suitable materials for this purpose include plywood, hardboard, aluminum sheet and plastic. The choice of material depends mainly on the tools and experience of the builder. The systems in the pictures show several types of construction.

To keep power losses to a minimum, all wiring should be done carefully. The parts of the circuit which control power for the igniter should be connected with fairly heavy wire (#18). Pilot lights can be hooked up with smaller wire. All connections throughout the system should be soldered whenever possible.

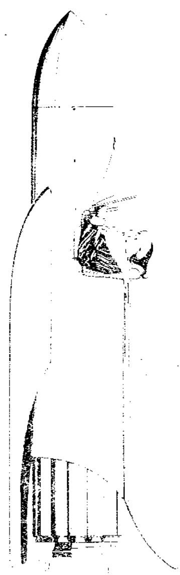
The positioning of parts on the panel is mostly a matter of convenience. It is best to draw the parts and wiring on a piece of paper before starting assembly. The drawing can be changed as needed until the best layout for parts and wires is found.

ODD-BALL DESIGN CONTEST

Take a good look at the list of prizes that go to the winners of this contest. Then sit down and design and build the strangest creature that ever staggered into the air. When you've flight tested your odd ball rocket and know it will work, send the plans, parts list and instructions to: Odd Ball Contest, Box 227, Penrose, Colorado 81240.

1st Prize--$50 in merchandise credit
2nd Prize--$25 in merchandise credit
3rd Prize--$10 in merchandise credit
4th Prize -- $5 in merchandise credit
5th through 10th Prizes--Astron Alpha Kits

.. RULES ..



1) All plans must be drawn to scale. Pencil or ink drawings are acceptable.
2) A parts list must accompany each entry.
3) Each entry must be flight tested to assure that it has suitable flying characteristics.
4) Only odd ball single stage designs will be qualified.
5) The center of gravity for the complete rocket must be marked on the plan.
6) Sufficient information must accompany the entry to allow judges to build an exact duplicate of the original model.
7) Entries will be judged on oddness, originality, practicality, neatness and flight characteristics.
8) Employees of Estes Industries and members of their immediate families are not eligible to enter this contest.
9) The decision of the judges is final.
10) Entries must be postmarked no later than February 28, 1966.
11) All designs entered become the property of Estes Industries, Inc. No plans or designs will be returned.

MODEL ROCKET NEWS

The Model Rocket News is published by Estes Industries, Inc. Penrose, Colorado. It is distributed free of charge to all the company's mail order customers from whom a substantial order has been received within a period of one year. The Model Rocket News is distributed for the purpose of advertising and promoting a safe form of youth rocketry and for informing customers of new products and services available from Estes Industries. Rocketeers can contribute in several ways towards the publication of the Model Rocket News:

(1) Write to Estes Industries concerning things you and your club are doing in this field which might be of interest to others.

(2) Continue to support the company's development program by purchasing rocket supplies from Estes Industries, as it is only through this support that free services such as the Model Rocket News, rocket plans, etc., can be made available. This support also enables the company to develop new rocket kits, engines, etc.

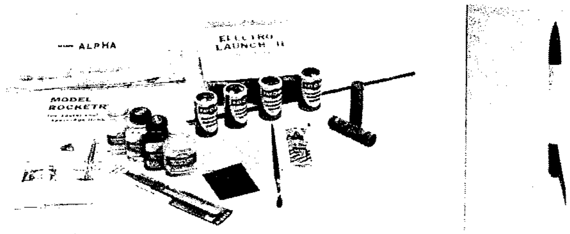
(3) Write to the company about their products and tell what you like, what you don't like, new ideas, suggestions, etc. Every letter will be read carefully, and every effort will be made to give a prompt, personal reply.

Vernon Estes
Publisher

William Simon
Editor

New Products

Beginners Specials are Better Than Ever!



BS-72 Now a Truly Complete Outfit!

Get your friends--or yourself--off to the best start in model rocketry with this complete Beginners Special. Everything a rocketeer needs, from batteries through sandpaper, is here. Getting started was never before so easy or enjoyable.

Featured in this special offer is the high flying, reliable Astron Alpha with quick change engine mount, 'chute recovery and super-streamlined design. What's more, you also receive, at a reduced price, a complete set of all the tools and supplies for building and finishing the model, the Estes Electro-Launch with batteries, engines for flying the rocket and an authoritative manual on model rocketry.

Check the list of contents below, then send in your order for the best Beginners Special ever offered in model rocketry.

COMPLETE BEGINNERS SPECIAL INCLUDES:

1 Astron Alpha Kit ...... #K-25	1 Design Booklet #P-1
1 Electro-Launch .... #FS-1	1 Engine .. #1/2A.8-2
4 Batteries .... #PFB-1	1 Engine .... #A.8-3
1 Sanding Sealer .... #SS-1	1 Sandpaper #SPEF-2A
1 Red Butyrate Dope .... #BRD-1	1 Sandpaper #SP-320A
1 Thinner & Brush Cleaner #BDT-1	1 Brush..... #PB-3A
1 White Butyrate Dope ... #BRD-1	1 Knife ..... #KNS-3
1 Tube White Glue....... #WG-2	

Cat. No. 651-BS-72 Special Price Post Paid **Only $7.25**

BS-60 A Fine Gift

Recommended for beginners who already have modeling tools and supplies, the $6.00 Beginners Special is an ideal gift for the model maker who hasn't tried the space-age hobby yet.

$6.00 BEGINNERS SPECIAL INCLUDES:

1 Astron Alpha Kit #K-25	1 Electro-Launch Kit #FS-1
1 Design Booklet #P-1	4 Batteries #PFB-1
1 Engine #1/2A.8-2	1 Engine #A.8-3

Cat. No. 651-BS-60 **$6.00 Post Paid**

BS-20 Also Available

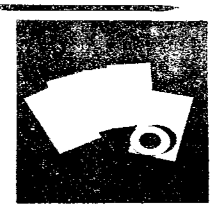
THE $2.00 BEGINNERS SPECIAL

When there's a club's or friend's launcher available for the beginner to use, this special is ideal.

1 Astron Alpha Kit #K-25
1 Design Booklet #P-1
1 Engine #1/2A.8-2
1 Engine #A.8-3

Cat. No. 651-BS-20 $2.00 Post Paid

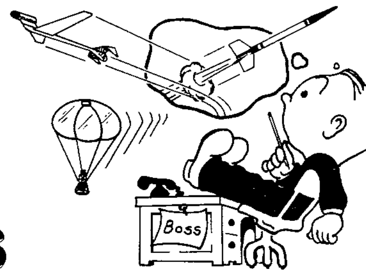
RA-2055 Rings



Perfect for building models with the new BT-55 body tube. Centers a BT-20 inside the larger tube for engine mounts, transitions, etc. Set includes 10 lightweight, high strength card stock rings. Shipping weight 2 oz.

Cat. No. 651-RA-2055 **$ .30 Per Set**

NOTES FROM THE BOSS



Many thanks to all of you for your compliments on the new catalog (#651). In answer to your questions—yes, additional iron-on decals are available. They're free on request when you place an order. If you're in a hurry and want to include 2¢ per decal (20¢ minimum) to help cover postage and handling, we'll be glad to send them along to you separately.

The official announcement of the 1966 Science Fair Contest will be carried in the next issue of the MRN. This contest will close about the time school is out next spring. If your project involves model rocketry, keep all of your work along with photos of the project so you can enter the contest.

The imaginative researcher has unlimited possibilities ahead of him. Many of the same persons who produce the best science fair projects today will be our most valuable and influential scientists and engineers tomorrow. But others who are doing research purely for enjoyment will find that the skills and knowledge they have developed make all of life more interesting and enjoyable—the scientific approach can help a person understand the workings of such different things as politics and poker.

Model rocketry is not very old, but already we've seen some very impressive work done in the field by students like yourself. Many of these projects have won awards ranging from ribbons to college scholarships. Each year the number of areas for research seems to increase. The area of aerodynamics alone shows great potential. What, for example, is the best fin shape? What is the ideal weight for a model of a given size and shape? Where is the trade-off point between acceleration and engine duration for different types of model? Other promising areas for study include recovery systems, aerial photography, thrust augmentation, materials and construction methods.

Following is the report on the flight of Mercury-Atlas 13, received by smoke signal and bongo drum after NASA decided to discontinue the use of electricity in their launchings:

"This is Mercury Control. Our guest launching officer today is Dr. Igor Fast, first American missile engineer to run the mile in under 4 minutes. The MA-13 flight is expected to set a new record of some sort. At the same time, Dr. Fast is expected to set a new record for the mile as he leaves the launch area.

"Dr. Fast is touching the match to the fuse—he's off and running. Lift-off should occur some time within the next 3 to 6 minutes. Dr. Fast is sprinting for a driftwood log on the beach. The fuse is burning up into the nozzle of the sustainer engine, the side fuses are almost to the booster engines.

"The technicians are pulling the ropes connected to the propellant valves to open them. Now the lox valves are being opened. All three engines are burning. The release on the anchor chain has burned through and the rocket is rising.

"It's wobbling—

tumbling. . . .

Dr. Fast is running faster. . . . ."

If you don't have a good electrical launching outfit, see pages 1 and 2. Perhaps the article will give you some ideas on designing and developing one of your own. One of the most important safety features of model rocketry is the control gained through electrical ignition.

The Camrocs are being mailed out at the time this is being written. All of those back-ordered should be delivered before the end of November. If you have a back order for a Camroc and don't receive it by Dec. 10, 1965, please send us your back order slip so we can check to make sure your order has been shipped. Thanks to all of you for your patience while the project was delayed.

Don't want to miss any MRN's? When you move, send us both your old and new addresses right away. That way we'll be able to make the change quickly, and you won't be skipped in any mailing.

Merry Christmas to all and a truly happy New Year!

SCIENCE FAIR CONTEST RESULTS

1st Place; Robert Morstadt, Waukegan, Ill.; "Ambient Temperature Effects on Model Rocket Engines." This project involved measurement of thrust and duration of engines at various temperatures.

2nd Place; Larry Marple, Fort Worth, Texas; "Investigation of the Krushnic Effect." The amount of thrust lost by recessing an engine various distances inside the body was measured in this project.

3rd Place; David Brown, Blackwell, Okla.; "Aerodynamics of Air Resistance of Shapes as Applied to Subsonic Rocket Flight." This project involved a study of pressure distribution over surfaces in a moving air stream to determine the best shapes for model rockets.

4th Place; Mark Talbot, Edmonds, Wash.; "Acceleration vs. Pregnancy." The effects of rocket flight on the development of the embryos of various animals were studied in this project.

A GIFT SUGGESTION

A Gift Certificate is the convenient way of giving. It can be used in place of other gifts when you're not sure what the receiver would like. Fill out this form or write the necessary information on a separate sheet of paper and mail to Estes Industries with your remittance in the amount desired for the gift. Your completed gift certificate will be returned via Air Mail. (Gift certificates make good gifts for birthdays and other occasions around the year as well as Christmas presents.)

Gift Certificate

Order Form

Gentlemen:
Please prepare a Gift Certificate as shown below:

Amount: ______________________ $ ______

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To: ______________________

MAIL CERTIFICATE TO:

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Address: ______________________

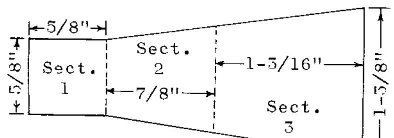
City: __________ State: __________ Zip ______

DATE	CERT. NO.	ISSUED BY

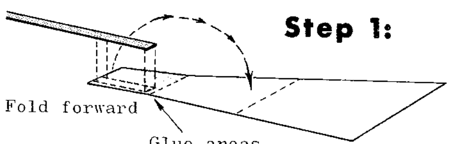
The Idea Box

New Shock Cord Mount

Start with a piece of bond paper of the dimensions shown.



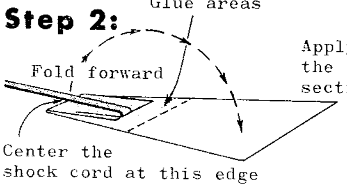
When cut out, prefold at the dotted lines.



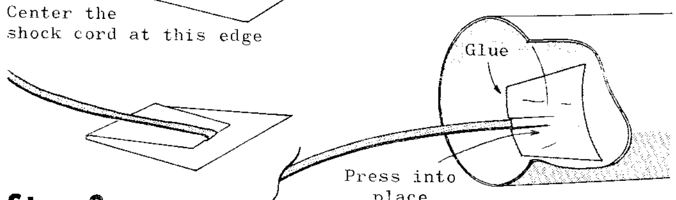
Step 1:

Apply glue to section 1. Lay the end of the shock cord into place. Fold the 1st section over the second one as shown.

Step 2:



Apply glue over the backside of the first and the exposed part of section 2. Lay the shock cord as shown and fold the cord and section 2, over section 3.

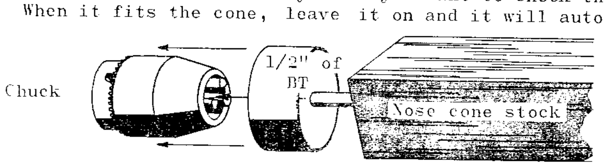


Step 3:

Apply glue to the inside of the body tube where the shock cord mount will seat. Hold the shock cord as shown and place the mount into position, pressing it to conform to the inside curve of the body tube.

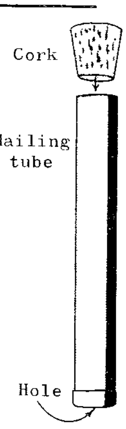
BT Makes Fitting a Nose Cone Easy

Peter Schrauth of Hamburg, N.Y. sends the following suggestion; "When making your own nose cones, slip a ½" piece of the body tube it's going to fit over the dowel before you chuck it. This eliminates taking the nose cone out and putting it back in the chuck every time you want to check the fit. When it fits the cone, leave it on and it will auto-



matically make you leave the correct amount of "shoulder" on your nose cone."

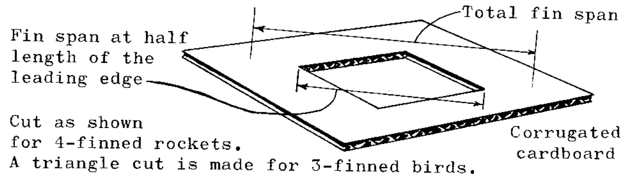
Another Use For the Engine Mailing Tube

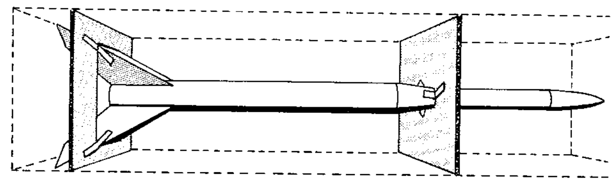


Mr. Terry Noelke of Detroit, Michigan suggests launching rod guards be made from engine mailing tubes. Conversion is easy as the tubes are already red...safer too, as they are larger and more readily seen.

Secure a cork at the 5 & 10 which will tightly fit the mailing tube. Remove only one end cap and contents of the tube. Insert the cork. Make a hole in the end cap large enough to receive the tip of the launching rod. (Or use the tube with one end cap "as is".)

Safer Model Rocket Storage or Transporting

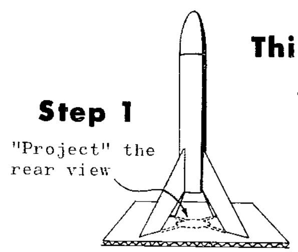




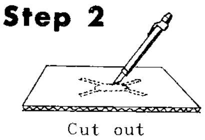
Opening is measured and cut so that about half of the fins come thru when guard is in place.

This Way Offers even More Support...

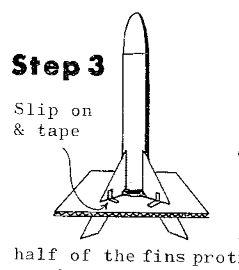
Step 1



Step 2

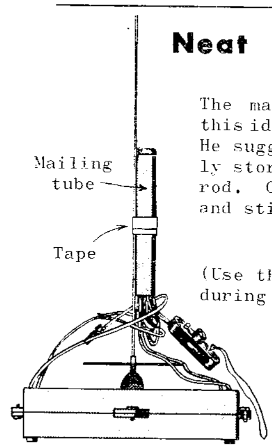


Step 3



Braxton Loftis, Jr. of Wheaton, Maryland protects his birds in storage or traveling with these packing supports. Cut two cardboard squares to fit the inside of the box. Then project the rear view of your rocket to one of the squares. Cut out the hole for the body tube and only half of the total fin span as shown in Step 2. Slip this square down over the body tube (notch as necessary to clear the launching lug) until about half of the fins protrude thru the slots. Apply masking tape as shown in Step 3. Center a hole of the proper size in the other square and slip on over the nose to a good location. Install the whole works in the box and tape the supports to the sides and bottom of the box.

Neat Launcher Cord Storage

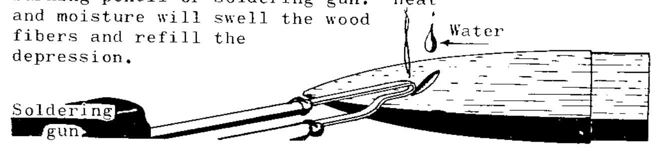


The mailing tube meets yet another need in this idea by David Stengar of Coquille, Oregon. He suggests that Electro-Launch leads be neatly stored in a mailing tube taped to the launch rod. Gather the wire into a handfull of folds and stick into the mailing tube as shown.

(Use the mailing tube for a launch rod guard during the day's operations at the pad.)

Some Dents Can be Removed!

Remove those dents in balsa nose cones, etc. by the method suggested by Jim Merriman of East St. Louis, Illinois. Put a drop of water on the dent and touch lightly with a wood burning pencil or soldering gun. Heat and moisture will swell the wood fibers and refill the depression.



R&D CONTES

Place	Winner	Project
1st	Ron Burri, Kansas City, Mo.	Activator Tube
2nd	Larry Renger, Palos Verdes, Calif.	Pop Pod
3rd	Chris Carstensen, Brookfield, Wisc.	Whirlibird
4th	Steven M. Davis, Oak Ridge, Tenn.	Parallel Boosters
5th	Jim Merriman, E. St. Louis, Ill.	UFO

ACTIVATOR TUBE 1st!

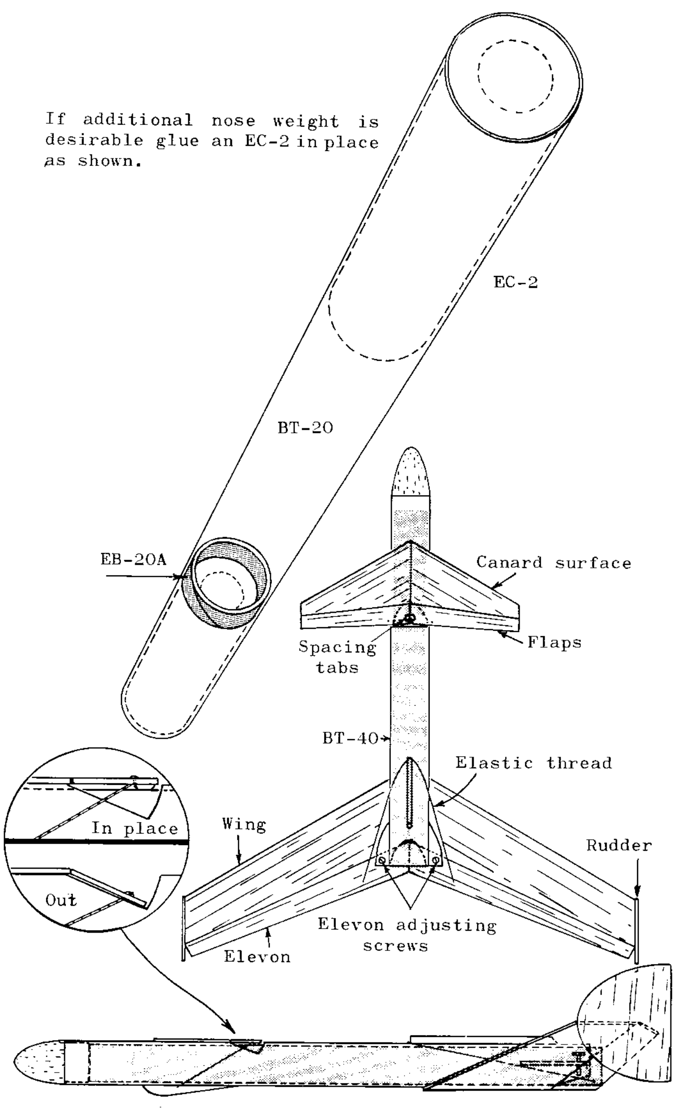
by Ron Burri

The activator tube system solves two problems which frequently arise with rear engine boost-gliders. First, it provides a neat and reliable method for activating canard flaps. In addition, it allows adding a removable weight to the nose of the model during the boost phase to give greater stability and a straighter ascent.

The activator tube itself must be large enough to hold an engine, yet small enough to slide freely (but not too loosely) inside the body of the model. A typical combination uses a BT-20 activator tube in a BT-40 model. BT-10 activator tubes can be used inside BT-30, but it is necessary to protect the mylar tube from the ejection charge by inserting a paper liner inside it.

The drawings below illustrate the construction of activator tubes and a vehicle designed to make use of the features of the activator tube. The tube should be painted a bright color to aid in locating it after flight. In addition, the engine must fit tightly in the activator for proper operation.

Typical Activator Tube



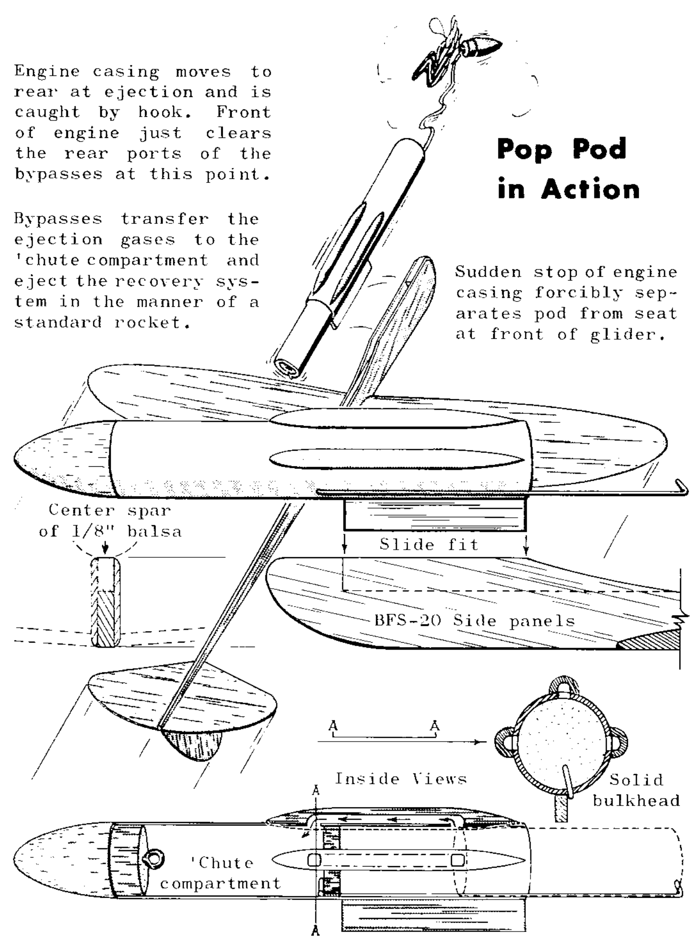
2nd! POP POD

by Larry Renger

The Pop-Pod, developed by the "Father of the front-engine boost-glider," represents a significant advance in the design of models for high performance and competition use. This system reduces weight and drag for the glide phase, provides a soft return for the pod and engine, and allows the use of one engine holder unit with several gliders.

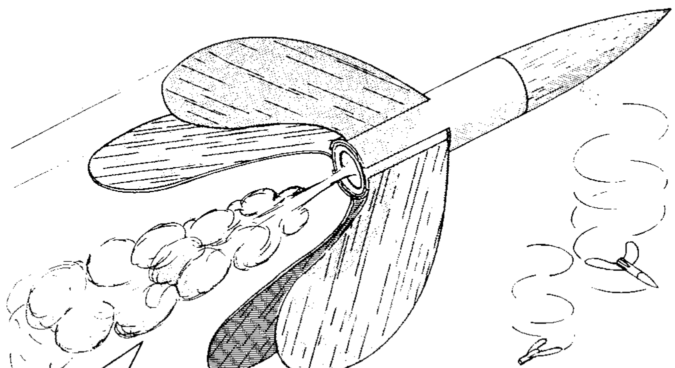
The pod itself is a 5" piece of BT-20 with a BT-20B nose cone. The bypasses are carved from spruce or hard balsa and coated heavily on the inside with white glue followed by high heat aluminum paint. In operation the ejection charge forces the engine rearward in the tube. The shock of the engine stopping against the wire hook separates the pod from the glider. With the engine in its rearward position the rear vents of the bypass are uncovered, allowing the ejection gases to travel forward to the parachute compartment. The nose cone is then forced off and the 'chute expelled.

The mounting lug on the pod must be fitted to the slot on the glider carefully. It must stay in place during powered flight but separate easily at ejection.



ST RESULTS!

Place	Winner	Project
6th	Clayton Davenport, Kansas City, Mo.	Gyro Recovery
7th	Gary Robertson, Kansas City, Mo.	Igniter Holder
8th	Tom Weaver, Winter Park, Fla.	Flexible Wings
9th	Paul Berg, Kings Park, N. Y.	Flap Recovery
10th	Elwyn H. Dolecek, Wash., D. C.	Transmitter



3rd! WHIRLIBIRD

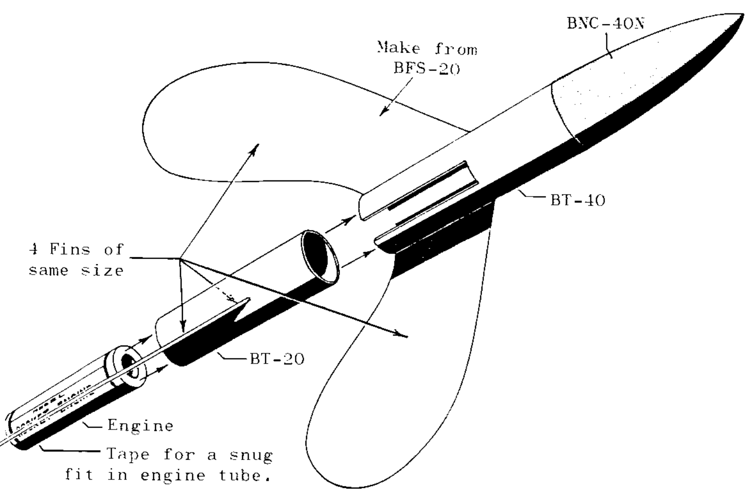
by Chris Carstensen

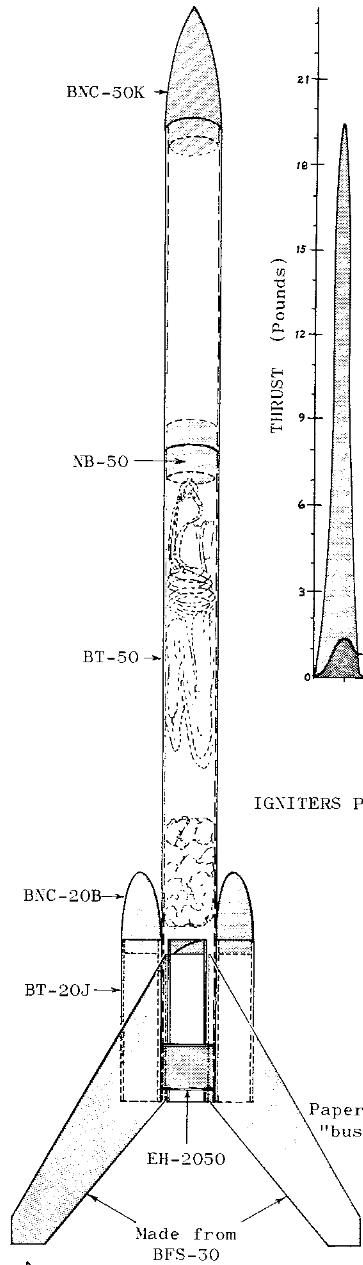
A new and quite different recovery system for small rockets, the "Whirlibird" is designed to go straight up in one piece; then at ejection, separate into two pieces, each one spinning like a maple seed.

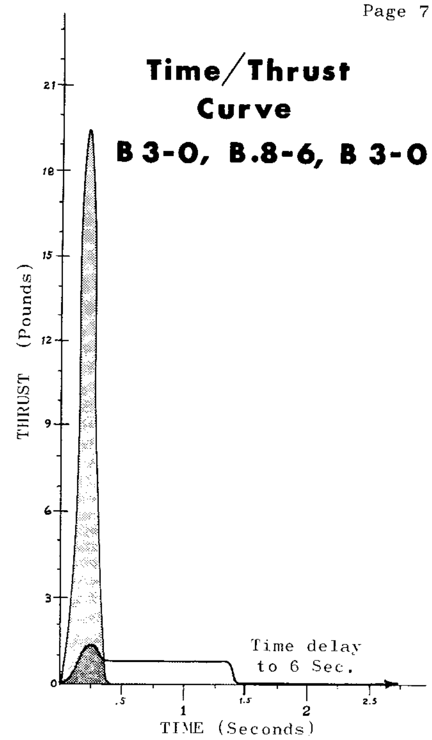
Rockets using this system are built with two body tube sizes, the smaller fitting into the larger. Two fins are attached to each tube. BT-20 and BT-40 are the most convenient combination.

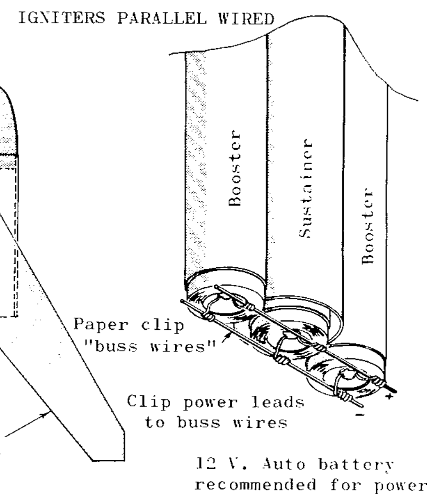
When the two sections are fitted together you have a stable rocket. When the ejection charge activates the BT-20 section is blown out from the BT-40 section. Each piece is not completely stable by itself and will come spinning down. The engine casing stays in the BT-20 section and this section is the first to land.

Tests so far indicate that fin design is not critical on this type of model. If the fins are large enough and placed properly for stability the rocket will behave correctly on the way up. On the return any fin that is of a reasonable size will not be able to stabilize the halves completely.









4th! PARALLEL BOOSTERS

by Steven M. Davis

Parallel boosters represent a unique approach to payload launching, combining features of clustering and multi-staging. In operation the model lifts off with all three engines thrusting. When the booster engines burn out, they are expelled from their pods; the central sustainer continues on up under its remaining thrust much like a normal upper stage.

This system provides high initial boost to get the vehicle off the pad and stabilized like most cluster rockets. Unlike the ordinary cluster model, however, the parallel booster design allows a pronounced dual thrust level as shown in the thrust-time curve. In addition, when the booster engines burn out, they are ejected, reducing the weight the sustainer must carry.

While any booster engine type may be used, B 3-0's take the most advantage of the system. For maximum altitude, a B.8-6 sustainer is recommended.

Many of the techniques described in Technical Report TR-6 on clustering apply to this type of model. The direct electrical ignition system using a 12 volt car battery is recommended. The igniters should be connected as shown.

Estes Industries Rocket Plan No. 36

BEAT THE AIR FORCE . . . Build Your Own

260 SPACE BOOSTER

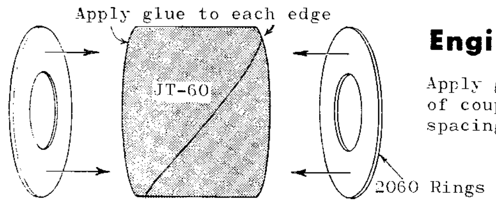
Among the potential applications for the 260" diameter solid motors under study is a family of solid boosted general purpose space vehicles. Since such a booster could be produced at a comparatively low cost (around $2.00 per pound), it would lend itself quite well to use with a wide range of upper stages. One proposed configuration would employ a single 260" solid as the first stage with a 156" solid second stage.

PARTS LIST

To build your own 260, you will need the following parts:

1 Body Tube--Part #BT-50H (7.75")
1 Body Tube--Part #BT-60K (7")
1 Body Tube--Part #BT-20 (Cut to 4.25")
1 Balsa Adapter--Part #TA-5060
1 Balsa Adapter -- Part # TA-550
1 Stage Coupler--Part #JT-60C
3 Adapter Rings--Part #RA-2060
1 Engine Block--Part #EB-20A
1 Screw Eye--Part #SE-1
1 Shock Cord--Part #SC-1
1 Parachute Kit--Part #PK-12
1 Sheet Clear Fin Stock--Part #CFS-20
1 Sheet Clear Fin Stock--Part #CFS-40
1 Launching Lug--Part #LL-2B

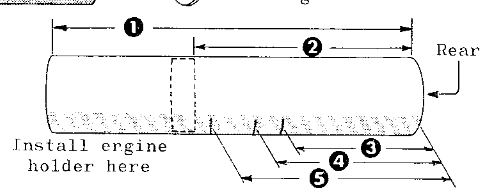
ASSEMBLY



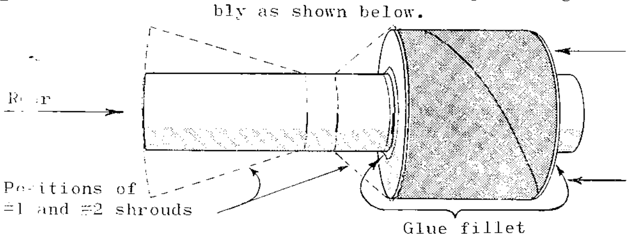
Engine Mount

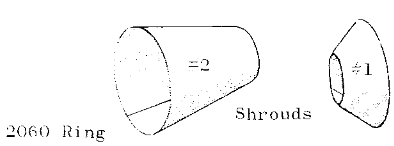
Apply glue to edges of coupler and attach spacing rings.

Dimensions:
1 - 4-1/4"
2 - 2-1/2"
3 - 1-1/2"
4 - 1-3/4"
5 - 2-1/4"

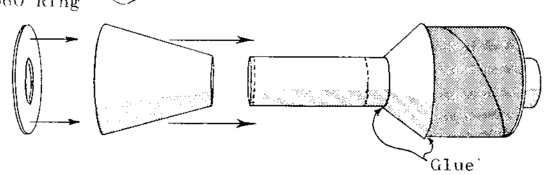


Mark the engine holder tube as shown above, making all measurements from the rear end. #3 and #4 are shroud markers and #5 positions the coupler-ring assembly as shown below.



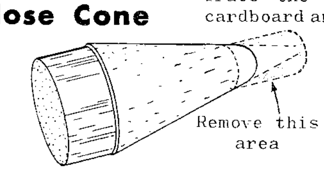


Form and Install Nozzle



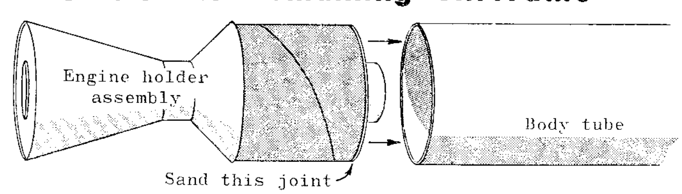
Trace the shroud templates onto heavy paper, cut out and form the shrouds. Slide shroud #1 into place against the coupler and apply glue around both joints as shown. Slide #2 shroud ahead of its mark and put the last 2060 ring just on the rear of the engine holder tube and glue in place. #2 shroud is slid back and centered on the ring. Apply glue to ring-shroud and shroud-tube joints. Let dry.

Shape the Nose Cone

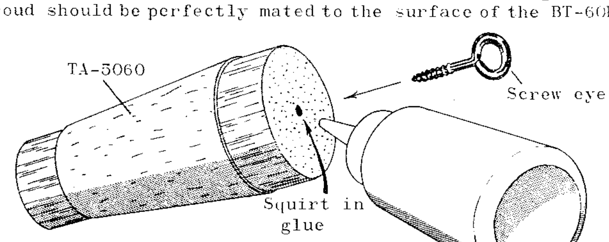


Trace the nose cone template onto cardboard and cut out. Carefully sand or carve away the shaded area of the TA-550 as is shown. Remove the excess length until the rounded shape is attained. Use the template frequently to check your work. Apply a coat of Astro-Seal or sanding sealer and set aside to dry.

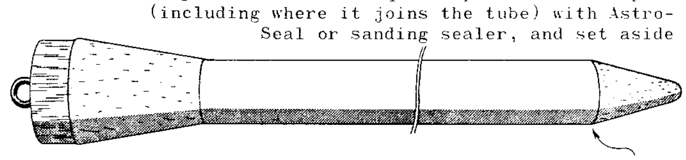
Assemble the Remaining Airframe



Sand the ring-coupler joint to get a smooth fit into the body tube. Spread glue inside one end of the BT-60K and slip the engine holder assembly into place. The edge of #1 shroud should be perfectly mated to the surface of the BT-60K.



Insert and remove the screw eye from the large end of the 5060 adapter. Squirt glue into the hole and re-insert the screw eye. Spread glue inside one end of the BT-50H and insert the other end of the 5060 adapter. Coat the tapered part of the adapter (including where it joins the tube) with Astro-Seal or sanding sealer, and set aside

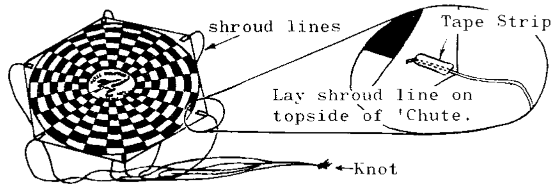


to dry. Check the fit of the nose cone at this time and sand it as necessary to obtain a smooth transition from the cone to the tube.

Install the Shock Cord

Refer to the Idea Box (Page 5) for the new shock cord mount and use it here. This new mounting is stronger and affords more protection to the shock cord from ejection gases.

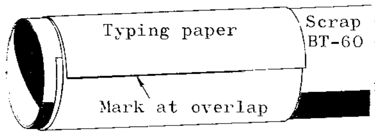
'Chute Construction

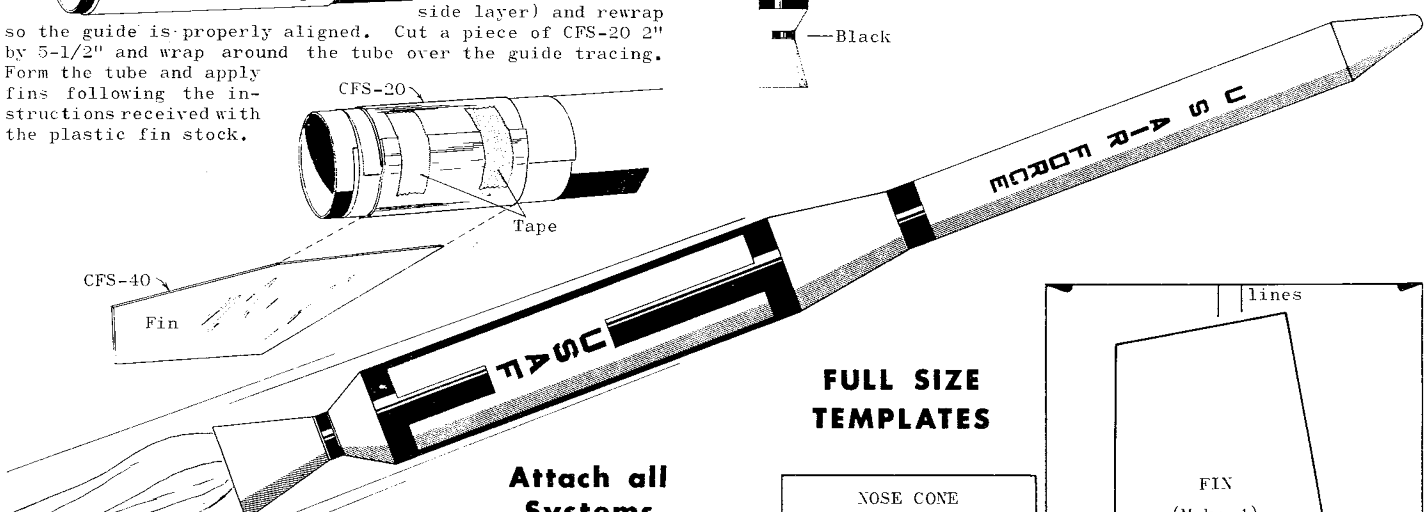


Standard parachute assembly is used as shown. If you have a snap swivel tie it in at the shroud line ends.

Prepare the Fin Unit

Cut a sheet of typing paper in half the long way. Wrap one piece around a scrap piece of BT-60 and mark where it overlaps as shown. Trace the fin marking guide template onto this area (the outside layer) and rewrap so the guide is properly aligned. Cut a piece of CFS-20 2" by 5-1/2" and wrap around the tube over the guide tracing. Form the tube and apply fins following the instructions received with the plastic fin stock.

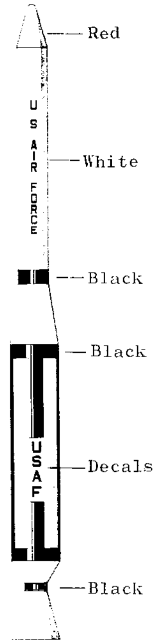




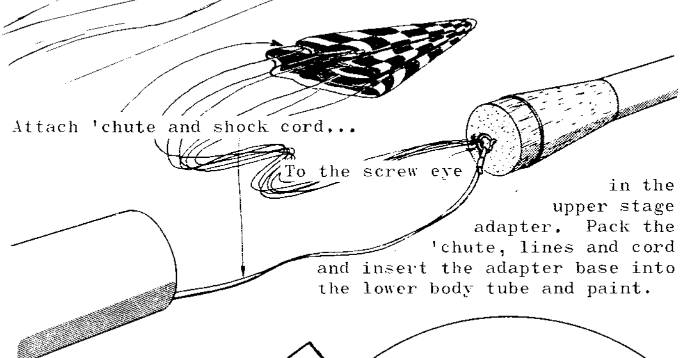
Paint Details

Seal all balsa surfaces using Astro-Seal or sanding sealer. If desired, apply putty to the cone joints, dry and sand smooth.

Remove the nose cone. Use a JT-50 and scrap BT-50 as a holder and give the entire body (including nozzle) a mist coat of white. When dry, lightly sand all surfaces and repeat. Apply a final coat of white and set aside to dry. Follow the same procedure in painting the nose cone red. (Same holder can be used without the coupler.) The black pattern may be applied with decorating tape (DT-1) or painted on. Decals are cut from the #D-5 sheet and applied. The same pattern is used on the opposite side.

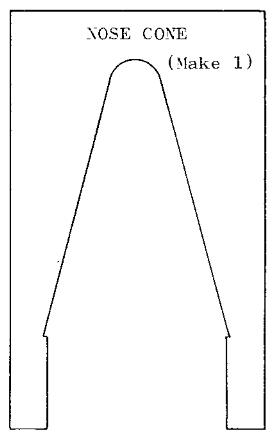


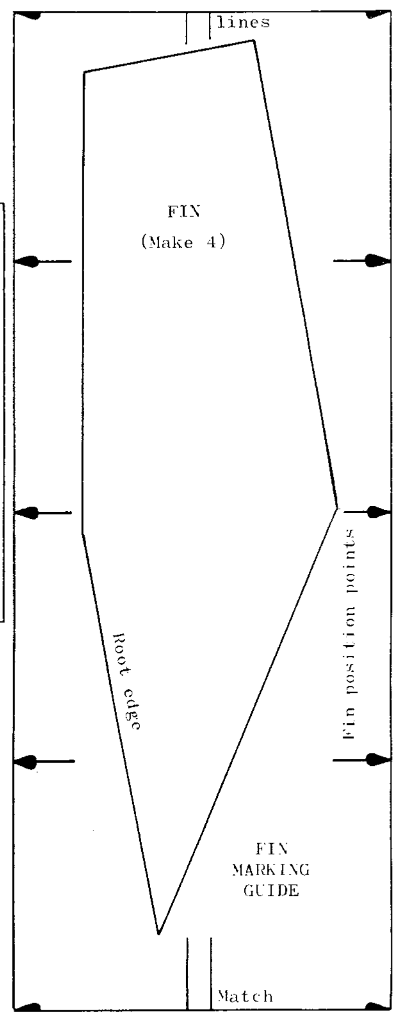
Attach all Systems

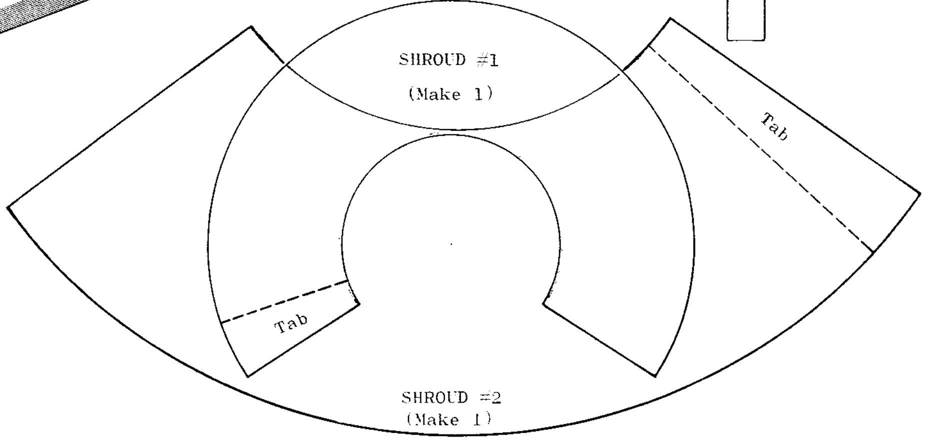


Attach 'chute and shock cord... To the screw eye in the upper stage adapter. Pack the 'chute, lines and cord and insert the adapter base into the lower body tube and paint.

FULL SIZE TEMPLATES







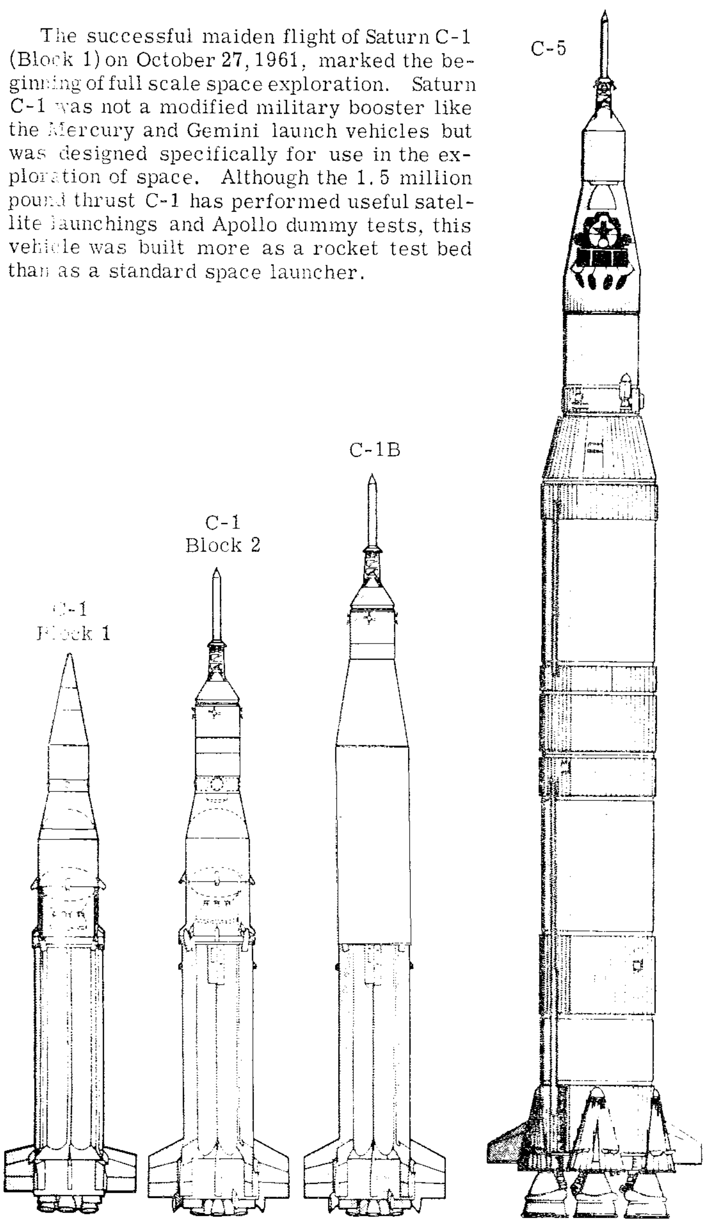
MODERN ROCKETRY IN PERSPECTIVE

by Dean Black

Since the launching of Sputnik I in 1957, big-time rocketry has served as a strong stimulus to the imagination of scientifically oriented young people. After catching the rocket "bug," the student of rocketry can hardly keep from developing a desire to see rockets fly and learn all he can about them. From model rocketry the basic principles can be learned and a rocketeer can see the "whys" and "hows" on a first hand basis. To really stay on top, however, requires a knowledge of what's happening in the development of our nation's first line of big boosters.

Big boosters are being developed in two different areas--the civilian front and the military front. For the peaceful scientific exploration of space NASA is developing the already famous family of Saturn super rockets.

The successful maiden flight of Saturn C-1 (Block 1) on October 27, 1961, marked the beginning of full scale space exploration. Saturn C-1 was not a modified military booster like the Mercury and Gemini launch vehicles but was designed specifically for use in the exploration of space. Although the 1.5 million pound thrust C-1 has performed useful satellite launchings and Apollo dummy tests, this vehicle was built more as a rocket test bed than as a standard space launcher.



SATURNS				
Rocket	Saturn C-1 (Block I)	Saturn C-1 (Block II)	Saturn C-1B	Saturn C-5
Overall Length	163' 7" to 182'	190'	224'	364' 6"
Number of Stages	2	2	2	3
1st Stage Length	82'	82'	82'	138'
1st Stage Diameter	21' 5"	21' 5"	21' 5"	33'
1st Stage Thrust	1,500,000 pounds	1,500,000 pounds	1,600,000 pounds	7,500,000 pounds
2nd Stage Length	81' 7" to 100'	41' (without payload)	59'	82'
2nd Stage Diameter	18' 4"	21' 4"	21' 8"	33'
2nd Stage Thrust	90,000 pounds	90,000 pounds	200,000 pounds	1,000,000 pounds
3rd Stage Length	n. a.	n. a.	n. a.	59'
3rd Stage Diameter	n. a.	n. a.	n. a.	21' 8"
3rd Stage Thrust	n. a.	n. a.	n. a.	200,000 pounds
Orbital Capacity	22,000 pounds	22,000 pounds	32,000 pounds	240,000 pounds
Lunar Capacity	n. a.	n. a.	n. a.	90,000 pounds
Weight	1,130,000 pounds	1,130,000 pounds	1,300,000 pounds	6,000,000 pounds

The Saturn C-1B, however, is designed to serve as a standard payload carrier well into the 1970's. The C-1B has a payload capacity that is half again as large as the C-1's. In fact, C-1B is really the combination of the results of C-1 and Centaur studies. It will probably be the Saturn C-1B that launches most of our country's unmanned space probes in the near future. For the launching of large orbital payloads and deep space probes of the size that will be most useful, however, Saturn C-1B will have to be greatly uprated in capability. NASA is already studying methods for giving C-1B enough power to launch these intermediate sized payloads that are too large for the present C-1B and too small for the Saturn C-5. The following methods may be used to increase C-1B's payload capacity:

1. Floxing--using a combination of fluorine and oxygen instead of oxygen alone as an oxidizer to increase specific impulse.
2. Increasing engine thrust of second stage from 200,000 lb. to 215,000 or 230,000 lb. by improvement of the J-2 engine.
3. Uprating the H-1 first stage engines to 225,000 lb. thrust each to give 2,000,000 lb. first stage thrust.
4. Adding a high energy Centaur third stage.
5. Refining structure to reduce dead weight.
6. Thrust augmentation--strapping two 120" diameter Titan III-C solid boosters or four M-55 Minuteman first stage motors on the Saturn's first stage.
7. Adding four 120" UTC solid motors as a new stage zero of about five or six million pounds of thrust.

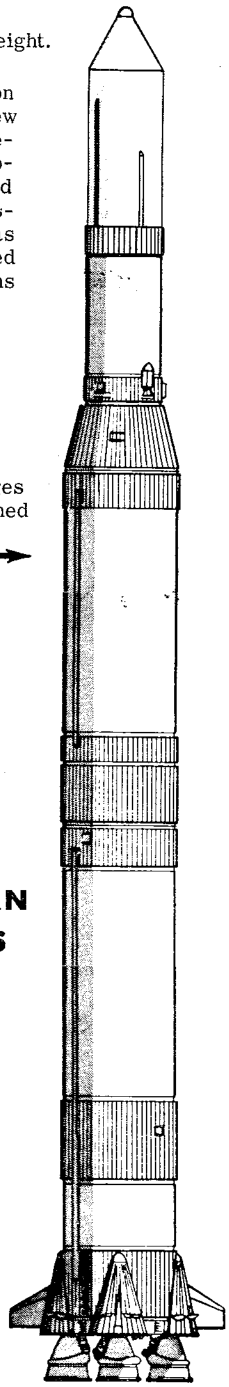
Such improvements could boost C-1B's orbital capacity into the sixty to eighty thousand pound range and give it the healthy deep space capabilities that will be needed.

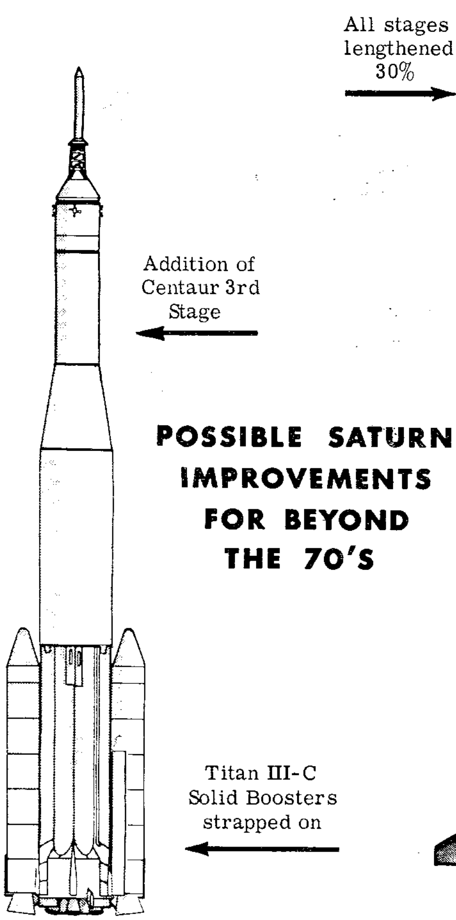
NASA SPACE TRUCKS

Saturn C-5 is NASA's space truck that will be the second of the workhorses, along with the C-1B, during the next decade. C-5 will be a mammoth cargo truck of immense capability. Not only will it be able to send Apollo spacecraft to the moon and quarter million pound space stations into low orbit, but also send large, elaborate probes to the planets and beyond. What comes after C-5? Americans aren't likely to be willing to pay for a rocket several times bigger and more expensive than the Saturn C-5 for many years to come. The answer for more power in the 70's will probably lie in uprating the C-5. Methods for increasing the capability of the C-5 will take much the same form as those being studied for the C-1B. These are:

1. Floxing.
2. Boosting F-1 engine power from 1,500,000 lb. each to 1,800,000 lb. to give a total first stage thrust of 9,000,000 pounds.
3. Boosting the power of the J-2 engine from 200,000 lb. to 215,000 or 230,000 lb. to boost the thrust of the second and third stages.
4. Lengthening stages about 30% by adding extra rings to the tank structures.
5. Thrust augmentation--adding four M-55's or four UTC 120" strap-ons to the first stage.
6. Structural refinement to reduce weight.

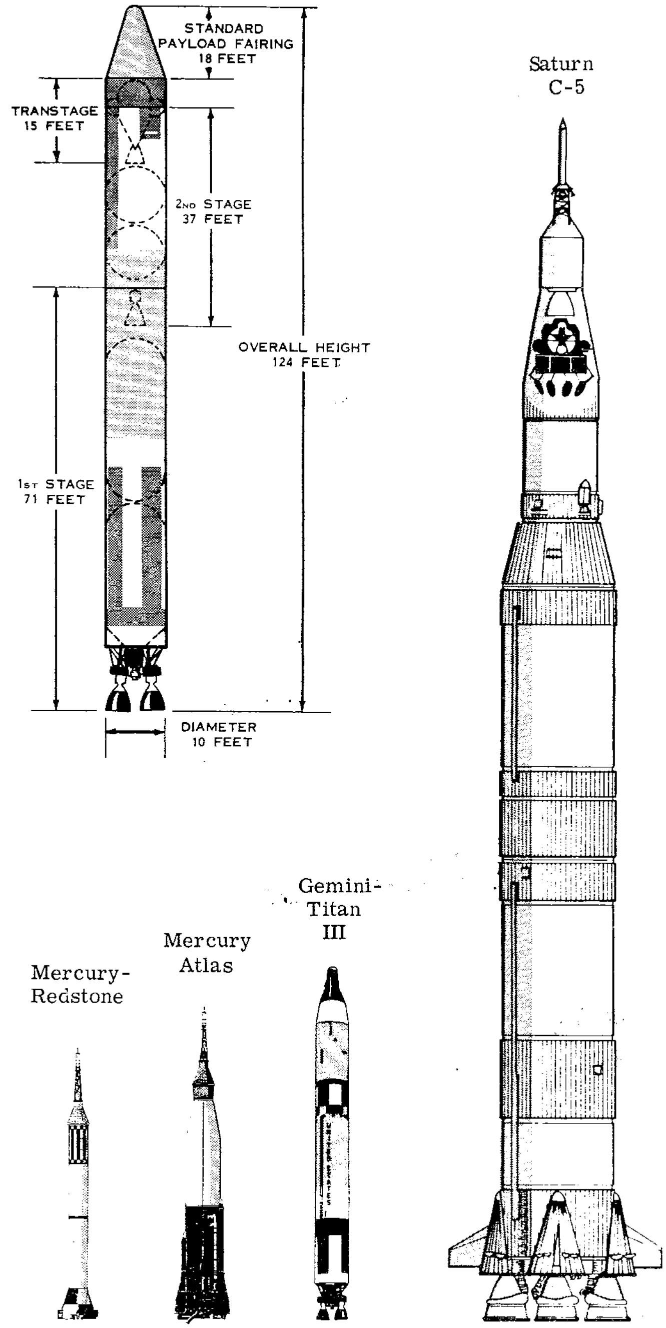
Although no official proposals are on the drawing board, a Saturn C-5 with a new solid fueled stage zero may eventually evolve. NASA is studying the possible applications of 156" and 260" diameter solid rocket motors of the type that will be discussed later in this report. As many as twelve 156's or eight 260's could be used as a stage zero rated in tens of millions of pounds of first stage thrust.





POSSIBLE SATURN IMPROVEMENTS FOR BEYOND THE 70'S

TITAN IIIA DIMENSIONS



COMPARATIVE SIZES

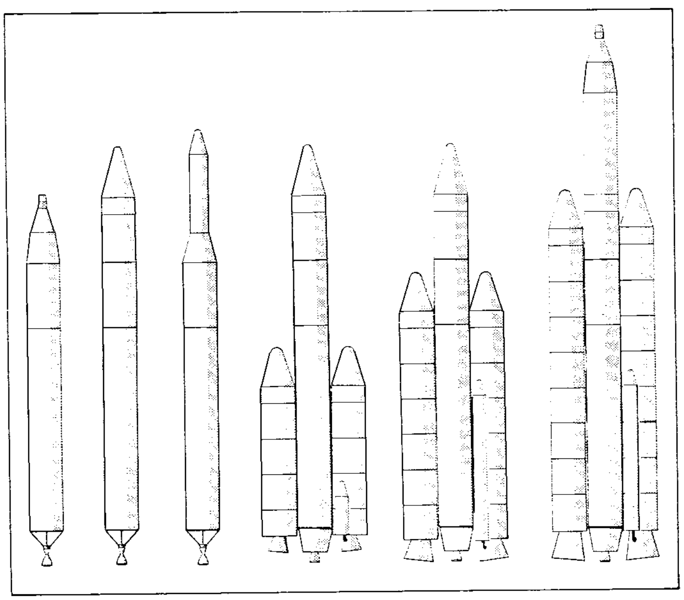
MILITARY SPACE BOOSTERS

Where does the military stand in space? Until recently the military had little at all to do with actual exploration and travel in space. Even without the spur of lunar travel and the billions of dollars of an enthusiastic country to work with, a military big booster capability is gradually developing. The title of the Air Force's standard bearer is Titan. Tremendous versatility and standardization has been built into this new line of fast-acting rockets. Prime contractor for the system is the Martin Company.

The present Titan family, along with its planned future additions, is built around a few basic standard pieces of hardware. The main vehicle is a structurally-strengthened modification of the Martin-built Titan II, the nation's most powerful ICBM. The Titan II alone launches Gemini. Titan II with a transtage and Titan II with an Agena B make the Titan III-A and Titan III-B respectively. The Titan III-A with two five-segment 120" diameter United Technology Corporation strap-ons make up the Titan III-C, the most powerful rocket yet fired by the United States.

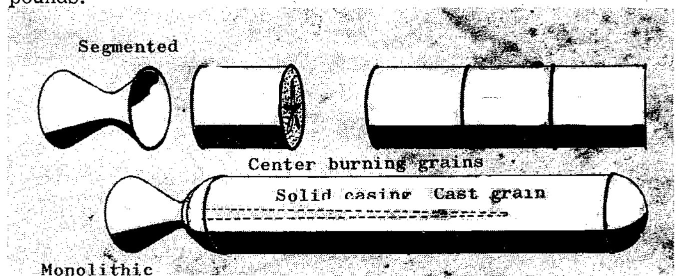
TITAN FAMILY

Rocket	Gemini-Titan II	Titan III-A	Titan III-B	Titan III-C (5 seg. strap-ons)
Overall Length	108'	124'	approx. 125'	127'
Number of Stages	2	3	3	4
1st Stage Length	71'	71'	71'	85'
1st Stage Diameter	10'	10'	10'	10'
1st Stage Thrust	430,000 pounds	430,000 pounds	430,000 pounds	2,400,000 pounds
2nd Stage Length	19'	37'	19'	71'
2nd Stage Diameter	10'	10'	10'	10'
2nd Stage Thrust	100,000 pounds	100,000 pounds	100,000 pounds	474,000 pounds
3rd Stage Length	n. a.	15'	31'	37'
3rd Stage Diameter	n. a.	10'	5'	10'
3rd Stage Thrust	n. a.	28,000 pounds	16,000 pounds	100,000 pounds
4th Stage Length	n. a.	n. a.	n. a.	15'
4th Stage Diameter	n. a.	n. a.	n. a.	10'
4th Stage Thrust	n. a.	n. a.	n. a.	28,000 pounds
Weight	343,000 pounds	370,000 pounds	350,000 pounds	1,400,000 pounds



This is not the full extent of the military's potential with its space boosters. Titan III strap-ons can be made as small as three segments or as large as seven so that the rocket can be tailored to the payload and mission.

The Air Force is also in the process of developing and testing huge thirteen foot diameter segmented rockets that can be made much larger than the present 10 foot strap-ons. These engines will develop anywhere from 1.4 to about 3.9 million pounds of thrust depending on the number of segments. The smallest segmented 156" motors have three segments, but up to five more 22' 4" long center segments can be added. The addition of each new segment increases thrust by half a million pounds.



There is one other 156" solid worth mentioning. This 320,000 lb. thrust fiberglass-cased motor is being built by Thiokol Chemical Corporation strictly as an upper stage motor. The motor will have a deeply submerged nozzle that will allow the entire power package to be compacted into an overall length of less than 21 feet.

As if all this weren't enough, the Air Force is showing an interest in even larger engines--260" diameter monolithic solids that will weigh from 1,770,000 lb. to 3,571,000 lb. and develop thrust ranging from 3,200,000 lb. to 7,300,000 lb. Later improved versions may go as high as eight or ten million pounds in thrust by using such exotic new oxidizers as hydrazinium diperchlorate and high energy fuel additives like beryllium. These engines would be brought to launching sites as massive single units and could be used singly or in clusters. With the three basic engine diameters--10', 13' and 21' 8"--the Air Force may develop a launch system of as yet unimaginable power.

BIG SOLIDS

Diameter (Inches)	Number of Segments	Weight (Pounds)	Thrust (Pounds)	Length (Feet)
156	1	240,000	320,000	21
156	3	777,000	1,400,000	78
156	4	1,030,000	1,900,000	101
156	5	1,330,000	2,400,000	124
156	6	1,600,000	2,900,000	147
156	7	1,900,000	3,400,000	170
156	8	2,200,000	3,900,000	193
260	Welded Solid	1,770,000	3,200,000	78
260	Welded Solid	2,800,000	5,000,000	95
260	Welded Solid	3,571,000	7,300,000	135