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The Journal of Miniature Astronautics

July 1969
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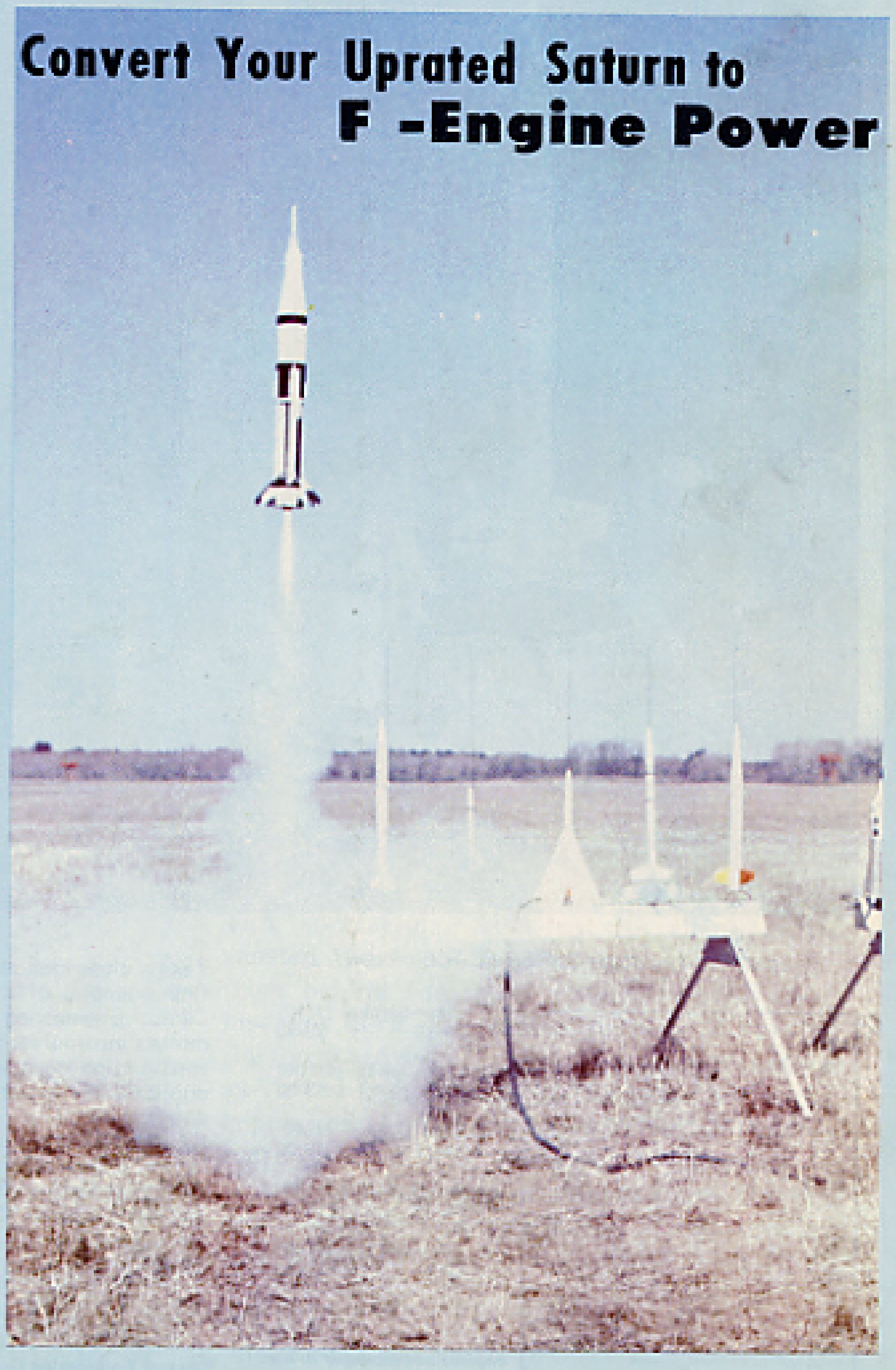

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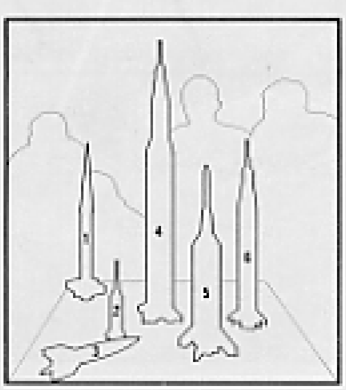

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Model Rocketry

Volume I, No. 9
July 1969

Cover Photo

Harold Kritzman's F-engine powered Estes Saturn I-B lifts off the pad at the MIT Convention launching last April. Full plans for converting your Estes kit to F-engine power begin on page 19. (Cover photo by George Flynn.)

From the Editor

In recent months we have seen a great number of articles on the theoretical aspects of model rocketry. Important problems such as dynamics, altitude performance, stability, and drag have been analyzed. One aspect, however, of the scientific method has been largely absent from these treatments – *experimental verification of the theory.*

Any scientific theory remains in the realm of pure speculation until it is tested by experiment. The predictions resulting from analytical derivations must be compared with experimental data. In most fields of scientific inquiry there are two groups: the theoreticians and the experimentalists. The theorist will arrive at a description of some physical phenomenon based on a combination of intuitive hunches, generally-accepted physical relationships, and previously-known data. He will then publish his predictions of the behavior of the physical system under investigation, whereupon the experimentalist will devise a method to measure the quantities of interest in the system described. He will compare his data to the theoretical prediction, and accordingly as the agreement is good or poor, accept or reject the theory. On the basis of this new data a more accurate theory may evolve, once again to be checked by an experimentalist. By this continuing process of "iteration" the theoretical description (and our understanding of the physical

(Continued on page 39)

Features

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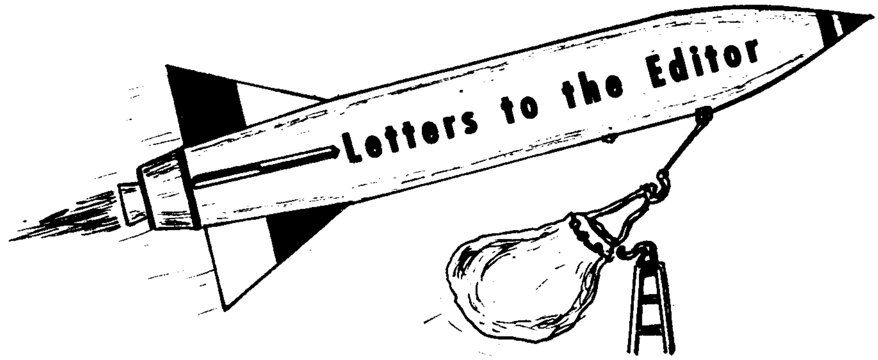


Teacher's Desk

I first saw your magazine lying on a teacher's desk at my high school. I nearly fainted, and although teacher's desks are strictly "taboo," I couldn't resist a peek. I was flabbergasted! At last, a high quality magazine dealing with model rocketry and model rocketry only! I read it through (with one eye on the door, in case the teacher returned) and then copied down the subscription price and address. Congratulations!

Eric M. Van
Natick, Massachusetts

NAR No. 1?

We are always hearing about G. Harry Stine, NAR No. 2. I was just wondering, who is NAR No. 1.

Also I would like to congratulate you on the very successful writing and publishing of this terriffic magazine! It appears to me that it is a great hit with model rocketeers of the U.S. I predict that **Model Rocketry** magazine will be the guide and official newsletter for all rocketeers as long as the sport lasts.

Also, is **Model Rocketery** magazine by any chance sold regularly to countries other than our own?

Chris Regan
Wayzata, Minnesotta

When the NAR was formed, in 1958, NAR No. 1 was assigned to the originator the hobby of model rocketry–Orville H. Carlisle. Carlisle began flying model rockets before 1957, and he holds the first model rocket patent issued by the U.S. Patent Office. But, more on Orville Carlisle in an upcoming article on the early history of model rocketry.

Model Rocketry has been distributed to Canada since the first issue last October. Overseas distribution began with the January issue, with magazines going to Australia, New Zealand, and Thailand. Since then, our international circulation has continued to increase. A recent agreement with an international magazine distributor will make **Model Rocketry** *available to newsstands in Europe and Asia during the summer.*

More Designs

Your mag is great! I especially like your designs for rockets. You should have more per issue. You should also have more finishing articles, and your *New Product News* should be expanded.

Eric Grunin
Spring Valley, New York

Hear that potential authors! Let's see some more designs and finishing articles. Articles should be sent to **Model Rocketry**, *Box 214, Boston, Massachusetts 02123.*

New Look

I was very surprised and happy to see the "new look" of your magazine, and the extra eight pages alone were worth the fifteen cents price hike. Of course, I still hope that you can change your printing process to include finer halftones, a better looking layout and type, and better paper (coated stock).

Now I would like to comment on a totally unrelated issue (pun not intended), and this is your use of many higher math, tecnically oriented articles. In my opinion, present content is perfectly balanced! There are beginners articles galore (and there is so much information available from the two major manufacturers). And, on the other hand, we have articles on telemetry, aerial photography, and altitude (stability) equations.

There is but one thing wrong with your technical and math orientated articles, and that is the astounding lack of 'pi' characters. The hand-drawn characters are a mess, and the typewritten equations don't reproduce well.

As for your article "Model Rocketry for the Depraved," my first impression was *fine*. I enjoyed reading it, and it made a good point; such basement bombers *do* exist. But then I thought about what would happen if I were trying to introduce someone to the safety of model rocketry, and I showed him that issue. Picture the Chief of Police reading about old Prodyne F engines blowing up at 50 feet above the ground! Then, to take his mind off this, you might show him another issue. Picture him now turning to the centerfold and reading about Leroy Piester's crashing Saturn V, a two-engine F cluster model going haywire; and, to top things off, a picture of a cluster rocket tipping off the launch rod and heading out horizontally. Better luck with the Fire Chief!

However, I hope you keep up the good work.

Joshua Hill
New York, New York

May Issue

An *absolutely unparalled achievement* in an astromodelers magazine, that's what fired through my mind with the speed of a model rocket upon receiving your May 1969 issue and removing it from its mailer. With all the excitement of setting a new world's altitude record, I delighted in your renovated magazine. The color photograph of a NARAM-10 launch rack, the new larger extended bold face letterhead, and your new increased price (??) were exquisite. And the best surprise of all, an additional eight pages of the greatest model mag on the American market, with the same great quality of alluring model rocket literature in each of the additional pages. When you come right down to the nitty gritty, **Model Rocketry** contains as much material as the more common model airplane mags.

The May issue was exceptional in content, too. Fox's article *Building an Inexpensive Model Rocket Transmitter* was an article of particular interest to me. His description of the XMTR was abridged and incomplete to anyone not acquainted with electronics. The XMTR is not a construction project for novice astromodelers.

Since mid-1968, Jeff Farash (a friend) and I have been researching in electronics pulps and manuals for plans to build a miniature transmitter with a range from 1/2 to 2 miles suitable for use in model rockets. Fox's article was a lifesaver and we are planning to construct it and possibly redesign it so that the output is increased and the sensitivity is improved.

Gordon Mandell's *Wayward Wind* presentation of closed breech launchers was excellently written and it was a truly original article. After all, how many articles on closed breech launchers have you read? I plan to design and construct a closed breech launcher for research purposes. I'll let **Model Rocketry** know how it turns out.

Under the 1967 **United States Model Rocket Sporting Code** the use of closed breech launchers appears to be prohibited. Rule 5.5 explains:

> A launcher must not impart to the model (rocket) any velocity or change in momentum except that caused by the model rocket engines contained in the model. A launch assisted by mechanical devices built into the launcher shall not be allowed

However, there is a small loophole in the rule that may permit closed breech launchers to be used in NAR sanctioned competition. The first sentence, "A launcher must not impart any velocity...except that caused by the model rocket engines..." allows breech launchers to be used as the velocity imparted to the model rocket is caused directly by the engine's thrust. The final sentence, "A launch assisted by mechanical devices built into the launcher shall not be allowed," does not permit breech launchers to be used as the piston used to collect the engine's jet gases is a mechanical device. I have written to the NAR Standards & Testing Committee to rule on this matter. I'll forward the reply to **Model Rocketry** when I have received it.

Your article on the Pittsburg Convention was also well written. The accompanying photos were also good, but lacked clarity. Why not write a similar article on the 1969 MIT National Convention, which, due to an unfortunate illness, I was unable to attend?

G. Harry Stine's *Old Rocketeer* presentation on postive ignition, an item of particular interest to me or any other rocketeer who has ever experienced the frustrations of ignition failure and repeated misfires. It may usher in a new era in model rocket engine ignition.

Pete Wysgalla's *Staged vs Clustered* also interested me to the extent that I looked through my back issue of Estes Industries **Model Rocket News**. Sure enough, in Volume 8 No. 2, Pete won second place in an Estes Science Fair Contest with the same presentation. His article was far from complete and there is a great deal of research work ahead of us till we reach the final verdict. It was, however, an excellent beginning, and without a beginning there can be no end.

Your May issue was definitely one of the best to ever come off your press, and I'm throughly impressed with your expanded magazine. I could go through the whole mag and comment, praise, and criticize the remaining manuscripts, but I've held onto your ear long enough.

Jim Bonner, NAR 12355
Holbrook, Massachusetts

Relativity

I want to commend you on having a really great magazine, but I just had to write you when I read that ludicrous article entitled "Relativistic Model Rocketry" by George Caporaso in your April issue.

I am only in the 8th grade, but it seems to me that the gross errors in the text of that article should be apparent to about everyone. The sheer idea that a model rocket, traveling at meer subsonic speeds, would experience any noticeable change in mass, length, or relative time-rate is unheard of. Here I feel it should be pointed out that the speed of light is 186,282 miles per *second*, and that to experience any noticeable change whatsoever a speed of at least 1/4 the above would be needed, and even then the change will not be noticeable to the naked eye or anywhere near measurable with a stopwatch. At a maximum speed of 500 mph, all of these type of effects would have long since been canceled out by even the minutest of changes in atmospheric pressure, humidity, wind, and even the tiniest of the unavoidable discrepencies in individual engines.

As for the Krushnik effect–let me put it this way: Einstein's original theory of spacial curvature and geometric distrotion in the vicinity of large masses was proved by noting the small amount of change in the paths of the light of distant stars produced in the area of the *sun* (considerably more massive than a model rocket) during a solar eclipse–the only time the light of such stars is visible here on earth. It is, therefore, inconceivable that the mass of a model rocket would produce a noticeable effect on the thrust of its engine.

Need I say more? Or was this article possibly another one of your jokes?

Mark Call
Shawnee Mission, Kansas

The Soviet Space Program -- A Growing Enterprise

Charles S. Sheldon II
Acting Chief, Science Policy Research Division
Legislative Reference Service, Library of Congress

Soviet Launch Sites

In the early 1950's, *Aviation Week* revealed that the United States had a capability based in Turkey for tracking Soviet vertical probes and intermediate range missiles launched from a site on the Volga River below Stalingrad. Presumably aircraft flights of the U-2 kept the United States abreast in the late 1950's of further expansion of Soviet missile and then space ground support facilities, but official reticence in discussing such matters has tended to obscure the facts and has led to a certain confusion in press speculation on such matters.

Our own experience in building ground support equipment leads to the supposition that Soviet launch pads are probably specialized to the needs of each model of launch vehicle currently active. Because pads and their supporting equipment are expensive, we can also assume the Russians have built no more than they believe they require for effective operations, and that these would tend to be grouped in a relatively small number of areas. Most launches are probably made at a fixed azimuth to avoid the inefficiencies of dog-legging. Hence, "walking back" the ground trace of the initial orbit on successive flights, when keyed to particular classes of launch vehicles, is important to finding the launch site. If the time of launch is known, or if flights occur at different inclinations so as to establish a nodal point, the launch site can be identified with a good deal of confidence of accuracy. In the absence of Russian names for some of these places, nearby villages or towns have sufficed for our naming purposes.

Tracking space objects by both visual and radio means is within easy reach of private individuals in all countries, to supplement whatever more elaborate tracking may be done by some governments with active radars or CW radio barriers. Therefore, even in the absence of Soviet corroboration, all three existing Soviet launch sites are well known through unclassified analysis.

Tyuratam

In 1957 when the Russians announced that Sputnik 1 was in orbit, it was a quick and natural assumption in the Western world that this device had been launched from the long-familiar test site in European Russia on the Volga. Only a few paid heed to calculations promptly published in Japan which showed that the link of the launch time and the ground trace moved the launch site to Kazakhstan, east of the Aral Sea.

It was not until 1961 when Gagarin was placed in orbit that the Russians gave the name Baykonur Cosmodrome to his launch site. Most early Soviet satellites were flown at an inclination of 65 degrees to the equator, and indeed, the initial ground trace for such an orbit passes through the village of Baykonur in Kazakhstan. But Western analysis of ground traces, known launch times, and later flights with different ground traces consistently carries the postulated Soviet launch site 230 miles southwest of Baykonur to the vicinity of Tyuratam, and hence this name is usually applied to the launch site. If the Baykonur name was intended as a Soviet subterfuge, its purpose is obscure in light of both the flight of Gary Powers in 1960 and the many calculations of ground traces.

With our assumptions that most launch pads are designed to handle repetitively launches of the same vehicle, one is led to certain conclusions about the original Soviet space launch site. The hardstand, flame deflectors, fuel and oxidizer lines, gantry if any, and height of work platforms would all have to be sized to accommodate the vehicles to be launched. Western specialists reviewing data on tracked objects and searching for obscure bits of information in Soviet statements had pretty well reached the conclusion that the original Soviet ICBM of 1957 became the basic space launch vehicle. Late in 1967 that was confirmed explicitly in Soviet public histories, and in April 1967 at the launch of Soyuz 1, Soviet journalists remarked on the historical marker alongside its launch pad which memorialized the launch of Sputnik 1 from the same site. Movie film released in 1968 of many historical launches up to Soyuz 3 showed elements of the same launch site and fittings.

Tyuratam has been used over the years not only for ICBM tests and the early Sputniks, but also for many other R&D flights, all manned flights, all lunar and planetary attempts, and all communications satellites. Located at 45.63 degrees N. Lat. and 63.27 degrees E. Long., it is most easily thought of as the Soviet equivalent of Cape Kennedy. Proliferation of programs and launch vehicels beyond the original one, while the first vehicle continues in use, suggests that there are other launch pads in the same general vicinity just as there are at the Florida site.

Kapustin Yar

In 1962, the Soviet Union announced a new program of launchings of Kosmos payloads to come from several cosmodromes, although the added ones have never been specifically identified in Soviet announcements. In light of the earlier test work with smaller vehicles detected near the Volga River, it was not surprising that ground trace of the first Kosmos craft led back to this test site, which is near Kapustin Yar. The economics of using the standard launch vehicle with a first stage thrust of over 1.1 million pounds for all space launchings were not ideal. So the Russians took a much more modest existing military IRBM, gave it an upper stage, and probably were able to launch it from an existing stand at this European site, whose location is approximately 48.52 degrees N. Lat. and 45.80 degrees E. Long. In contrast to the ultimate variety of inclinations and vehicles used at Tyuratam, suggesting large scale space operations, Kapustin Yar has a very modest space role. Every payload has had an inclination to the Equator of close to 49 degrees, and most of the payloads have been of modest size, spin-stablized. The combination of vertical probe work and modest orbital flights reminds one respectively of White Sands, New Mexico, and Wallops Island, Virginia. Although the approximation is crude, it may help the reader in orientation.

Plesetsk

The team of British school boys directed by Head Science Master G. E. Perry at the Kettering Grammar School has for some time done a remarkably fine job of tracking Soviet spacecraft. In their early years this was accomplished with a surplus radio worth about $80, a considerable dedication, and logic in applying known principles of physics. They were the first private citizens to disclose early in 1966 that Kosmos 112 was not only placed at a higher inclination than previous spacecraft, but that the initial ground trace was well to the west of both Tyuratam and Kapustin Yar. Some months later when another Kosmos payload also with a more westerly ground trace was put up at a different inclination, the ground trace crossed the earlier ground traces near Plesetsk at 62.7 degrees N. Lat. and 40.35 degrees E. Long. This has since been confirmed as a nodal point for many flights, and with enough variety of probable launch vehicles to lead to the supposition of several different launch pads. Thus the Kettering group deserves credit for identification of a key site not yet acknowledged by the Russians, although it had been rumored in the West as a possible missile site.

This complete Soviet silence and the repetitive nature of military support flights from this location suggest an operational role similar to that of Vandenberg Air Force Base, California. The parallel is extended by its use for launch of weather satellites, as well as other payloads, at much more extreme inclinations to the equator than come from the other two launch sites.

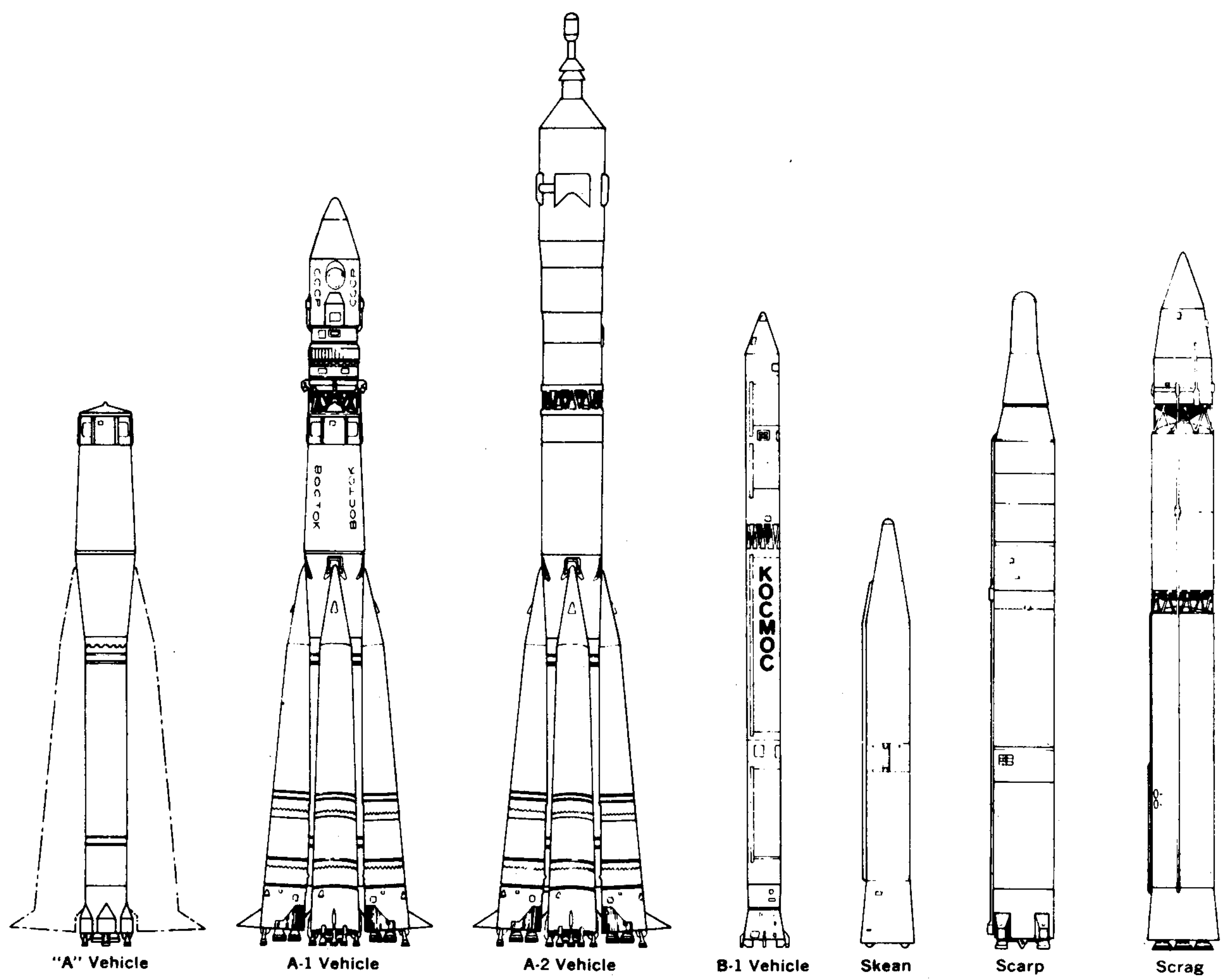
Thus, there is a rough correspondence, sometimes uncannily close, to the pattern of three launch sites in the United States. And in the Soviet case, knowledge of the launch site is therefore an important first clue to the nature of the mission and the launch vehicle used. If one is not able to construct his own ground trace of orbits, often the clue to pinpointing the site for those flights at an inclination of about 65 degrees which may come from either Tyuratam or Plesetsk, lies in the launch time. Plesetsk flights usually go up later in the day so that they may be brought back to the recovery zone in Kazakhstan at the same morning hour preferred for Tyuratam launches. Again, much of this detail has come from Kettering studies of beacons on the Soviet recoverable craft, Doppler shifts in their signals with retrofire, and changes in signal strength with parachute deployment after reentry, with ground contact, and with final recovery (signal end).

Soviet Launch Vehicles

Only since 1967 have any Soviet launch vehicles for orbital flight been put on public display, together with moderately extensive statistics on their performance. In earlier years, some bits and pieces were released, usually in a form which did not permit adequate calculations of the nature of the vehicles in question. One upper stage was revealed in 1959, and some rocket engines in escape payloads also were seen in intermediate years. Even now, there are finer points of the engineering which are not made wholly explicit, and some vehicles which have not been unveiled.

In the absence of adequate Soviet names and descriptions, or even of a public Western nomenclature system, a synthetic classification has been invented for purposes of this article. The basic launch vehicles, often military rockets, will be assigned letters; the upper stages, if any, which make them useful orbital flight systems, will be assigned numbers; any final stages needed for escape or special re-entry will be assigned letters; and finally, those which cannot be determined from public sources will be marked X.

Six basic launch vehicles are hypothe-



SOVIET LAUNCH VEHICLES

sized: A,B,C,D,F, and G, with X for the unknowns. The added upper stages, which may or may not be specialized to serve a single class of launch vehicle, will be designated 1,2,3,etc. One catagory, which may have employed either 1 or 2 will be marked 1/2. The escape rocket (often a fourth stage) will be labeled e; any extra maneuverable stage will be marked m; and any special re-entry rocket will be marked r.

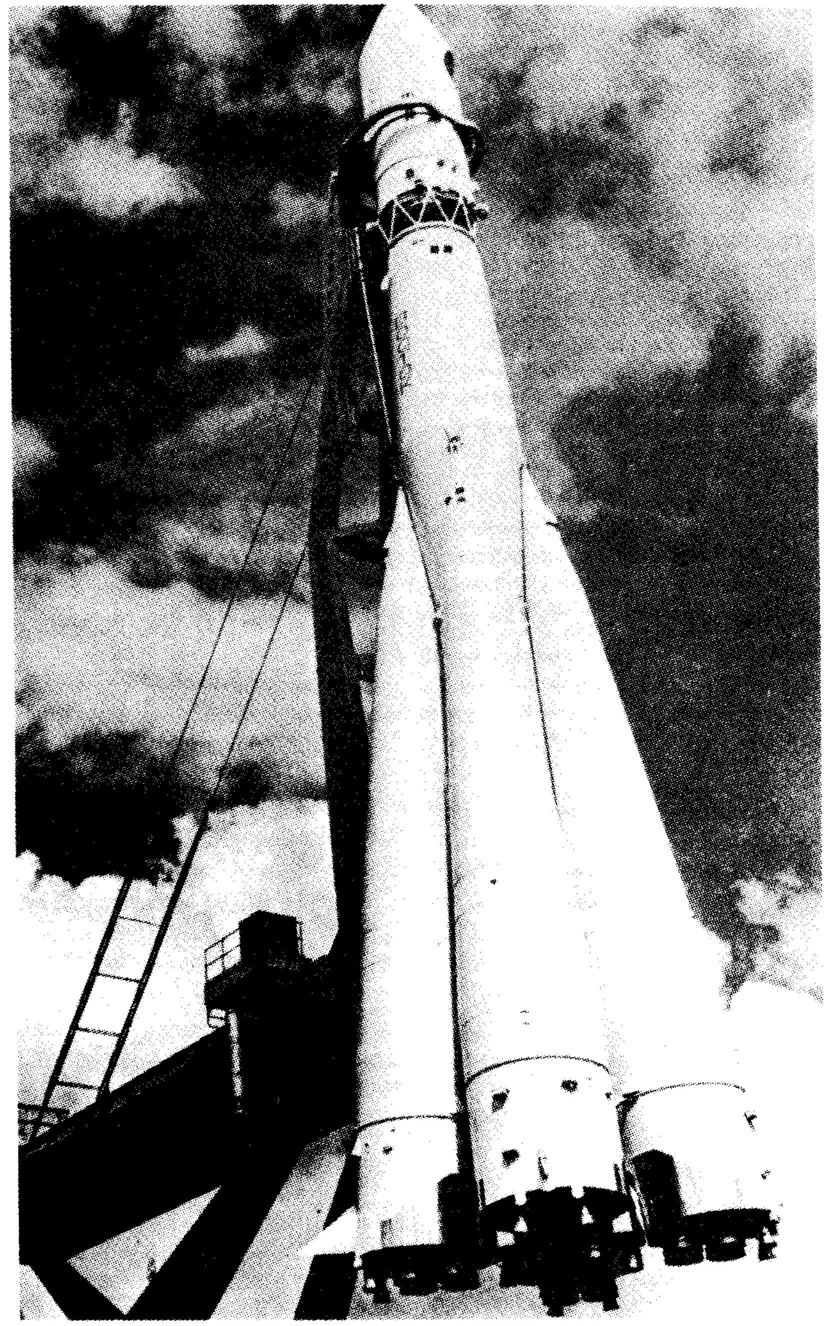
"A" Series: Vostok – the Standard Soviet Launch Vehicle

During the period 1954-57, the Gas Dynamics Laboratory in Leningrad developed an engine called the RD-107, which with its variant, the RD-108, became the basis of the original Soviet ICBM. The first ICBM was launched from Tyuratam in Kazakhstan on August 3, 1957; and on October 4 that year, the first satellite, Sputnik 1, was placed in earth orbit with this vehicle. The same was true of Sputniks 2 and 3.

The original Soviet ICBM was designed before the thermonuclear breakthrough was a practical certainty, and is therefore a very large vehicle. It consists of a central core liquid stage 91.8 feet long and 9.7 feet in diameter, a plain cylinder through its lower portion, then flaring and tapering again at the upper end in a hammerhead effect. Grouped around the plain cylinder portion are four liquid stage strap-ons, each 62.3 feet in length and 9.8 feet maximum diameter, each tapering toward the upper end as modified elongated cones. When all five sets of tanks are assembled, the result is a fluted pyramid effect which is rather graceful, with a maximum base diameter, including four stubby fins, of 33.8 feet.

The four strap-ons carry the RD-107 engine, which burns liquid oxygen and a hydrocarbon, operating a single shaft turbine assembly to pump the oxidizer and fuel to four conical exit nozzles and to two steering rockets. There are auxiliary systems to pump a hydrogen peroxide gas generator and to run a liquid-nitrogen- to-nitrogen-gas pressure supply. Operating at 60 atmospheres pressure, the system produces a vacuum thrust of over 224,800 pounds with an I_{sp} of 314 seconds. The chambers are double wall regenerately cooled, with an inner lining of copper. The RD-108 engine which powers the central core sustainer apparently differs from the RD-107 only by having four steering rockets instead of two, and a longer burning time. All four strap-ons and the core ignite before liftoff, and after the four strap-ons drop away, the core continues to burn. This gives a combined thrust (vacuum equivalent) of over 1,124,000 pounds. At lift-off, there are 20 main thrust chambers plus 12 steering nozzles all in action.

When this ICBM was used to orbit the first three Sputniks, it was not used very efficiently, lacking an added stage. In the case of Sputnik 3, the payload was 2926 pounds. The entire core vehicle went into orbit, very much in the manner of the early Atlas Project Score launch. For purposes of the present classification this basic vehicle will be designated A.



Shown at the U.S.S.R. Exhibition of Economic Achievement in 1967 was the Vostok (A-1) booster, identified as the vehicle which carried Cosmonaut Yuri Gagarin into man's first earth orbit in 1961. Evolved from the original Soviet ICBM, the basic "A" version, without upper stages, orbited the early Sputniks. Configuration shown above has the basic 1½-stage first stage plus first-generation orbital stage.

When the Russians were ready to send their first direct-ascent unmanned payloads to the moon, the A vehicle was used, plus an added stage, so that it will be designated the A-1. At burnout this final stage weighed about 3500 pounds, including the payload which weighed about 800 pounds. This added upper stage was the first space propulsion vehicle to be put on display by the Russians, soon after the flights in 1959.

By study of the Vostok manned craft displays first shown in 1965, it seems a good hypothesis that this same lunar upper stage was also used as the final stage for the orbiting of these craft. The Russians call the whole vehicle assembly Vostok, although the name originally was applied to the payload itself.

Table of Launch Vehicles

Designator	Characteristics	Typical Payload
A	Core vehicle in orbit	Sputnik 1, 2, 3
A-1	Separated upper stage	Luna 1, 2, 3; Vostok
A-2	Separated longer upper stage	Voskhod
A-2-e	Orbital launch platform	Luna 4 on; Zond 1, 2, 3; Venera; Mars; Molnya 1
A-1/2	Public data lacking on separated stage length; may be A-1 or A-2	Some Kosmos
A-m	Maneuverable with no separated stage; may be A-1-m	Polet
A-X	Possibly maneuverable with no separated stage; may be A-m or A-1-m	Kosmos 102, 125
B-1	Small, spin-stabilized, and usually with separated stage	Kapustin Yar Kosmos and some Plestsk Kosmos
C-1	Multiple payloads or circularized orbit single payload	Tyuratam Kosmos a 56° and Plesetsk Kosmos at 74°
D	Possibly core vehicle in orbit	Proton
D-1	Large payload in earth orbit	Kosmos 146, 154
D-1-e	Orbital launch platform	Zond 4 on
F-1-r	Fractional orbit platform	FOBS Kosmos
G-1; G-1-e	Very heavy launch systems	Postulated Webb's giant
X-1-m	Maneuverable system and variants; could be A-1-m, F-1-m, or a new system, H-1-m	Kosmos 185, 198, 209,217, 248, 249, 252

Added Soviet details are available about the total vehicle. Its height to the tip of the shroud over the payload is 125 feet (33 feet beyond the basic vehicle). The combined thrust of all stages is 1,323,000 pounds, which by subtraction gives us a final stage thrust of 199,000 pounds from the single nozzle in that stage. Before the Russians revealed the particulars quoted above, they described the Vostok vehicle as having a power output of 20 million horsepower–not a particularly useful measure, but pertinent to a later step in this analysis. In earth orbit, the A-1 vehicle as used for Vostok lifts about 10,400 pounds, not counting the separated final stage whose burnout weight is about 3200 pounds.

Another interesting feature of the A-1 vehicle is its rugged construction. It was first seen in the West in 1967 when it came in segments by ship to Rouen, France, and was trucked to Le Bourget for assembly. With cables attached to the extreme ends of sections, men could walk up and down the length of the suspended sections without damaging them. According to a Soviet movie, the total vehicle is assembled in Tyuratam in the horizontal position attached to a strongback. It is moved by rail to the launch pad, where it is tilted to a vertical position over a flame deflector pit, and big arms at the pad swing up to steady it until launch, when they swing back again. One arm has an elevator to carry checkout crews or cosmonauts to the top of the vehicle.

After the A-1 version appeared, a still more complete exploitation of the basic launch vehicle was obtained by building an improved upper stage which has the same cross section as the earlier stage, but is longer. The actual hardware has not been put on display and only fleeting views have appeared in Soviet movies. This stage may be about 20 feet in length instead of the approximately 6.5 feet of the earlier vehicle. The Russians claim that this improved vehicle involves a total assemblage of seven engines instead of six as used for Vostok. Its original use was for orbital platform launches to the planets, and for that purpose the added stage can be understood. But it has also been used for the Voskhod and Soyuz earth orbital flights as well. The Russians ascribe a total thrust of 1,433,000 pounds to the improved version, which suggests some combination of 309,000 pounds divided between the last two stages, probably mostly in the longer third stage. The Russians have claimed for this combination a total lift capacity of 16,500 pounds, compared with a first successful use in 1961 of 14,292 pounds (a platform intended to launch a Venus probe from orbit).

The orbiting platform technique has been used for all Luna flights since 1963, the Molniya 1 series, the Zond flights, and Mars and Venera flights. Although the Russians claim an extra engine in the Voskhod series, no second spent rocket casing appears in orbit, so this improvement over the A-1 will be designated the A-2, while the

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orbiting platforms which then fire a probe stage will be designated the A-2-e.

Because the Russians have credited Kosmos series flights with weights up to 16,500 pounds, the A-1 and A-2 may both be in use within the Kosmos program. Without sufficient optical tracking data on empty rocket casings, there is no public way to identify which has been used on each flight; so those of uncertain classification will be labeled A-1/2. Exactly when the A-2 was first introduced is not known, so assuming the A-1 was used through the Vostok period, the A-1 label is made specific that far.

There have been four flights from Tyuratam for which no separated carrier rocket was reported in orbit. Their occurrence relatively early in the space program make the A vehicle the best guess for a booster. Two of these were Polet flights with an advertised capability of maneuver. They will be designated as A-m. If the A-1 was involved, the penultimate stage was suborbital, and we cannot establish the correct designation as A-1-m. If there was no standard upper stage, it was replaced with a maneuverable stage which in either case remained attached to the payload. The other two payloads without separated carrier rockets in orbit were Kosmos 102 and 125, which had perigees in the Southern Hemisphere. This at least raises the question of possible maneuver, and whether they represent a follow-on to the Polet series. They will be labeled A-x because the final stage cannot be determined from the record. Again, they could be A-l-x or A-m or A-l-m but this is not known.

The Russians themselves have said the Elektron series was put up by the Vostok or A-1 rocket, so this designation requires no further analysis.

"B" Series: Kosmos– the Small Launch Vehicle

After Tyuratam had been used for some time with launch vehicles of ICBM-size, a second cosmodrome was opened at the earlier vertical probe and IRBM test site of Kapustin Yar on the Volga. These modest payloads, variously estimated as weighing between 285 and 1000 pounds, are more nearly akin to the Explorer satellites of NASA, and have been used in a fairly steady but unspectacular program of science, component testing, and perhaps for obscure military purposes. In 1967, this vehicle was finally put on display in the Moscow museum. Previous Western estimates proved correct that it was the IRBM coded Sandal by NATO, plus an upper stage. The Russians themselves label this launch vehicle the Kosmos.

Earlier in 1967, the Russians revealed at the Paris Air Show the upper stage power plant of their small Kosmos. It is designated the RD-119, and was developed between 1958 and 1962 by the Leningrad Gas Dynamics Laboratory. In concept, it is not unlike the RD-107 and RD-108, and the Russians point to its great efficiency. It operates at a pressure of 80 atmospheres, has a thrust of 24,250 pounds, and a vacuum I_{sp} of 352 seconds. It burns liquid oxygen and dimethyl hydrazine. The single nozzle is bell-shaped, and a single shaft turbo pump system drives the fuel and oxidizer supplies as well as a fairly elaborate set of auxiliary nozzles for roll, pitch, and yaw.

The total vehicle combination, which we will designate the B-1, is 98 feet long and 5.4 feet in diameter. Most of the payloads it puts up are spin-stabilized, and then the carrier rocket is separated. A few do not separate; in one case there were two payloads, and in another, a special aerodynamic stabilization system was used.

"C" Series–the Intermediate Vehicle

Within the Kosmos series have come launches of multiple payload from Tyuratam at an inclination of 56 degrees. The Russians said a new and different launch vehicle had long been used. Some of these orbits have been circularized at various heights into long life orbits. The numbers put up at one time and the orbits attained might well be beyond the capability of the B-1, Sandal-based system. Also, optical studies of these payloads give no indication that they are put up by the A-1 class large vehicle.

Accordingly, a search of the known stable of Soviet military missiles which with an added upper stage would do this task suggests the NATO-named medium range ballistic missile, Skean, as the likely candidate for the first stage. But this launch vehicle has not been put on display in any space museum, so final confirmation is not possible as could be done with the Sandal. This postulated third vehicle will be designated the C-1. First it put up three payloads at a time, then five at a time, all at 56 degree inclination. Then came later launchings at the same inclination (apparently unique to this launch vehicle) which carried single payloads only. Assuming that the developmental phase typical of many Tyuratam launches was over, a new series of operational flights–with the same apogee and perigee characteristics but at a 74 degree inclination from Plesetsk–have followed and could have been made with the same vehicle. Recently after a long pause another payload from Tyuratam was launched with an inclination of 56 degrees.

"D" Series: Proton– a Non-Missile Space Launch Vehicle

In 1965, the Soviet Union announced the launch of a scientific payload named Proton by means of a new launch vehicle which has never been pictured or displayed. The payload weighed 26,896 pounds, and according to the Soviets the launch vehicle had a total output of over 60 million horsepower. They drew the further parallel that it had three times the capacity of their Vostok (the A-1).

It was rather curious that a vehicle whose first stage might easily have 3,300,000 pounds of thrust would put up only double the payload of the Vostok vehicle. When this inefficiency was coupled with visual observations of an accompanying rocket casing of about 90 feet in length and 16 feet in diameter (by British calculation), the implication was strong that in this first test, and the two subsequent ones, a central core vehicle had been placed in orbit, and that later versions would have better staging and hence a much higher lift capability. We shall designate this block one version the D launch vehicle.

In 1967 came two Kosmos test launches which were then quite obscure as to purpose. British optical measurements of a large payload, in addition to a more moderate carrier rocket, suggested a possible weight for the payload of almost 66,000 pounds, since it was about 46 feet long by 10 feet in diameter. These figures would square with a reasonable assumption for the capacity of a D-1 version of Proton, with a first stage thrust of 3,300,000 pounds, as 40,000 to 60,000 pounds. Such a vehicle would be capable of supporting a manned circumlunar flight.

Consequently, it was not too surprising when Zond 4,5, and 6 came along, and in late November of 1968 were officially described as precursors to such a manned flight. The circumlunar version is probably best designated as D-1-e. Such a vehicle should be able to send from 9900 to 15,400 pounds around the moon based upon the comparative ability of the A-2-e to send over 3300 pounds to the moon. Likewise, the D-1-e may be able to send planetary probes of 6600 to 8800 pounds, compared to the A-2-e capacity to send over 2200 pounds on such flights.

The most common Western assumption about the Soviet program is that to this point the Russians have not switched to use of hydrogen or other high energy fuel. This is signaled by the relatively low announced weights of payloads compared with the high thrust of the vehicles. It was somewhat surprising, then, in November of 1968, to have a Proton 4 flight, after a lapse of some years, with an announced payload weight of over 37,000 pounds. This might have been a D-1 vehicle, with a performance on the very low edge of Western estimates of its capacity. Or it might represent a markedly improved version of the D vehicle such as would be occasioned by a redesign of the core to use a high energy fuel. Public data are too scanty at this point to resolve such questions, and as usual, the Russians are not saying.

"F" Series: Scrag or Scarp–a Military Launch Vehicle

The Russians have paraded in Moscow two different weapons which were described by them as capable of orbital delivery of nuclear weapons to any spot on earth. One was a three-stage liquid fueled rocket, with the stages linked by a lattice structure. It was nicknamed Big Brother by the Western press, and called Scrag by NATO. In a later year, a second rocket was paraded. It was also liquid fueled, perhaps with two stages, although the precise points of division were not wholly certain. It was bottle-shaped, and the smaller diameter warhead end may have incorporated a third stage. This rocket was labeled by the Western press the SS-9, and NATO calls it the Scarp.

Since 1966, a series of Kosmos flights have shown characteristics quite different from all others. The first two were not even announced–the first such lapse in almost 4 years. When more came in 1967, the Soviet press release format was different, particularly leaving out any reference to an orbital period. This suggested that the payload was up for less than one orbit, although some debris was usually up for several orbits, and in a form suggestive of the launch platforms used for escape missions rather than low earth orbital flights. Moreover, these were the lowest of any Soviet flights. Together, these facts–the low orbit, the presence of both a platform and a separated carrier rocket, and the early recall of the payload with no period announced–all signaled reentry tests. But the purpose of these tests was obscure. Some Westerners thought of Soyuz experiments to overcome the troubles experienced by Komarov; but if so, why was the orbit selected so different in inclination and altitude? Rumors of a weapons relationship, to give credibility to the parade claims, circulated for many months. It was clear the Russians were doing nothing to hide the fact of re-entry tests. Secretary McNamara finally tagged them, not conclusively, but with a fairly high order of probability, as FOBS (fractional orbital bombardment system) tests.

It is not possible from any obvious public clue to settle whether these flights are made by Scrag or the newer Scarp. The use of a unique inclination (50 degree) suggests a different launch pad at Tyuratam and therefore a different rocket from the A-1/2. Hence this military rocket will be coded the F-1-r, to indicate a new launch vehicle, an orbital stage, and a re-entry stage.

"G" Series: a Possible Very Heavy Lift Launch System

Unless the Russians flight-test new vehicles, it is difficult to be positive about their existence from public sources, since they do not permit visits to factories, test stands, or launch sites. There has long been speculation that the Soviet lead in larger launch vehicles would not be surrendered willingly; and since the time table for our Saturn V was well known, we could expect a corresponding Soviet system in roughly the same time scale.

From 1967 on, James E. Webb, Administrator of NASA, testified before Congress that such a Soviet system was being prepared, that it would probably have more thrust than Saturn V, and that in its full development it would have a greater lift capacity. These reports were amplified in 1968 both by George Mueller and Wernher von Braun, both prominent in the NASA organization. There has been no public statement on such a Soviet launch vehicle from either the President or the Department of Defense. Some press writers have doubted the reality of this vehicle, ascribing the statements to the budget needs of NASA.

The Russians have not settled the matter for us so far, although they have long talked in general terms of the need for still larger vehicles to support manned flight to the planets. The only reference found is a claim in the Czech magazine *Student* for October 4, 1967, page 3, purportedly quoting Soviet General Kaminin and Cosmonaut Popovich as saying such a large vehicle is in an advanced stage of development.

Tentatively then, until the Russians make a flight or unveil details, the designator for Webb's Soviet giant will be G-1, and if used for escape missions, then G-1-e.

"X" Series: Unidentified Launch Vehicle

Through techniques discussed in this article–i.e. relating orbit characteristics, launch site, and mission information–almost all classes of launch vehicles can be estimated with a fair consistency.

About the only remaining hard-to-classify cases are seven Kosmos flights from Tyuratam which seem to be of a group. At least some have maneuvered, having generally first been put into a low circular orbit, then moved to a higher circular orbit. The last two such flights ended up in a still higher eccentric orbit. The purpose of these flights is not yet apparent. The launch vehicle, which may or may not be new, will be designated for the time being as X-1-m.

Soviet Program Elements

An extensive discussion of program details would take more space than this article will permit. The table which follows attempts to supply, by year of launch, data on each named type of Soviet payload, along with an identification of the launch site and the launch vehicle. Because the Kosmos label covers so many programs, its elements are subdivided into probable missions in order to match the detail already supplied on non-Kosmos flights. For convenience, subtotals are shown for Kosmos flights; for earth orbital flights and escape flights (some earth orbital listings were escape mission failures); and for the three launch sites. With this as a guide, it should be possible to refer to the details by individual flights listed in the Condensed Log.

Practical applications of Soviet flights are aimed at weather reporting, communications, and navigation (perhaps also including military electronic ferreting). These applications came later in the Soviet program than in the United States, and many early flights were apparent failures, but now performance is improving.

The largest single element in the Soviet program is the conduct of military photographic observation missions, although these flights may also carry secondary payloads part of the time. One Soviet military program goes beyond passive support, and that is their FOBS, for which there is no U.S. equivalent.

Of obscure purpose are at least three series of different vehicles whose common thread is the fact or the suggestion of maneuver. These may include engineering tests of components for incorporation in other craft. Various Western observers have pointed to such disparate ultimate goals as building space stations, maneuvering near the moon, conducting satellite inspection, and even leading towards a full orbital bombardment capability. But no real answer is possible now without more Soviet disclosures.

Manned flights and their precursors up to 1968 through Soyuz were all conducted with the A family of vehicles. Now we have the Soviet announcement that the larger D (Proton) family is also being groomed for such work, tested under the Zond label.

After Luna 3, all Soviet escape missions and also their communications satellites in eccentric earth orbit have used the technique of launch from an orbiting platform. These are termed Tyazheliy Sputnik by the Russians (e.g., Tyazheliy Sputnik 5 launched Venera 1). Hence lines are provided for the count of these platforms.

Lunar and planetary failures which attained earth orbit were not always named in the earlier years, but now are given Kosmos cover names; both categories are included in the table.

Soviet Goals

Soviet space objectives include not only the seeking of scientific knowledge for its own sake, but several other important purposes. One is the practical application of space flight to civil and military ends. Another is to gain the indirect spillover of advanced space technology into general industrial advance and systems management. Not least is to create a political effect both on their people at home and on the rest of the world through an image of leadership and progress in matters technological. There may also be a certain mystical belief inherent in their thought that the universe is there to be explored and ultimately mastered.

SOLICITATION OF MATERIAL

In order to broaden and diversify its coverage of the hobby, MODEL ROCKETRY is soliciting written material from the qualified modeling public. Articles of a technical nature, research reports, articles on constructing and flying sport and competition models, scale projects, and material relating to full-scale spaceflight will be considered for publication under the following terms:

1. Authors will be paid for material accepted for publication at the rate of two dollars ($2.00) per column inch, based on a column of eight-point type thirteen picas wide, for text, six dollars fifty cents ($6.50) for drawings, and two dollars ($2.00) for photographs accompanying text. Payment will be made at the time of publication.

2. Material submitted must be typewritten, double-spaced, on 8½ by 11 inch paper with reasonable margins. Drawings must be done in India ink and must be neat and legible. We cannot assume responsibility for material lost or damaged in processing; however our staff will exercise care in the handling of all submitted material. An author may have his manuscript returned after use by including a stamped, self-addressed envelope with his material.

3. Our staff reserves the right to edit material in order to improve grammar and composition. Payment for material will be based on the edited copy as it appears in print. Authors will be given full credit for published material. MODEL ROCKETRY will hold copyright on all material accepted for publication.

Those wishing to submit material should send it to:

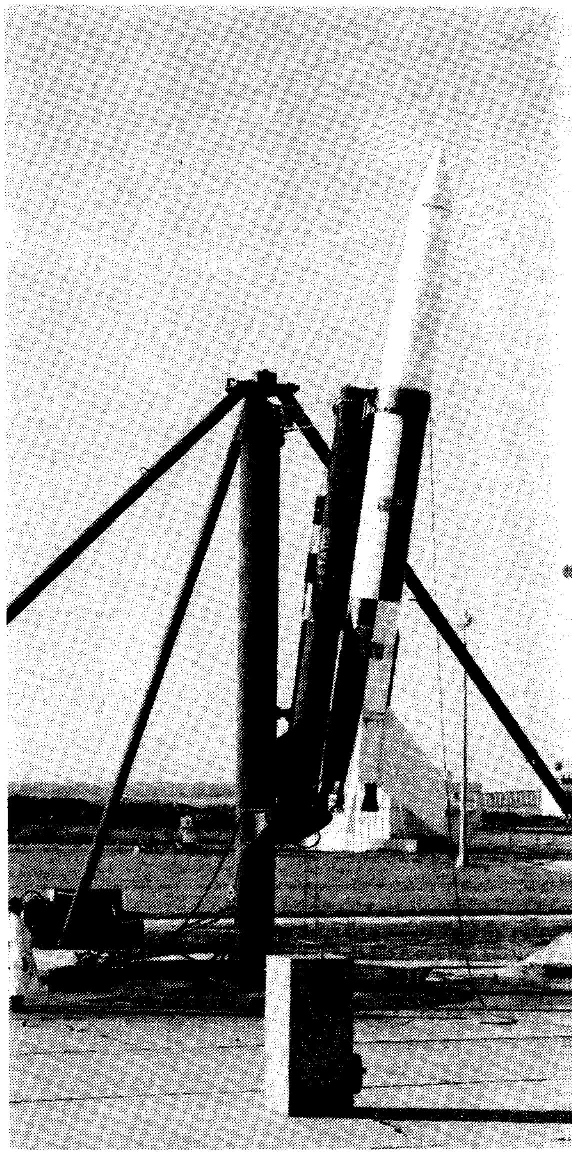
Editor, Model Rocketry Magazine, Box 214, Boston, Mass. 02123

Build this super-scale model of
NASA's top-performing sounding rocket

Astrobee 1500

(Flight 16.02GT)

by Charles Duelfer



The Astrobee-1500 is the most powerful sounding rocket in the NASA program. This two-stage solid propellant rocket was developed as a company- funded project of the Space-General Corporation, El Monte, California.

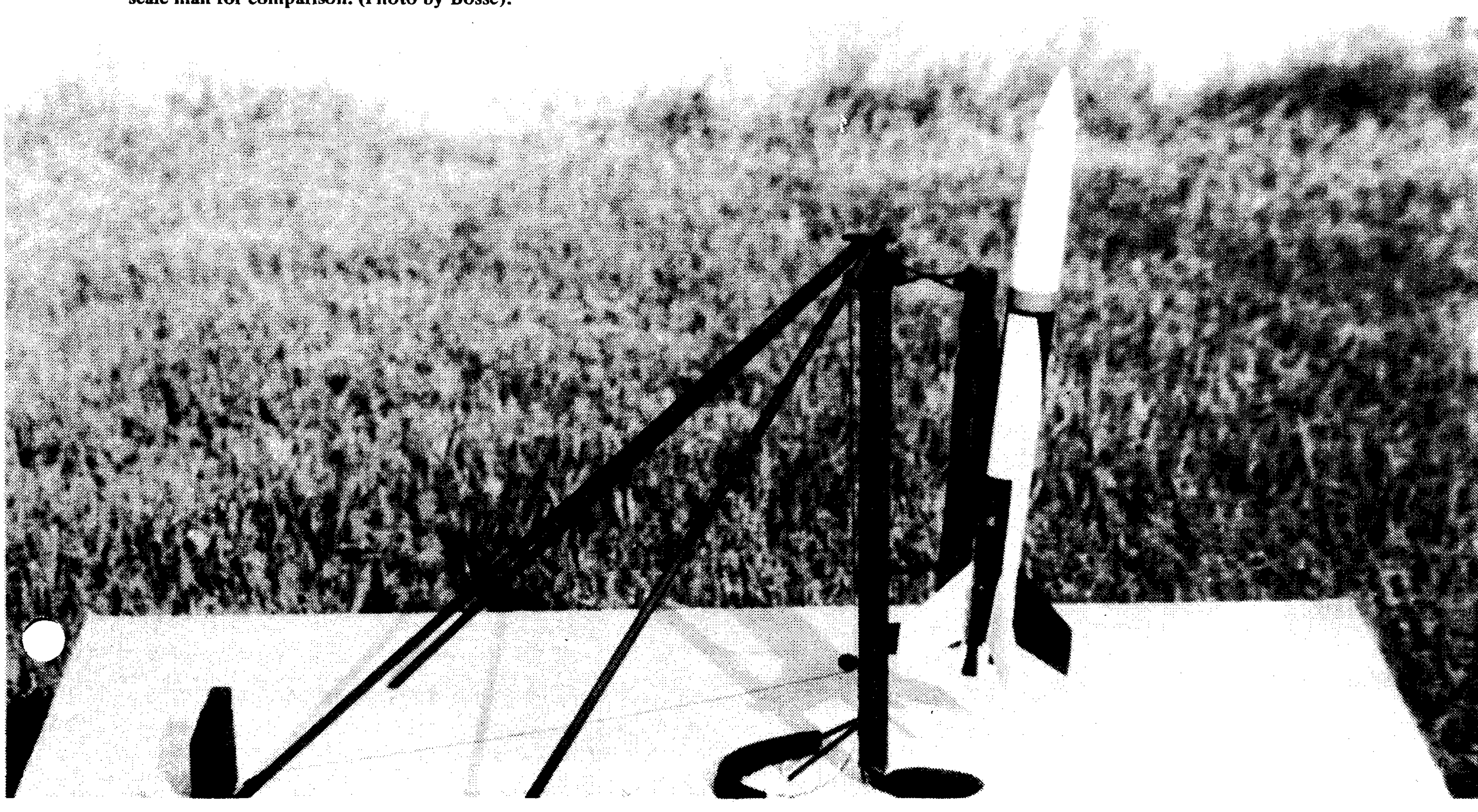
The Astrobee-1500 is a high performance rocket which is capable of carrying a payload of 100 pounds to an altitude of 1500 statute miles. Weight of the payload may vary however from 60 to 300 pounds. The vehicle houses a payload compartment with about 6.1 cubic feet of volume.

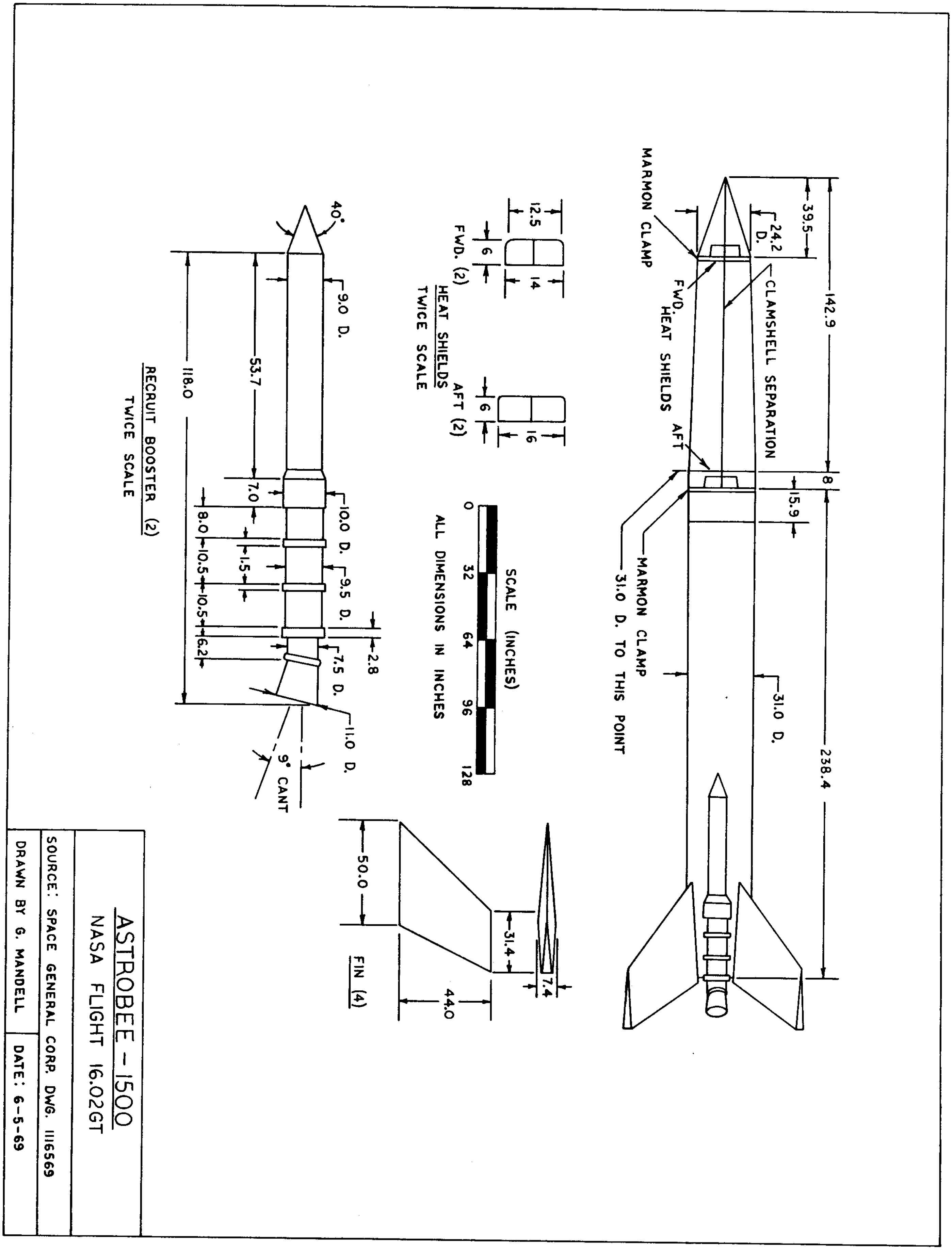
All information pertains to flight number 16.02 GT, launched October 21, 1964, from Wallops Island, Virginia.

Propulsion for the Astrobee-1500 is provided by four solid propellant motors. The first stage is comprised of an Aerojet-General 28KS-57000 (Junior) motor augmented by two Thiokol 1.5 KS-35000 (Recruit) boosters. The total thrust of this first stage is 125,000 pounds, and it has a burning time of 40 seconds. The second stage is powered by an Aerojet-General 30KS-8000 (Alcor) engine. This has a thrust of 11,000 pounds and a burning time of 30 seconds.

Stabilization of the Astrobee-1500 while its first stage is burning is provided by four 8 degree wedge fins. These fins are aligned such that a nominal roll rate of 2.5 revolutions per second is achieved at first stage

The downrange side of Astrobee 1500 Flight 16.02GT is shown on the launching pad at NASA's Wallops Station (left). Note the scraped paint near the top of the booster pod. (NASA Photo) Below is a scale model of the Astrobee 1500 and pad. Note the size of the scale man for comparison. (Photo by Bosse).




ASTROBEE - 1500
NASA FLIGHT 16.02GT
SOURCE: SPACE GENERAL CORP. DWG. 1116569
DRAWN BY G. MANDELL
DATE: 6-5-69
142.9
39.5
24.2 D.
MARMON CLAMP
CLAMSHELL SEPARATION
FWD.
HEAT SHIELDS
AFT
8
15.9
MARMON CLAMP
31.0 D. TO THIS POINT
31.0 D.
238.4
12.5
14
6
FWD. (2)
16
AFT (2)
HEAT SHIELDS
TWICE SCALE
SCALE (INCHES)
0
32
64
96
128
ALL DIMENSIONS IN INCHES
40°
9.0 D.
53.7
118.0
7.0
10.0 D.
8.0
10.5
1.5
9.5 D.
10.5
6.2
2.8
7.5 D.
11.0 D.
9° CANT
RECRUIT BOOSTER (2)
TWICE SCALE
50.0
31.4
7.4
44.0
FIN (4)

burnout. The second stage is gyroscopically stabilized with a nominal rollrate of 12.5 revolutions per second. The thrust for this spin is produced by four Atlantic Research Corporation 1KS-210 motors. This second stage rests on a spin table that is mounted by means of a support subassembly to the forward end of the Junior motor. The entire second stage is enclosed by a clam shell heat shield which is secured by two Marmon clamps.

The Astrobee-1500 has two on-board systems to insure the proper sequencing of events during its flight operation. One acts as the primary system and is an electronic timer initiated by the decay of the first stage chamber pressure. The second system acts as a back up and is triggered by launch acceleration. At time zero operation will begin with the ignition of the Junior engine. Ignition of the recruits is attained by a first motion switch on the launcher. The recruit boosters burn out at T+1.8 seconds, and at T+49.5 seconds, explosive bolts in the Marmon clamps fire, allowing the clam-shell heat shield to open by centrifugal force. This heat shield, however, is not entirely jettisoned. The Alcor engine ignites at T+50 seconds and separates itself from the first stage by deforming a separation diaphragm. Burnout of the second stage Alcor engine occurs at T+80 seconds.

Model Construction

Constructing a scale model of the Astrobee-1500 is not a project for the novice rocketeer. However, for the more experienced modeler, it is a good choice for the scale or space systems events in NAR sanctioned competition. The vehicle's four large fins keep any problems that might be encountered with stability at a minimum, while points are also awarded to it because of its moderately high degree of difficulty.

The scale which you choose to construct your model depends largely on how much detailing you wish to include. Generally speaking, the smaller the scale, the less detail you can include, but also the larger the scale, the more prominently your mistakes will show. I have found that for most purposes about a one-inch diameter body tube is best.

After selecting a body tube, the next problem is the nose cone. This must be turned by the modeler himself, since none are commercially available. I would suggest using a hardwood instead of balsa wood stock for this purpose. There are two reasons for this. One is that with hardwood the additional weight would insure flight stability by bringing the center of gravity forward and thereby eliminating the need for further weighting as is commonly necessary with balsa. Secondly, hardwood is much easier to finish than balsa being less porous and easier to fill.

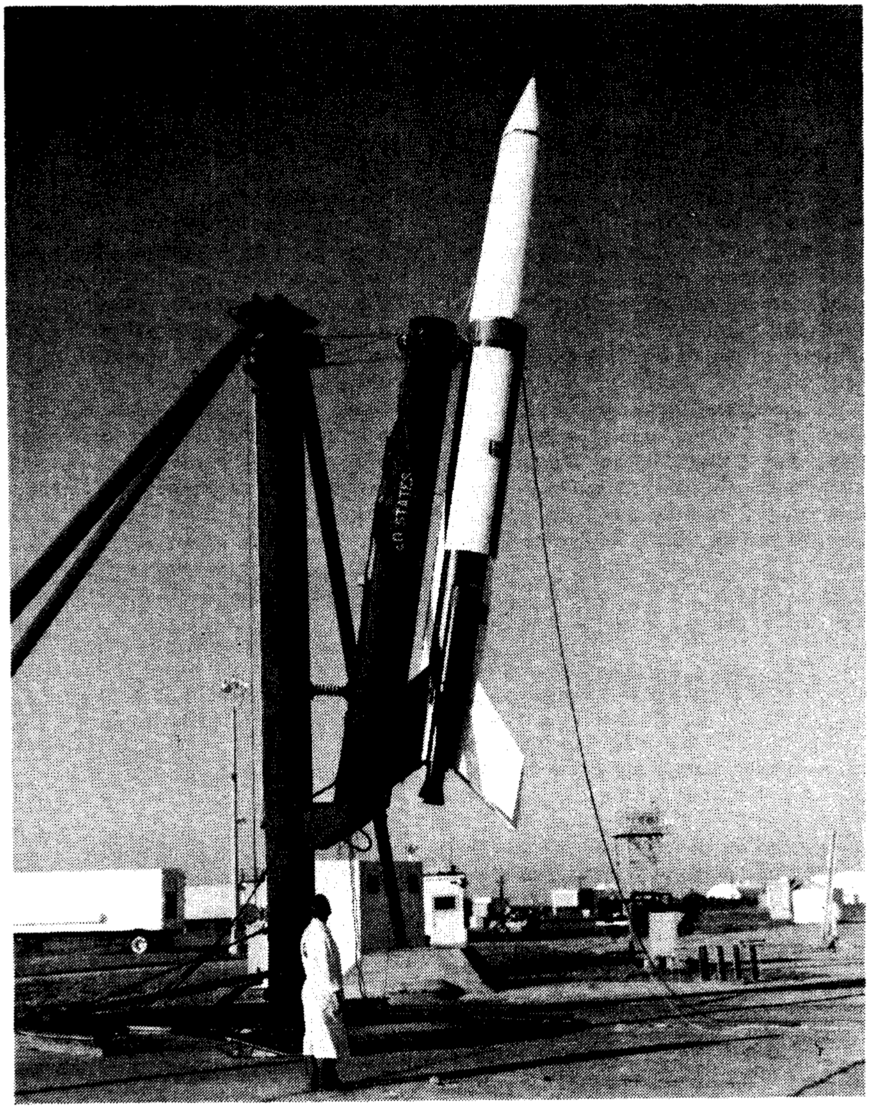
The fins of the Astrobee-1500 are wedge fins and must be carefully sanded to obtain the proper form. Here balsa should be used.

The two recruit boosters may either be turned on a small lathe or a dowel may be used with the rings formed by building up layers of masking tape. The latter method is usually easier. It must be noted, however, that the recruit nozzles have to be formed separately because of their 9 degree cant. They may be shaped from a dowel of a larger diameter.

Other details on the Astrobee-1500 are four heat shields, two forward and two aft. These may be made of thin poster board or a similar material, since their thickness on a scale model is negligible. There are also two quadraloop telemetry antennas, one located just under each aft heat shield.

The paint pattern for the Astrobee-1500 is difficult and care must be taken in masking to obtain sharp lines. It is advisable to paint the entire model white and then mask and paint each successively darker color. The color scheme was as follows:

The first stage motor was divided into eight quadrants by longitudinal lines from the fin tips and by a circumferential line mid-way between the two ends of the first stage motor. The aft side quadrants, the forward bottom quadrant, Fin 1, and the Recruits were painted a dull black. The upper forward quadrant was divided by a line from its forward left corner to its aft right corner. The resulting triangle on the right was also painted black. The interstage insulation between the first stage motor and the base of the clamshell heat shields, and bands around the forward ends of the recruits were reddish brown. The two Marmon clamps are silver. There also were two portions of paint scraped off on the downrange side revealing the unpainted metal. This was caused when the vehicle was rotated in its cradle.



NASA Flight 16.02GT on the launcher at Wallops Station. All dark areas are painted black. The light areas are white. (NASA Photo)

Model Rockets Legalized in Riverside County, California

Launching Site Established at Prado Park

The Riverside County, California, Board of Supervisors have reversed that county's long standing prohibition of model rocketry. The action followed a recommendation from Robert T. Andersen, county administrative officer, to approve the use of model rockets within the county in a "controlled program of model rocket launching from specifically designated sites."

His recommendation came after a six month review of the county policy by his office, the County Forest Ranger, the County Counsel, County Parks Department, model rocket manufacturers, and several interested groups. After the review he said it was "my opinion that a controlled program would be workable."

Supervisors also authorized the County Forest Ranger in cooepereation with the County Parks Director to establish a model rocket program at the county's Prado Park. Andersen told supervisors that other launching sites could be established in other parts of the county as the demand for their existence was made known.

Last year a request for a site in the Coachella area was made by a fifth grade school teacher from the city of Coachella. The request is expected to be renewed immediately for a launching site in that area. Previously, supervisors rejected requests from both Corona-Norco rocket enthusiasts and the Coachella Valley enthusiasts but agreed to have the model rocketry program studied this year.

In his recommendation Andersen told the supervisors that he felt a rocket program could be "an educational value to the youth of this county." They adopted a resolution authorizing the State Forest Ranger to approve one or more rocket programs in the county to be administered in accordance with the state law.

The program will be limited to the Prado Park and "to other park areas in the county which are approved by the State Forest Ranger for this purpose."

Washington State Championship

The Nova III Club of Spokane will host the Washington State Model Rocket Association Aero-Modeling Championship I on August 2 and 3. Contest Director Mike Aronson has announced that events to be flown include altitude, payload, parachute duration, and boost glide duration. A trophy will also be awarded for the best workmanship done on any model at the meet.

Plans for the meet are progressing on schedule. The Nova III Club will have engines available for sale at a booth. There will also be a food stand.

The entrance fee will be $1.50 if paid in advance, or $2.00 for registration on the day of the meet. An additional 50 cents fee will be charged for each event entered. Contact Mike Aronson, Contest Director, c/o Washington State Model Rocket Association, 1100 7th Avenue S.E., no. 5, Puyllup, Washington 98371.

NAR Field Trip

Visit to NASA Lewis Research Center

NAR sections in Western Pennsylvania, Western Maryland, Ohio, and West Virginia will have an opportunity to visit the NASA Lewis Research Center this summer. A tour of the center has been arranged for Friday July 18. Presently Lewis is developing advanced nuclear propulsion systems for deep space exploration. The tour was arranged by the Leader Administrative Council of the NAR.

News Notes

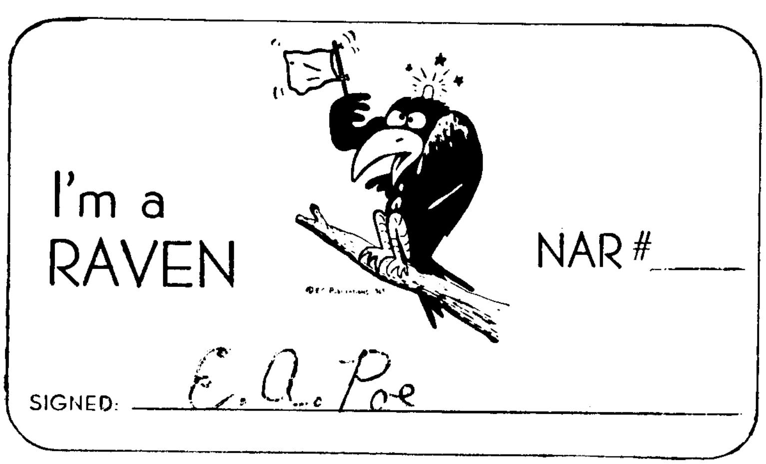
NAR Scale Modeling Group Formed

The Fairchester section of the NAR has formed a scale modeling group called the *Ravens.* The purpose of the newly formed group is to promote scale model rocketry amon NAR members. Each Raven is required to have at least five scale rockets operational at any one time. Plastic scale kits are excluded, and at least three different rockets must be modeled.

All NAR members meeting these qualifications are invited to join. There is no application fee, and members will receive the Raven membership card pictured. All members will also receive a bi-monthly newsletter featuring the latest information on military, research, and space vehicles.

To join the Ravens, send a 3 x 3 inch black and white photo of five of your operational scale models and your NAR number to the Fairchester Ravens, c/o Richard Sternbach, 30 Fawn Drive, Stamford, Connecticut 06905. Allow about 2 weeks for processing applications.

Several Fairchester Ravens will attend the NARAM in August, and will try to organize a Ravens meeting during the event.



The Model Rocketeer to be Featured in **Model Rocketry**

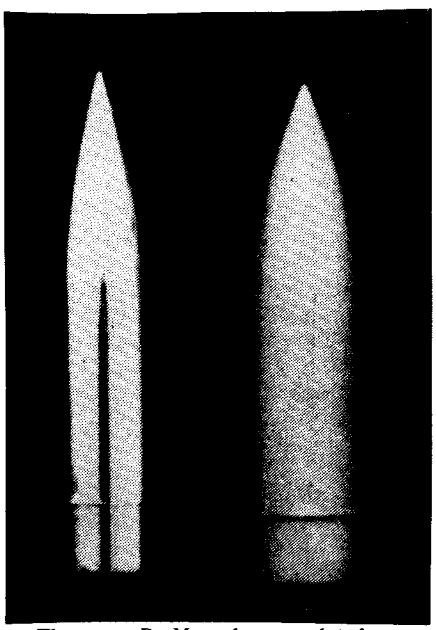
Beginning with the August 1969 issue, *The Model Rocketeer* — official newsletter of the National Association of Rocketry – will be featured monthly in Model Rocketry. Model Rocketry will be distributed to NAR members as part of their membership. *The Model Rocketeer* section, under the editorship of Lindsay Audin, will contain current contest news, section activities, technical reports, and information on services. It will be expanded from the present 1 to 2 pages to between 4 and 6 pages with its incorporation into Model Rocketry.

NAR Names Division Managers for Midwest and Southwest Section Activities

Robert Atwood, NAR Director of Section Activities, has announced the selection of Mel Severe and James Poindexter as Division Managers for NAR Section Activities for the Midwest and Southwest regions respectively. Severe, president of the Metro Denver Rocket Association, will have responsibility for NAR sections in Colorado, Nevada, Utah, Idaho, Montana, and Wyoming. Poindexter will be responsible for NAR sections in New Mexico, Arizona, Oklahoma, and Texas. Division Managers for the four other regions were named previously: Jay Apt, Northeast; Richard Sipes, Southern; Manning Butterworth, Mid-America; and Dean Boles, Pacific.

New Product Notes

The Bo-Mar Development Company has introduced ultra-high luster chrome-coated plastic nose cones. The cones are 3½ inches long, weigh 102 grains, and fit any engine size body tube. Priced at 75 cents each, they add instant brilliance and beauty to any model rocket.

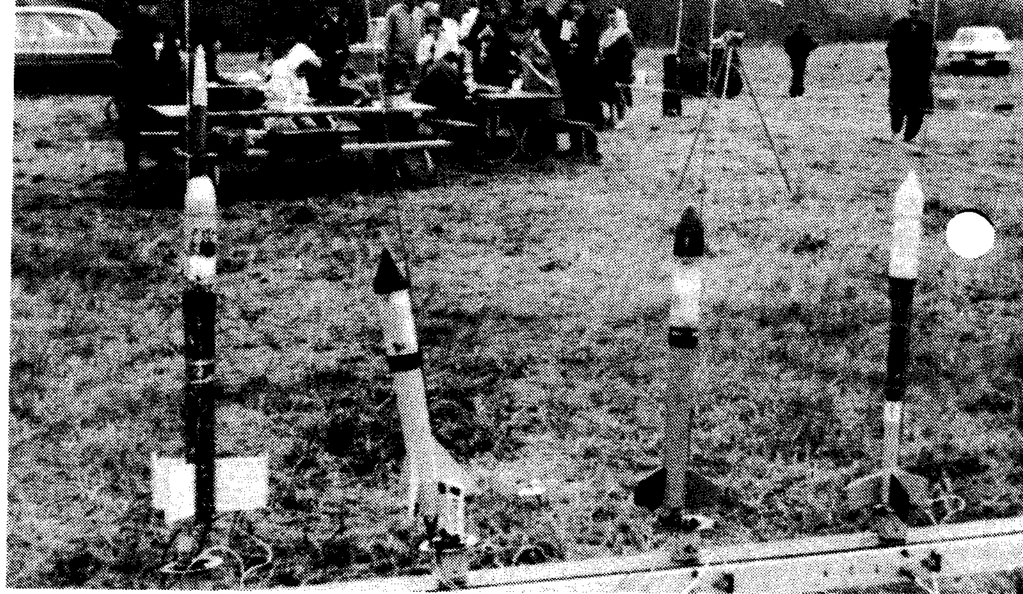


The new Bo-Mar chrome plated nose cone (left) is priced at 75 cents, while the beige plastic cone (right) sells for 50 cents.

Plain plastic nose cones, without the plastic finish, are also available from Bo-Mar. Weighing only 102 grains, these hollow nose cones can be used to house stabilizing weights, instrumentation, or recovery systems. Produced from neutral beige plastic, these cones are easily covered with enamel paints made for plastic models. Price 50 cents each.

Bo-Mar also announces their Flex-A-Pad Launcher, with tripod legs, extra large pad area fitted with 1/8 inch thick asbestos, 12 feet of zip cord, terminals, launch rod, and heavy duty battery clips. Priced at only $5.00, the Flex-A-Pad Launcher can handle 6 or 12 volts and ignite A through F engines.

Wenzel Engineering Company has just introduced an ideal two-staged demonstration rocket -- the Little Whitey. The rocket kit is completely prefabricated from styrofoam and balsa. Just under four feet tall, this not-so-little two-stager lifts off slowly and stages in full view of spectators. A full-size blueprint in professional aerospace style is included with the kit. Little Whitey is priced at $9.95 and can be ordered from Wenzel Engineering Company, 16 Newbridge Road, Hicksville, New York 11801.



All ECRM photos by Richard Sipes

Contest Director Jim Barrowman presents awards to the winners at the close of this year's East Coast Regional Meet (left). This year's entries included such strange birds as those on the eggloft rack (right).

Rocketeer competition was high at the first big meet of the year;

ECRM-3 NAR Competition

by Richard Sipes

On April 18-20, 1969, the NARHAMS section of the National Association of Rocketry hosted the 3rd East Coast Regional Meet (ECRM-3) at Camp A.P. Hill, Bowling Green, Virginia.

The sky was overcast and there was a threat of rain as most participants arrived at the launch site early Saturday morning. The crowd gathered for the opening ceremonies, where it was announced that ECRM-3 would be renamed the Carl Kratzer Invitational (in honor of the founder of the series). Carl has served as the NARHAMS contest and records committee chairman from the formation of the section to the end of the 1968 contest year. He is currently attending Cornell University in Ithica, New York. Carl's thorough organization and personal attention to details has been greatly missed by the section, especially at this large meet. Nine sections were represented by a total of 86 contestants, some of whom came from as far away as Pittsburgh, Pennsylvania.

SECTION STANDINGS

Section	Points
M.A.R.S.	1365
NARHAMS	1317
A.A.R.	498
R.C.	228
TOFTOY	220
S.S.B.	159
U.F.O.	96
NARCAS	93
STEEL CITY	63

The first contest of the morining was the Class 1 Parachute Duration portion of the Quadrathon event. The winds were from 10 to 15 M.P.H. and the modelers had to decide the proper size of chute to use. Under the Quadrathon rules, if you lose your rocket or cannot fly in any portion of Quadrathon, you lose qualifying points for the entire event. Some contestants played it safe and used twelve inch chutes, while others were brave and went to larger ones. Many rockets were seen drifting off into the next county; or like that kite of Charlie Brown's, into the nearest tree. Some very ingenious rocketeers called out the base fire department. The Army even supplied a chain saw, but the first yank broke the starting cord. Thanks to the Camp Hill personnel and the fire crew, some of the models were retrieved from their lofty perch.

The second event of the Quadrathon was Class 1 Altitude, and for the most part things went smoothly with some good altitudes. But due to overcast skies, quite a few tracks were lost.

Pee Wee Payload was the third part of Quadrathon, and people were frantically trying to find a payload weight they could use. Thanks to the good sportsmanship of the contestants, there were enough to go around. Again the modelers took to the pads, more determined to get a good flight than to put them back in the running for a place in the Quadrathon. Some very good flights were recorded, with altitudes over 300 meters. As the contest was nearing the end, the storm front predicted that morning started to move in. With the looks of the sky and the increasing wind, the contest director Jim Barrowman called an end to the day's proceedings and a hasty breakdown of the launch range began. Unfortunately the scale judging tent didn't make it through the wind. Several scale birds were in the tent when it came down, but only minor damage was done.

If someone had timed how long it took to pack up the launch area it would have set a record. Just as we made it back to the motel the rains came, and I do mean rains. For a while it looked as if we were going to have a flash flood and the outlook for Sunday was not too promising. Rumor had it that Jim Barrowman was hurredly building an ark. But this didn't dampen the spirits of the group—the boost-glide event could always be flown in the hallways of the motel.

During the evening an atmosphere of frolic prevailed. The contestants, oblivious to the weather, were ready for the next day's events. One unfortunate casualty of the evening was Andy Elliot of the NARHAMS section, who broke his arm in a fall. But after a quick trip to the doctor he was ready to compete on Sunday. Now there's a devout rocketeer.

The next morning it appeared the rains had stopped, but we had a new situation to contend with. During the night the temperature had dropped into the forties and fifties.

ECRM-3 MEET RESULTS

OVERALL MEET WINNERS

Division	Place	Name	Section	Points
Senior	1st	Paul Conner	NARHAMS	213
	2nd	Sipes Team	M.A.R.S.	144
	3rd	Howard Kuhn	M.A.R.S.	132
Leader	1st	Bob Singer &	NARHAMS	150
		Jim Stevenson	M.A.R.S.	
	2nd	Mark Mercer	NARHAMS	129
	3rd	Guy Norlin	Toftoy	105
Junior	1st	Chet Townsend	R.C.	174
	2nd	Tom Stevenson	M.A.R.S.	114
	3rd	Bill Kirsch	M.A.R.S.	99

QUADRATHON

Division	Place	Name	Section	Results
Senior	1st	Paul Conner	NARHAMS	386 Points
	2nd	Sipes Team	M.A.R.S.	23 Points
	3rd	Harry Cole Sr.	M.A.R.S.	13 Points
Leader	1st	Bob Singer	NARHAMS	697 Points
	2nd	Mark Mercer	NARHAMS	342 Points
	3rd	Guy Norlin	TOFTOY	258 Points
Junior	1st	Chet Townsend	R.C.	403 Points
	2nd	Bill Kirsch	M.A.R.S.	335 Points
	3rd	Alan Chaikin	NARHAMS	324 Points

SWIFT BOOST-GLIDER

Senior	1st	Major Ken Lyon	M.A.R.S.	113.5 Sec.
	2nd	Howard Kuhn	M.A.R.S.	54.6 Sec.
	3rd	Harry Cole Sr. &	M.A.R.S.	30.0 Sec.
		Paul Conner	NARHAMS	
Leader	1st	Guy Norlin	TOFTOY	9.3 Sec.
Junior	1st	Tom Burris	M.A.R.S.	172.3 Sec.
	2nd	Scott Snyder	A.A.R.	151.0 Sec.
	3rd	James Kerley	M.A.R.S.	58.1 Sec.

EGG LOFT

Senior	1st	Paul Conner	MARHAMS	228 Meters
Leader	1st	Jim Stevenson	M.A.R.S.	260 Meters
Junior	1st	Harry Cole Jr.	M.A.R.S.	313 Meters
	2nd	Carroll Yung	U.F.O.	288 Meters
	3rd	Kris Lyon	M.A.R.S.	268 Meters

SCALE

Senior	1st	Howard Kuhn	M.A.R.S.	D-Region Tomahawk
	2nd	Sipes Team	M.A.R.S.	D-Region Tomahawk
Leader	1st	Jim Stevenson	M.A.R.S.	D-Region Tomahawk
	2nd	Bruce Blackistone	NARHAMS	
	3rd	Mark Mercer	NARHAMS	
Junior	1st	Tom Stevenson	M.A.R.S.	Honest John
	2nd	Sam Atwood	A.A.R.	IQSYTomahawk
	3rd	Craig Kuhn	M.A.R.S.	IQSYTomahawk

Winners of the Egg Loft Event--From left to right; Paul Conner, Jim Stevenson, Carroll Yung, and Kris Lyon.

Winners of the Swift B/G Event--From left to right: Major Ken Lyon, Howard Kuhn, Paul Conner, Guy Norlin, Scott Snyder; front row Jim Kerley, and Tom Burris.

Tammy Guthrie sat huddled in her army blanket. People who had been wearing short sleeve shirts the day before now had to find something warmer. It was almost as if you were going to be soaked then baked on Saturday, then freeze dried on Sunday. The contestants that didn't get to fly in Pee Wee Payload on Saturday due to the storm flew their birds first. After the completion of Payload came the event most contestants seem to look forward to–the Egg Loft.

As the modelers prepared their birds, it became obvious that at least one "F" engine was going to be flown. Carroll Yung, of the UFD Section, normally has pretty good luck with this engine, though his demonstration flight at NARAM-10 went into the woods under power. Weathercocking and tipoffs were a problem with the new size eggs, and many rockets were seen burying themselves into the ground. *Oh Well!* you could always have scrambled eggs for breakfast the next morning. The luckiest flight of the day occurred when an egg capsule landed in the trash can just behind the launch area without breaking the egg. With the appearance of the molded capsules from Competition Model Rockets there were fewer broken eggs recorded, even when the parachute failed to open properly.

Next came the Scale flights. They were supposed to be flown from a separate launch pad during the boost-glide event. A loose wire caused a small fire in the pad and the event had to be moved to the main launch racks. Quite a few different models were entered, from a "D" Region Tomahawk to a Javelin. One of the most spectacular flights of the day was Tom Stevenson's Honest John. When his recovery system failed to deploy, the model buried itself about an inch into the ground. However, there wasn't a scratch on it when the model was brought back to the inspection area. Some contestants remarked that it must have been made of cast iron. It certainly looked like it, since it was modelled after the Army's design with a dull olive drab (as Jim Barrowman calls it) paint job.

The final part of the Quadrathon event was Streamer Spot Landing. The rocketeers spent quite a bit of time trying to aim their models to land right on the spot, only to find that by the time they were launched the wind had shifted and the model would land a few hundred feet away. This is the first time that the Quadrathon event has been flown at a regional in this area. It's a very difficult event to run, especially with 86 contestants, but the NARHAMS section pulled it off very nicely.

The last event of the day was Swift Boost-Glide and out came the Mantas. It seemed as if everybody was flying one. Again the wind took its toll of models and many potentially winning glides were last seen heading toward Richmond. Quite often the models would Red Baron as they tangled themselves in the pods or streamers.

The meet closed with the presentation of awards. NARHAMS went all out this year with the ribbons and trophies to be presented. For the Quadrathon event, Competition Model Rockets presented kits to the winners. The rivalry between the MARS Section and the NARHAMS Section again showed up, with MARS edging past by a score of 1365 points to 1317 points. A surprise was in store when the third place for the meet went to Annapolis Association of Rocketry with 498 points. AAR acquired 40 new members this winter, giving quite a boost to the club, I'm sure.

Thus ended another meet, and from this writer's opinion it was a complete success considering the number of contestants that attended. A good time was had by all!

Winners of the Quadrathon Event--From left to right: Paul Conner, Bob Singer, Mark Mercer, Guy Norlin, Chet Townsend, Bill Kirsch, and Alan Chaikin.

Winners of the Scale Modeling Event–From left to right; Howard Kuhn, Jim Stevenson, Bruce Blackistone, Mark Mercer, Tom Stevenson; front row Craig Kuhn, and Sam Atwood.

Add power to spare and avoid the problems of cluster ignition in the Estes Uprated Saturn

Convert the Saturn Scale to 'BIG F' Power!

by Harold Kritzman

The Estes Uprated Saturn 1 kit is a fine example of the beautifully detailed scale birds currently available from the manufacturers for the experienced model rocket builder. Such kits demand many hours of painstaking model construction. However, once you have completed each instruction perfectly, you should end up with a bird worthy of anyone's praise.

There is only one drawback to building such large scale models as the 1/100 scale Uprated Saturn 1; they require at least 3 or 4 A through C engines to lift them high enough off the pad for safe parachute recovery. As you probably experienced previously, the successful ignition of 3 or 4 clustered model rocket engines can be achieved usually only after the utmost care has been taken in setting the ignitors and a well charged car battery is used. It is still possible for simultaneous ignition of all the engines to not occur even after good clustering techniques are applied and, as a result, the beautiful large-scale bird will lift off the pad underpowered, and fall back to earth before the chutes are even ejected. It is sad, indeed, to see the face of a fellow rocketeer after he has witnessed his perfect rocket get severly damaged on its first flight due to faulty ignition of its clustered engine.

There are two obvious solutions to this problem. One is to build large, detailed rockets for display purposes only. Most rocketeers would consider this alternative a waste. A more desirable solution would be to remove the clustered engines and substitute the reliability of single engine power in their place. Such a switch can be accomplished using such port-burning model rocket engines as the FSI F 100-8 or the Centuri F 94 or F 55 with suitable delay times.

The cost of a single F 55, F 94, or F 100 model rocket engine is about twice that of four C6-5's, and the extra 10 Newton-seconds of inpulse carries the rocket only 100 feet higher than the full four engine cluster, but the worry of faulty ignition causing damage to the results of your many hours of careful labor is greatly reduced and the resultant flight is quite spectacular.

Photo by Norman Smith

Designer Kritzman with his converted Estes Uprated Saturn 1 prior to its first flight at the MIT Convention last April.

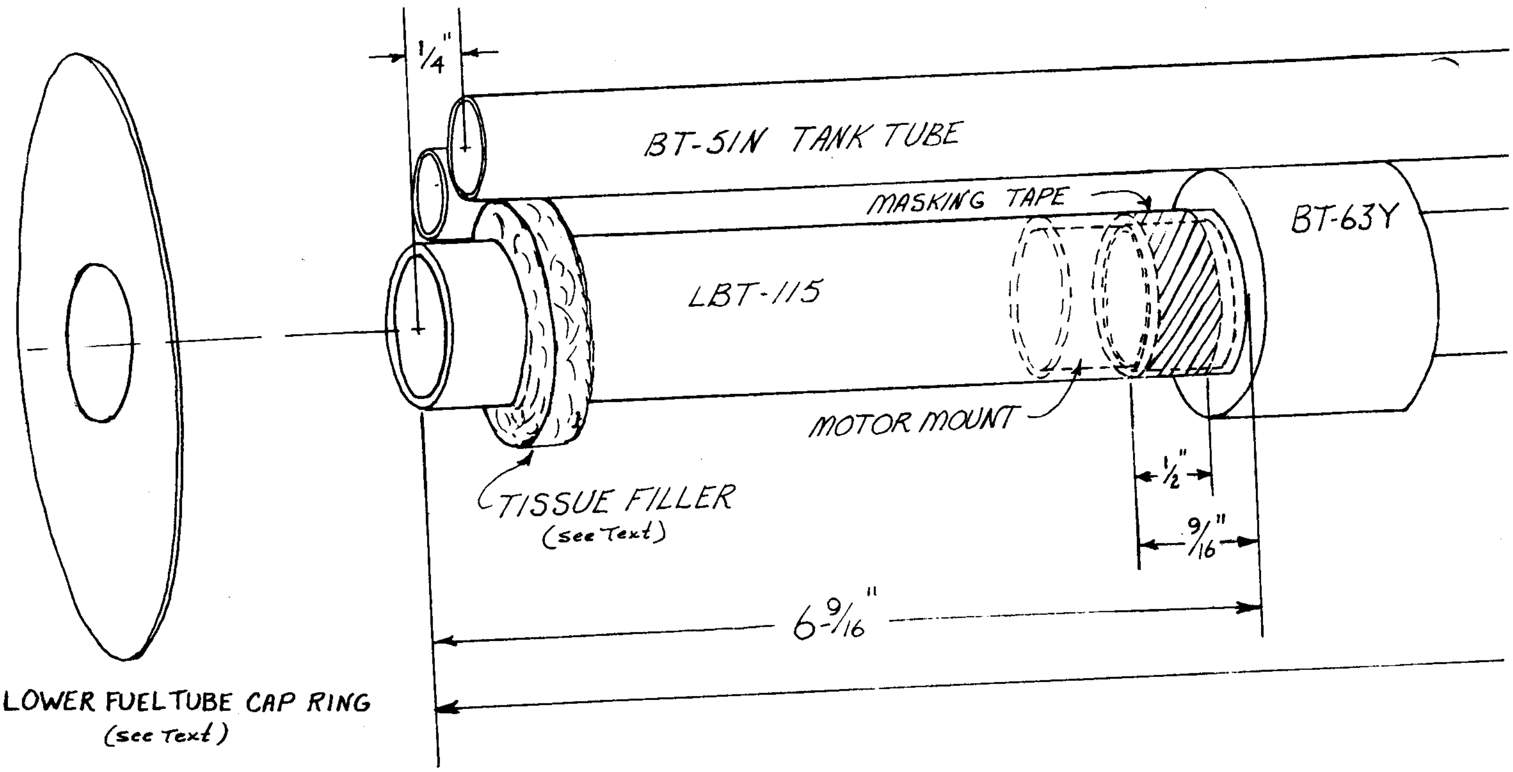
As a warning, do not attempt this conversion if you have had little or no experience with the very powerful F series engines; they demand extra-strong engine mounts and generous amounts of glue. Also, do not attempt to use the FSI F 7-6 or any other end-burning engine in place of the port-burners, since they do not have sufficient average thrust to lift and stabilize the 15.5 ounce converted Saturn.

In addition to the materials supplied with the Estes kit, you will need the following parts:

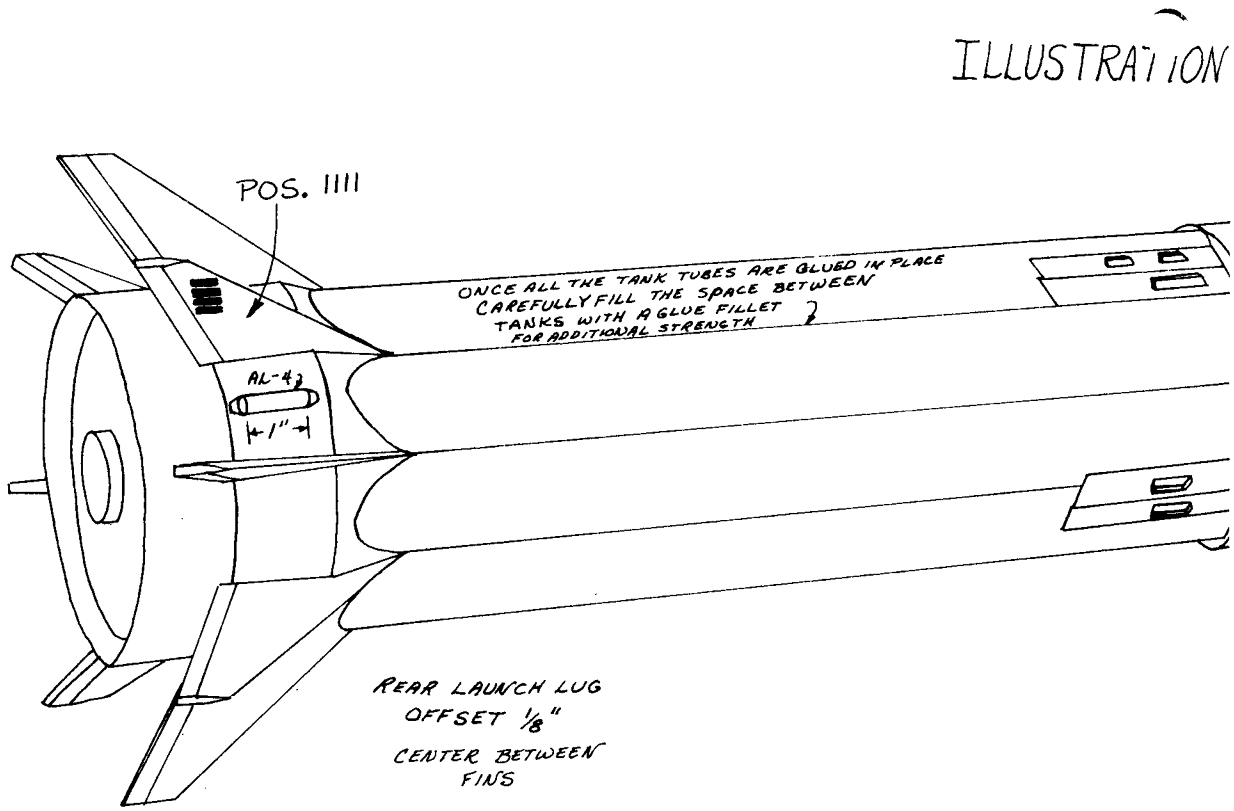
Centuri LBT-115 booster tube (8" long)
Centuri AL-4 (2" long)
Estes 651-AP-1 heat resistant paint
FSI MM-201 motor mount
Titebond or any very strong white glue
1/2" wide masking tape
Tissue paper
Estes 651-GR-2 gauze reinforcing material
Modeling knife, paints, and metal cutting saw

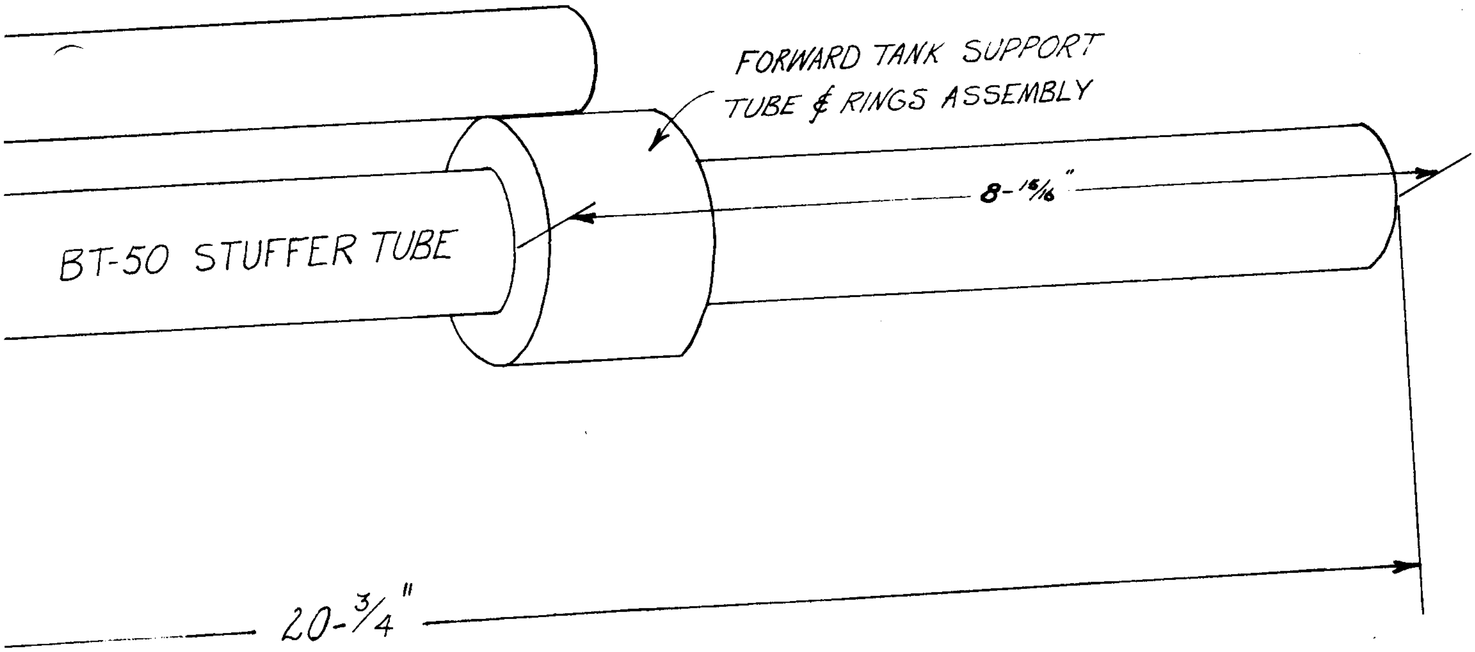
To begin conversion of the Saturn 1 to 'F' power, refer to panel one of the Estes instructions and compare it to illustration one. Disregard any instructions which deal

ILLUSTRATION ONE

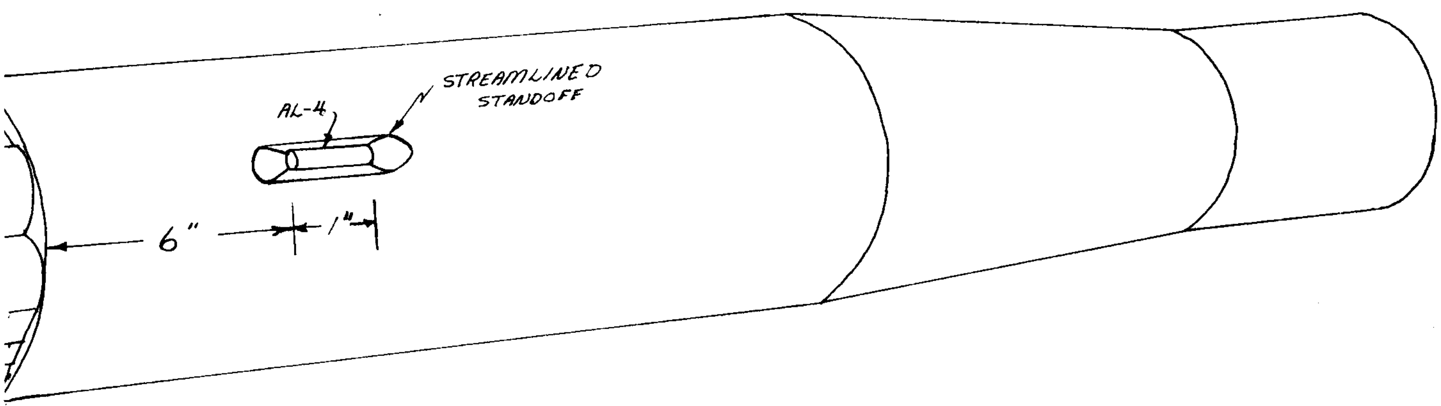


ILLUSTRATION





TWO



FORWARD LAUNCH LUG
OFFSET 1/4"
ALIGN WITH REAR
LUG

DESIGNER	DATE	DRAWN		DATE
H. KRITZMAN	4/30/69	H. KRITZMAN	H.K.	4/30/69

"F" ENGINE CONVERSION

ESTES UPRATED SATURN I KIT

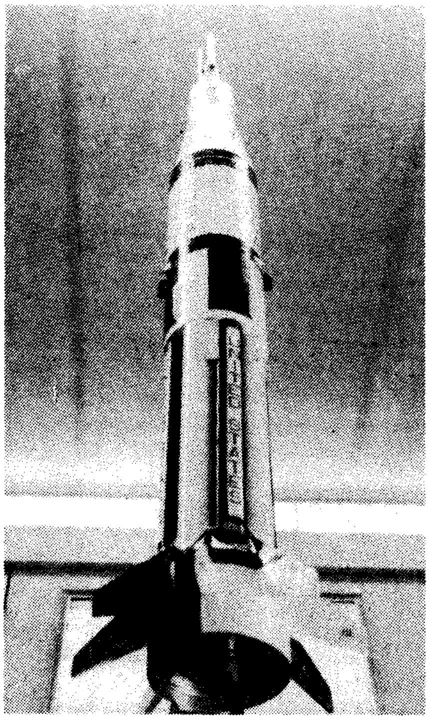
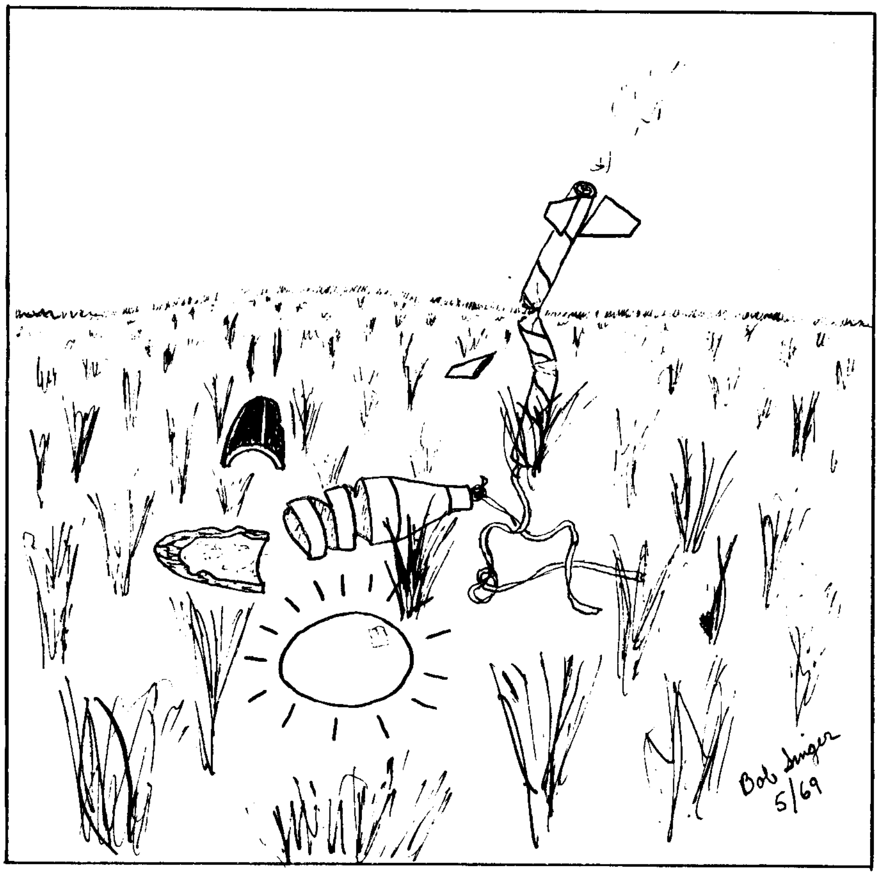


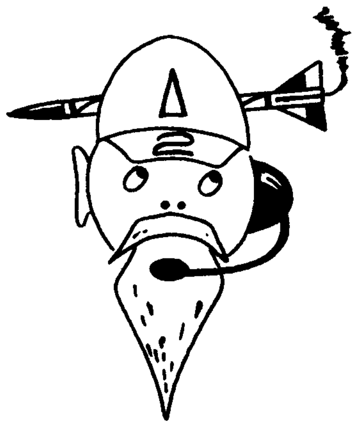
Photo by H. Kritzman

View of the converted F-engine powered Uprated Saturn 1 showing the engine in place.

with the making of the four engine tube assembly and do not slot the BT-63Y or any of the "fuel tank" tubes. Cut the BT-50 Stuffer tube to 15-5/16" long. Cut the LBT-115 booster tube to 6-9/16" long. Remove the shock cord cable from the FSI MM-201 motor mount if you find one attached and insert the motor mount as illustrated. Be generous with the glue, and be careful to place it all around the surface where the engine mount will be seated in the engine holder. Allow the engine holder and mount to set completely. The forward tank support tube and rings assembly should be made and placed 8-15/16" from the forward end of the Stuffer tube. Now make an identical support tube and rings assembly from the uncut BT-63Y and slide it onto the rear of the BT-50 Stuffer tube 9/16" from the end. Glue this assembly into place. Take the 1/2" masking tape and wrap it around the rear end of the Stuffer tube until it is just the right size to slide tightly inside the engine holder against the engine mount. Before you glue these two sections together, take the heat resistant paint and coat the inside of the Stuffer tube as far up as you can reach. Now glue these sections together very carefully and keep the pieces aligned until the glue sets. The completed assembly should be the same length as the original. Place the eight BT-51N "Fuel Tank" tubes around the stuffer tube just as in panel one. Since these tubes no longer provide support directly to the engine tube assembly as they did in the unmodified kit, tissue paper, wet with glue, should be inserted into the space between the engine holder and the tank tubes as illustrated. Also glue each tank tube to the adjacent one to provide additional strength to the whole rear assembly.

You may now continue construction of the Saturn exactly as Estes instructs until the Lower fuel tube cap ring is to be glued in place. Be careful when you are removing the cap ring from the sheet not to punch out the clover-shaped hole in the center. Instead of removing these four punch-outs, coat the back-side of the cap ring with glue to secure them in place. When it is dry, trace the engine holder around the center of the cap ring and cut it out. Now you may glue the cap ring in place. Continue construction as per Estes instructions until the placing of launch lugs is discussed. Because of the heavy weight of the modified Saturn 1, it is advisable to use the Centuri AL-4 and a 3/16" diameter rod at least four feet long. A rail sytem can also be used. Refer to the illustration for instructions on applying the lugs. Do not use a retro-rocket housing to hide one of the launch lugs as Estes instructs. A 3/16" aluminum launch lug should be secured in place with gauze wet with glue. All other instructions are the same as for the unmodified kit.





The Old Rocketeer

by G. Harry Stine NAR#2

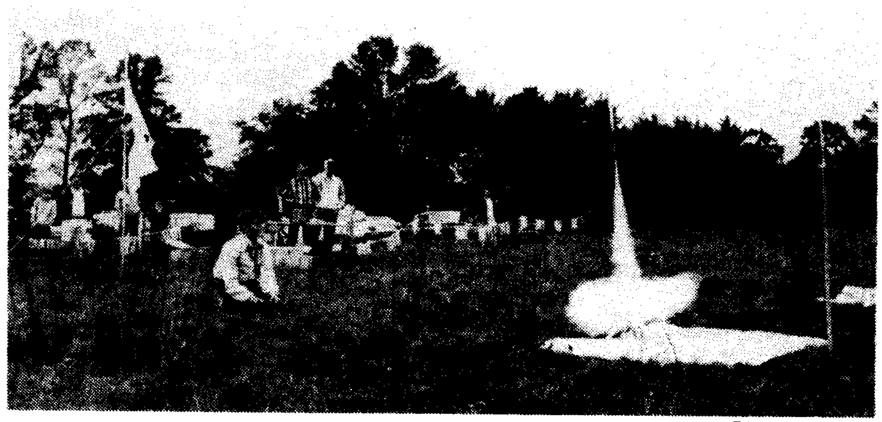


Photo by Stine

The YMCA Space Pioneers' Misfire Alley range in operation as Dave Vesey launches. Behind him at range control are Steve Englund as Range Safety and Jon Besson, with headset on, giving the count from Range Control. Note the banners on the barrier separating the firing areas from the prep and spectator areas. Also note that tarps are used under the launchers to prevent grass fires.

Way back in 1957-58 when today's model rocket range procedures were being laboriously worked out, based on range safety procedures and philosophy that had been pounded into me down at White Sands Proving Ground by Nat Wagner and Herb Karsch (who in turn learned the hard way with the German A-4), we didn't have nichrome igniters and no manufacturer made a simple electrical firing system. As a result, the familiar launching rack system of club flying was worked out. I'm sure you all know about it—the club buys and builds a multi-launcher rack using saw-horse hardware, plus a multi-launcher firing panel capable of handling all the launchers on the rack, plus the P.A. system, plus the big auto battery that is needed to operate everything. (And if you don't know about it, look it up in the *Handbook of Model Rocketry*.)

And I suspect that there isn't a model rocket club in the world using the rack system of launching that hasn't had troubles—who is responsible for keeping the firing panel in good condition, who charges the battery, who replaces the firing clips, who keeps the rods clearn, who repairs the P.A. amplifier, and who drags this pile of stuff to and from the range on firing day?

But when 1965 rolled around and I was asked by Phil Rose and Dick Ploss to start the New Canaan YMCA Space Pioneers model rocket club, I saw the opportunity to start fresh with a whole batch of new ideas. One of these was an entirely new system of operating a model rocket range.

It was Dick Ploss, now head of the Long Beach, California, YMCA, who tagged it "Misfire Alley," a name it doesn't deserve, really.

Basically, to cover some material that is in the *Handbook of Model Rocketry* but which, apparently, nobody at all has read carefully, Misfire Alley is a Cape Kennedy style of range. there are large 6" x 6" signs on 5-foot posts denoting the launch areas or launch points. These are strung out on a line with about 10-15 feet between launch points. The launch points are numbered from 1 to whatever highest number you want; in New Canaan, we use 12 launch areas and have rarely needed to have more than this.

In the Misfire Alley system, everyone who wants to fly supplies his very own personal launcher, firing system, and firing battery! Every manufacturer makes one today. They are included in every starter kit. So we do not have the same situation that prevailed when the rack system was developed.

Everyone chooses his own launch area and sets up his own launcher and firing system as shown in the drawing.

The only range equipment needed is (a) a P.A. system with loudspeaker and microphone, which is required or needed on all ranges anyway, (b) the launch point number signs and posts, which can be packed away into a surplus Army footlocker for transportation and storage, (c) a barrier and barrier poles, which are used on all ranges anyway to keep the spectators in their proper place, (d) two tables and two chairs, (e) a flagpole, and (f) a tracking system and communication system.

None of this Misfire Alley range equipment is difficult to make nor is any of it highly specialized—except the P.A. system and the communication system, which require some knowledge of electronics, but which can be purchased in kit form these days. If you build the P.A. system correctly with solid-state devices, it should never give you any trouble.

All of this equipment will take a tremendous amount of beating and doesn't require any maintenance whatsoever except charging up the range P.A. system battery if you use a wet cell; modern P.A. systems can run on dry-cells, and it then becomes a problem of just replacing flashlight batteries.

In the YMCA Space Pioneers Section of NAR, we're now into our 4th year of use with our Misfire Alley range equipment. We had to replace the original Hot Shot battery that we had in 1966 for range communications power, and we got a wet cell auto battery that we keep on trickle charge using a model train power pack. (Trickle charge: keeping a lead-acid wet cell battery on a constant current charge with a current less than 1% of the amp-hour rating of the battery or less than 10% of the 16-hour charging current of the battery.) We've had to repair the original RDC Sta-Put trackers several times to replace broken bubble levels, and we've modified the RDC trackers extensively. We've had to repair the range communications wire a couple of times to fix bad splices. But that is the total amount of range equipment maintenance we have had to do, and would have had to it anyway, regardless of whether we had the rack system or the Misfire Alley system.

We have *not* had to replace firing clips, exhaust deflectors, rods, firing leads, firing switches, or all the other pesky things that need continual maintenance with the rack system.

With Misfire Alley, you *always* have a launcher available to you, whenever you want it. It's your own. When you get ready to fly, you present your model for safety check at the safety table next to the range barricade gate. If the bird checks out, you then proceed to your launch area...making sure you have your safety key in your hot little hand. You approach your launching point from the range control side, being careful not to cross anyone else's launch area as you do so. Strangely enough, this has posed no safety problems in Misfire Alley because it's a double-check system: you look out about crossing somebody else's area, and he is on guard against you doing it, too, if he has a hot bird on the pad.

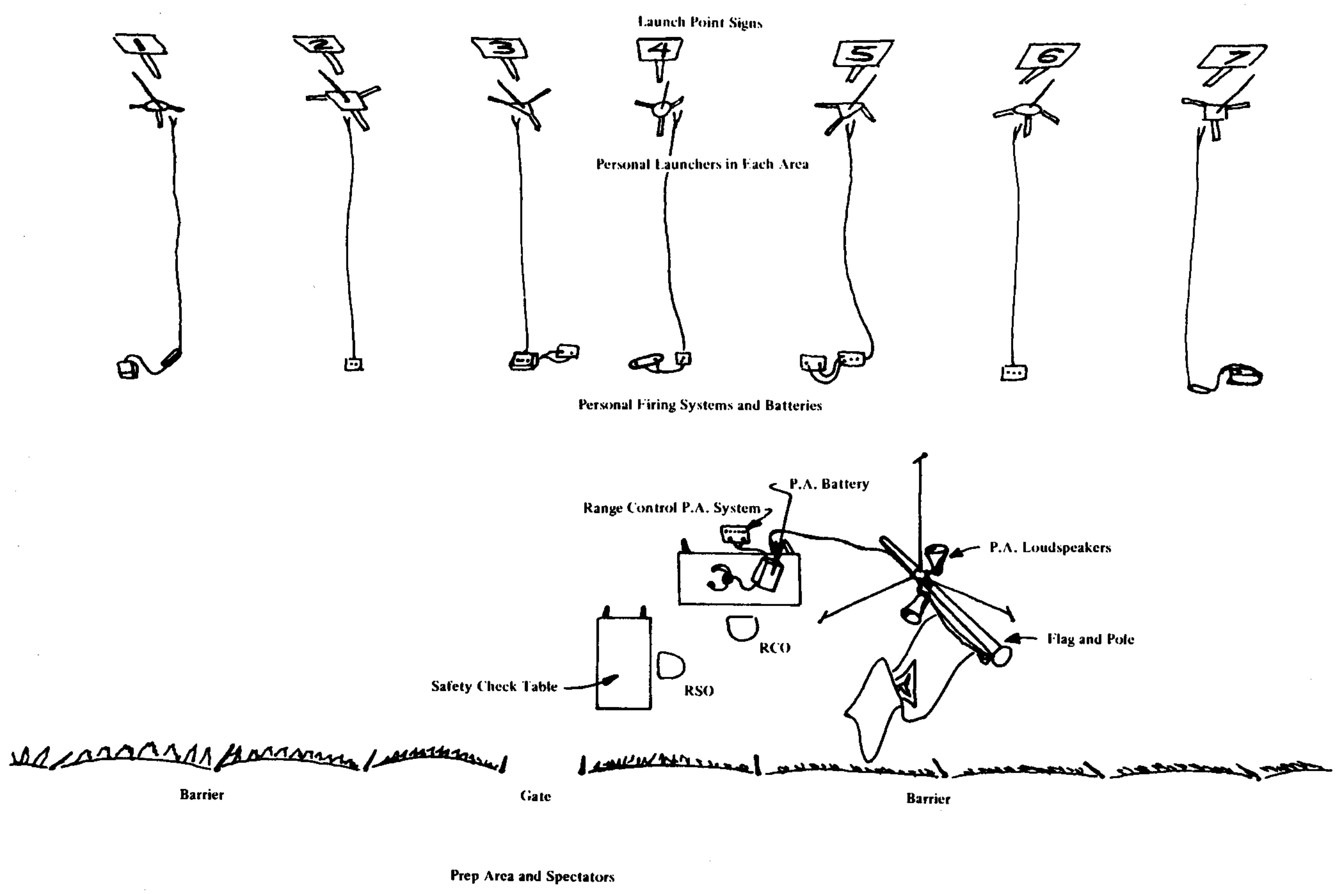
You can put your own bird on your own launcher and hook up your own firing system. If you want to tilt your launcher to correct for weathercock or to put your bird into the proper downrange area, you can do this easily and quickly. In fact, once a person has flown from Misfire Alley for a couple of sessions, it becomes quite a bother to fly from a rack where there is no option for launcher tilting. Furthermore, the proximity of the models on a rack seems to be far too close after you've gotten used to the wide open spaces of Misfire Alley. No, having a model lift off only 10-15 feet away from you doesn't bother you in Misfire Alley after the first time; it is perfectly safe to be in your own launch area hooking up while a bird is being counted down and launched from the area next to you.

When everything is ready to your own satisfaction, you retire to your firing point and raise your hand to indicate to the Range Control on the P.A. system that you are ready to go.

In Misfire Alley, the Range Control Officer really runs the show. He does not push firing buttons, His only worry is range operations. He keeps his eyes open for raised hands on the firing line and assigns priorities for launching sequence. He calls up the trackers and advises them of the launch area, model, color of model, and other factors of an up-coming flight. He maintains safety and discipline on the range, reinforced by the Range Safety Officer. When he is satisfied that the range is ready for the flight of a given model, the Range Control Officer is the one who gives the count-down over the range P.A. system after the Range Safety Officer has given launching clearance.

The modeler himself inserts his own safety key and pushes his own firing button, If there is a misfire, it's *his own fault , and he can't blame the club. It's his own firing system, battery, and launcher.* If his clips are dirty, it's his fault. If his battery is too small or too weak, he'd better get on the ball and get a battery that will haul the mail for him.

A modeler has trouble with his launcher and firing system only about twice (at the most) before he smarts-up and gets himself some equipment that will do the job for him. In the process, he learns much more about electrical theory, electrical wiring, batteries, and ignition systems than his compatriot in a club that uses the rack system.



A typical club launch site using the Misfire Alley system.

We have never had a safety problem using the Misfire Alley system. We have never required modelers to turn in their safety keys to the RSO and pick them up only when ready to launch; this would cause far too much confusion and delay. We have had two burned fingers on the range, both caused by faulty wiring of the firing system ...so now we have a pre-launch firing system check-out for safety before the first flight of each day.

Flying on a Misfire Alley range is relaxed. You fly when ready from your own equipment. It has lots of room and is spread out.

An abortive Misfire Alley system was tried at the 8th National Model Rocket Championships, and everybody came away afterward convinced that the Old Rocketeer was out of his tree when it came to the system. Let me state here and now that NARAM-8 did *not* use the true Misfire Alley system. It had a central range firing battery, a central range safety switch, inadequate wiring (No. 22 bell cord), and only 8 launch areas. Of course, that system wouldn't work! Misfire Alley is an individual responsibility system. NARAM-8 tried to insert an overall master control into it, and that doesn't work. In addition, there weren't enough launch areas. There should have been 18. We have been able to fly Regional Meets with 12 launch areas.

In some cases, people double-up on launchers with two or more modelers flying from the same launch and firing equipment. In other cases, two or three different launchers and firing systems have been set up in the same launch area. Since the probability of two or three modelers on the same launch equipment wanting to fly at the same time is low, there is rarely a conflict. For two years, the three Stines flew off the same equipment together. And the chances are, if you're really hot to fly, haven't brought your own launcher, or are up against some glitch in your own equipment, somebody else will let you fly off his equipment for the afternoon.

Misfire Alley is flexible and permits this sort of thing without getting tied up in knots.

Misfire Alley also encourages the "loners" in town to come and join in, eventually joining the club itself. These loners have gotten used to flying on their own, pushing their own button, and doing their own thing; often, they do not care for the super-collectivism of a rack system where somebody else decides when their bird will go and pushes the button for them. We Misfire Alley Addicts have gotten to the point that, when we go to another range, we will always take along our own launchers anyway, setting them up alongside the rack. If the host club insists on using the rack system, we will ask to use our own launchers on the ground behind the rack, but with the rack system firing leads attached. If worst comes to worst, MA Addicts will fly off a rack...but with the same queasy feeling about the closeness of the models that a Rack Addict feels when he is in Area 2 with a bird launching from Area 3.

There is absolutely no question about the fact that a Misfire Alley range, run according to Misfire Alley philosophy, works and works safely. The YMCA Space Pioneers have worked the bugs out of it since 1965 when we first experimented with it. I have not heard of other clubs using Misfire Alley, and I often think that we are a lone voice crying vainly in the wilderness. Maybe the rumors of the debacle of NARAM-8 have frightened or otherwise biased model rocketeers, but I hope that this article has straightened out the story about NARAM-8. Perhaps I can convince others to try Misfire Alley now, so that they can discover from their experience that the Old Rocketeer ain't off his bird after all!

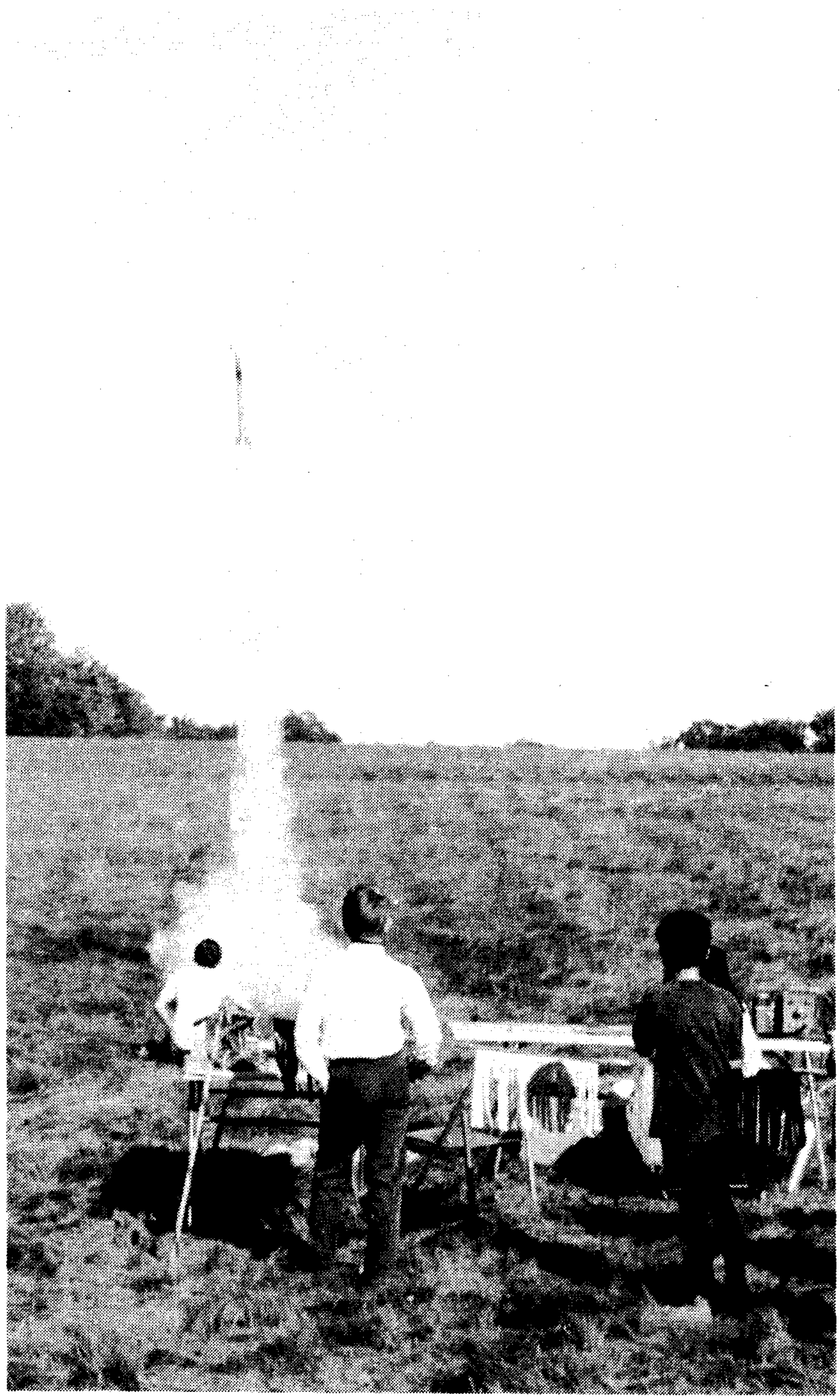


Photo by Stine

Peter Spielman of the YMCA Space Pioneers launches a Centuri "Scorpion" with an F engine from the club's Misfire Alley in Waveny Park, New Canaan, Conn.

Model Rocket Bookkeeping Made Relatively Simple

by Kevin Barkes NAR #12335

Well, fellow rocketters, it's time for a nostalgic look into the distant past– yes, back to your very first model. If you're like me, you constructed it in record time. It had four fins (three if the glue didn't dry), and used the *fragmentation* recovery system. After awhile, I looked at the packing materials, and hark–behold the strange piece of literature named the *Model Rocket Data Sheet*. At first I carried a few sheets along just to look sophisticated to the younger members of the cult. After being expelled from our flying field (town officials, like the NAR, do not observe the fragmentation recovery system as a safe way to terminate a flight) I took another look at those sheets with the fancy printing on them. After a thorough search, I found another field. This time, I kept careful records of each flight–this not only looks good, but convinces officials that you are sincere.

There are many advantages of having a record of each flight:

1) You can verify that you did or did not fly certain rockets at certain times;

2) You have a record of the performance of your rocket;

3) By preserving the record flight of the rocket, you can tell if other designs along the same line will function with a good degree of safety;

4) You can judge for yourself if the engine sizes are up to par for the performance you expect.

On the next page, there is an example of a typical flight data sheet, which is used by my club–Homestead Missile Research. Your own data sheet may have more or less information spaces. The reverse side is blank, so that additional information can be added. A good data sheet should have the following essentials:

1) Name of your organization;

2) Rocket name or model number;

3) Location of flight;

4) Date and time of liftoff;

5) Weather data, including temperature, wind speed and direction, humidity and visibility;

6) Payload and instrumentation data, including condition of payload before and after launch;

7) Basic rocket data. In this catagory, you can be as detailed or as simple as you want. Usually, though, it is best to enter as much information as possible, and even include a picture or drawing of the rocket. There can then be no confusion as to what rocket it was, if you fly rockets of similar configurations.

8) Launching data. Usually, this is the most limited catagory. Accordng to the NAR rules, you are supposed to use only an electrical launch system. So, put down other basic information, such as type of launch (rod, C-rail, or tower), and launch angle.

9) General remarks. The altitude (altazimuth figures can be omitted, if you want) and all computations can be done either on scrap paper or on the back of the sheet. Remarks is a rather general and large subject, and covers a great deal of territory. Use your own judgement.

10) Engine specifications. On this subject, let's hope you are using NAR approved engines. If you fly in a limited area, forget about any engine that is larger than C. You'll only be wasting your time and money and endangering someone else's property or health.

11) Firing data. This includes flight characteristics, etc. Again, use your own judgement. Design your flight sheet for yourself. Like an insurance policy, "It should fit you like a glove."

Perhaps you've noticed that some of the information repeats itself, such as altitude, visibility, recovery system, and velocity. The reason is simple: in the event that someone wants to know how your rocket was fired, you send them Launching and Firing data. The information included there should satisfy their hunger. Who, you may ask, would want to see my flight sheets? So far, my records have been "requisitioned" for study only by the local officials. This is because, dear friends, that to most adults the sport of model rocketry is nothing more than a glorified firecracker outing. So it's best to be formal. Don't sneak into the football field at six in the morning. Make everything, right down to the last impressive detail, look official. I thank the NAR for its bulky membership card. It looks very official and the word *National* gives your friendly police the idea that there is more than just one of you.

I can sense, even as this is being written, the thought lurking in the backs of your minds: *"What the heck does he think we are? We can't afford personalized data sheets!"* Ah, my friends, but you can. If your school has a mimeograph, ask them if your club can use it. Usually they'll be more than happy to oblige.

If your club has an ample amount of money in its treasury, you can have your sheets printed. Our club got data sheets at a low price because we knew the local printer. Otherwise, one-thousand sheets will run you about $20. But please, don't go to the printer and ask for only one-hundred or so. The basic price is about $16, which includes typesetting, rent of equipment, etc. After that, you're paying for the paper. With luck and little searching, you should be able to get data sheets printed up at a reasonable expense.

After you have your sheets, it's best that you devise a filing system of relative simplicity. Our club uses this one:

The rockets are divided into four groups: Single staged, Multi-staged, Clustered, and Test or Experimental models. Under each of these groups, divide them alphabetically. Your rockets should then be in this order: Alpha, Beta, Centaur, Delta, etc. Sub-divide these groups into chronological order; that is, put the first flight first, second next, then third, etc. When the rocket is either lost or retired from flight, the file on that certain rocket is closed–no more entries will be made. To aid in processing of data, it is best to attach a photograph or drawing on the upper part of the sheet.

If your launching will be covered by the fourth estate, remember one thing– they're out for sensationalism. If you have any really outstanding flights, make copies of the data sheets and present them to the press. It will look scientific, but the altitude and dimensions of the rocket are the thing they'll be after. If your ego is hurt by the fact that they don't even mention that you used a symmetrical airfoil, secant designed nose cone, remember–*they won't understand it anyway!*

Data sheets make a nice addition to your library and raise your esteem among officials and residents in your locale. They can also help keep you out of trouble, as

ROCKET
DATA
SHEET

Rocket No. 102

Name or Model No. Windy-II

HOMESTEAD MISSILE RESEARCH

PLACE W. Mifflin North High School Ballfield

DATE 4/24/69

WEATHER DATA:

Temperature 68 deg. F

Wind Direction West

Wind Speed 5-7 m.p.h.

Precipitation none

Visibility (Grd.) good

Visibility (Air) excellent

Appx. Ceiling 18,000 ft.

Humidity 50%

SPECIAL DATA

Launch observed by 2
W.Miff. officers.

INSTRUMENTATION

PAYLOAD (If Any)

Type

Weight

Condition

ROCKET DATA

Name Windy II

Length 22.5"

O.D. 1.325"

I.D. 1.283"

No. Fins four

Type clipped delta

Nose Cone BNC-55AC

Recovery System 18" chute

LAUNCHING DATA

Type Rod

Means Electrical

Angle Vertical

REMARKS:

Visibility Excellent

Range 200 feet

Est. Alt. 800feet

Real Alt. 840 feet

Speed 450 fps max.

Time 41 sec. tot.

Payload none

Recovery 18" chute

Rocket flew with good stability, only slight spin. Rocket fell 200 feet before parachute deployed due to improper packing.

ENGINE SPECS.

N.A.R. Code Designation B 6-4

Total (Max.) Thrust 48 oz.

Average Thrust 6 newtons

Type Estes Series I

Prop. Wt. 0.01374 lbs.

Max. Wt. 4.5 oz. lift-off.

FIRING DATA

Time of Firing 4:30 pm

Misfire

Reason

Action Taken

Takeoff Normal 4:31 pm

Est. Alt. 800 feet

Flight Behav. good stability

Burning Time .83 seconds

Est. Vel. 450 fps max.

Part. Failure parachute delay

Total Flight Time 41 sec.

Impact 200 feet downrange

Remarks Flight O.K.

evidenced by the following example:

One Sunday, a friend and I decided to fly a new design, and to get some experience at photographing rockets in flight. The launch pad that we were using was an old type with a long spindle that had a knack of breaking off at untimely moments. So friend John and I went merrily off to a field behind the local high school and, I might add, two hundred yards from the local police station. We set up all our equipment and, as luck would have it, the spindle broke. We thrust the launch rod into the ground, and placed the rocket on it. To our surprise, it worked perfectly All was going well until we noticed some commotion among our audience. They were usually unattentive and merely glanced in our direction when a rocket took off. Today, however, they had just cause to be excited as, cruising up in our direction was a local police car.

I eyed the observers carefully and stalled as much as I could.

After about five minutes, one patrolman got out of his car and came towards us. His hand lightly touched the revolver at his side. Suicide was the main thing on my mind (it's strange what the mind thinks in such situations). I thought that he was going to ask of me FAA-ACT flight clearance, or that he was one of the few people who knew that model rocketry was illegal in my state.

He reached us. Immediately I whipped out my license. He asked me what I was doing. I said, in a high falsetto, that we were flying model rockets. He asked me if I had a permit. I showed him my NAR license. He glanced at it, still not satisfied. My companion showed him his photographer's press card from the local newspaper. He still looked unimpressed. He ordered, in a booming bass, "Fly one."

I fumbled through my range kit and came up with the data sheet seen on the preceeding page. I wrote, in pencil (the latter was typed after I reached the safe confines of my suburban abode) approximate wind speed, etc. I then politely requested the officer to move back with me to the 25-foot mark. He just stood there, a mere seven feet from the launcher. Again I asked. Again, no response. I picked up my trusty altiscope, and took my place. My companion took his place at the launch button, camera in hand, breath coming in short nervous gasps.

The countdown began: "Ten, nine, eight"–I wonder if a fourteen year old can be arrested for arson–"seven, six, five"–and after I just spent ten bucks to replenish my range kit–"four, three, two, one"–my life started to flash before my eyes–"liftoff," I squeaked. Luckily, the rocket flew straight and true. The ejection charge opened exactly on time! However, in my haste and fear, I had forgotten to repack the chute, which had been in the rocket all afternoon. The rocket plummeted earthward. It fell fifty, a hundred, two hundred feet–and then, like a trumpet from heaven, a reassuring "pop" resounded. The rocket floated gently to the ground. The officer, who had been watching the flight with narrowed eyes, looked at me, shook his head, and walked off to his car. As they drove off into the sunset, I completed the information on my data sheet.

You may question my saying that a rocket data sheet saved my life–but every once in a while, I go up to the station; the officers like my NAR license and those "scientific" sheets I carry around with me.

q & a

I was wondering if you had plans or knew someone who had plans for a small *MULTI*-channel transmitter. I am considering sending a transmitter up in a rocket. I was considering the transmitter in the *NAR Handbook* but I would like several channels insted of one.

Dennis J. Colarelli
Arvada, Colorado

According to G. Harry Stine, an eight-channel AM-FM model rocket transmitter was developed by Grant Gray of Littleton, Colorado around the year 1960.

Unfortunately, the plans for this device were never published anywhere to my knowledge, and the design is unknown to me and to anyone I have been able to contact about it. We have no information whatsoever regarding any other multi-channel transmitting device, and it is unlikely that any other such transmitters were ever built. Model rocketry has yet to get a decent amount of date from *single* channel transmitters!

If you have never built a model rocket transmitter before, may I suggest that you try the one published in the May issue of **Model Rocketry** and see what kind of useful data you can take with it before you get into more complicated, multi-channel devices. It's a fair bet that before you exhaust the possibilities of single-channel telemetry, we'll have a multi design for you to work with.

Any questions submitted to this column and accompanied by a self-addressed, stamped envelope will be personally answered. Questions of general interest will also be answered through this column. All questions should be submitted to:

Q and A
Model Rocketry *Magazine*
Box 214
Boston, Mass. 02123

The 'Goliath' is a 2-stage sport rocket designed for the beginner in multi-staging or flying in limited space. It will reach altitudes of 600-800 ft. with ½A-6, series III engines. The 8" chute is sufficient to return it from this altitude with no damage.

To insure firing of the upper-stage engine, I usually install a small piece of Jetex in the nozzle before taping (Jetex is available at your local hobby shop).

When installing the engines, wrap them tightly together with a piece of cellophane tape without overlapping. This technique is described in detail in Estes technical report TR-2 (multi-staging). It is advisable to read this report before flying the Goliath.

Assembly Instructions

1) Cut one 6" long Estes BT-20 tube, and one 1¾" long BT-50 tube.
2) Cut the Estes EH-2050 engine holder down to 1¾" long and install an engine block flush with one end. Then, glue the assembly together and install it inside the 1¾" BT-50 tube.
3) While the booster section is drying, start cutting the fins. Cut both sets from 1/16" thick balsa. (The fin pattern from the drawing is full scale.) Remember the grain direction when cutting. Sand these to an air foil shape; round leading edges and sharp trailing edges. Apply 2 coats of balsa filler, allow it to dry and then sand to a smooth finish.
4) Install the other engine block inside the 6" tube 1¼" from the end.
5) Sand and fill the nose cone and install a screw eye in the bottom.
6) Attach the 8" long shock cord in the tube folding it in a piece of paper and then gluing it, leaving enough room for the nose cone to fit. Tie and glue the other end of the shock cord to the screw eye.
7) For the chute, cut a piece of plastic bag or chute material to form an 8" chute. Cut and install the shroud lines, making each 8" long. Tie the lines to a snap swivel and attach to nose cone.
8) Copy the paper shroud pattern onto a heavy piece of paper and cut out. Form a conical shape, glue it together, and glue it to the top of the booster section making sure that it is straight.
9) Mark off the 6" tube 90° and glue fins onto it: apply 2 fillets of glue when dry and set aside to dry.
10) After the paper shroud has dried on the booster section, mark off 90° for the booster fins, glue and apply glue fillets.
11) Cut the launching lug and also a piece of balsa strip that will bring the launching lug away from the tube enough so it won't ride on the booster section. Make sure when glued on, it doesn't line up with a fin on the booster section.
12) Sand and paint as desired. Use bright colors to make easy recovery.

GOLIATH

by Al Bean

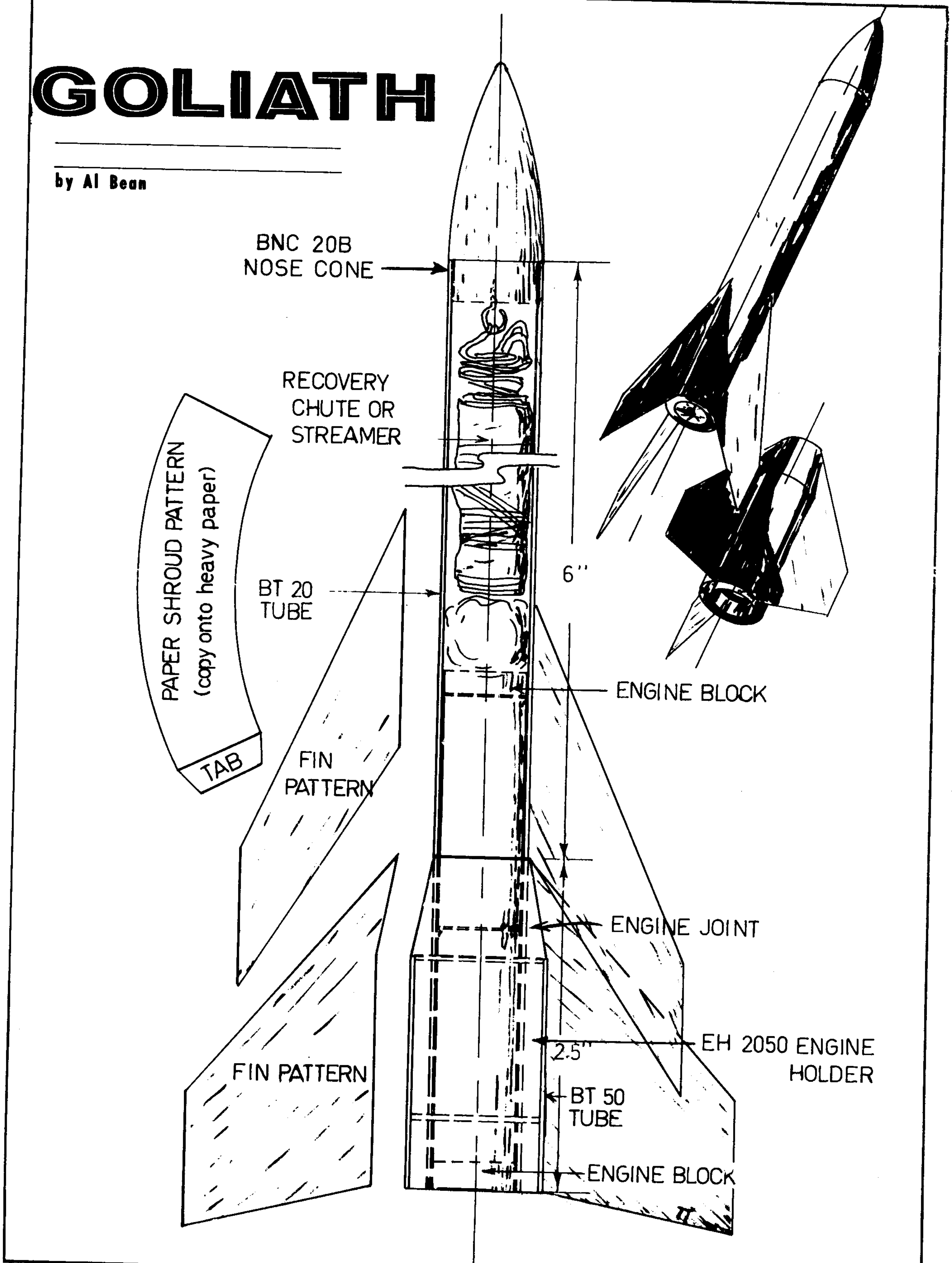
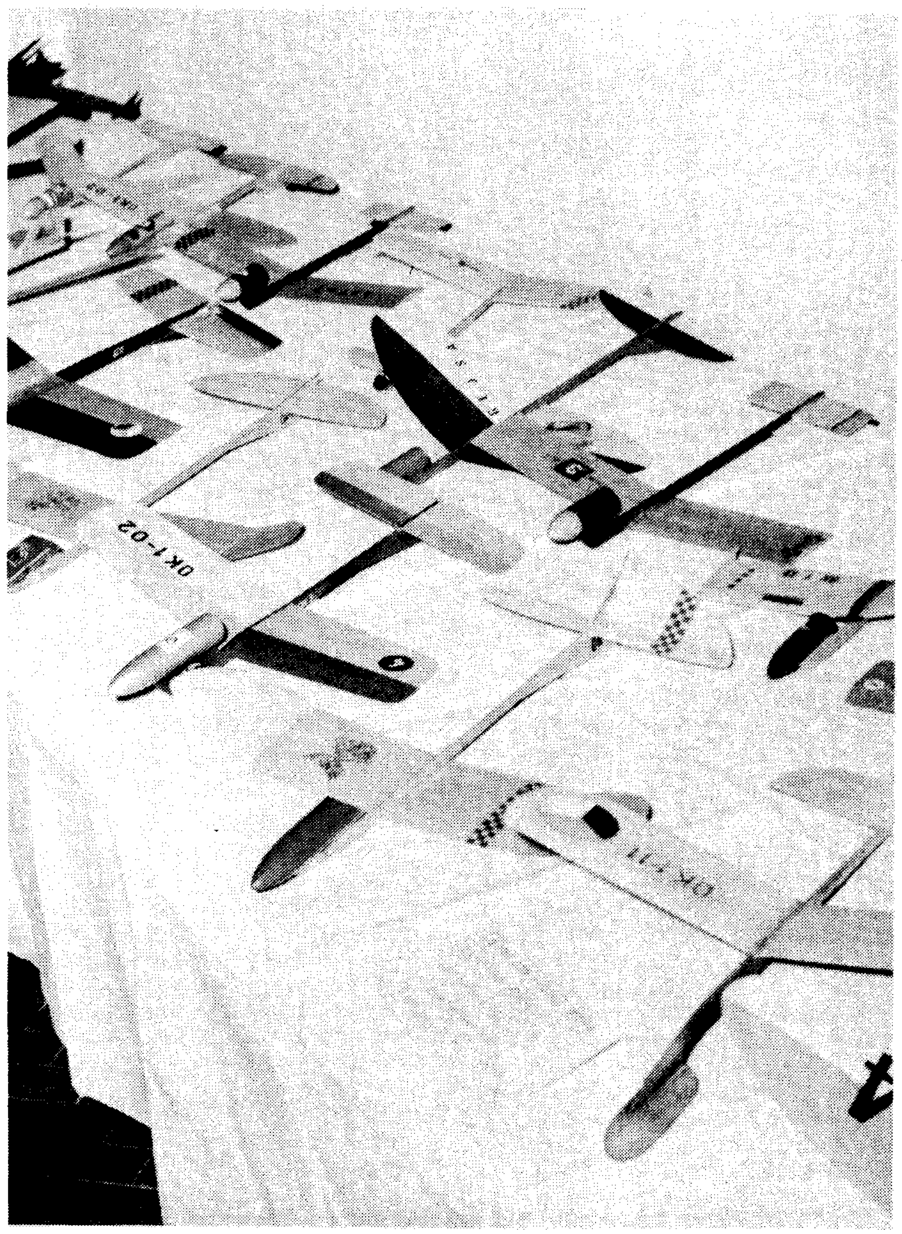


PHOTO GALLERY

Readers are invited to submit photographs of their model rockets for publication on this page. Our staff will select those photographs having superior quality and composition for inclusion in the **Model Rocketry** *Photo Gallery. Send your photos to:*

Photo Gallery
Model Rocketry
Box 214
Boston, Mass. 02123



Technical Notes

George Caporaso

The notes on the coupling of the dynamic oscillations to the altitude equations will be continued in an article to appear in next month's issue of **Model Rocketry**. I will concentrate on a general outlook for the future scientific development of model rocketry in this month's column.

As in any branch of physical science, there are certain major problems which must be treated by a general theory and a vast quantity of minor problems and technical details which must be attended to.

In the area of total model rocket flight performance and analysis almost all of the major problems have been solved. The idealized altitude perfromance can be computed by a host of methods. The dynamic behaviour of a rocket can be adequately treated by Mandell's dynamics and the relative aerodynamic and inertial parameters can be calculated. The dynamics have then been coupled to the altitude equations.

Every relevant performance parameter can be calculated or measured save for the drag coefficient. No unified, coherent approach to model rocket drag and fluid mechanics has been presented. *This problem is the last major problem of analytical model rocketry.*

Once a major theoretical treatment of model rocket drag is presented, a host of minor case studies will remain. Such problems as how much does the drag coefficient change when the launch lug is removed, and how much does the interference drag of the fin-body tube joint contribute to the total drag? How does the exhaust affect the base drag? How does the paint finish affect the drag? What is the minimum angle for the curvature of a boat-tail or adapter section? These and other problems will be answered by a developing treatment of drag. The minor problems will constitute the loose ends which the main theory must treat. The main theory will be vague at first. The treatment of the successive minor cases mentioned above will clarify and develop the theory into a highly precise framework.

Much of the work that must be done in this area is merely the unification and assimilation of existing knoweldge on the nature of drag. It will involve detailed and thorough wind tunnel testing of model rockets. No satisfactory drag theory for model rockets can be obtained without these vital wind tunnel tests. The wind tunnel testing is critical because model rockets operate in a Reynolds number and size regime where little data is available.

A tremendous amount of work must be done on determining the flow of the boundary layer around model rockets. Studies should be made in smoke tunnels to determine where and what causes the boundary layer to become turbulent and break away. observations must be made as to the effects on boundary layer separation of the number and thickness of fins, as well as their profiles and geometries. What does the launch lug do to the boundary layer? Does beveling of the lug reduce the disturbance?

The smoke tunnel can answer questions of boundary layer separation at the nose-cone joint, fin joints, lug joints and at adapters and boat-tails. Will a boundary layer cling more tenaciously to the rocket if the layer is turbulent or laminar? How do the effects vary with velocity? The effect of the paint finish on the boundary layer must be ascertained. Some quantitative measure of the roughness or smoothness of a paint finish must be obtained to correlate the boundary layer condition to the finish and to provide predictive power for the theory.

The effects of fin geometries and aspect ratios on the drag and on the drag with angle of attack must be ascertained. How dependent is the pressure drag on the shape of the nose cone? Many of these questions have been answered for single and isolated instances. What is needed is a general theory, a treatise on the subject. It must build upon solid aerodynamic principles and substantial wind tunnel data should supplement the treatment in areas where theory is inadequate or lacking. Prof. Gregorek at Ohio State University is working on wind tunnel testing routines and has summarized some semiempirical data in his paper—*A Critical Examination of Model Rocket Drag for use with Maximum Altitude Prediction Charts*. Mark Mercer has presented some results of his wind tunnel tests in Centuri's TIR-100 altitude technical report.

The wind tunnel tests that are required will take hundreds of hours of work to compile, but they must be done before a satisfactory solution to the drag problems can be obtained. Drag coefficients should be cataloged for various shapes so as to verify the validity of any drag prediction equations that may be derived or listed. Drag studies for near sonic velocities must also be carried out. As fuels and engines become more efficient, burnout velocities have well surpassed the Mach 0.5 mark where a cubic resistance term may become significant, it must be treated in the theoretical altitude equations. If it is significant but less than the magnitude of the quadratic term, it can be treated by perturbation theory and the standard altitude equations. If the magnitude of the cubic term is larger than the quadratic term, new analytic approximations must be derived. Some of these will be presented in an article in **Model Rocketry** at a later date.

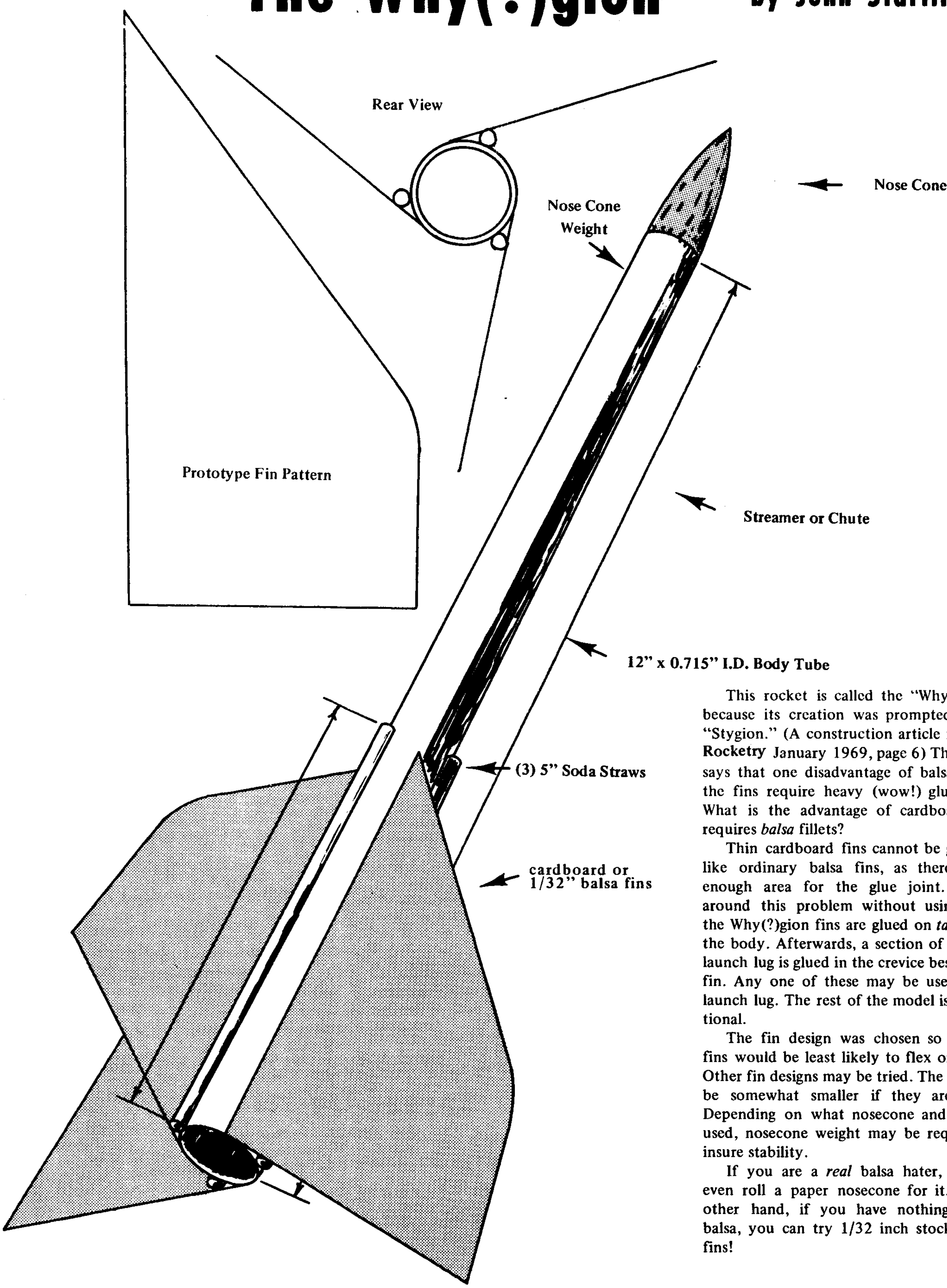
The problem of supersonic transition should also be treated. Although there is no verified instance of a model rocket traversing the sound barrier, the possibility of transonic flight is increasing with the gradual introduction of high specific impulse perchlorate rocket fuels into the model rocket engine market.

Once the drag theory is presented we will not say as Lord Kelvin did that all major laws have been discovered and that the task of the next generation is to calculate all the known solutions to the next decimal place. Rocket instrumentation and payloads remain virtually untouched. There is an infinity of work to be done in the area of tracking and rapid range data reduction. The aerodynamics and technology of boost gliders is a wide open area. New materials, new high efficiency fuels and design innovations will push model rockets beyond the performance bounds considered in all present theories, necessitating revisions. Much work also needs to be done on optimization and it is hoped by the author that this can be done to some degree by analytical methods using the oscillation-altitude coupling equations to be presented in the August issue.

It will be the scientist's somewhat satisfying dilemma that every successful theory he presents uncovers more questions than answers thus providing an unlimited opportunity for research, experimentation and theorization, and model rocketry as a scientific hobby, is no exception.

The Why(?)gion

by John Starling



This rocket is called the "Why(?)gion" because its creation was prompted by the "Stygion." (A construction article in **Model Rocketry** January 1969, page 6) This article says that one disadvantage of balsa is that the fins require heavy (wow!) glue fillets. What is the advantage of cardboard if it requires *balsa* fillets?

Thin cardboard fins cannot be glued on like ordinary balsa fins, as there is not enough area for the glue joint. To get around this problem without using balsa, the Why(?)gion fins are glued on *tangent* to the body. Afterwards, a section of straw or launch lug is glued in the crevice beside each fin. Any one of these may be used as the launch lug. The rest of the model is conventional.

The fin design was chosen so that the fins would be least likely to flex or flutter. Other fin designs may be tried. The fins may be somewhat smaller if they are swept. Depending on what nosecone and fins are used, nosecone weight may be required to insure stability.

If you are a *real* balsa hater, you can even roll a paper nosecone for it. On the other hand, if you have nothing against balsa, you can try 1/32 inch stock for the fins!

Build a Spin Rate Sensor & a Rocket Direction Finder

for the transmitter described in May...

by Richard Q. Fox

The preceeding installments of this series described a small, lightweight transmitter designed for use with model rockets. The transmitter operates on the 27 mc. Citizen's Band with an output of 100 mw, and was designed to telemeter the data from various plug-in sensors. A temperature sensor was described last month. This installment describes a spin-rate sensing module, and a radio signal direction finder for use with the transmitter.

The spin rate indicator is the simplest module to use with the transmitter. It consists of a photocell placed behind a hole cut into the side of the rocket body tube. When the sun hits the photocell, the cell's resistance drops, raising the pitch of the transmitter's audio output. When the photocell is pointing away from the sun, its resistance increases, thereby lowering the pitch of the transmitted audio tone.

While the rocket is in flight, the pitch of the transmitted signal will rise and fall as the photocell points towards and away from the sun. The transmitted signal may be tape recorded on the ground, and the spin rate of the rocket can be obtained by counting the number of rises and falls in the pitch per second (See figure 1).

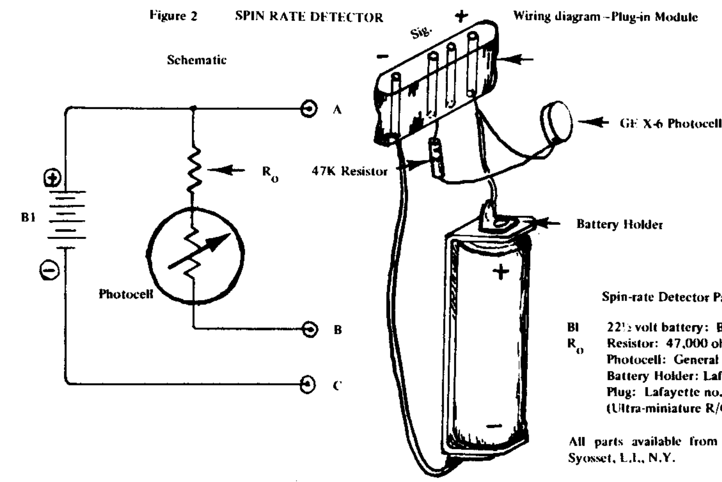
Assembly

The spin rate indicator module can be easily assembled from parts available from Lafayette Radio, Syosset, Long Island, New York. Follow the wiring diagram and parts list for construction (See figure 2). Parts placement is not critical. The photocell will cause the transmitter to produce only inaudible tones if the cell is exposed to full sunlight, so it is necessary to keep the face of the photocell partially masked in order for the transmitter to send an audible tone.

Direction Finder

The direction finder described here will

Figure 2 SPIN RATE DETECTOR



Spin-rate Detector Parts List

B1	22½ volt battery: Burgess Y-15
R_0	Resistor: 47,000 ohms, ½ watt
	Photocell: General Electric X-6
	Battery Holder: Lafayette no. 34H5005
	Plug: Lafayette no. 99H9091
	(Ultra-miniature R/C connector)

All parts available from Lafayette Radio, Syosset, L.I., N.Y.

Figure 1

SPIN RATE

Transmitter and rocket hanging from 12 inch parachute.

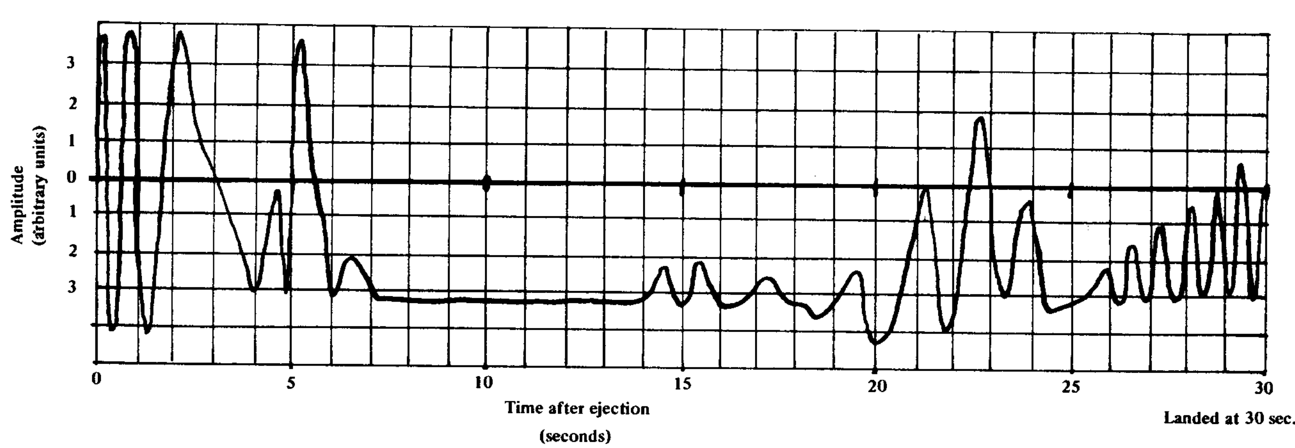
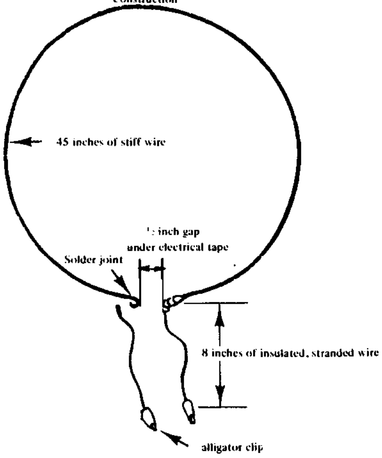


Figure 3

DIRECTION SENSITIVE ANTENNA

Construction



Solder stranded wire to solid wire loop and tape up to prevent one end of the stiff wire from shorting against the other end of the stiff wire.

indicate where an operating model rocket transmitter is located. It is an extrememly simple, cheap, external attachment which makes any receiver sensitive to the direction of origin of transmitted signals. The author has used the direction finder on several occasions to recover rockets that drifted out of sight. In one case, a transmitter-carrying vehicle drifted into a woods. The direction finder led the way through the woods to the tree that the rocket was hanging from.

Construction

The direction finder is an antenna which is constructed from a 45 inch piece of heavy gauge wire, similar to coat hanger wire. The wire is formed into a circle, and 8 inch pieces of stranded hook-up wire are soldered to each end of the heavy wire (See figure 3). The two ends of the heavy wire are covered with tape and then taped against each other to form a circle (See figure 4). Alligator clips are soldered to the other ends of the stranded wire.

Use

One of the clips should be connected to the metal case of the receiver. (If the receiver case is plastic, the clip should be attached to the mounting hardware of the earphone jack.) The other clip should be connected to the end of the antenna, with the antenna fully extended. Turn the receiver on, and hold it upside down, with the direction sensitive antenna hanging from the receiver (See figure 4).

Turn on the model rocket transmitter and listen for its tone on the receiver. With the receiver several hundred feet from the transmitter, rotate the loop antenna and listen for variations in intensity of the received signal. When the signal is the loudest, the transmitter will be in the plane of the antenna, and the antenna should be "pointing" at the transmitter. When the signal is weakest, the antenna will be "pointing" 90 degrees away from the transmitter.

When tracking down the location of a signal, rotate the antenna for maximum strength and walk in the direction indicated by the antenna's position. When you are so close to the transmitter that its signal starts to overpower the receiver, rotate the antenna for minimum strength. Positioning the antenna for minimum strength will allow accurate close range location of the transmitter.

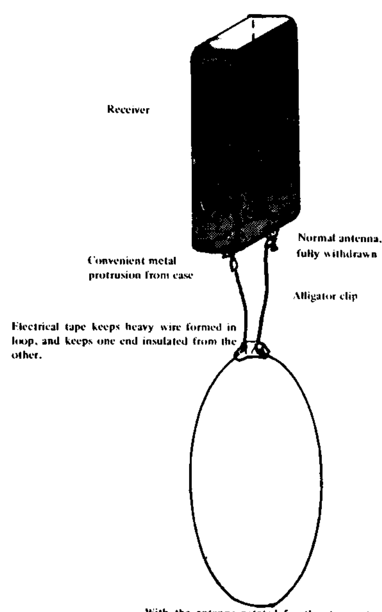
Unfortunately, the direction finding antenna is bi-directional. It will not tell you whether the transmitter is in front of you or behind you. If the signal becomes weaker as you walk "towards" it, you're going the wrong way!

Next month: an accelerometer module for the transmitter.

Figure 4

DIRECTION SENSITIVE ANTENNA

Use



With the antenna rotated for the strongest reception, the transmitter is located either to the left or to the right.

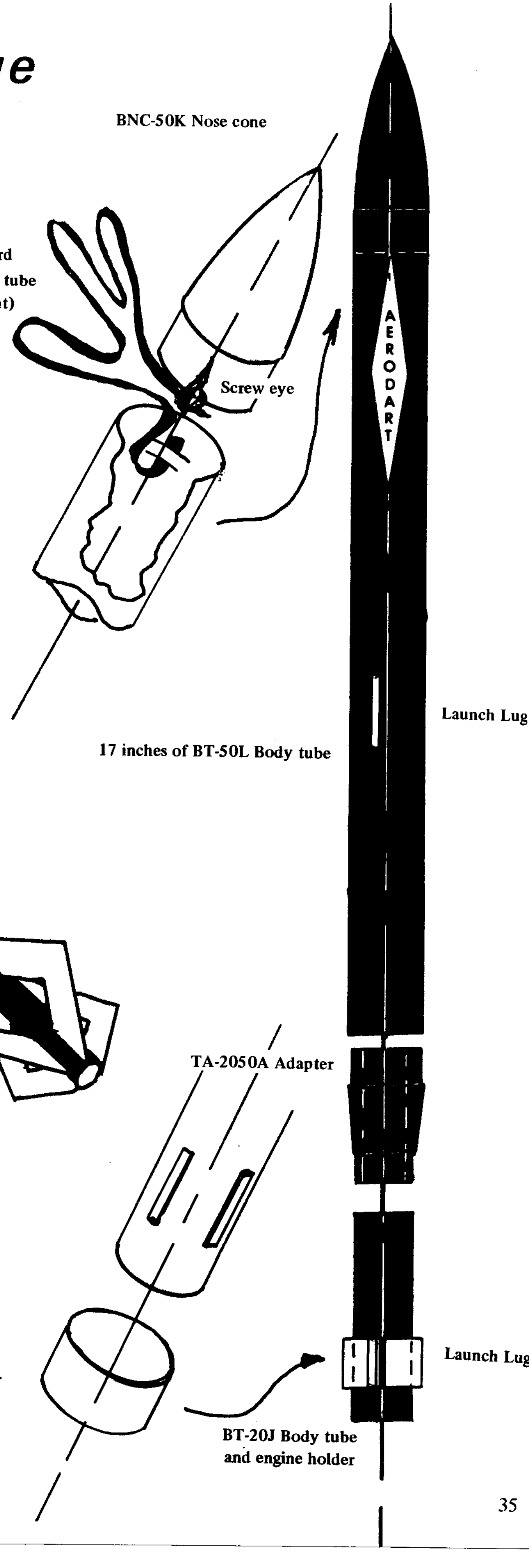
The received signal will be strongest when the transmitter is in the plane of the antenna.

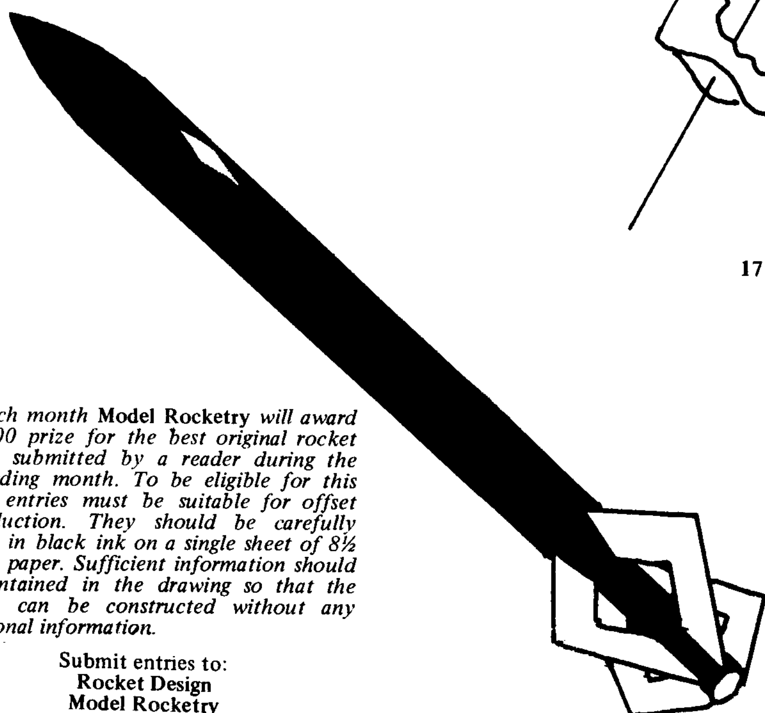
Reader Design Page

The Aerodart, designed by Nick Abramovitz of Crestwood, Illinois, is a distinctive rocket with cut out fins.

The adapter (Estes TA-2050A) is hollowed out by drilling and filing a 1/2 inch hole. When the inside of the adapter is fairly smooth, coat the balsa with a layer of white glue to prevent it from burning. Then trim off 1/4 inch from the small end, before gluing into the tubes. The adapter acts as an engine block.

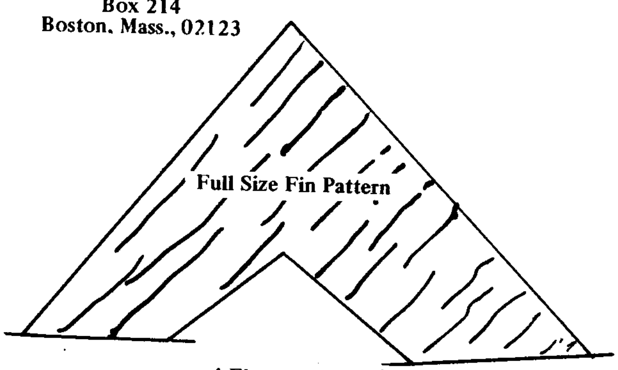
To mount the ring of BT-50 on the tail, cut 4 strips of balsa 1/8 inch by 1/8 inch by 0.7 inch. Glue these 5/8 inch above the nozzle end of the BT-20J tube, 90 degrees apart. Then sand these strips until the 0.7 inch tube fits snugly over them. Finally, glue the tube onto the strips.



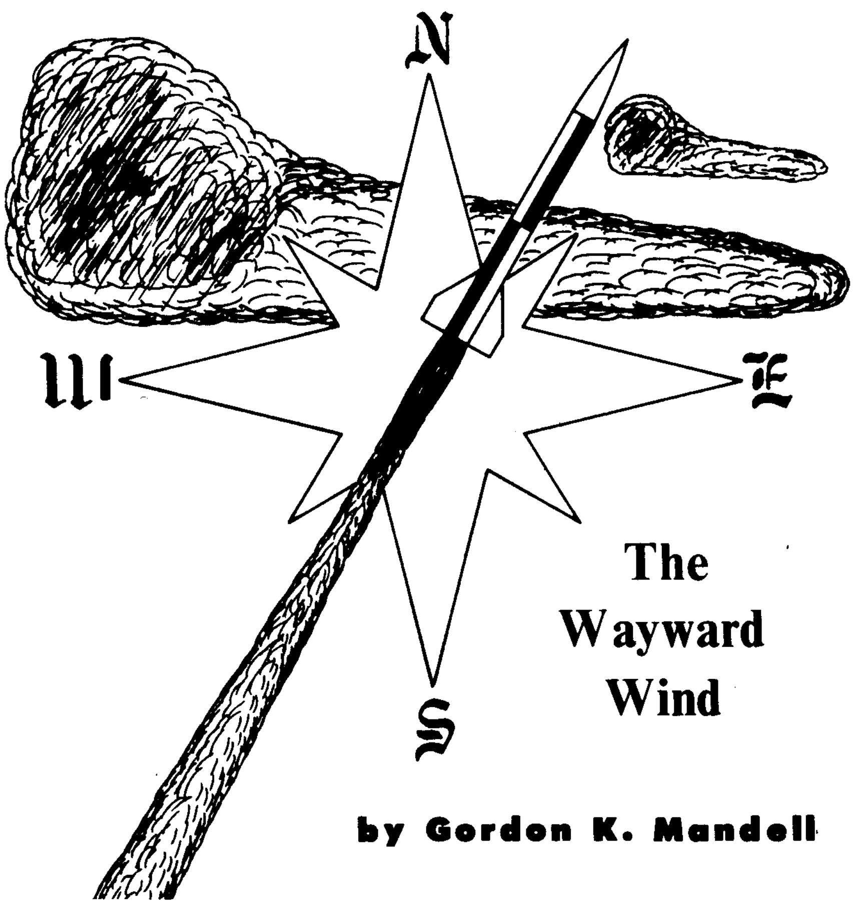


Each month **Model Rocketry** *will award a $5.00 prize for the best original rocket design submitted by a reader during the preceeding month. To be eligible for this prize, entries must be suitable for offset reproduction. They should be carefully drawn in black ink on a single sheet of 8½ by 11 paper. Sufficient information should be contained in the drawing so that the rocket can be constructed without any additional information.*

Submit entries to:
Rocket Design
Model Rocketry
Box 214
Boston, Mass., 02123



4 Fins cut from 1/8 inch stock



The Wayward Wind

by Gordon K. Mandell

INTERLOCKING FINS

At the outset of this column a couple of months ago I dwelt at some length upon the sad state of communications in our hobby. One of my prime purposes in writing these pages is to help avoiding the wasteful duplication of effort associated with small, short-lived enclaves of independent rocketeers working in the dark, oblivious to what other hobbyists are doing or have done before them. I went so far as to claim that many pet ideas and innovations in model rocketry are invented and re-invented many times over by individuals who never heard of each other, and each of whom thinks he's got the original version of a great invention.

Well, this month I've got a prime example of that very process in action. We have had nearly a dozen people come running in to tell us of a "great, new idea" each of them has "discovered" within the last couple of months. In each case, of course, it was the same idea. And in no case was the self-proclaimed inventor the true originator of the concept. The idea involved is nearly as old as the hobby itself; so old, in fact, that I don't even know who was the *first* to use it.

The concept I'm referring to is that of a multistaged rocket whose stages have fins so configured that, when the complete vehicle is assembled, the trailing edges of the fins of each upper stage merge into the leading edges of the fins of the stage immediately below it. Such a method of construction is referred to as having *interlocking fins* and produces a vehicle that, from afar, appears to have but a single set of fins running the full length of the rocket. Figure 1 shows a typical three-staged model built in this fashion. The chief advantage of the design, aside from its sleek appearance, is reduction in drag due to a minimization of the number of apparent leading and trailing edges encountered by the airstream. It has been in common use for at least eight years.

The first such rocket I remember seeing was sitting down in the basement of Paul Hans (then NAR no.554) in Manhasset, New York, in November of 1961. It was a three-staged bird looking much like the one in Figure 1, except that it incorporated braces (Figure 2) on the lower-stage fins to prevent the fins on the various stages from moving laterally with respect to each other and thereby ruining the smoothness of the leading-edge-to-trailing-edge joints. Like most of Paul's early rockets, this one had a flourescent orange and white paint scheme which made it easy to tell that it had in fact been successfully flown—the black residue from staging was clearly visible around both interstage separations. As I recall it, this vehicle was built and first flown in the summer of 1961, so this places the latest possible date at which the technique could have been invented.

A number of rocketeers, including myself, became enthusiastic devotees of the interlocking-fin technique for several years with varying degrees of success. Several altitude and payload rockets which I built for the 1962 Nationals (including a two-staged Coaster model) incorporated interlocking fins, and one small ship named *Thunderdart* took second in an event at that time called Double Peewee Altitude, in which an A engine was used in the lower stage of a two-staged model, and a ½A engine in its upper stage. In this particular model the fins not only were interlocked, but the upper stage fins served as a stage coupling guide for the lower stage by extending straight aft of the upper stage body tube for an inch or so (Figure 3). This technique was commonly used to get the fin area as far aft as possible, but of course a bit of aluminum foil had to be glued to the root extension to prevent damage from the hot exhaust of the upper stage engine.

Since the 1961-1962 period the fortunes of interlocking-fin designs have alternately waxed and waned. The concept was re-invented any number of times and used enthusiastically for a time by each inventor, but never did become the predominant mode of constructing multistaged models. Among the major model rocket manufacturers Rocket Development Corporation adopted the principle for use in kit design, incorporating interlocking fins into the boosted version of the *Cardinal* and their three-staged *Patriot*. (More recently, AMROCS introduced interlocking fins on their three-staged *Omega*.)

One reason for this was that the interlocking configuration, while certainly highly competitive, never proved clearly superior to other multistaged designs in competition. The frequency with which interlocking-finned models won any given altitude or payload-altitude event was never noticeably greater than the corresponding frequency for other designs. It is probable that the claims of drag reduction voiced in favor of interlocking-finned rockets are somewhat exaggerated and not always necessarily true at all. The normal mode in which such vehicles were constructed involved the mating of a sharp trailing edge on the upper stage to a flat leading edge on the lower stage (Figure 4A). The joint thus produced was not smooth and the airflow pattern over it could certainly not have been as smooth as if no joint were present, although it is conceivable that the situation *was* an improvement over the separate-fin arrangement. Sometimes the upper-stage trailing edges were made flat (Figure 4B) in order to produce a smooth joint. This they seemed to do rather well when precision-made, but of course the flat trailing edges on the

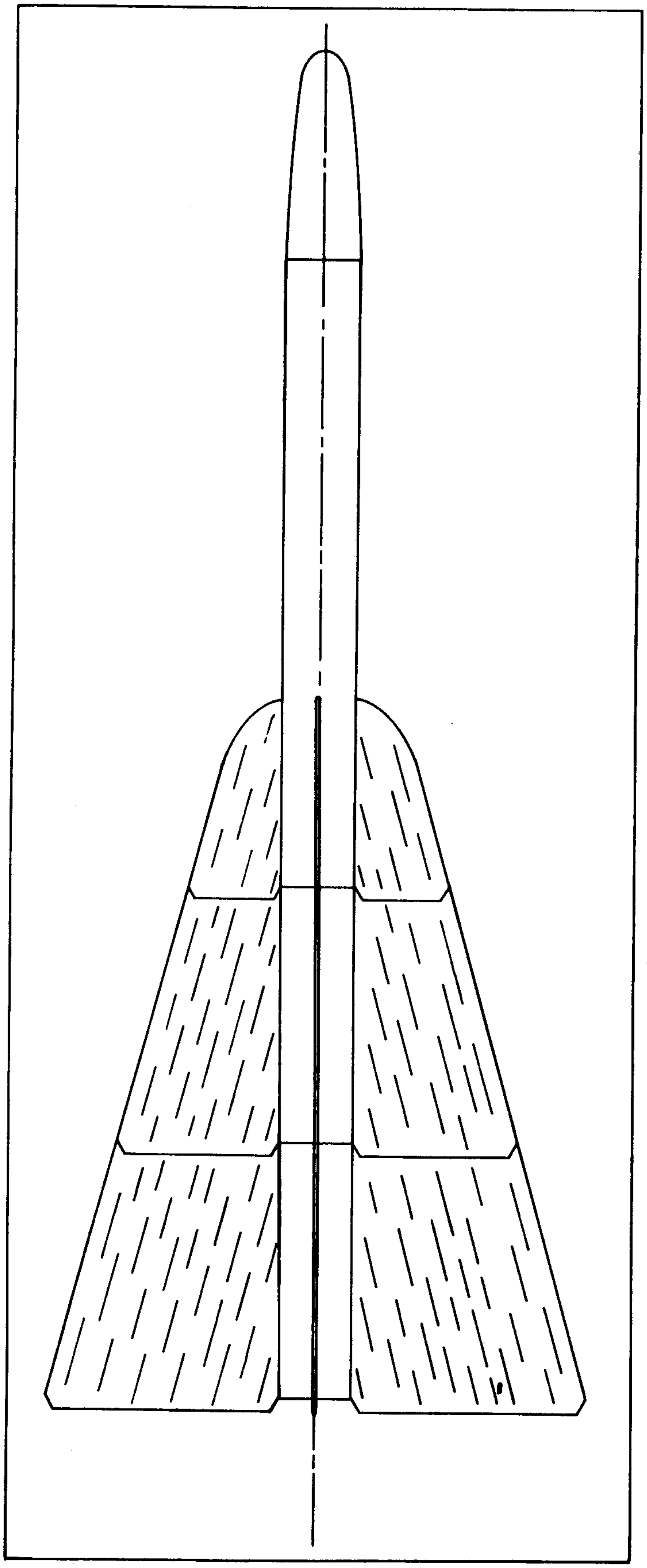


Figure 1. A typical three-staged interlocking fin design.

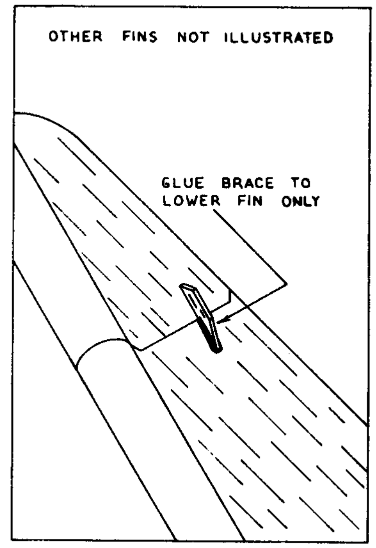


Figure 2. Braces at interstage fin joints.

upper-stage fins were a performance penalty after stage separation. A smooth joint is also theoretically possible with no performance penalty after separation if the airfoil of the lower-stage leading edges is made precisely the inverse of the airfoil of the upper-stage trailing edges (Figure 4C), but the manufacture of such a joint is so difficult as to be impractical. The only really feasible form of smooth interstage fin joint appears to be that of Figure 4D, which involves some penalty due to increased fin frontal area. I have never observed the form 4D in use on any actual flying model.

In addition, the lateral area involved in interlocking-fin designs tends to be unnecessarily great, particularly when lower-stage lengths become substantially longer than the length of their rocket motors alone. Even with smooth fin joints the increase in friction and vortex drag associated with these large surfaces can easily more than offset the advantages gained by the use of the interlocking configuration. The greatest care must therefore be exercised in the design of interlocking-finned models to avoid this inefficient use of lateral area. The fins of the topmost stage must be as small (without loss of sufficient stability) and as far to the rear as humanly possible, and in no case should the length of body tube used in each lower stage exceed the length of the engine used in that stage.

And, of course, the interlocking-finned design requires the utmost skill and craftsmanship during construction or the whole advantage of the system will be lost. If any one of the upper-stage trailing edges fails to mate to within a 64th of an inch with any one of the lower-stage leading edges, either longitudinally or laterally, the drag of the rocket may well be higher than would be the case if separate fins were used. Craftsmanship is where the average model rocketeer really falls flat on his face, since few people stay with the hobby long enough to acquire any significant degree of craft skills.

Even many of our long-term hobbyists seem never to have felt the stimulus of pride in workmanship. And so it is not surprising that the interlocking-fin idea has never quite realized all its inherent possibilities. None of the versions I have seen since 1962 have been really well-executed, and as long as this state of affairs prevails the concept of interlocking fins seems doomed to play the role of a rocketeer's fad, occupying an undeservedly restricted niche in the broad spectrum of model rocket design. I trust, however, that the publication of its history in these pages will at least prevent its development from being set back to the drawing-board stage every few months and will in that measure, at least, improve the state of our affairs.

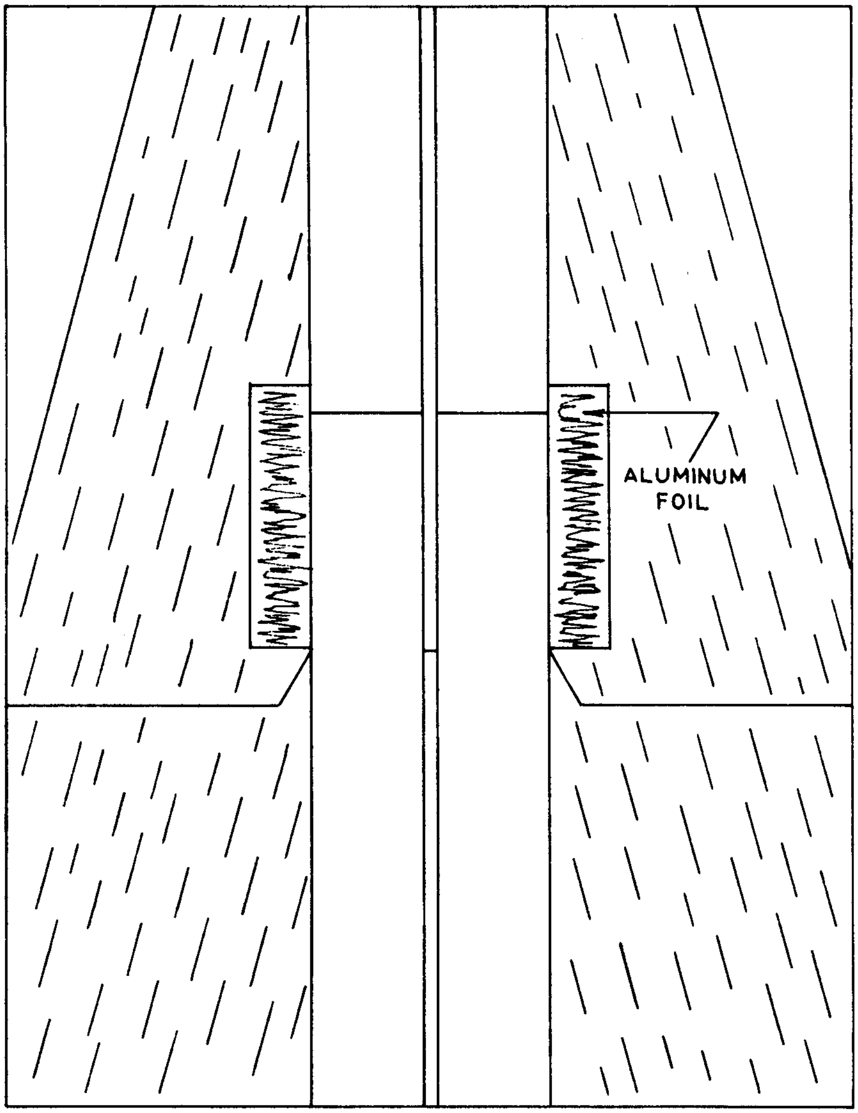


Figure 3. Stage coupling guide configuration.

The above was just one of many examples of inventions, ideas, and concepts that have been rediscovered time and again throughout the history of model rocketry at a shameful waste of talent and brainpower—a waste that could have been avoided if an effective forum for the presentation of such developments had been available.

Model Rocketry *provides such a forum in* The Wayward Wind. . . *so why break your back duplicating somebody else's work? Send that pet theory, idea, design, gadget, etc., to me in care of* The Wayward Wind, **Model Rocketry**, *Box 214, Boston, Massachusetts 02123. If we don't know about it, you've got a clear go-ahead for further development. If we do, you'll avoid repeating something that's already been done and be able to pick up where the last man left off if development is not yet complete or go on to something else if it is. Don't be secretive, or the value of your work may be lost forever. . . or you may not get credit for it when it finally comes to light. Contribute something to your hobby; be a useful member of its R & D community. Let us hear from you.*

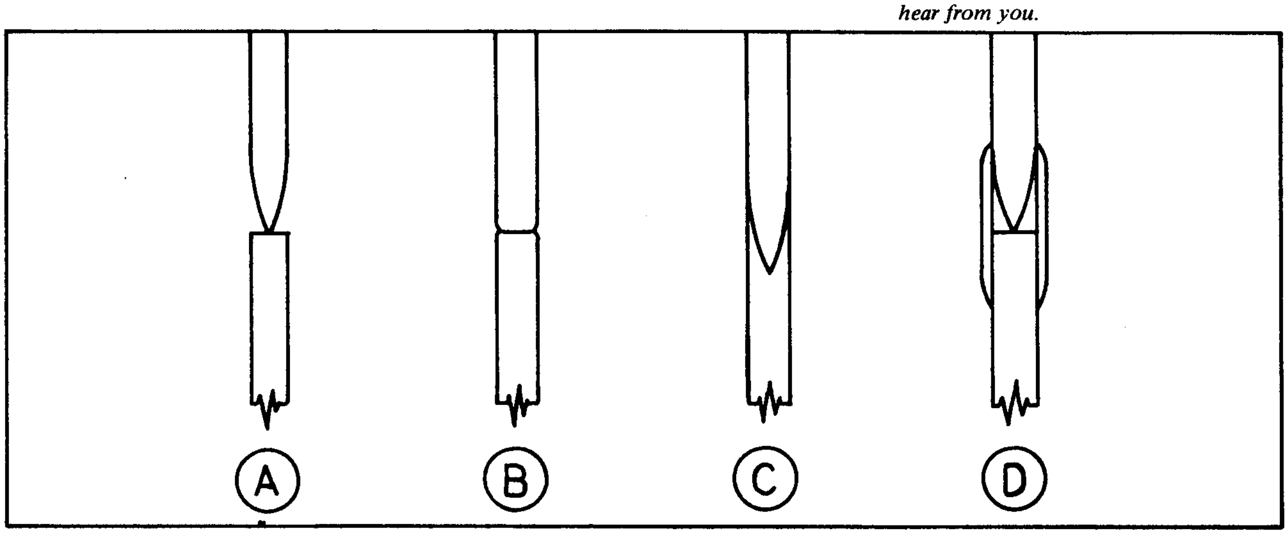


Figure 4. Forms of interstage fin joints. A: sharp trailing edge to flat leading edge, the most common form. B: flat trailing edge to flat leading edge, reduces drag before staging but increases it afterwards. C: sharp trailing edge to form-fitting leading edge, impractical to manufacture. D: sharp trailing edge to cup leading edge, good but involves frontal area penalty.

(Club Notes continued)

rocket which reached an altitude of 1600 feet, is one of the club's major accomplishments. Senior members of the club have also launched a radio beacon transmitter, taken aerial Camroc photos, and launched a scale Estes Saturn 1-B.

Gary Schwede of Las Veges, New Mexico won a trip to the International Science Fair, Fort Worth, Texas with his model rocket project. Schwede, a senior at Robertson High School, Albuquerque, New Mexico, entered his project titled *"Research on the Stability of the Conical Configuration for Sub-Sonic Astrodynamic Vehicles."* He told the Albuquerque **Journal**, "I happened to look at a paper cup in the shape of a cone, and that started me on the whole kick." His preliminary results indicate the cone shape to be a good one. "It seems to have an abnormally low drag coefficient."

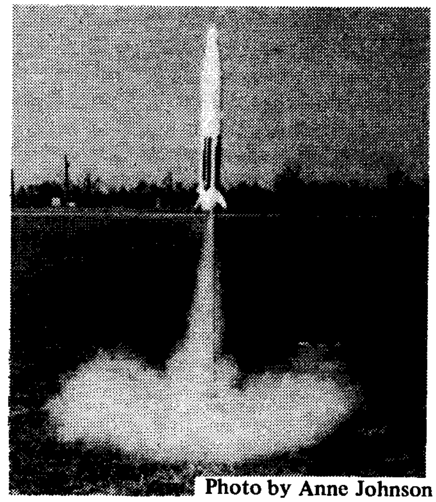


Photo by Anne Johnson
Courtesy of the Cheraw Chronicle

David Haley, NAR 9458LR, is shown with his scale model Uprated Saturn 1-B in Apollo configuration. He is a member of rocket club organized in the Cheraw High School physics class. The school group, under the direction of science instructor John Hutchinson, is presently designing a 40 inch tall, four engine cluster rocket to carry a radio transmitter and small instrumentation aloft.

The ninth grade general science class at Shenango High School in New Castle, Pennsylvania organized an outdoor assembly on the school football field. They displayed and flew 49 rockets which had been constructed as a class project. Afternoon classes were pleasantly interrupted for almost an hour during the 9th grade rocket demonstration.

Robbie McGuire, a 15 year old high school sophomore, returned to North Canaan Elementary School to lecture the eighth grade class on rocket propulsion. The program, arranged by North Canaan teachers Thomas Glennon and Donald Severance, traced the history of rockets back to the early Chineese experiments and outlined the principles of rocket propulsion. At the conclusion of the talk, the group moved outside to view the launching of an Avenger rocket.

(From the *Connecticut Western News*)

A model rocket club has been organized under the direction of Mrs. Carol Kidd at the Sparta Junior High School, Newton, New Jersey. The Rocket Club, composed of 7th, 8th, and 9th grade students at the school, was organized when many of the Sparta students expressed an interest in model rocketry. To become a member, the student is required to pass a rigorous test based upon safety precautions associated with model rockets and engines. After successfully completing beginners projects in single stage rocket design, members are encouraged to undertake more advanced projects. At the school competition each May, the Sparta Junior High School model rocket champion is selected.

The newly formed Fanwood section of the NAR hosted a competition for rocketeers from the New Jersey area on April 6th. John Belkewitch, national secretary of the NAR, attended the meet. The Fanwood section was started when Al Lindgren and his family moved to New Jersey from California, where they belonged to an NAR section. The Fanwood section meets once a month, mainly for discussion meetings and workshop sessions.

Members of the Agusta Model Rocket Association have been barred from holding a public demonstration in Agusta, Georgia. The Board of Education and the Fire Department of Agusta have refused permission to hold a demonstration launching from the Richmond Academy drill field on the grounds that model rockets are unsafe. Thus far, appeals by club members Clifford Hardin and Henry Saul have not proved successful in convincing city officials of the safety and educational value of model rocketry.

The Columbus Society for the Advancement of Rocketry is sponsoring the Midwest Model Rocket Regional Competition for NAR members in the Midwest. The meet is scheduled for June 28 and 29.

The newly formed Queen City Model Rocket Club is looking for new members in the Cincinatti area. Interested rocketeers should contact Mark Pescovitz, 4098 Rose Hill Avenue, Cincinatti, Ohio.

Send your club or section newsletters, contest announcements and results, and other news for this column to:

Club News Editor
Model Rocketry Magazine
P. O. Box 214
Boston, Mass., 02123

(From the Editor continued)

process) is made more accurate.

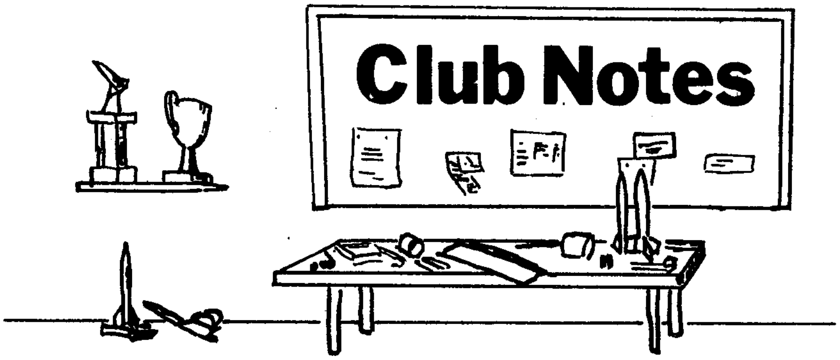
We have a goodly number of theorists in our hobby today (not that we can't use more of them), but where is the data? Why do we let so many of their theories go unverified? An unchecked theory can scarcely be said to be any better than no theory at all.

In many fields of scientific endeavor the theoretical work is highly regarded indeed, but the experimental verification is recognized as being just as important. The theoretician respects the experimentalist, since he realizes that, without experiments, the value of his theory could never be determined.

So let's get some of that experimental data! The last eight issues of **Model Rocketry** have carried numerous articles containing analytical predictions of model rocket behavior which need to be verified. Some require no elaborate instrumentation; just some interest and a good deal of time. While the glamor of generating a hundred feet of computer printout cannot be denied, that printout is less useful than scratch paper unless we can be sure that it *accurately reflects the behavior of an actual rocket.*

Summer is here; the flying weather is beautiful. Those young rocketeers who are still in school should have plenty of spare time. So pick out some theoretical prediction that catches your interest and test it... and test it...and test it. When you get done write up a report on it and send it in to us here at **Model Rocketry** so that the results of your work can benefit the greatest possible number of your fellow hobbyists. Let's make this summer one of discovery in model rocketry!

Club Notes



The Conant High School Invitational Rocket Meet was held on Saturday, May 3. Entrants came from Conant High School and Robert Frost and Hellen Keller Junior High Schools, Schaumburg Township, Illinois. Winners in parachute duration were: first, Rick Haase with 28.5 seconds; second, Gene Mayeda with 22.6 seconds; third, Glenn Mueller with 18.5 seconds; and fourth, Fred Robinson with 18.3 seconds. In the streamer duration (longest time of flight with a single 1" X 18" streamer) Bill Eggbeer took first with 28.2 seconds; Jim Kline took second with 20.0 seconds; Terry Nick took third with 17.0 seconds; and Jim Larpente took fourth with 16.4 seconds. The Egg-Loft duration (longest time of flight with raw egg with unbroken recovery of egg) was won by Gene Mayeda with 79 seconds; Mark Feicho took second with 42 seconds; Bill Eggbeer took third with 35 seconds; and Fred Robinson took fourth with 30.7 seconds. In spot lanking Bill Eggbeer placed first; Ken Harper placed second; Dana Eckberg took third; and Rick Haase took fourth. Meet overall winners were Bill Eggbeer (Conant) first; Gene Maveda (Conant) second; Rick Haase (Robert Frost) third.

The first issue of *The Constellation*, newsletter of the Arc-Polaris Rocket Club, Portales, New Mexico, reports on the construction of the club's new launching range. The new pad, about two acres in size, is located about four miles southwest of Portales on the Roswell Highway. At the present time, the pad facility is being prepared for use with the First Annual Southwestern Model Rocketry Conference (July 27-29) sponsored by the Arc-Polaris club. Work on the pad will be spread over the next two years, with the outcome expected to be a new launch complex with a nice green lawn and a surrounding chain link fence.

The Vineland Senior High School Rocket Club, now three years old, recently attracted the attention of two local newspapers—the **Vineland Times Journal** and the **Catholic Star Herald**. Under the leadership of the high school chemistry teacher Jo Walter Spear and club president Robert Chasse the club's membership has increased to 25, including 4 girls. The recent launching of *Chasse's Pride* (see photo), a six foot

(Continued on page 39.)

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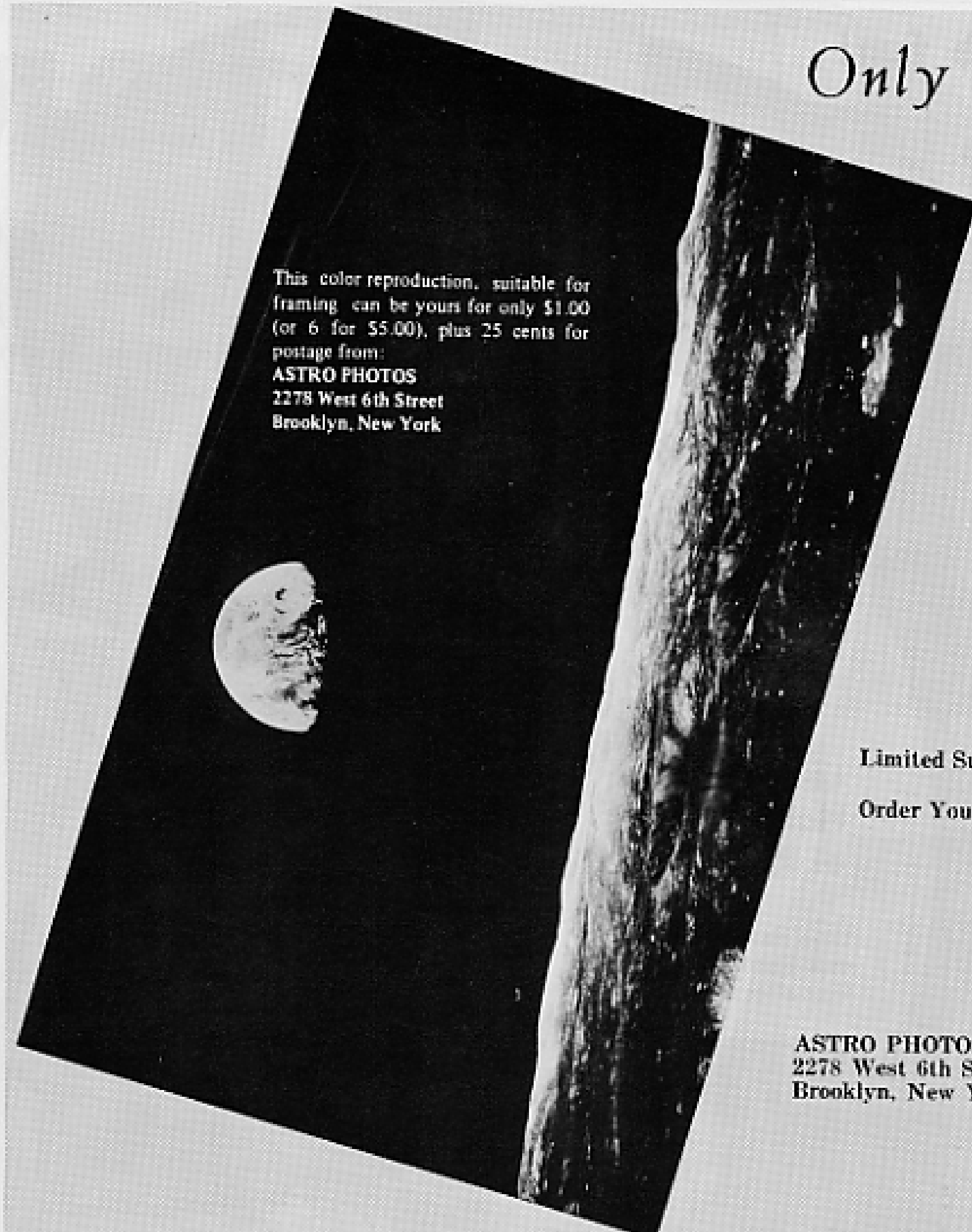

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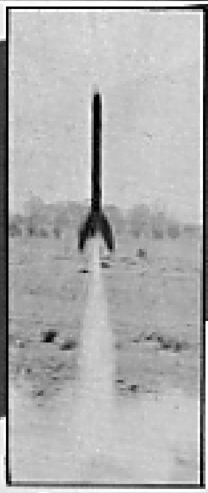

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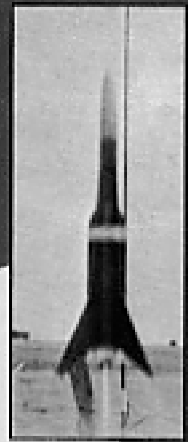

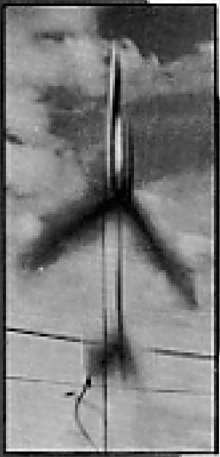

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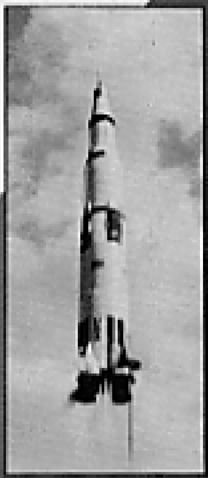

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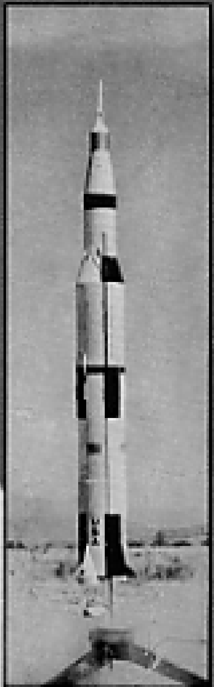

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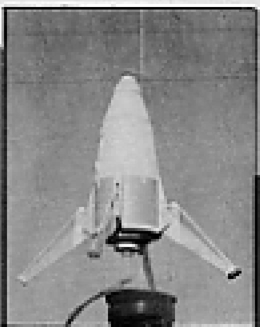

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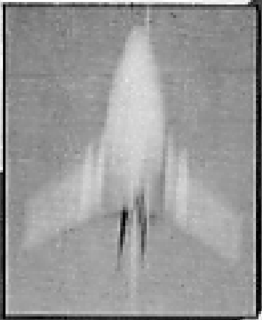

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