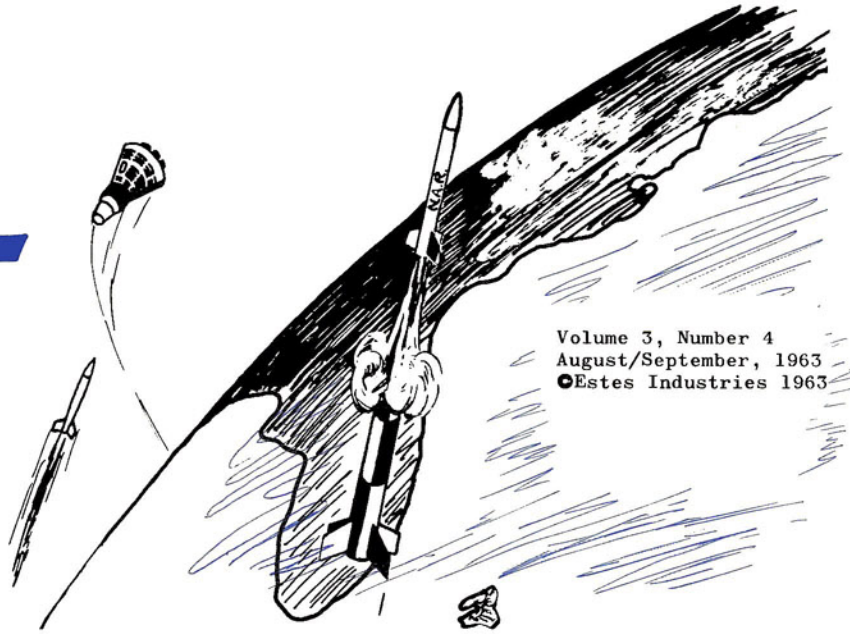
MODEL ROCKET NEWS

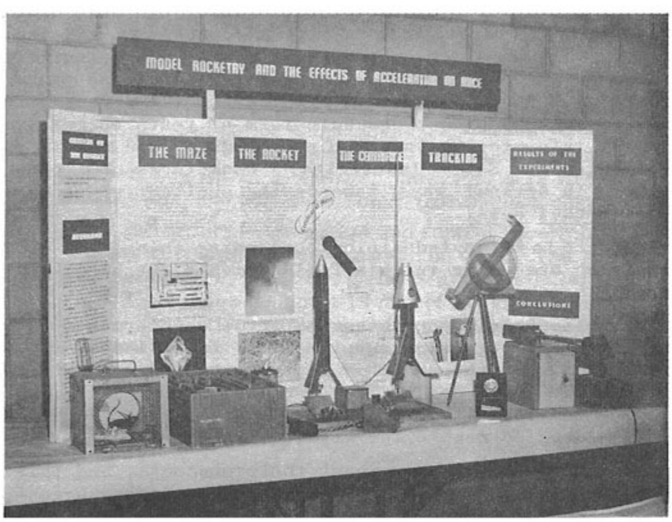


Volume 3, Number 4
August/September, 1963

Schmidt Project Named Best In Science Fair Contest

"Reducing Drag on an Astrodynamic Vehicle," a science fair project by Roy Schmidt of Denham Springs, La., received first place honors in the recent Science Fair Contest sponsored by Estes Industries. Roy's project was a study of the effect of paint on rocket performance. In the project he measured the performance of a rocket before and after painting, and discovered that the rocket performed considerably better after painting, even though the paint increased its weight. For a picture of Roy's project, see V3, N3 of the Model Rocket News.

Second place in the contest went to "Model Rocketry and the Effects of Acceleration on Mice" by Terry Krumm of Dayton, Ohio. Terry's objects, as he states at the beginning of his report, were to (1) build and fly model rockets capable of lifting payloads in excess of three



This display by Terry Krumm is especially well done, and shows all equipment used in his project.

ounces and (2) to use these rockets to study the effects of acceleration on trained mice. Experimentation in the project included the construction and use of a camera carrying rocket, training a mouse to run a maze, testing the mouse in a home-made centrifuge, and finally testing the mouse in actual rocket flight.

Continued page 2

Developing a Winning Science Fair Project

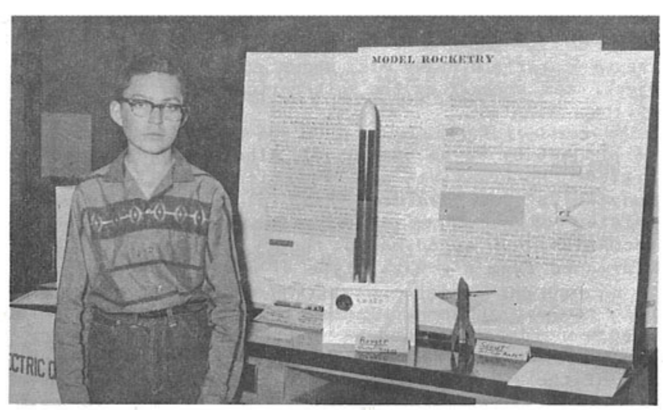
What makes a winning science fair project? What can a person do to improve his chances of winning?

A survey of some of the projects entered in Estes Industries' Science Fair Contest shows many of the features which a winning project should have. While it is impossible to predict the choice of the judges, a properly conducted science fair project in almost any of the areas related to model rocketry should have an excellent chance in any fair.

There are three parts to any acceptable science fair project; research, report, and display. A good project has to be good in all three areas.

RESEARCH

The first step in any project is to choose a subject. While this may sound obvious, many people fail here and as a result fail in their projects. Some of the better subjects which have been used include the application of mathematics and aerodynamics to the development of a high performance model rocket, a study of model rockets and the effects of acceleration on mice, a study of the effect of paint in reducing drag, a study of the effect of fin shape on rocket performance, and research on the design requirements of boost gliders.



One of the best projects on basic model rocketry, this display by Bill Bennet shows clearly the construction of typical models.

Continued page 2

Developing - - Continued

In choosing a subject the rocketeer should consider his own interests and capabilities as well as the possibilities for developing an interesting project on the subject. The sooner the subject is chosen, of course, the sooner work can begin on the project, allowing more work to be done, with the result that the rocketeer has a project of which he can really be proud.

With the choice of a subject comes the choice of the objective of the project. The objective may often be the same as the subject, such as "Determining the Effect of Rocket Weight on Rocket Performance," or the one may proceed from the other as in "A Study of Augmenter Principles," with the objective of determining how much, if any, benefit is derived from the use of a jet pump on a model rocket.

When the objective of the project has been determined it is time to plan the experimentation and gathering of data. The experimentation may consist of launching a rocket several times before painting and then several times after painting, recording the altitude for each flight, as in Roy Schmidt's project on reducing drag, or it may consist of several different experiments, each based on the preceding one.

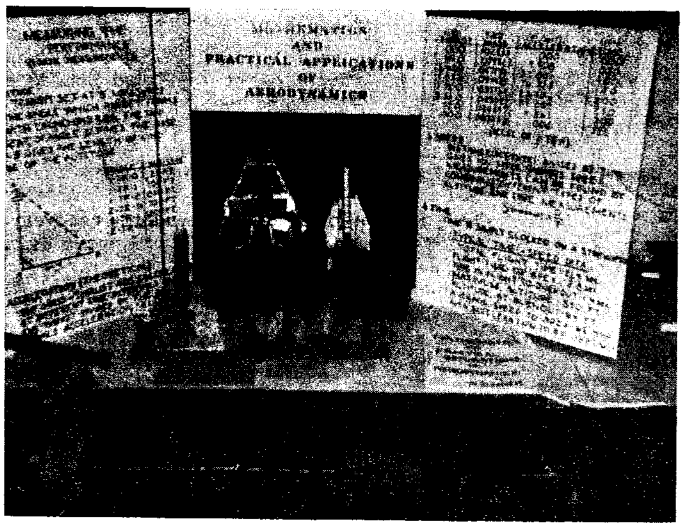
The nature of the experiments will be determined by the subject which is being studied. It is necessary to sit down and decide what information is needed and how it may be obtained. These experiments must be conducted in such a manner as to determine the truth, not to support a previously formed opinion.

In any project actual research should be conducted if the work is to have any merit at all. Part of the purpose of the science fair is to determine who can do the best job of performing this research. All experiments must be performed carefully; accuracy is very important. Enough tests must be performed to provide reliable data. Everything that can be photographed should be. After the tests have been made the results must be checked carefully to insure their reliability.

After all data has been collected and a study of all available printed material relating to the subject has been completed, it is time to compile the results. Photographs are developed, graphs and charts are drawn, and all observations are written down in logical order. When all this has been done it is time to draw some preliminary conclusions.

Once these preliminary conclusions have been formed some more tests which will check the validity of the conclusions should be devised and carried out. This

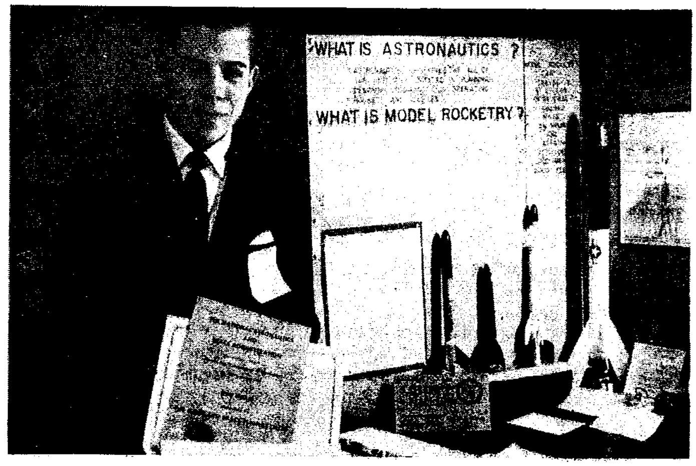
Contest - - Continued



Wayne Sumner's display also shows equipment used in his project, and emphasizes the mathematical aspect of the project.

A project by Wayne Sumner of Albert Lea, Minnesota, entitled "Mathematics and Practical Applications of Aerodynamics" was awarded third place. This project consisted of a series of experiments in the use of mathematics and aerodynamic theory to obtain the best performance from a general type of model rocket.

The contest judges commented that all three projects showed considerable thought and care in their preparation, and were outstanding in their various applications of the scientific method. The judges also stated that it was especially hard to pick winners in this contest because there were so many good projects entered, and added that almost all entries deserved the highest praise.



"Astronautics Through Model Rocketry," by Douglas Frost, featuring live payload and camera launchings, was concerned with the use of model rockets in studying astronautics.

The Model Rocket News

Vernon Estes, Publisher — William Simon, Editor — Gene Street, Illustrator

The Model Rocket News is published approximately six times annually 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.

(4) Participate in the Writer's Program (described in Volume 2, No. 3 of this publication). Not every article submitted will be accepted, but it is through trying that one gains skill, and those which are accepted contribute greatly to the enjoyment of model rocketry by other persons also.

Developing - - Continued

may seem a rather drawn out procedure, but the accuracy of the results more than pays for the effort. The best science fair projects show this devotion to accuracy.

REPORT

Most reports on science fair projects can be divided into three parts, introduction, body, and conclusion. The report is usually a step by step account of the research work conducted, with any additional material which may be necessary to explain the project.

The introduction should normally explain the objectives of the project and the approach taken in carrying out the objectives. The body is an account of the experiments and methods used, and should contain the data gathered in the experiments. The conclusion contains a statement of the results of the project as related to the objectives (the conclusions which may be drawn from the experimentation and study).

DISPLAY

The display should be done just as carefully as any other part of the project. It is important as it must explain the project in terms anyone can understand and must attract the judges' attention to the project.

Among the things which help make the display interesting and should be included are the equipment used in the project, charts and graphs, photographs, and a condensed version of the report. Other things such as thrust-time curves and diagrams of equipment also help considerably. If electric power is available it can be used to operate attention-attracting devices such as a revolving rocket, automatic slide projector, blinking lights, etc.

The entire display must be neat. Clean, large, legible lettering, orderly distribution of charts, pictures and equipment, and attractive colors all help. Here, as elsewhere, the imagination of the entrant is of first importance.

EVALUATING A PROJECT

In the light of what we have learned from the entire group of projects we can study a typical project and consider its good and bad points. "Effects of Acceleration on Rocket Performance," by Jerry Jones is a good example to consider. This project is a study of the relation of acceleration to rocket altitude in rockets with different thrust to weight ratios but identical mass ratios (or identical total power to weight ratios).

Jerry begins his report by stating that many rocketeers believed that their rockets would go higher with Series II engines than with Series I engines of identical total impulse. His own observations seemed to indicate that this was not always the case, so his object in this project was to determine what effect, if any, the level of acceleration would have on the performance of his rockets.

Jerry's selection of a project is quite good, since he has picked a subject which interests him and covers an area in which he already has considerable experience. Also his subject is one which has not been covered extensively by other researchers, giving him a chance to contribute to the science of rocketry.

In the body of his report Jerry tells how he built a rocket weighing .24 ounce. With a 1/2A.8-2 engine in place the rocket weighed exactly .80 ounce. He fired this rocket twice using one Altiscope 100 feet away from the launcher to determine the rocket's altitude. The first flight was computed at 270 feet, the second at 740 feet.

This variation in altitude appeared to be unreasonable and impossible considering the rocket and the engines used until he noticed that if the rocket had reached an altitude of about 400 feet on both flights but had drifted 50 feet away from him on the first flight and 50 feet towards him on the second he would have gotten approximately the readings he did. For the remaining flights he decided to use a 1000 foot baseline.

The rocket was launched three more times with the same engine-weight combination and altitudes of 316', 325', and 325' were recorded. Then an engine of twice the total impulse (the A.8-3) was placed in the rocket. Lead weights were placed inside the rocket to double its takeoff weight, and it was fired three times to

Morton Katz developed a rocket-borne radio transmitter for his project, showing quite a few possibilities for further developments.

altitudes of 344', 344', and 354'. Following this the rocket was brought up to a weight of 2.62 ounces with a B.8-4 in place and once more fired three times to altitudes of 364', 383', and 364'. Finally the rocket, at the same weight, was fired three times, using B 3-5 engines, to altitudes of 306', 315', and 315'.

All launchings were conducted in the late afternoon in perfectly calm weather. The launcher used a 1/4" thick steel rod, 6' long, set in concrete in the ground to give precise control of the rocket's flight path. A scope liberated from an air rifle was mounted on the Altiscope to make late afternoon tracking easier.

It is impossible to find fault with Jerry's research work up to this point. He has organized his tests to give exactly the same ratio of total impulse to weight on each flight. Only the acceleration is allowed to vary. Under drag-free conditions away from the influence of gravity all rockets would reach identical speeds. He has repeated each test enough times to give fairly good average altitudes for each combination.

But Jerry stops here, and that's where he falls down. He hasn't made any tests to determine burnout altitude for the different combinations, and so he doesn't have any indication as to whether differences in altitude occur before burnout, after burnout, or both. He didn't make any graphs of the results, and on the basis of only three flights for each engine-rocket combination he states flatly that for every 100% increase in average acceleration there is a 7% decrease in performance. While his evidence is sufficient to show that there is a decrease in performance, he does not have enough data to attempt to give an exact figure. It would have been more justifiable to state that for every 100% increase in average acceleration it appears that there is approximately a 5% to 10% decrease in performance.

In his display Jerry showed his rocket, an engine, his Altiscope, and his Electro - Launch. On the board behind the equipment he had a brief version of his report posted. Jerry's project didn't place in this year's fair, but he knows what he did wrong, and what he can do to make a better project, and plans on winning next year.

New Products

Astron Sky Hook Kit

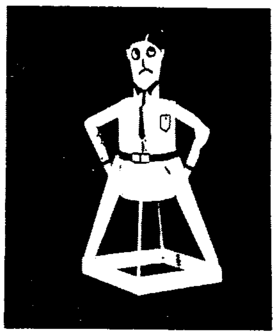
See the plans for this sweet flying bird on page 7! Complete kit, with all parts and detailed instructions, Cat. No. 631-K-8 $1.35.

Astron Cobra Kit

Study the plans on page 8! You'll like this easy-to-build, fun-to-fly cluster bird. Order the Astron Cobra, Cat. No. 631-K-10, $3.50.

Engine Holder Tubes

BT-20 body tubes in 2-3/4" long sections, especially made for use as engine holder tubes in cluster rockets. You won't have any trouble finding other uses for these. Cat. No. 631-BT-20J, $.10 ea. 3/$.20

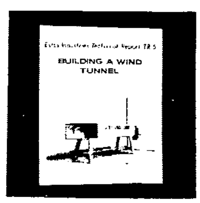


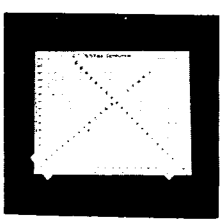
Astron Space Man Kit
(Formerly Called Man in Space)

The "most different" model rocket kit, the Astron Space Man is available only because so many of you asked us to sell it. Add the Space Man to <u>your</u> rocket collection. Flies with all single-stage Series I engines, use 1/2A.8-2 for first flights. Kit is complete with all parts and easy-to-follow instructions (but no engines).
Cat. No. 631-K-9 $ .75

Wind Tunnel Plans

Full plans for building a wind tunnel to measure rocket stability. Instructions for motor and hand powered versions, finding center of pressure, etc. A good project for clubs and experienced modelers
Cat. No. 631-TR-5 $ .25



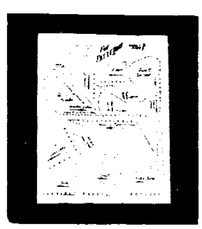


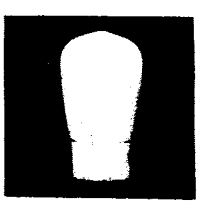
2-D Altitude Computer

Instructions and charts for making a simple, reliable altitude computer for use with Altiscopes, etc. Easily built with materials from around your house. Gives altitudes quickly and easily from data given by tracking stations.
Cat. No. 631-AC-1 $ .25

Fin Pattern Sheet

Fourteen different popular fin designs, all tried and proven, printed full size on heavy index stock. Simply cut out and trace around pattern to transfer design to balsa. A must for the model rocket designer.
Cat. No. 631-PP-2 $.25 ea., 3 / $.50





Space Man Nose Cone

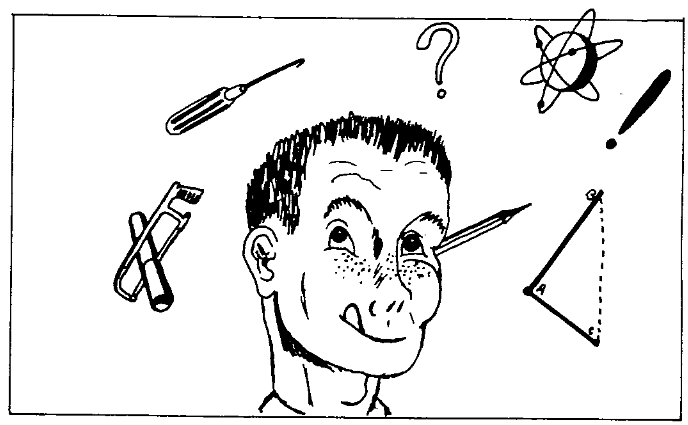
Replacement nose cone for the Man in Space rocket, made from select balsa. Lightweight, ideal for use with your own special Odd Ball design. 1.8" long by .9" max. diameter. Fits body tube BT-20.
Cat. No. 631-BNC-20P $.25 ea. 3/$.50

Idea Box Contest

Got a special idea or method to make model rocket building or flying easier or more enjoyable? Or an easy way to make better models? If you've got ideas that could be helpful to other rocketeers, send them in to the IDEA BOX CONTEST, c/o Estes Industries, Box 227, Penrose, Colorado, 81240. You may be one of the lucky ones to win one of these big prizes!

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 Sky Hook kits.

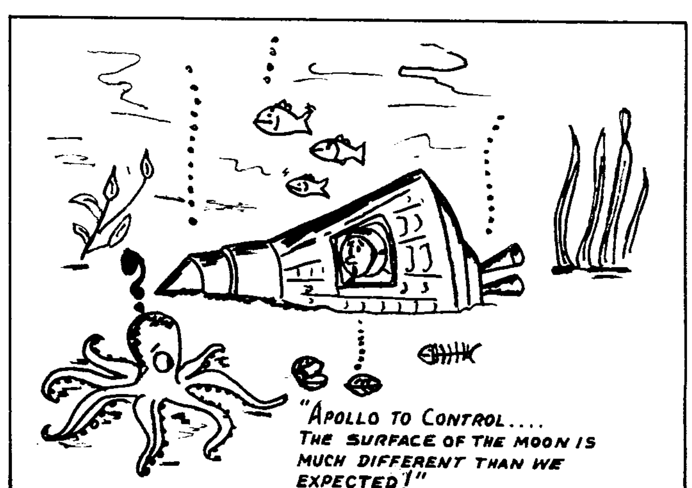
Winning ideas will be published in the <u>Model Rocket News</u>, so send yours in today!



Win FREE Merchandise!

<u>CONTEST RULES</u>

1) All entries must be presented on 8-1/2" x 11" paper.
2) Each entry must have been tested to assure that it is practical.
3) Sufficient information must accompany each entry to permit judges to try the idea.
4) The decision of the judges is final.
5) Entries must be postmarked no later than midnight, December 31, 1963.
6) If the same idea is submitted by more than one person, entries of that idea will also be judged first on date of postmark, and then on neatness of entry and completeness of explanation. Only the best entry of the idea will be considered for a prize.
7) All entries become the property of Estes Industries, Inc., and no entries will be returned.



NOTES FROM THE BOSS

After watching some of the younger members of the Astron Rocket Society struggle and strain to get their rockets ignited and launched, and then reading letters from some of you fellows who have similar problems, it appears that some comments on rocket ignition are in order. For safety and professional appearance, there's no way to beat all-electrical ignition, provided you know how to use electrical ignition.

Most problems with direct ignition are a result of lack of care in forming and installing the igniter. When winding the igniter it is important to make a neat, evenly spaced coil. No part of the wire should touch against another, and the wire must not loop back over itself.

When the igniter is inserted into the engine, the wires leading to the coil should come out on directly opposite sides of the nozzle. The coil must touch the propellant grain if the engine is to ignite, so it must be inserted as far as it will go. (But don't push too much wire into the nozzle and short the igniter against itself!) When the kleenex is tamped into the nozzle it should be directly between the wires leading to the coil to keep them as far apart as possible. The kleenex must be tamped in hard enough to keep the igniter tightly in place.

If the igniter is installed so that no part of it touches another (so electric current will have to travel all the way through the wire and heat the coil rather than "short out" and bypass the coil), and with the coil all the way into the nozzle and in contact with the propellant grain (so heat from the coil will reach the propellant), the igniter will be good.

However, there are some other steps which must be taken if the engine is to ignite. Every time a rocket is put on the launcher the jaws of the microclips must be cleaned with an emery board or a piece of sandpaper to give a good connection with the igniter. The clips are attached as far up into the nozzle as possible so the current has less wire to heat and will heat the wire faster and hotter. The clips must not be allowed to touch each other or no current will reach the igniter. If the length of the nichrome igniter between the two clips is too great, the launcher may not have the power to heat the wire enough, or the wire may burn in two outside the nozzle before the coil has gotten hot enough to ignite the engine.

With the nichrome installed and connected correctly, the engine will ignite if the launcher's power supply has enough "oomph." For launchers such as the Electro-Launch which use size D cells, four size D PHOTOFLASH batteries such as Ray-O-Vac are recommended. Ordinary flashlight batteries do not have enough power. Six volts is the minimum voltage for rocket launchers, and twelve or eighteen volts will give even faster and more dependable ignition.

To test the launcher to see if it has enough power, place the microclips about 1-1/2" apart on a piece of nichrome wire. Press the firing switch. If the nichrome glows bright red, the launcher has enough power to ignite a model rocket engine.

A well installed nichrome igniter on a suitable launching system will give very good results. Misfires will almost disappear, and your rocketry activities will be much more enjoyable.

LETTER SECTION

After purchasing your Astron Ranger kit, building it, and flying it several times, I have reached several conclusions. First, it performs beautifully, especially with a fair-sized payload. Second, twice out of the four times I have flown it (using B.8-4 engines every time), with the electric/Jetex system described in the plans, one of the engines has ignited just enough later than the others (or just enough earlier) to cause the rocket to veer off in one direction, in one case contrary to a brisk wind. While I realize that slight irregularity in ignition is unavoidable with this system, I feel that in future editions of the kit instructions you should include a warning to fly this model in an especially large field.

Third, as a result of the veering flight of the rocket described above I once had to chase the darned thing through a field of wet cow manure; fifty feet of soft, damp sand; a fair-sized stream; and under a barbed-wire fence. Then I had to come back. Another run through such an obstacle course, all the time dreading that the rocket might come down in one of several large trees nearby, would hardly be worth the $3.75 the kit cost. For this reason I recommend that in future kits of this size and power, a pair of streamers be used instead of two 17-inch parachutes. That thing drifted a half a mile on a calm day!

David Randall
Dayton, Ohio

After reading your letter, we have come to the conclusion that we are glad Colorado has a nice dry climate and we don't live on a cow ranch! I'd suggest that you either cut a hole about two inches in diameter in the center of your parachute or tape the chute partly closed. This will allow the rocket to descend to earth faster, but with a softer landing than a streamer would give.

-----Vernon Estes

. . .Can you tell me about a good recovery system for booster stages? A couple of days ago, I was watching a top stage going up, and the booster came whizzing down. It wasn't supposed to be stable by itself, but, to tell the truth, it was a lot more stable than the top stage, and it missed me by less than a yard! That whiz-thunk sort of shook me up, and I would like to do something about it. So, if you know how to recover a booster stage, please tell me.

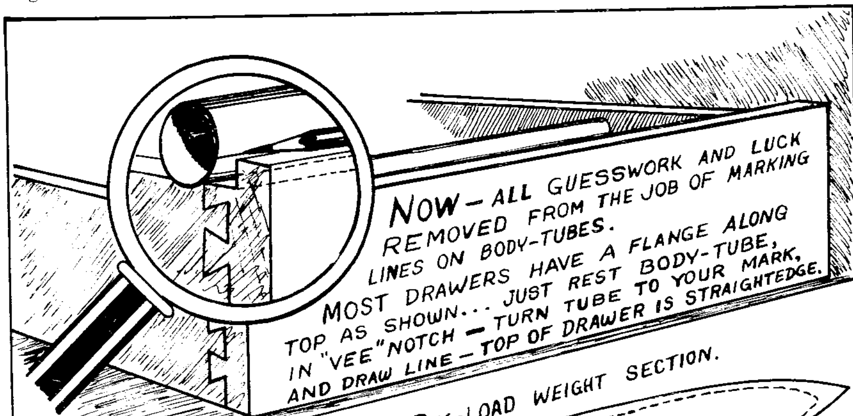
Robert Owen
Tulsa, Oklahoma

Designing a booster to be unstable by itself is the best recovery system I've seen yet. Normally the following procedure will result in a booster that tumbles every time the upper stage separates from it. The first step is to find the center of gravity (balance point) of the booster with everything but fins in place. Draw a fin pattern, cut it out, and balance it on a straight edge. The edge of the fin that is to be glued to the body must be at a 90° angle to the straight edge. In an unstable booster the balance point will match or be up to 1/4 inch ahead of the booster's center of gravity. Generally the double-swept fin and similar types which stick out straight away from the body will be best. Fins with a lot of sweep-back will not work. With the upper stage in place, the entire rocket's center of gravity should be far enough forward to stabilize the whole rocket on the upward flight, but when the upper stage separates from the booster, the booster will tumble back if the center of the fin is at the right point in relation to the stage's center of gravity.

-----Vernon Estes

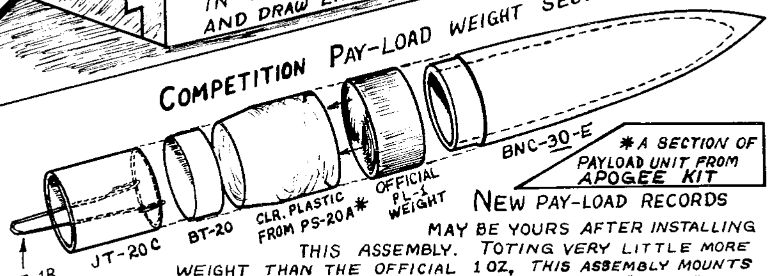
. . .I am a boy 54 years old, but still like to build rockets and fly them. I would like to know if any of your other customers are older folks, and would like to hear from them if so.

Herbert Wilson
Box 25
Milton, Ky.



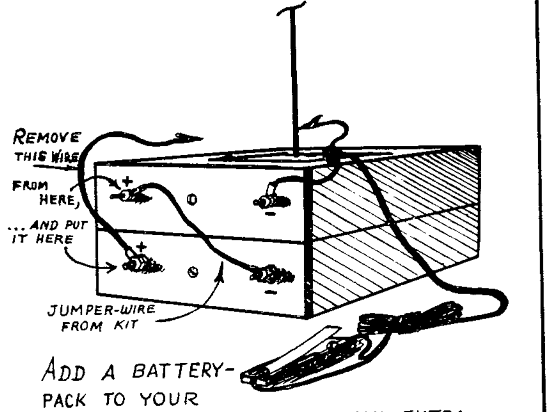
NOW – ALL GUESSWORK AND LUCK REMOVED FROM THE JOB OF MARKING LINES ON BODY-TUBES. MOST DRAWERS HAVE A FLANGE ALONG TOP AS SHOWN... JUST REST BODY-TUBE, IN "VEE" NOTCH – TURN TUBE TO YOUR MARK, AND DRAW LINE – TOP OF DRAWER IS STRAIGHTEDGE.

COMPETITION PAY-LOAD WEIGHT SECTION.



NEW PAY-LOAD RECORDS MAY BE YOURS AFTER INSTALLING THIS ASSEMBLY. TOTING VERY LITTLE MORE WEIGHT THAN THE OFFICIAL 1 OZ, THIS ASSEMBLY MOUNTS COMFORTABLY ATOP THE APOGEE, REPLACING THE "STOCK" PAY-LOAD SECTION, AND NOSE CONE. HOWEVER, ANY HIGH-PERFORMANCE BIRD WITH A BT-20 BODY-TUBE SHOULD GIVE THIS UNIT A REAL RIDE!

CONSTRUCTION IS NORMAL, EXCEPT FOR SWELLING THE PLASTIC SECTION, AND FOR HOLLOWING THE NOSE CONE. TO FIT PL-1, YOU MUST HEAT PLASTIC TUBE WITH HOT WATER – AND IMMEDIATELY WORK PL-1 INTO TUBE-END AND FARTHER, TO A DEPTH OF 5/8". YOU MAY HAVE NEED TO REHEAT TUBE TO GET THIS DEPTH. ONCE STRETCHED, TUBE WILL "HOLD" THE NEW I.D. AND YOU NEED ONLY TO WORK PL-1 BACK AND FORTH A FEW TIMES TO INSURE SMOOTH REMOVAL AND REPLACEMENT FOR AN OFFICIAL WEIGH-IN. THE NOSE CONE IS CAREFULLY SPLIT DOWN IT'S CENTER-LINE – THEN HOLLOWED WITH GOUGE AND KNIFE. TRY FOR A 3/32" WALL THICKNESS EXCEPT FOR NOSE AREA AS SHOWN. WHEN HALVES ARE GLUED TOGETHER, THE SHOULDER IS TRIMMED TO 1/4" AND SANDED TO BECOME A PRESS-FIT INTO PLASTIC TUBE, "SEATING" ON PL-1. ONE MORE THING, ALLOW 1/4" OF TUBING TO PROTRUDE ON EACH SIDE OF PL-1 – YOUR PLASTIC TUBE SHOULD MEASURE 7/8" IN LENGTH. GLUE SLT-1R, JT-20C, BT-20 & PLASTIC TUBE AS A UNIT – PL-1 AND NOSE CONE PRESS INTO PLACE.

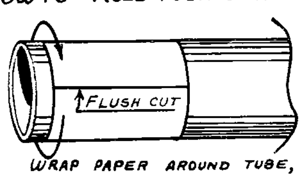


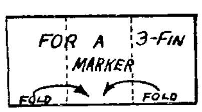
ADD A BATTERY-PACK TO YOUR ELECTRO-LAUNCH AND GAIN EXTRA-PUNCH AND LONGER BATTERY LIFE. JUST THE THING FOR YOUR CLUB-LAUNCHER AND AN ALL-DAY SHOOT.

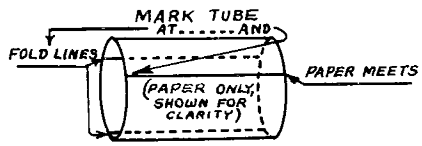
ATTACHMENT IS SIMPLE – JUMPER WIRE COMES WITH PACK KIT – ASSEMBLE UNIT AS INSTRUCTED – COAT TOP OF PACK WITH WHITE GLUE AND CLAMP PACK TO BOTTOM OF ORIGINAL ELECTRO-LAUNCH. ALLOW TO SET OVERNIGHT. A HEAVY BOOK, IRON, OR STACK OF MAGAZINES WILL DO NICELY, IN PLACE OF CLAMPS. **WARNING! BATTERY POLARITY MUST BE CORRECT FOR UNIT TO WORK.**

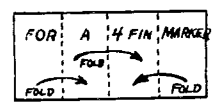
THE IDEA BOX

HOW TO "ROLL-YOUR-OWN" FIN-MARKER.... THAT IS.



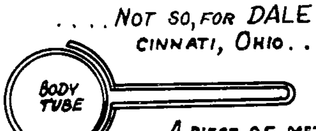






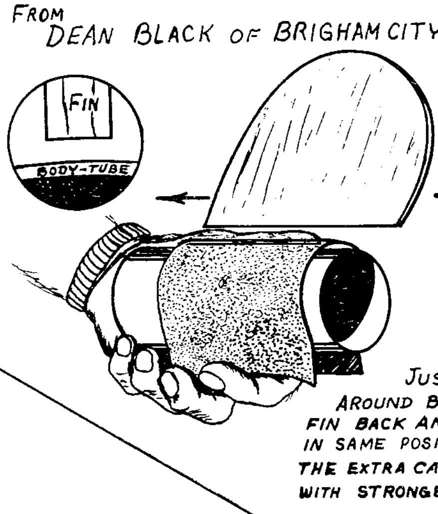
WRAP PAPER AROUND TUBE, AND CUT FLUSH. THEN REMOVE AND FOLD IN 3 EQUAL PARTS. PLACE AROUND TUBE AGAIN AND MARK AT BOTH FOLDS AND WHERE PAPER MEETS. FOUR FINS CAN BE MARKED AS EASILY. OUR THANKS TO YOU, TERRY DUFF OF DES MOINES, IOWA FOR THIS IDEA

FINS CAN BE A PROBLEM... TO KEEP 'EM PERPENDICULAR TO BODY-TUBE WHILE GLUE DRIES. ....NOT SO, FOR DALE JACKSON OF CINCINNATI, OHIO... WHO SHARES HIS IDEA SHOWN HERE.



A PIECE OF METAL 1/2" WIDE, BENT TO MATCH CURVE OF BODY-TUBE – WITH A SLOT LONG ENOUGH TO RECEIVE FIN TO BE FITTED, MAKES THIS TOOL... NO DIAMENSIONS ARE SHOWN, AS THERE ARE MANY BODY-TUBE SIZES IN USE. THIS TOOL COULD BE A USEFUL ADDITION TO YOUR RANGE-KIT.

FROM DEAN BLACK OF BRIGHAM CITY, UTAH, WE GET THIS METHOD OF SANDING THE GLUE-EDGE OF FINS, TO MATCH CURVE OF THE BODY TUBE TO WHICH THEY ARE TO BE ATTACHED.



JUST HOLD SANDPAPER AROUND BODY-TUBE – PASSING FIN BACK AND FORTH ON GRIT IN SAME POSITION AS IT WILL OCCUPY. THE EXTRA CARE WILL REWARD YOU WITH STRONGEST POSSIBLE JOINT.

BE SURE TO ENTER THE "REALLY BIG"

IDEA BOX CONTEST!

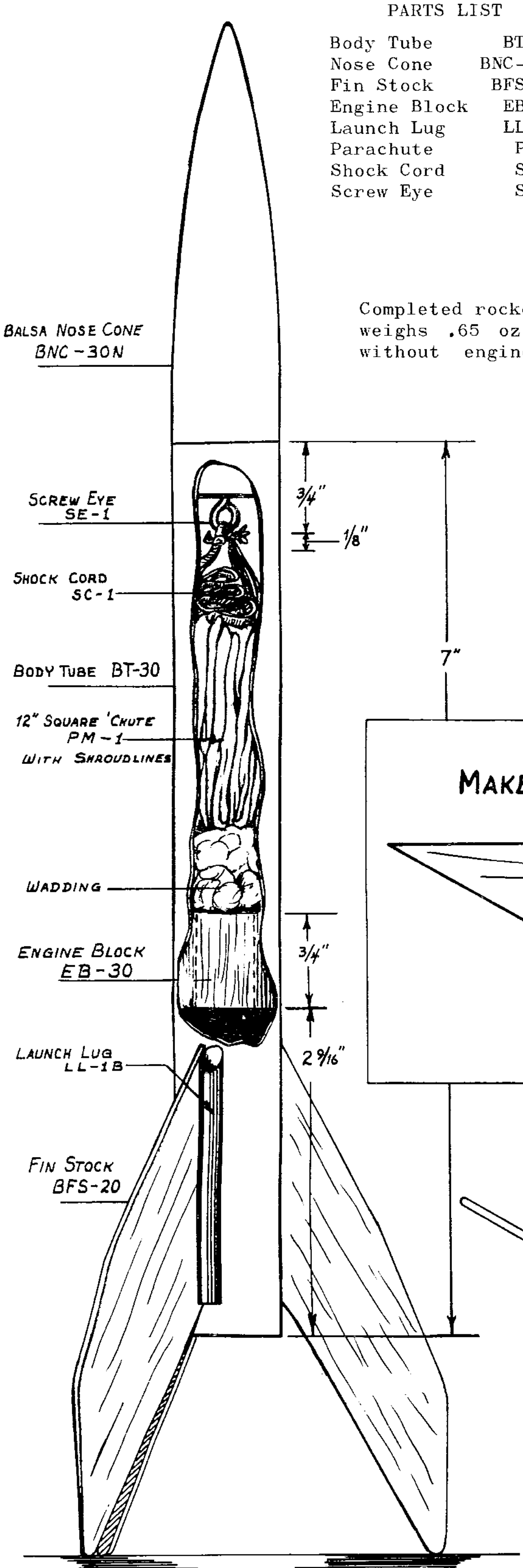
SEE ALL DETAILS ON PAGE 4

Sky Hook

PARTS LIST

Body Tube	BT-30
Nose Cone	BNC-30N
Fin Stock	BFS-20
Engine Block	EB-30
Launch Lug	LL-1B
Parachute	PM-1
Shock Cord	SC-1
Screw Eye	SE-1

Completed rocket weighs .65 oz., without engine.

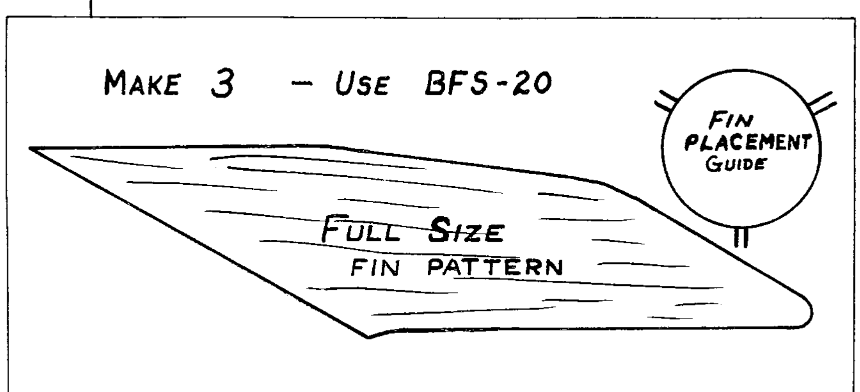


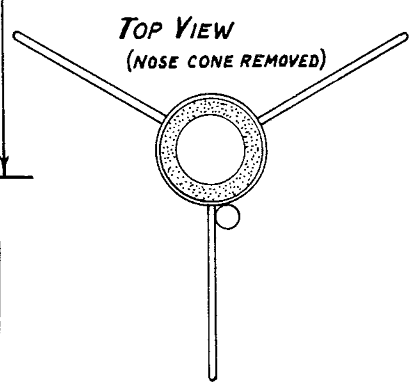
First cut a body tube 7" long. Then glue the engine block in place 2-9/16" from the rear of the body tube. To do this, first mark an empty engine casing 2-9/16" from one end. Place a large dab of glue on the end of your little finger, reach through the end of the body tube as far as possible, and spread the glue around the inside of the tube. Insert the engine block into the end of the tube, and holding the empty engine casing by the end with the mark on it, quickly push the engine block forward until the mark on the engine casing is even with the end of the body tube. Remove the engine casing immediately.

Cut out the fins, mark the tube to space them correctly, and glue them in place. Cut two slits in the forward end of the body, one below the other, 3/4" and 1" from the end of the tube. Insert one end of the shock cord through the two slits from the inside, and glue. Glue the launch lug in place. Attach the screw eye to the nose cone. Assemble the parachute and tie the ends of the shroud lines to the screw eye. Tie the free end of the shock cord to the screw eye.

Sand all balsa surfaces, and paint the rocket the desired colors. To fly the Sky Hook, pack flameproof cotton or rock wool down against the engine block from the top. The wadding should fill at least 1-1/4" of the tube. Pack the parachute in on top of the wadding, with the shroud lines and shock cord over the 'chute. Put the nose cone in place. Wrap tape around the engine until it makes a tight friction fit inside the body. Install the nichrome igniter, and the Sky Hook is ready to launch.

Available in easy to build kit form, complete with all parts and detailed instructions. Order the Astron Sky Hook, Cat. No. 631-K-8, $1.35. Shipping weight, 5 oz.

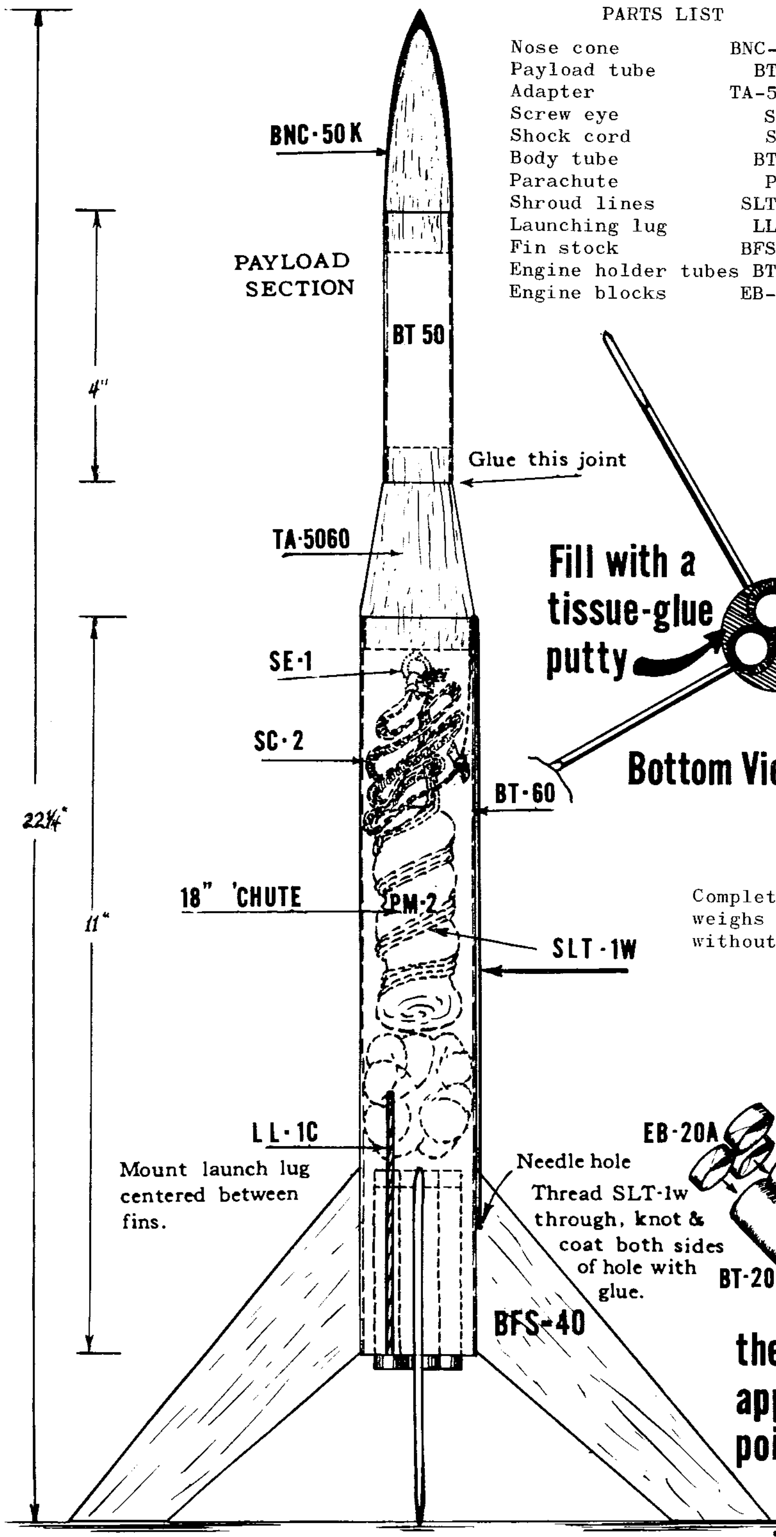


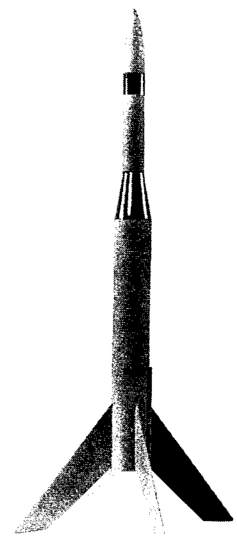


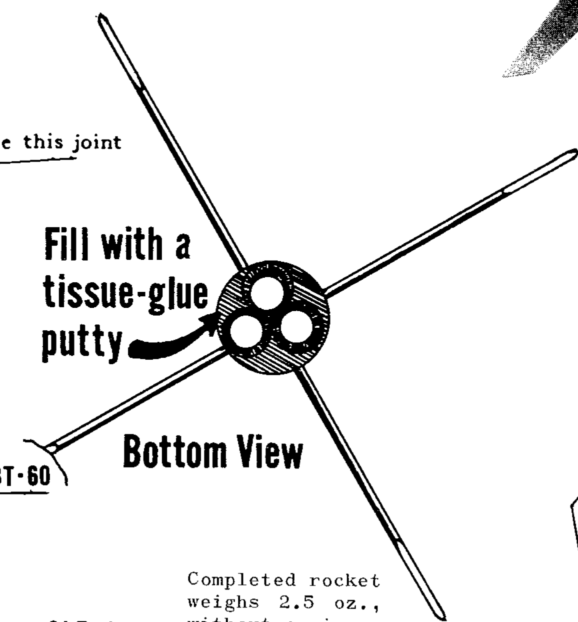
the COBRA

PARTS LIST

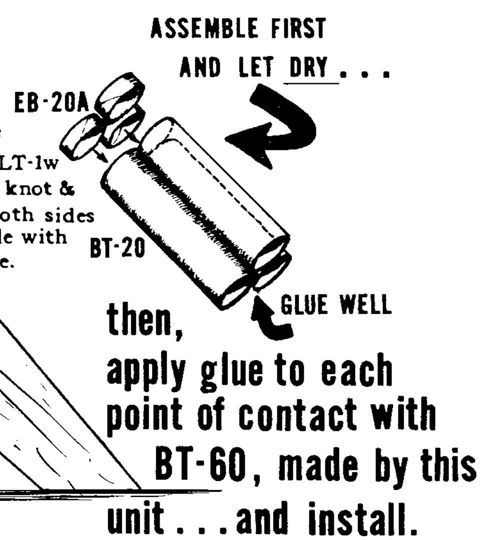
Nose cone	BNC-50K
Payload tube	BT-50
Adapter	TA-5060
Screw eye	SE-1
Shock cord	SC-2
Body tube	BT-60
Parachute	PM-2
Shroud lines	SLT-1W
Launching lug	LL-1C
Fin stock	BFS-40
Engine holder tubes	BT-20
Engine blocks	EB-20A

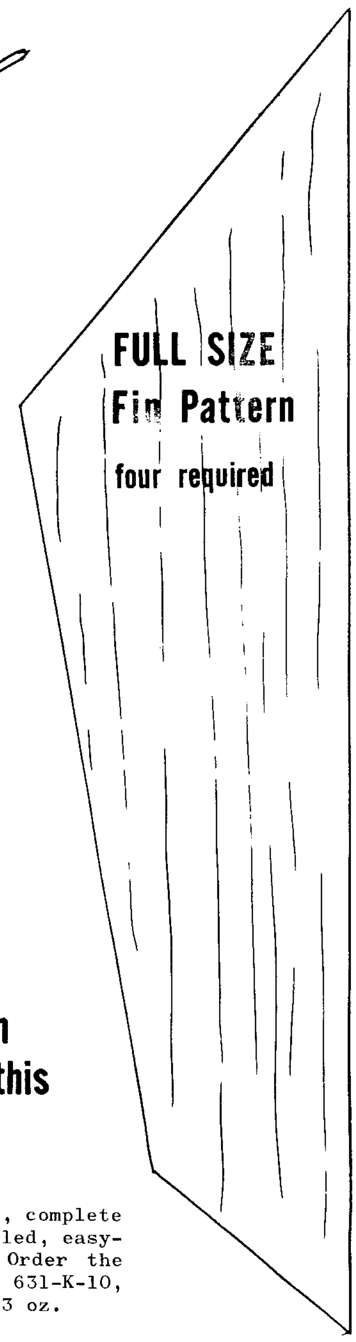






Completed rocket weighs 2.5 oz., without engines.





Glue engine holder assembly together first . . . then glue into end of body tube with the engine blocks on the inside. Use standard procedures for the rest of the rocket. Shock cord is attached to one end of a 13" piece of shroud line, other end of line is glued to hole in fin. Read the technical report on cluster rockets before building and flying the Cobra.

Also available as a kit, complete with all parts and detailed, easy-to-follow instructions! Order the Astron Cobra, Cat. No. 631-K-10, $3.50. Shipping weight, 13 oz.

Estes Industries Technical Report No. TR-6

Cluster Techniques

These reports are published as a service to its customers by Estes Industries, Inc., Box 227, Penrose, Colorado 81240.

INTRODUCTION

One of the most common and valuable techniques in the development of launch vehicles to boost large payloads is the use of several engines in a cluster to provide enough thrust for first stage lift-off and acceleration. Typical clustered launch vehicles include NASA's Little Joe, Saturn I and Saturn V.

In professional rocketry clustering makes it possible to combine several smaller, less expensive and more reliable rocket engines to boost the payload. If a single larger engine were to be used in a new launch vehicle design there could be a delay of several years before the engine can be developed, resulting in a vastly greater cost.

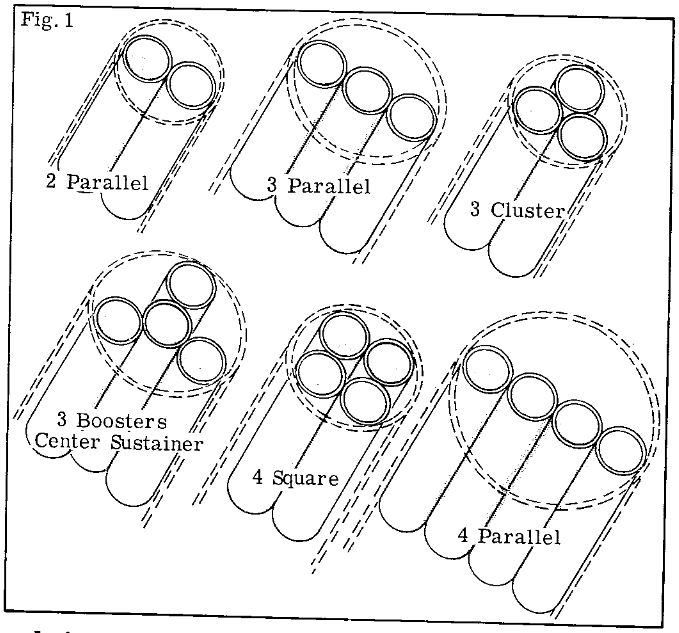
Model rocketeers can get many of these same advantages by using clusters in their vehicles. Many of the problems a model builder will encounter are similar to those met by professionals.

CLUSTER ROCKET DESIGN

ENGINE ARRANGEMENTS

It is common when clusters are mentioned to immediately think of three or four engines set in some arrangement that will allow them to all fit in a round body tube. Actually, any arrangement of two or more engines in the same stage of a model can be considered a cluster. Generally, four engines are the most that should be used in a model rocket, since more engines make ignition less reliable. Some typical arrangements are shown in Fig. 1.

Fig. 1



In designing a cluster rocket first make sure that thrust will be balanced around the center line of the rocket. An unbalanced arrangement will normally cause the rocket to veer off course. Similarly, all engines located away from the centerline of the rocket should develop the same amount of thrust. For example, the two outer engines in a parallel 3 engine cluster must be the same--although the center engine might be a B. 8-4, if one outer engine is a B 3-5, the other one must be a B 3-5.

All engines should be located fairly close together. Avoid wayout designs with the engines spaced several inches apart. The distance from the center of the nozzle of one engine in a cluster to the center of the nozzle of any other engine in the cluster should not be more than 10% of the rocket's length. It is better to keep the engines positioned so they almost touch each other. If this is done variations in thrust will not make the rocket veer off course.

Unusual engine arrangements should be developed carefully. Check to be sure the thrust from all engines will balance. A slight amount of imbalance or misalignment can be offset by using extra large fins or a small amount of spin angle on the fins. If thrust is very far out of balance, however, the rocket will not fly straight enough to be safe.

ENGINE MOUNTING

Once the basic engine arrangement for a cluster model has been chosen, the next step is to design an engine mounting system. The engine mounting system serves three purposes: First it should hold the engines securely in place throughout the flight. Second, it should align the engines so they work together as a unit and give a straight flight in the desired direction. Finally, the engine mounting system must seal the rear of the rocket so that the recovery system ejection gases cannot leak out through cracks and holes in the back of the model.

The first item to consider in designing the engine mounting system for a new model is a method for retaining the engines. They can be held in place either with masking tape or engine holders (#EH-2 or #EH-3). Masking tape (which is wrapped around the engine to make it fit tightly in the mounting tube) has the advantages of lighter weight and lower initial cost. On the other hand, engine holders do not weigh much more, allow quick and easy replacement of engines, and are positive -- once the engine is in place it is held securely and won't come out until it is intentionally removed.

Fig. 2

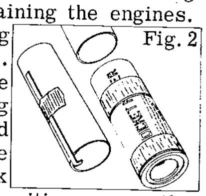
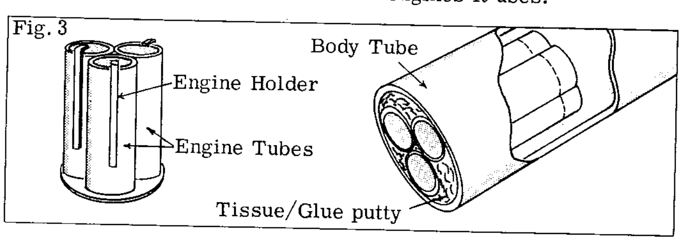


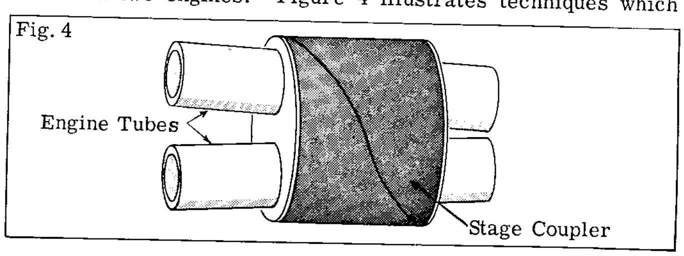
Figure 3 shows typical engine mounting systems for a three engine model. Note that when engine holders are used, the spaces between tubes are sealed at the front of the engine mounting tubes, while when masking tape is to be used to secure the engine in place the spaces can be sealed at the extreme rear of the rocket. The same considerations apply to any other cluster model, regardless of the number of engines it uses.

Fig. 3



If a body tube is large enough to hold three engines, it can also hold two engines. Figure 4 illustrates techniques which

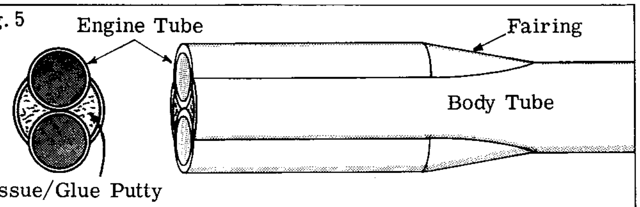
Fig. 4



can be used to position and align engine mounting tubes which would otherwise fit too loosely in the rocket body tube. When it is necessary to make special rings to position and support the tubes, the rings should be cut from fairly heavy cardboard such as is used in shoe boxes. An Estes #KNS-1 knife, wrapped with three or four layers of masking tape and mounted in an ordinary school compass, makes an excellent tool for cutting the rings.

Occasionally it is desirable to mount several engines in a body that would normally be too small. A good example of this would be the use of two engines in a model with a BT-55 body tube. In this case slots should be cut in the body. Each slot should be the same length as an engine mounting tube and just wide enough to let the mounting tubes stick out the same amount on each side of the body. Figure 5 shows a typical rocket built in this way. The cut-out pieces of body tube can be trimmed to make fairings for a smooth transition from the body to the projecting engine mounting tubes. A fairing can also be made by cutting a nose cone in half and carefully carving and sanding the halves until they fit smoothly in place.

Fig. 5



From these examples it can be seen that there are countless ways of mounting engines. As long as the engines are held in alignment, the rear of the model is sealed to prevent ejection gas leakage and a path is provided for the ejection gas to blow forward, just about any system will work. In any case, the engine mounts must be strong enough to stand up to the engines' maximum thrust. The best way to make sure the engine mounting system will be strong enough is to use plenty of glue when building it.

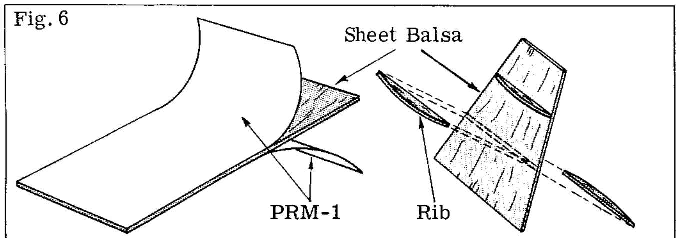
STABILITY

Because the weight of several engines is concentrated in the rear of a cluster rocket, extra attention should be given to designing the rocket so it is stable. Since the engines will not always all be producing exactly the same amount of thrust at the same time, an extra margin of stability is needed. A good cluster model will have extra-large fins. These fins should be located well to the rear on the body--fins ahead of the model's center of gravity (balance point) should be avoided since they make the model less stable.

It's easier to stabilize a tall rocket than a short one. Since body tubes are relatively light, there's no real reason to use too short a tube. In general, a two or three engine model should use a body between 15" and 24" long. If the model carries a payload it should be located near the very front of the rocket. This forward payload weight, combined with a long body, brings the center of gravity forward and increases the model's stability. *

Since a cluster rocket will usually be heavier than a single engine model, it is apt to land harder. In addition, the forces acting on a cluster model's fins in flight are greater. The result is that the cluster model will need extra strong fins. Big fins should be made stronger than small fins. Because of this one-eighth inch thick balsa sheet is the most popular fin material for cluster birds.

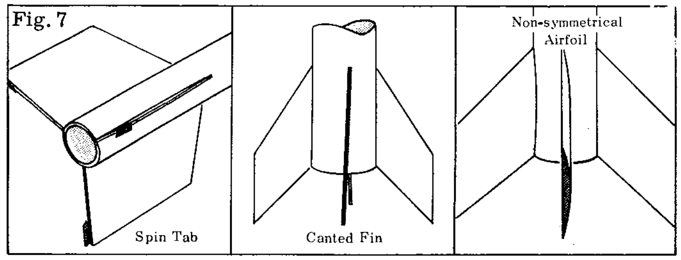
Fig. 6



Fin stock thinner than 1/8" can be used, but it should be reinforced for best results. Two reinforcing methods are commonly used: Self-adhesive paper (#PRM-1) can be applied to both sides of the fin or strengthening ribs can be glued to the fin, parallel to the root edge and spaced evenly along the fin as shown in figure 6.

A small amount of spin can be useful with cluster rockets. Slightly off-center thrust can be evened out if the rocket spins slowly. However, too much spin will waste thrust since drag on the rocket increases as the rocket spins faster. One way to give the rocket the right amount of spin is to glue the fins to the body at a slight angle. A non-symmetrical airfoil on fins that are straight on the body will also produce enough spin. Finally, a small angled "spin tab" can be added near the tip of each fin. In any case, make sure all fins or tabs are made to spin the rocket in the same direction.

Fig. 7



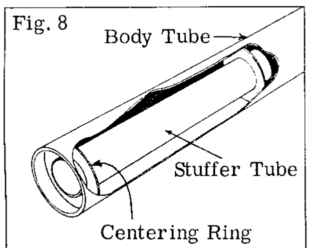
It can be mighty embarrassing to lead all your friends in a grand procession out to the launch pad for the maiden voyage of your "super" bird if that bird decides to go up 50 feet and then loop around in the air. To avoid this embarrassment (and to insure safety) TEST IT BEFORE YOU FLY IT. Use either a wind tunnel or the string method described in Technical Report TR-1 to make sure the model will be stable. If the model is tested by the string method it should have at least a 15° to 20° "margin" of stability. If the rocket is not stable you can either make it longer, add nose cone weights or install larger fins.

RECOVERY

Since a cluster rocket is usually larger and heavier than a conventional rocket, its recovery system must be designed to handle a greater load. Parachute recovery is the only system which has actually proven practical for cluster rockets. Generally, two parachutes are used on models with large payload sections; rockets with small payload sections often need only one parachute. Some designs, however, may require three or even four 'chutes. A good rule to follow is to provide at least 40 square inches of parachute area for each ounce of rocket weight.

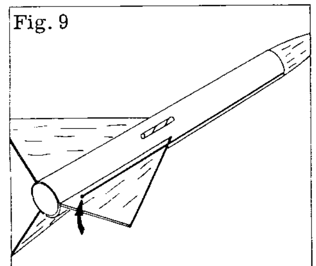
There is a reason for using at least two 'chutes on a model with a large or delicate payload section. This eliminates the possibility of the payload section snapping back on the shock cord after ejection and damaging the rocket or payload. The parachute on the payload section can be attached directly to a lightweight payload section. For heavy or delicate payloads, however, a short length of shock cord should be used to connect the 'chute to the payload section. The booster section's 'chute should be attached with a 1/4" wide shock cord at least 18" long (part #SC-2).

Fig. 8



Additional steps can be taken to improve a cluster rocket's recovery system. A "stuffer" tube can be used in a long booster body to control the ejection gases and to keep the parachute from moving too far rearward in the body. The stuffer tube can be a section of either BT-20 or BT-50, centered and held in place in the body with two rings as shown in figure 8.

Fig. 9



To reduce fin breakage the recovery system can be attached to the outside rear of the body instead of the front. This is done by gluing one end of a string in a hole in the body about one inch from the rear. The other end of the string is tied to the shock cord. The string should be long enough to reach up the side of the body tube and back two or three inches into the inside of the body tube.

*For more information on stability, see Technical Report #TR-1 and Technical Report #TR-9. These reports may be ordered at $ .25 each.

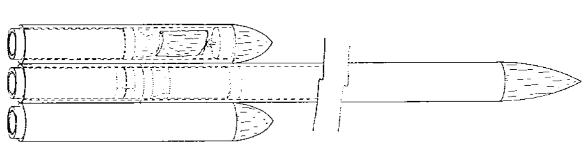
The best way to protect parachutes from the heat of ejection gases is to use an adequate amount of flameproof wadding. Use enough loosely packed wadding to fill the body for at least twice the diameter of the tube. Stuff the wadding into the tube just far enough to allow space for the parachutes, shroud lines and nose cone. Don't push the wadding all the way to the rear of the tube.

MULTI-STAGING

Clustering can be combined with multi-staging only under special circumstances. Certain rules must be followed if the rocket is to be either safe or successful. The first rule is that only the first stage can be clustered. To understand the reason behind this, remember that each engine in a multi-stage model rocket must be coupled directly to the engine ahead of it. However, if three engines in one cluster stage are each coupled to engines in another cluster stage, one booster engine will burn through a tiny fraction of a second before the others. This variation in time is enough to force the stages apart before the other two engines can ignite.

As a result, the only successfully proven staged and clustered system uses a bottom stage which has one engine in the center and two or three engines alongside it. This center engine is coupled directly to the single engine of the next stage. The outside engines can be placed in pods with a streamer or parachute recovery system to return the booster gently. In this case the outside engines should have short delays (B . 8-2).

Fig. 10



IGNITION

Ignition is the most important part of successful clustering. All engines must ignite at once or within a tiny fraction of a second of each other. Many techniques have been tried to obtain successful ignition. Some methods proved unreliable, others were also unsafe. The only system which has proven safe and reliable through extensive testing is direct electrical ignition using standard igniters.

Five things are necessary for successful electrical ignition: The correct engines must be used; the igniters must be installed in the engines correctly; the igniters must be connected together correctly; the electrical launching system must be in good condition with good connections throughout and the launcher battery must have enough power. If there is a flaw in any of these five areas, ignition will not be completely successful. If everything is done correctly, all engines will ignite at the same instant and the rocket will roar skyward.

TYPES OF ENGINES

Since the usual purpose of clustering is to boost a payload to a greater altitude than would be possible with a single engine, it is usually necessary to use A or B class engines. A single engine rocket using a B 3-5 engine will normally lift a payload higher than a cluster rocket with four 1/2A . 8-2 engines. However, 1/2A or smaller engines can be useful for the first test flights of a lightweight cluster model.

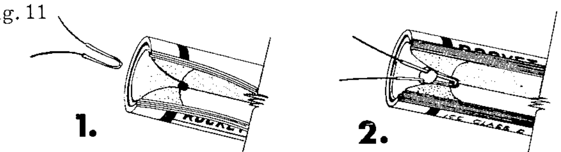
To decide which engines are best for a rocket, divide its total weight (including payload and engines) by the number of engines it uses. Compare the result with the "maximum rocket weight" listed in the engine selection chart in your catalog to find which engines can be used. For a more accurate choice of engines, read Technical Report #TR-10 (50¢ per copy). The method described on page four of the report gives good results. Careful selection of engines can prevent damage to the rocket which might occur from too early or late ejection.

NOTE: Before installing the engines in your cluster rocket, pack the front of the engine above the ejection end cap with flame-proof wadding. This eliminates any possibility of one engine's ejection charge igniting the ejection charge of another engine and damaging the rocket. This is extremely important when one engine in a cluster fails to ignite at lift-off.

INSTALLING THE IGNITERS

For direct electrical ignition the igniters in the individual engines must be installed correctly. Before starting, read the instructions which come with your Estes engines. Several points should be remembered when installing igniters; First, the igniter must be inserted so its coating touches the black propellant grain. The bent end of the igniter should reach at least 9/16" into the end of the engine. The heat generated by the igniter is not great enough to cross a gap between the igniter and the propellant and still start the engine. There must be direct contact.

Fig. 11



1. Bend and insert...
2. Tamp in wadding

The second point to remember is that the igniter must not "short" or touch itself. The one lead should follow one side of the nozzle; the other lead should follow the opposite side of the nozzle. If these leads cross and short circuit, the current cannot reach the part of the igniter which is against the propellant and the engine will not ignite.

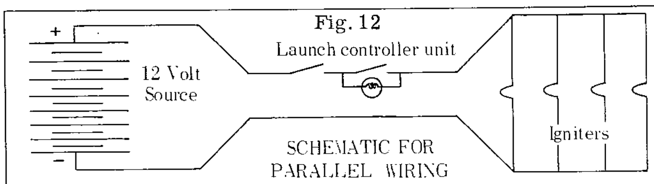
Finally, the wadding must be tamped in carefully and firmly. A small square (3/4" x 3/4") of flameproof wadding (Cat. #RP-1A) is rolled into a ball, dropped into the nozzle between the leads, and forced down further into the nozzle with a ball point pen or pencil point. When the wadding is installed correctly it is possible to pick up the engine by one igniter lead and shake lightly without the igniter coming loose.

It's best to test your igniter installation techniques by flying single engine rockets many times. When you know that you can install igniters and get successful single engine ignition every time, you're ready for a cluster.

CONNECTING THE IGNITERS

For positive ignition all igniters must be connected in parallel. There is a reason for this. If the igniters are connected in series, one igniter will burn through first and stop the flow of electricity to the others. When the igniters are connected in parallel the burn-through of one igniter lets more electricity flow to the others, making them heat faster. A series connection often results in the ignition of only one engine; a good parallel connection almost always results in the ignition of all engines.

Fig. 12



There are several good ways to connect the launcher leads to the igniter leads. In a parallel cluster the simplest method is to use two straight pieces of stiff wire (a straightened paper clip will do) for buss bars as shown. A pair of tweezers can be used to wrap the igniter leads around the wires--one lead from each engine to one wire, the other lead to the other wire. One micro-clip from the launcher is connected to each buss bar.

Fig. 13

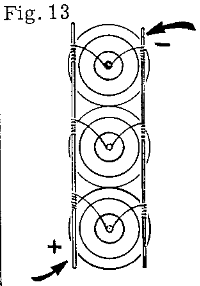


Fig. 14

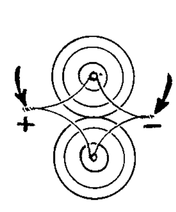
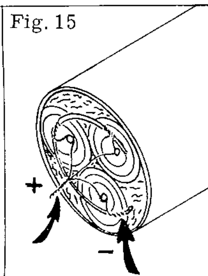


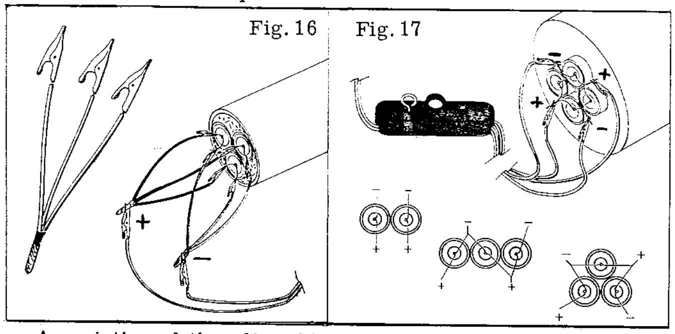
Fig. 15



A combination of these two methods can be used for three engine circular clusters. First the engines are placed in the rocket so one igniter lead is toward the inside, the other toward the outside. The inner leads are twisted together. A wire loop (a large paper clip makes good raw material) is then formed and the outer igniter leads are twisted tightly around the wire of the loop. One micro-clip is attached to the twisted leads at the center, the other clip is attached to the loop.

When two engines mounted close together are used the best method is to simply connect the igniters to each other. If the engines are inserted in the rocket so the leads match as in fig. 14, the ends of the igniter leads can be twisted together quite easily. The launcher's micro-clips are then clipped onto the twisted leads for launching. When twisting or wrapping igniter leads, be careful not to pull the igniters out of the engines or away from the propellant.

Still another method is to use several clips on each launcher lead. The most common way of doing this is to make two "clip-whips" as shown in fig. 16. These clips attach to the igniters, one clip from one whip to one lead of an igniter, a clip from the other whip to the other lead of the igniter. With the clips in place, pieces of masking tape are applied at all points where there is a chance of the clips touching each other. The leads from the electrical launching system are then connected to the twisted ends of the whips.



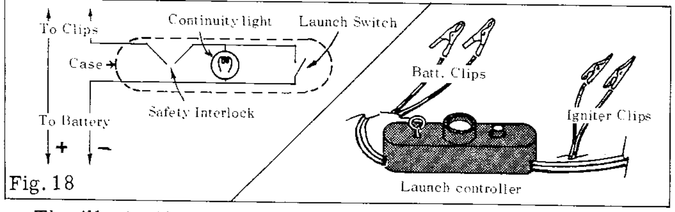
A variation of the clip whip system uses four micro-clips, permanently attached so two fork off from each launcher lead. The leads should be marked so the pairs of clips which are connected to the same lead can be easily identified. This system was developed for use with the four engine cluster in the Uprated Saturn I model, but also works well with two and three engine models. Fig. 17 illustrates a good four-clip electrical system along with several suggested connection methods.

Many other methods can be used to connect igniters on cluster models. The important points to remember are that the igniters must be in parallel, they should be connected as close in to the nozzle as practical and the micro-clips must have clean contact surfaces. Sand or file the jaws of the clips before each launching. After the rocket is on the pad and hooked up make a careful inspection to be sure there are no places where bare leads or micro-clips touch each other and create a short circuit.

THE POWER SYSTEM

Most rocketeers have access to a good, proven power supply for cluster launching--the battery in the family car. A car battery has more than enough power for igniting a reasonable number of engines and need not be removed from the car to be used. A fully charged six volt car battery which has clean terminals can be used to ignite up to 3 engines. However, a 12 volt car battery is far better, and will handle up to four engines easily.

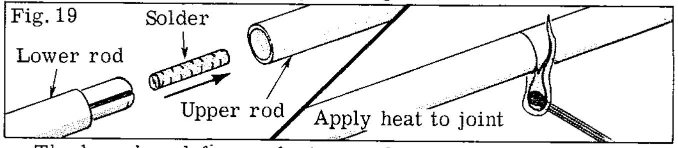
To connect the battery to the rocket and control the electrical current, a heavy duty launch system should be used. The Estes "Launch Control System" (Cat. No. 651-FS-5) or a similar unit is ideal. A suitable unit uses about 18 feet of #18 two conductor wire. Make all connections in the system carefully. If possible solder all permanent joints; a soldered joint conducts electricity better and is less apt to come apart at the wrong time.



The illustration shows a typical launcher circuit. If heavier wire (#16, for example) is used, the distance from battery to rocket may be increased. If the length of the wires is kept to a reasonable minimum, however, more current will reach the rocket, giving faster and more reliable ignition. Any system must be capable of delivering at least 5 amperes to each igniter. If the current is less than this the engines will not ignite at the same time; some may fail to ignite at all.

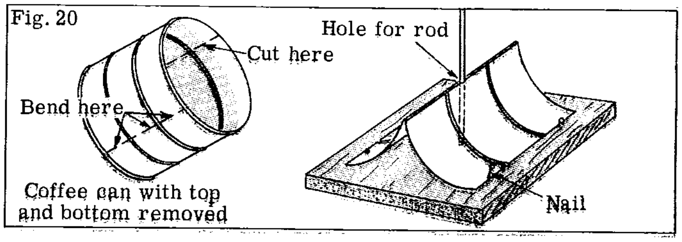
LAUNCHERS

In addition to a heavy duty power supply, a cluster rocket needs a heavy duty launcher. A unit such as the Tilt-A-Pad is designed to handle a cluster model of reasonable size. Even so, special care should be taken. First, the legs should be spread as wide as possible, locked tightly in position, and held down with rocks or bricks. A two-piece rod should be fitted tightly. If the joint between the rod sections is even slightly loose, it can be tightened by soldering (see fig. 19).



The launch rod for a cluster rocket should be at least 36" long. However, unless something is drastically wrong with the model, there is little reason to use a rod more than 54" long. Normally a 1/8" diameter rod is adequate. For extra large models it may be desirable to obtain a four to six foot long rod of either 3/16" or 1/4" diameter from a local hardware store or machine shop. (If a larger diameter rod is used, a special launch lug will be necessary. A large soda straw will work.)

When a launcher is designed especially for use with cluster rockets it should have an extra large blast deflector and a large, heavy base. A two foot square piece of 3/4" thick plywood makes a good base. The round (Cat. No. 651-BD-2) blast deflector works well with most rockets. A good deflector can also be made from a coffee can as shown.



USE A CHECKLIST

To avoid skipping a vital step when preparing a cluster model for flight it is often worthwhile to make up a countdown checklist for your rocket. The list below covers the general requirements of most cluster rockets. For rockets with special characteristics a more detailed checklist should be prepared.

☐ 18 Install enough loosely packed flameproof wadding to fill the body for a distance equal to at least twice its diameter. Pack the 'chutes, shroud lines and shock cord in over the wadding and slide the payload section into place.

☐ 17 Select engines of the correct size and pack flameproof wadding into them ahead of their ejection end caps.

☐ 16 Install igniters in the engines, making sure they touch the propellant grain and do not short circuit.

☐ 15 Insert the engines into the engine mounting tubes so the igniter leads are positioned correctly. Make sure the engines are held securely in place.

☐ 14 Connect the igniters together, to a loop, clip whips or buss bar as necessary to form a parallel connection.

☐ 13 Remove the safety key from the electrical system.

☐ 12 Place the rocket on the launcher. Support it off the blast deflector if necessary for access to the igniter wiring.

☐ 11 Clean the micro-clips with a file or sandpaper.

☐ 10 Connect the micro-clips to the igniters.

☐ 9 Double-check all connections to make sure the igniters are hooked-up in parallel and there are no short circuits.

☐ 8 Clear the launch area. Alert the recovery crew and trackers.

☐ 7 Check for low flying aircraft in the vicinity and for unauthorized persons in the recovery area.

☐ 6 Arm the launch panel and begin the final countdown.

☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 LAUNCH!