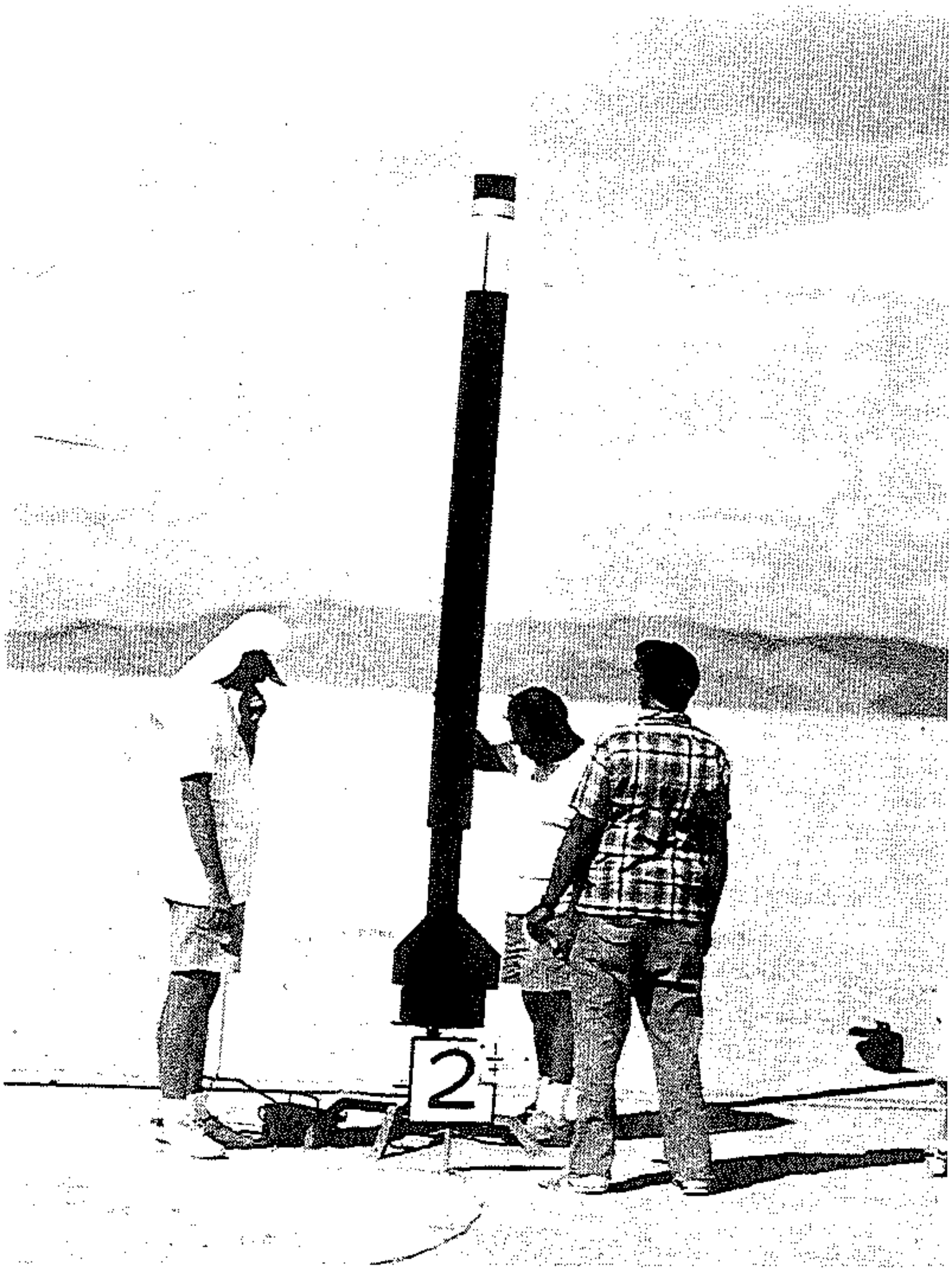
SPORT NEWS

Fall 1991 THE LEADER IN SPACEMODELING $2.50

TEN YEARS OF LDRS!



Model Rocketry's Longest Publishing, Most Controversial Newsletter!

Fall 1991 Volume 16, Number 5

"The Official Newsletter of the Jerry Irvine Fan Club"

Finally, it seems, the noose is tightening around Jerry Irvine's neck. For years, SNOAR NEWS has warned its readers of Jerry Irvine and his schemes. In the following pages, you'll be able to read in more details or Jerry's woes. We could stand here and say "I told you so for the past ten years", but the sad part is that the problems that Frank Kosdon has had with Jerry is only the tip of the iceberg. Who really knows how much money Jerry has obtained in less than honest ways?

Quite frankly, a lot of people out there are to blame for Jerry's continued presence in the hobby. It seems everyone was willing to give Jerry a second chance (which Jerry then took maximum advantage of). More than one person has admitted we were right all along. Don't give Jerry a first chance, let alone a second! *JD McNeil*

Fan Club Headquarters...

QUOTABLE

"What can I say about the infamous *SNOAR NEWS?* This is a publication that has weathered and generated more debate and allegations than even John Z. Delorean."

Jerry Irvine, reviewing *SNOAR NEWS* in the January 1984 issue of *California Rocketry.*

COVER STORY:

A huge 15' tall model sits on the launch pad at LDRS-X. On the back cover, the big bird lifts off. Sorry, but we didn't figure out who flew it. *(Matt Steele photo.)*

CREDITS:

Fan Club President: JD McNeil; Membership: Matt Steele; Finance: Chris Pearson Tours: Tony "Maddog" Williams; : Chas Russell, Dan Kafun, Merchandise: J. Pat Miller, Chuck Rogers, Clarence Thomas

IMPORTANT STUFF

SNOAR NEWS is published in a random manner by SNOAR, NAR Section #337.

Subscriptions are no longer available. Be thankful you got this issue. This is a single issue and constitutes one issue towards completing your subscription. Right now, it seems that there's a couple of issues left to go.

Any resemblance to any real persons in this publication is not intentional. The opinions and viewpoints expressed within do not represent SNOAR, the NAR, or anyone else. Don't bother to sue us, its not worth the time.

Publishing Funds: Courtesy North Coast Rocketry

Published with a Mac SE and a Laserwriter IINX.

Th..Th..Th..That's all, folks!

The Decline and Fall of Jerry Irvine or: US Rockets Crashes and Burns!

By Janet Alia and Philip Lato

The opinion expressed below are those of the authors exclusively

Much has been said of Jerry Irvine and US Rockets in the time that US Rockets has been in business (usually prefaced by obscene expletives and rude hand gestures), but we will here chronicle what may well be the demise and destruction of Jerry Irvine and his many guises as a model rocket manufacturer. In retrospect, we must admit that there have been several times in the past that Jerry Irvine seemed down for the count, as various people and publications, one of which, we are proud to admit, is *SNOAR News,* hounded and prosecuted him underground. Only to have him surface again, several years later, like a bad case of hemorrhoids, or Richard Nixon, to rip-off a whole new population of high-power rocketeers who knew nothing of his past track record.

It is well-known and documented that Jerry Irvine has ripped-off many people in the past eleven years, including customers, suppliers, and advertisers. We have gotten many letters complaining of year long delays in delivery, if there was any delivery at all, shabby product, exploding motors, bounced checks, missing parts, misrepresentation, and outright theft. Most of these people were reluctant to to anything about it because of the hassles faced in a interstate lawsuit, although some people have sued him and succeeded. As Jerry once told a customer in Columbus, Ohio that he ripped off to the tune of $1200, "Well, you're in Ohio and I'm in California...", challenging him to do something about it.

The whole thing centers around one person, Frank Kosdon. This is one man who Jerry Irvine will live to regret that he ever made his acquaintance. A bit of history first is in order though. Frank Kosdon was a graduate of MIT and a former member of the MIT Rocket Society, a chartered NAR section. He worked in the aerospace field, making rocket motors for many years before leaving it, but in 1985, started making small rocket motors again. He contacted several other model rocket companies, and acquired the name of Jerry Irvine as a local rocket manufacturer. He met Jerry in 1987, soon after Irvine formed one of his many "paper" companies called 'Powertech', a rocket motor making consortium. Some

The Powertech Raid of 1991

The following is a letter by Frank Kosdon to the Tripoli Board members. The opinions expressed below are Mr. Kosdon's.

In August, 1987 I was active in experimental rocketry and building/ testing my own motors. At that time, I became aware of the existence of Tripoli. I had the misfortune of being directed to Jerry Irvine. I was solicited by him to invest in a motor manufacturing entity called "Powertech". "Powertech" initially consisted of Jerry Irvine, myself, and five other individuals - two of which are Tripoli members. Two of these Tripoli members smelled a rat and bailed out of Powertech. They have nothing to do with the events described below.

I had personal problems in 1987 through1989 whose resolution occupied most of the my time. Consequently, I was nearly inactive in Powertech during that time. In 1989, I became more active in both Powertech and in my own rocketry activities. Starting in mid 1990, and into 1991, things turned very sour between myself and Mr. Irvine, resulting in claims and legal demands by myself against Mr. Irvine. It is not the purpose of this letter to discuss here the nature of these with Mr. Irvine - they will be addressed in the courts - but to detail what I call "The Powertech Raid of April 7, 1991".

Earlier this year, I finally decided that I had had enough and decided to withdraw from Powertech. At that time I had in my possession disputed company assets which I want to hold as security for payment of claims against Mr. Irvine. These assets consist mainly of chemicals. In addition there is a mixer from John Rahkonen/Prodyne which has been deeded to me.

On March 1, 1991, I filed a claim against Mr. Irvine. In the State of California, the plaintiff (me) can not serve the court papers on the defendant - Mr. Irvine. I had made the arrangements with another individual to serve the papers at the Lucerne launch on March 2. The launch was canceled due to inclement weather. My next attempt to serve Mr. Irvine was to be at the April 6 launch at Lucerne. The person who was going to serve Mr. Irvine had vehicle trouble and could not make it. I asked a few other people and they declined. However, Mr. Irvine did get served the next day, April 7, in my drive way.

Mr. Irvine thought he knew my routine, which he figured was to spend Sunday at Lucerne or, failing to do that, to go to the beach. Mr. Irvine left Lucerne about 1 PM on Saturday (early because it was very windy). Mr. Irvine lives about 100 miles from me. I presume starting after he arrived home he started randomly phoning my house to see if I were home (which I was not). Very early Sunday morning, of Irvine's other "paper" companies, so called because they existed only on ad paper, and were not legally documented companies or corporations, were; US Rockets, California Model Rockets, California Rocketry, California Rocketry Publishing, Composite Distribution, Experimental Rocketry magazine, and Toy Rockets.

Powertech originally consisted of six people, notable among them was Chuck Rogers, who is now the president of the Tripoli Rocketry Association, and Korey Kline, president of Ace Rockets. Frank joined the group soon afterwards. It wasn't until 1989 though, that Frank had much to do with the group because of personal problems. When he got back in touch with them in '89, both Kline and Rogers, already smelling a rat, had left the group.

This is when the problems started. Powertech bought equipment from John Rakhonen, who old high power rocketeers might know as the president of ProDyne, and Irvine, in his best business form, bounced the check for $1750 on John, of which $750 is still unpaid. At this point, Kosdon became suspicious of Irvine, as Irvine could, or would not give an accounting of materials and monies. Frank at that point refused to invest any more cash, and only contributed supplies.

It was at this time that both Frank Kosdon and Gary Rosenfield of Aerotech began development of reloadable consumer rocket motors, probably one of the greatest turning points in the hobby of model rocketry. It was also at this time that Powertech had its only business meeting, and this signaled the beginning of the end for Powertech. Jerry Irvine once again could, or would not disclose any financial information about the operation. Kosdon at this point refused to pour any more propellant for Powertech, but allowed Irvine to use his facilities to make and pour it himself.

In July 1990, Jerry Irvine floated a flyer at LDRS announcing the US Rockets line of reloadable motors, which were in reality, Frank Kosdon's motors, unbeknownst to

he put his plan into effect.

My house has a detached garage and a long driveway. I arrived home about 11 AM on Sunday. Partway up the driveway, I noticed a pickup truck backed up to my garage. I stopped the car and hence blocked the driveway. Present were Mr. Irvine and two of the three other remaining members of Powertech, John Lee and Brian Teeling. On March 31, 1991 I sent Mr. Irvine a letter stating that if he or any others came on to my property he (they) would be placed under citizen's arrest for trespassing. I immediately placed all three individuals under citizen's arrest for trespassing. The pickup truck's bed was fully loaded with everything in the garage concerning model rock ts. I did not know until later that they had rifled the shelves and had taken a considerable number of my own undisputed items. They even had taken boxes out of my other car in which to pack the items! Many of these items were tied down in the pickup truck bed. My primary concern was to unload the truck. As I started to undo the ropes, Mr. Irvine tried to stop me. I brushed him off. He then tried to stop me again. By then, I had had enough. After a short chase, I caught up with Mr. Irvine and slugged him right in the cheek. When I tried for the next hit he turned tail and ran like hell. John Lee started to come over to protect Mr. Irvine. I went for Mr. Lee, but before I got to him, he had second thoughts and he called it quits. From that point on there was no more interference by Mr. Lee or Mr. Teeling.

Shortly thereafter Mr. Irvine started to come back up the driveway to prevent the unloading. I went for Mr. Irvine, and again, he ran like hell, shouting that he was going to get the cops and have me arrested for assault and battery. About the time I got the truck unloaded, I remembered the court papers and my camera in the car. I took five photos and called my girlfriend to come over and serve Mr. Irvine the papers.

Shortly after the call to my girlfriend, three Ventura cops arrived. The cops kept me separated from the others. At the time, except for the mixer body, I did not realize that there were a number of undisputed personal items in the boxes which I had not as yet unpacked. Mr. Irvine tried to get me busted for battery and I tried to get the other three for burglary and trespassing. The cops said it was a civil dispute and they would not arrest people wherever possible.

While the cops where here my girlfriend arrived and she served Mr. Irvine with the lawsuit. The three cops, myself, Mr. Teeling, and Mr. Lee are witnesses that Mr. Irvine was served in my driveway. Shortly thereafter, the cops ordered me to back my car out of the driveway so that Mr. Lee could remove his truck.

After they left, I discovered many personal items that they had attempted to steal. I also noticed that they had gotten away with a vacuum pump which was in the cab of the truck and I had failed to notice it.

For a while, I assumed that I had arrived home just in the nick of time and that they were within seconds of leaving with their haul. I have since realized that the actual truth might be much worse. The following is only speculation and an educated guess on my part (since it did not happen), but I will share my thoughts and fears with you. The most important item on the truck was the mixer. However, it was incomplete and useless at this point. It must have occurred to Mr. Irvine that perhaps a remaining component of the mixer was in the house. In my recent correspondence, he has tried to stake a claim on my reloadable motors and the merchandising thereof. Therefore when I unexpectedly arrived home, the three of them, flush with the success of their mission, were discussing the pros and cons of breaking into my house in order to steal the remaining mixer components, reloadable motor components, my personal papers, and who knows what else? I am glad that I did not have to find out the answer to that the hard way and I am glad that I arrived home when I did.

I feel the purpose of their mission was to do a knockout blow on me in order to force me to retaliate with violence the next time I saw him at Lucerne in May. He could then attempt to bust me and sue me.

I learned one thing about Mr. Irvine on April 7. He does not understand the language of English or decency, but he definitely understands the language of fists.

Frank. This caused a lot of friction between Kosdon and Irvine.

Later that year, Irvine brokered a deal for chemicals for a friend of Kosdon's, and the deal went sour. Irvine ripped off Aerojet General by refusing to pay for the chemicals, which were supposedly bad, didn't pay the $800 freight charge, and then sued the buyer. Because the buyers lawyer failed to file some court papers, Irvine won the case, for a $15,000 judgment!

Well anyway, things were really on the skids at that point. In February 1991, at Winterfest, Kosdon wanted his reloadable motors tested. Jerry Irvine insisted that they be tested as US Rockets motors. A loud verbal argument occurred, and the motors were tested as Kodson's, not US Rockets. After this, Frank Kosdon told Jerry Irvine that he could no longer use his equipment to cast propellant.

After this Kosdon figured that Irvine would file a nuisance lawsuit against him, so he decided to strike first and file against him at Lucerne, for the cash and labor costs that he put into Powertech.

Before he could file, the "Great Powertech Raid" occurred on April 9, which can be read about elsewhere. On that same day, Kosdon served the papers on Irvine. On April 25, Frank Kosdon won a judgment against Jerry Irvine, as Irvine did not appeal. Another person who loaned Jerry Irvine money, Tim Collins, at this point hired a private investigator to look into the whole situation concerning US Rockets and Jerry Irvine.

In the meantime, Jerry Irvine's house was foreclosed and sold by the bank. Kosdon tried to levy the first US Rockets bank account, but failed. Irvine had since moved the offices of US Rockets to a new location, right after Irvine's old landlord sued and won a judgment against him for failure to pay back rent. Kosdon then moved against the headquarters of US Rockets with the county sheriff in order to seize merchandise to be sold to pay off the judgment. The sheriff took one look at the office and thought it was deserted because it was such a mess! Consequently, Kosdon didn't get any merchandise to settle the judgment.

Several days before LDRS-10, Brian Teeling, figuring that he was on the wrong side of a losing battle, cleaned out the motor inventory of US Rockets and quit the company. Consequently, Irvine had no motors to sell at either LDRS or Lucerne. At LDRS, Brigitte Irvine, Jerry Irvine's wife, served Brian Teeling with a $5000 lawsuit over his 'acquisition' of the motors. Also at LDRS-10, Frank Kosdon served Jerry Irvine with another lawsuit for the consumer retail cost of all the motors he made him propellant for. Frank won't tell us the exact amount of the suit, but it exceeds $200,000! Denise Savoy from Aerotech also served Irvine with papers for a lawsuit from a Aerotech dealer that Irvine ripped off.

On August 12, Kosdon filed another levy against a second bank account that US Rockets had. He got the account numbers from another vendor that Irvine had bounced a bad check off of. He was able to seize $1329, or so he thought. It turns out that the $1500 check that Irvine deposited was from a less than honest customer. It bounced! So Kosdon got nothing from that, and Jerry Irvine, true to form, bounced check written on that amount all the way from LDRS to Los Angeles.

Right after LDRS, Jerry Irvine stated that US Rockets had been sold to another person, Gavin Green, and asked the sheriff for the money back, not knowing the check had bounced. Gavin Green, a Jerry Irvine groupie, met with Kosdon and his lawyer, and decided that buying US Rockets might not be such a good idea, and told Irvine the deal was off. Irvine has filed court papers concerning the sale of US Rockets, but once again, he bounced a check for $16 off the court reporter for the filing fee (can you believe this guy? You NEVER, NEVER, NEVER bounce a check off a government office! They will hound and persecute you to death!) He now says that another person, who will remain anonymous, had purchased US Rockets.

On September 12, Frank Kosdon and Irvine showed up in court for the judgment ruling. Irvine was ordered to pay Kosdon $300 a month on the judgment amount. The payment date was the 25th of each month. While in the courtroom, Tim Collins served Irvine with papers for a $25,000 lawsuit over the money he loaned him. The court bailiff then threw them all out of court for causing such a commotion.

On September 27, Kosdon got a check from Irvine, postmarked the 26th, for $300. It was a US Rockets check. Of course, it bounced higher than a rubber ball. Well, lo and behold, the state of California has a 'bad check law' which enables a person to file suit for three times the amount of the bad check,up to $500. The NAR used this ruling to sue Irvine years ago after he bounced several checks off of the NAR for NARAM and magazine advertising. So Kosdon sued Irvine again for $300, plus the extra $500. The new lawsuit was served to Irvine at Octoberfest.

Also at Octoberfest, Jerry Irvine had sent letters to some Tripoli Board members (notable among the persons not getting a copy were Bruce Kelly and Gary Rosenfield, or Aerotech), claiming that Kosdon had ripped-off the design of his reloadable motors from US Rockets. Irvine went around taking pictures of all the litigants in the suits, and Frank Kosdon chased Irvine around the field, threatening to break his camera.

October 9th was the court date for Brian Teeling regarding the lawsuit for $5000 which Irvine had filed against him for taking the US Rockets motors. Jerry Irvine never filed the "proof of service" which is the document which proves that he gave Teeling the court papers. Jerry Irvine also decided not to show up and the case was dismissed. It was generally believed that Irvine filed the suit for the harassment value only.

After conferring with Kosdon's lawyer, Brian Teeling, Bob Klaus and John Lee, the last three remaining Powertech members decided to join Frank Kosdon in the lawsuit against Jerry Irvine. On October 10th, the new lawsuit was filed with the courts.

Irvine has since hired a lawyer and filed a response to this lawsuit, and Kosdon expects a response to be filed to his also. This will slow the wheels of justice a bit.

The final chapter in the saga of Frank Kosdon versus Jerry Irvine has yet to be written. Frank Kosdon says that he won't give up until he shuts Irvine down forever. Irvine really doesn't have the resources to fight a sustained court battle; so Frank may be the eventual winner, but whether or not he gets any financial return on his lawsuits remains to be seen.

Mr. Ivine could not be reached for comment. It seems all of his phone lines have been disconnected.

Name and Address of Court: VENTURA COUNTY MUNICIPAL COURT, VENTURA DEPARTMENT
800 SOUTH VICTORIA AVENUE
VENTURA, CALIFORNIA 93009
(805) 654-2610

SMALL CLAIMS CASE NO. MS 99483

NOTICE TO ALL PLAINTIFFS AND DEFENDANTS:	*AVISO A TODOS LOS DEMANDANTES Y DEMANDADOS:*
Your small claims case has been decided. If you lost the case, and the court ordered you to pay money, your wages, money, and property may be taken without further warning from the court. Read the back of this sheet for important information about your rights.	*Su caso ha sido resuelto por la corte para reclamos judiciales menores. Si la corte ha decidido en su contra y ha ordenado que usted pague dinero, le pueden quitar su salario, su dinero, y otras cosas de su propiedad, sin aviso adicional por parte de esta corte. Lea el reverso de este formulario para obtener información de importancia acerca de sus derechos.*

PLAINTIFF/DEMANDANTE *(Name and address of each)*:	DEFENDANT/DEMANDADO *(Name and address of each)*:
FRANKLIN J. KOSDON 316 CAROL DRIVE VENTURA, CA. 93003	JERRY IRVINE 883 E. KINGSLEY, APT. D POMONA, CA. 91767

☐ See attached sheet for additional plaintiffs and defendants.

NOTICE OF ENTRY OF JUDGMENT

Judgment was entered as checked below on *(date)*: 4-25-91

1. ☒ Defendant *(name, if more than one)*:
shall pay plaintiff *(name, if more than one)*:
$ 3311.00 principal and $ 8.00 costs on plaintiff's claim.
2. ☐ Defendant does not owe plaintiff any money on plaintiff's claim.
3. ☐ Plaintiff *(name, if more than one)*:
shall pay defendant *(name, if more than one)*:
$ principal and $ costs on defendant's claim.
4. ☐ Plaintiff does not owe defendant any money on defendant's claim.
5. ☐ Possession of the following property is awarded to plaintiff *(address of property)*:
6. ☐ Payments are to be made at the rate of $ per month, beginning on *(date)*: and on the day of each month thereafter until paid in full. If any payment is missed, the entire balance becomes due immediately.
7. ☐ Other *(specify)*:

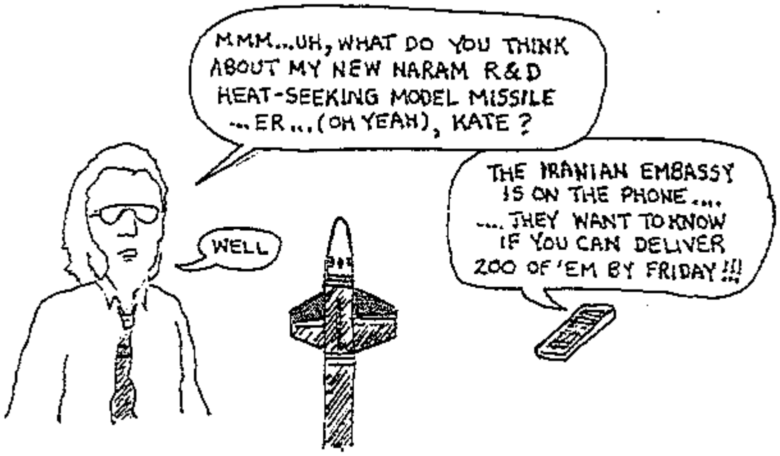
8. ☐ This judgment results from a motor vehicle accident on a California highway and was caused by the judgment debtor's operation of a motor vehicle. If the judgment is not paid, you may apply to have the judgment debtor's driver's license suspended.
9. Enforcement of the judgment is automatically postponed until the time for filing an appeal expires, and if filed, until the appeal is decided.
10. ☐ This notice was personally delivered to *(insert name and date)*:
11. CLERK'S CERTIFICATE OF MAILING — I certify that I am not a party to this action. This Notice of Entry of Judgment was mailed first class, postage prepaid, in a sealed envelope to the parties at the addresses shown above. The mailing and this certification occurred at the place and on the date shown below.

Place of mailing: 800 South Victoria Avenue, Ventura, California 93009
Date of mailing: 4-30-91

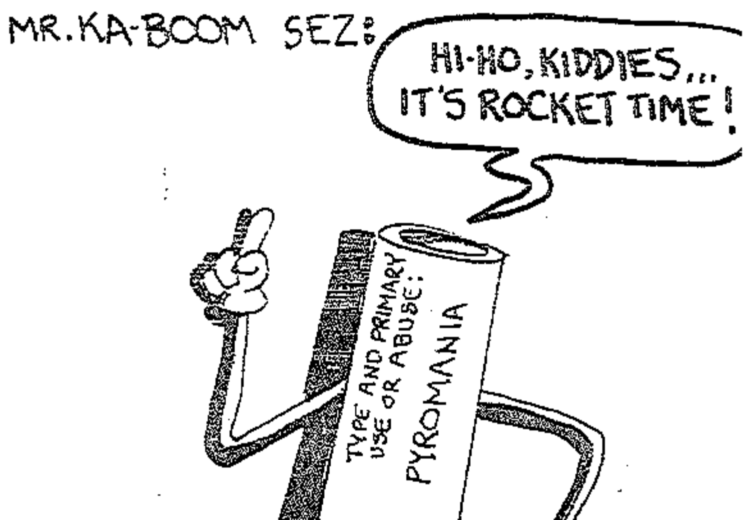
Sheila Gonzalez, Executive Officer and Clerk, by [signature], Deputy

— You have a right to a small claims advisor free of charge. Read the information sheet on the reverse. —


FUTURAMA!
COMICS PRESENTS
by Mr. Maddog


MMM...UH, WHAT DO YOU THINK ABOUT MY NEW NARAM R&D HEAT-SEEKING MODEL MISSILE ...ER...(OH YEAH), KATE?
WELL
THE IRANIAN EMBASSY IS ON THE PHONE.... ....THEY WANT TO KNOW IF YOU CAN DELIVER 200 OF 'EM BY FRIDAY!!!


SO HEAR ME NOW AND BELIEVE US LATER...!
SNOAR
NEWS


MR. KA-BOOM SEZ:
HI-HO, KIDDIES... IT'S ROCKET TIME!
TYPE AND PRIMARY USE OR ABUSE:
PYROMANIA

A Theoretical Analysis of Why Black Powder Model Rocket Motors Fail or "Why Motors Sometimes Go BOOM"

By
Matt Steele
Team NCR

(This report placed first in its division at NARAM-32)

INTRODUCTION

The catastrophic failure of a model rocket motor (or a "cato", as it is commonly known) often generates a great deal of discussion. The reasons for the failure of the motor are blamed on a variety of causes. Despite the development work done by Flannigan and Shector on the causes of catos in D12 motors, very little theoretical work has been done to explain why model rocket motors fail as they do. This paper will present the reasons why black powder model rocket motors fail.

SUMMARY

Over the past years, numerous studies have demonstrated that black powder model rocket motors will fail if exposed to temperature extremes. What has not been presented in the past is the isolation of the causes of these failures.

Using basic structural analytical techniques, it can be shown that the standard model rocket motor has a basic design problem when exposed to high temperatures. Typically, the grain expands more than the case would at a given temperature. When the grain cools, the case does not necessarily return to its previous position, but instead may suffer from creep, leaving a gap between the grain and case. This gap then becomes a failure point, allowing the grain surface area to be larger than designed. This causes casing overpressurization, which results in either a case rupture or "spitting the grain".

Large black powder motors with cores (such as the FSI Loadlifter series) have additional stresses that make them even more likely to cato.

These theoretical predictions closely match the experimental data generated to date.

From a design standpoint, improvement would be likely if the motor case was less susceptible to creep. Going to a thicker case wall is also an option, but will only work up to a

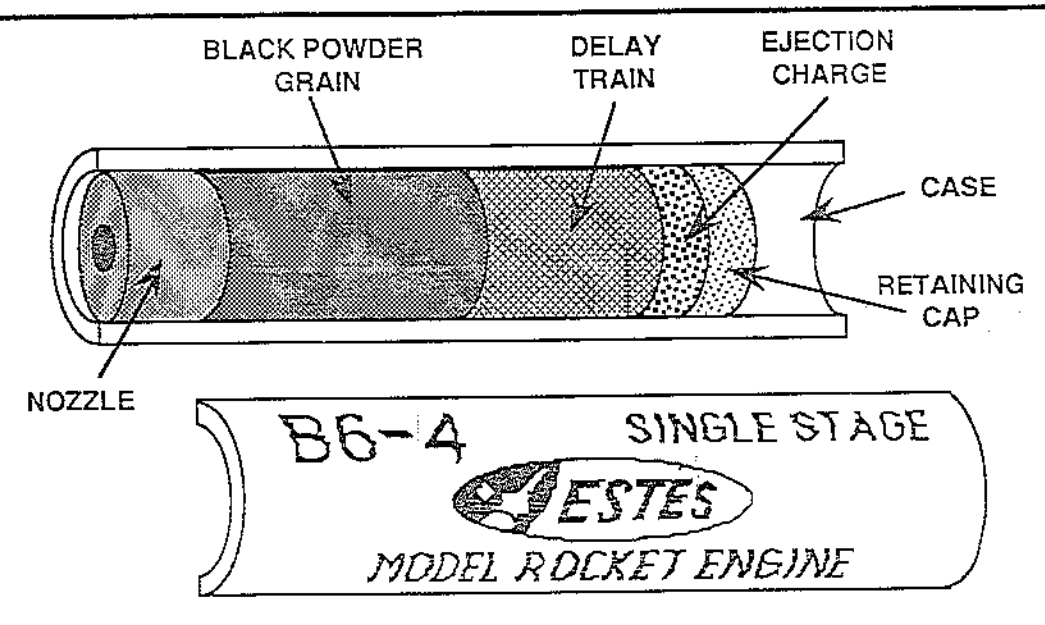


FIGURE 1 TYPICAL BLACK POWDER MOTOR

point.

Until black powder motor case improvements are made, rocketeers would be wise to keep their rocket motors from being exposed to temperature extremes.

BACKGROUND

Motor Design

A black powder model rocket motor consists primarily of the following components:

Casing	A convolute wound paper tube
Nozzle	A modified deLaval design that channels the flow of the hot gases and particles produced during combustion
Propellant	A pressed black powder charge
Delay Train	A slow burning, smoke producing mixture that allows the rocket to coast
Ejection Charge	A small gas producing charge that is intended to activate the recovery system

Figure 1 presents a cutaway diagram of a typical black powder motor.

Motor Manufacture

Typical model rocket motors are made by compressing the black powder charge, nozzle, and delay train into the casing. Usually, hydraulic or pneumatic rams are used, exerting considerable pressure. The casing expands slightly during the ramming process. The resulting tension at case/grain interface holds the grain in place. The case, as a result, has an induced loading condition.

Figure 2 illustrates the basic equilibrium state of the completed model rocket motor.

Observed Failure Mechanisms

In the most extensive study performed to date (432 D12 motors), Fred Shector discovered that motors exposed to temperature extremes would incur separations of the case/grain interface.

Figure 3 illustrates this condition.

Shector noted that this condition could induce failures by increasing the burning surface area of the propellant. This in turn would produce more combustion gas and particles, resulting in an overpressurized condition. That, in turn, would lead to a catastrophic failure of the rocket motor.

Figure 4 illustrates normal motor operation

Figure 5 illustrates the burning that occurs when a grain/case separation occurs.

Figure 6 illustrates a catastrophic failure.

OBJECTIVE

It was the objective of this study to present a sound theoretical basis for the causes of grain/case separations when black powder rocket motors are subjected to temperature extremes.

APPROACH

This paper identified two areas of interest: 1) the effects of thermal excursions on the case and grain, and 2) to examine the structural characteristics of the motor casing.

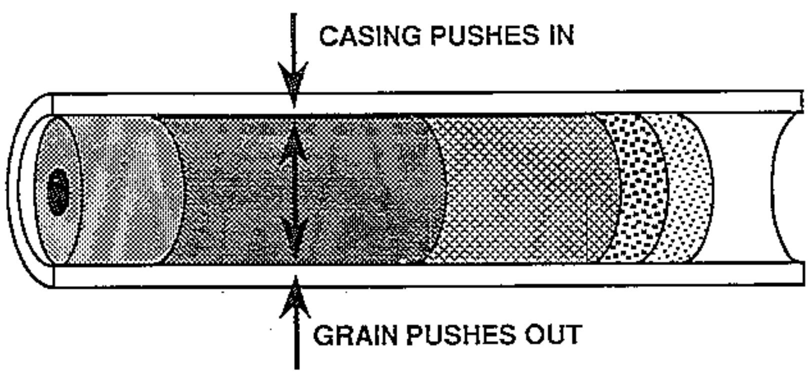


FIGURE 2 EQUILIBRIUM STATE OF A BLACK POWDER MOTOR

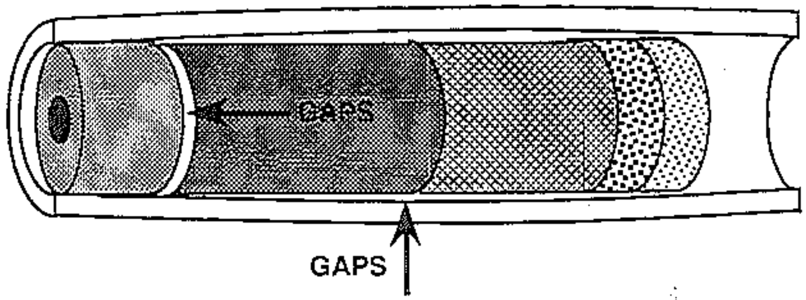


FIGURE 3 SEPARATIONS AFTER TEMPERATURE CYCLING

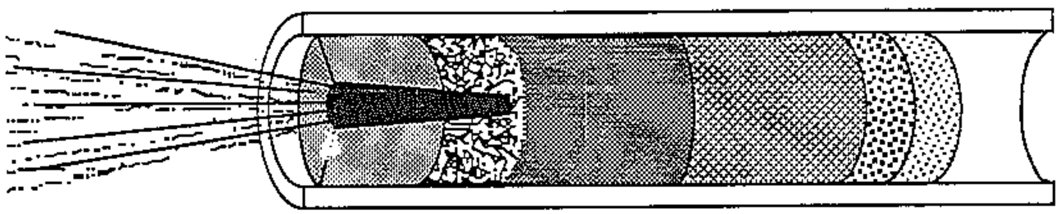


FIGURE 4 NORMAL MOTOR OPERATION

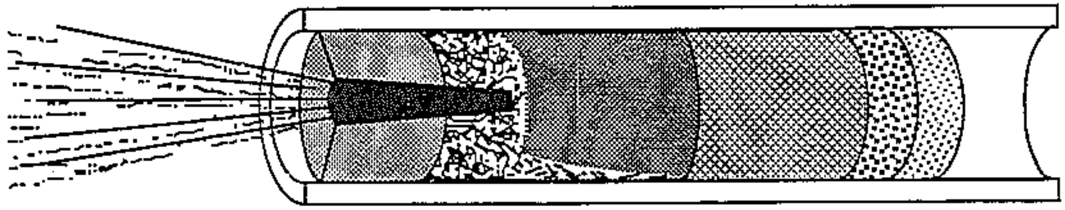


FIGURE 5 INCREASED BURNING AREA

In order to keep this paper on an understandable level that

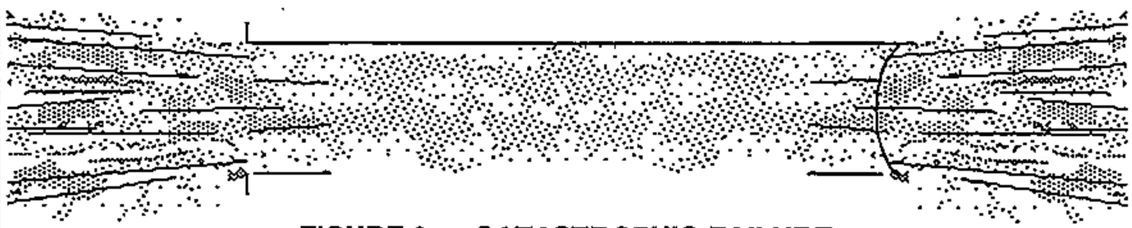


FIGURE 6 CATASTROPHIC FAILURE

most rocketeers can understand, I will only present a general argument and generalized results. In order to perform a more detailed analysis of this problem, a finite element analysis and thermal coefficient of expansion measurements should be conducted. However, this would be an expensive and time consuming endeavor, and would yield little useful data except to the motor designer. It is not the scope of this paper to go into that level of detail.

I have chosen to present only basic structural analytical models and rough order of magnitude calculations to explain the failure mode mechanisms in general.

DISCUSSION

Basic Analysis

A basic analysis of the structural characteristics of a rocket motor considers:

a) the source and character of the loads
b) the character of the stress bearing materials
c) the interaction of the stresses

Of primary interest in this case are the loads induced due to thermal cycling and the loads induced at ignition.

For thermal cycling, we know that tension and compression from thermal expansion causes stresses on the grain surface. This may induce cracking of the grain at the case/grain interface. In cored motors, these stresses can cause cracking of the inner core.

At ignition, the case generally expands and the grain compresses. In end burning motors, the axial pressure differential is great. Any area of grain fracture or debonding may be a source of motor failure.

Thermal Effects

Black powder is a relatively low performance propellant that has been in use since the first model rocket motors were developed. Although the content may vary, Table I presents typical black powder components.

TABLE 1

Black Powder Components	Typical %
Potassium Nitrate (Saltpeter)	75.0
Sulphur	12.5
Carbon, Amorphous (Charcoal)*	12.5

* Gunpowder charcoal, usually made of alder, willow, or hazelwood, is about 95-97% carbon and 3-5% ash. For the purposes of this analysis, it will be assumed to be 100% carbon.

Source: Chemistry of Pyrotechnics

In my research I could not find any evidence that casing or black powder grain coefficient of thermal expansion measurements had ever been made or even considered. However, a search of reference texts revealed that there were established values for most of the major components of black powder model rocket motors. This information is presented as Table 2.

TABLE 2

MATERIAL COEFFICIENT OF CUBICAL EXPANSION

Material	Mean value * (x10 -6)
Sulphur	223.0
Potassium Nitrate	196.7
Carbon, Amorphous	23.6
Clay, ceramic	24.3
Paper casing	102.3 **
Iron	355.0
Copper	488.8
Lead	839.9
Rubber	4870.0
Parafin	5880.0

* Between 32° deg. and 212° deg. F
** Based on wood, across fiber values

Source: Handbook of Physical Properties

One fact becomes apparent after examining the data in Table 2. That is, two of the major components in black powder have very large coefficients of expansion compared to other materials used.

After examining the expansion coefficients of the black powder materials, it is clear that the sulfur and potassium nitrate mixture have relatively high values in comparison to the carbon. Since black powder is a physical mixture rather than a chemical composition, it is reasonable to assume that expansion coefficient will be largely a function of the sulfur and potassium nitrate, with the effects of the carbon being rather small. Also, since the sulfur and potassium nitrate make up 82.5% of the total mixture, it is reasonable to assume that the actual expansion coefficient is probably in the range of 196.7 - 223.0. For the purposes of this analysis, I have selected a value of 196.7 (the value for potassium nitrate) for the black powder expansion coefficient. Due to the low coefficient of expansion for the carbon, its effect has been considered to negligible.

This is intended to be conservative. I suspect that the actual coefficient may be closer to the value of sulfur. Since the interactions are not well understood, though, I thought it may be more realistic to analyze the expansion of the largest component, potassium nitrate. This may, in actuality, understate the actual calculations of thermal expansion, but will not mask the effects.

From the equations

(Equation 1) $L = Lo\ (1 + C\ VE)$

and

(Equation 2) $LE = f(VE,3)$

where L0 = length of material at 0° C
L = length of material
C = temperature of material (°C)
VE = coefficient of volumetric expansion
LE = coefficient of linear expansion

we can calculate what the increase or decrease in diameter of a propellant grain might be at a given temperature.

Table 3 shows the calculated growth of a black powder grain as a function of temperature. Figure 7 depicts it graphically for the Estes D12.

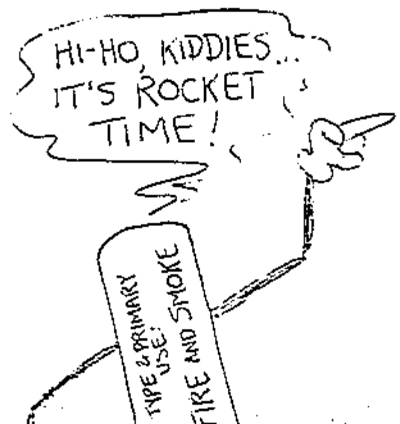


TABLE 3

TEMPERATURE VS. GRAIN DIAMETER

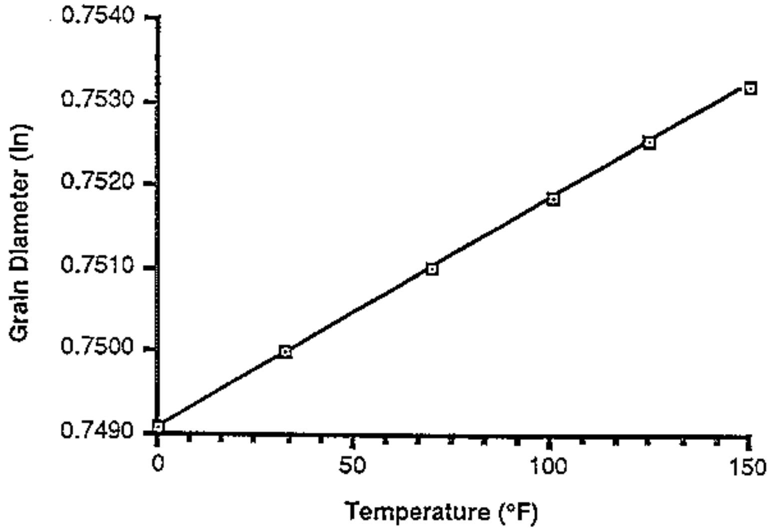
Motor Type	Temperature °F (°C)	Diameter (inches)	Difference from Ambient (in)
Estes Mini Motor			
	0 (-17.78)	.2497	- .0006
	32 (0)	.2500	- .0003
	70 (21.11)	.2503	
	100 (37.78)	.2506	+ .0003
	125 (51.67)	.2508	+ .0005
	150 (65.56)	.2511	+ .0008
Standard Estes Motor			
	0	.4994	- .0013
	32	.5000	- .0007
	70	.5007	
	100	.5012	+ .0005
	125	.5017	+ .0010
	150	.5021	+ .0014
Estes D12			
	0	.7491	- .0019
	32	.7500	- .0010
	70	.7510	
	100	.7519	+ .0009
	125	.7525	+ .0015
	150	.7532	+ .0022
FSI Loadlifter			
	0	.8740	- .0022
	32	.8750	- .0012
	70	.8762	
	100	.8771	+ .0009
	125	.8780	+ .0018
	150	.8788	+ .0026

Nominal grain diameters are assumed to be at 0° C (32° F) for ease of calculation.

Clearly, as the temperature rises, the larger diameter motors start to experience significant swelling of the grain at higher temperatures. Since we know that motors do not split wide open when exposed to these temperature, we must assume that the case expands by the same amount.

One might not worry about this phenomena if it were assumed that the case would return to its original diameter upon cooling. However, as we shall see later, this is not always the case in materials like the case.

Table 3 also indicates that if the grain gets cold enough, a gap may be created. The temperature that this may occur at appears to be too cold for all but the heartiest of rocketeers.



Secondly, the internal equilibrium (as illustrated in Figure 2) load may cause the case to begin to contract around the grain and minimize the gap.

As a result, it appears that the source of most motor catastrophic failures occur as a result of hot temperature excursions. This fits in better with the typical scenario that a modeler encounters (i.e., a lot of rockets fly in hot weather, very few in cold), and agrees with Shector's results. Because of this, the analysis will concentrate on the hot temperature scenario that appears to be more common.

The generalized condition described above is primarily for a solid grain, typical of most Estes motors. If the motor is a core burner, such as the FSI "Loadlifter" series, additional problems may be encountered.

This is primarily due to the fact that the core configuration induces additional stresses on the grain. The hoop stress is the greatest at the center of the grain. At hot conditions, the core will bow outward (as illustrated in Figure 8). The gap between the the case and the grain is likely to be even more pronounced than in solid grain configuration.

Additionally, the forces of ignition pressurization work against this configuration. If a cored motor has a gap between the case and grain, the force of ignition pressurization may crack the grain, resulting in an increase in burning surface area and a cato.

Comparative failure rates for motors of roughly the same

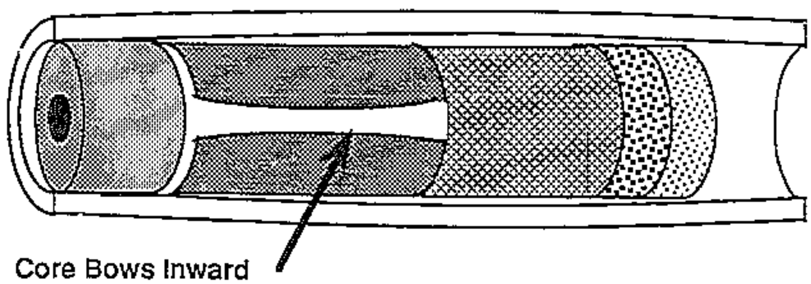


FIGURE 8
CORED MOTOR AT HIGH TEMPERATURE

size (such as the FSI F7 and F100) seem to support the theory that cored black powder motors are more likely to fail.

STRUCTURAL CONSIDERATIONS

A convolute would paper motor casing is essentially a composite material— that is, a system that consists of an adhesive resin system and a reinforcing fiber. In this case, the fiber is the paper, and the resin is the glue that bonds the paper together.

Tensile testing of metals at normal temperature ranges generally show one basic type of stress-strain curve. Composites are generally more sensitive to time and temperature effects. It appears that the casing material for black powder motors has been assumed to reflect the basic characteristics of metal properties -- that is, there is little variation to stress-strain curve with time and temperature. Yet, it is quite clear that the manufacturing process takes advantage of the composite nature of the casing when the case walls are expanded slightly to compress the black powder grain. Because of this, it appears that techniques more common to the analysis of composites materials would be in order.

Creep and Relaxation Phenomena

The phenomena of creep and relaxation is known and can be demonstrated in composite materials. Creep and relaxation can be illustrated by considering a test specimen that is loaded in tension.

A force is applied to a specimen and an initial deformation is observed. With time, the test bar will permanently elongate. Creep is defined as non-recoverable deformation, with time, under a constant load. Consider a similar specimen caused by the same force, but in this case the specimen is confined to the initial deformation. The force decreases with time. Relaxation is defined as decrease of force, with time, required to produce a constant strain.

Basic creep and relaxation behavior are measured by a simple uniaxial tension test. The data are usually given graphically. From the individual curves, the time-dependent

moduli are calculated. The time-dependent creep modulus is defined as:

(Equation 3)

$$E_t\ \text{creep} = f(\text{Stress}, \text{Strain at time } (t)) = f(F0 / A0, \Delta Lt / L0)$$

where
F0 = Constant force, lb
A0 = Original cross-sectional area, in.
L0 = Original length, in.
ΔL = Increase in length at time (t), in.

The time dependent relaxation modulus is similarly defined as:

(Equation 4)

$$E_t\ \text{relax} = f(\text{Strain at time } (t), \text{Stress}) = f(Ft / A0, \Delta L0 / L0)$$

where
L0 = Initial deformation, in.
Ft = Force at time (t), lb

Similar behavior can be shown for temperature effects.

The modulus accuracy limit is used as a checkpoint when making creep (deformation) and relaxation (force decay) calculation.

It has been shown experimentally that the creep modulus and relaxation modulus are similar in magnitude and for design purposes may be assumed to be the same. That is Et creep = Et relax. Therefore, only one time-dependent and temperature modulus (called the apparent modulus) is necessary.

Elastic design equations which were developed for metals can be applied to composites, such as a black powder rocket motor case. The deflection equations are expressed in terms of two material variables, the elastic (Young's) modulus and Poisson's ratio; while the stress equations are only dependent on load and geometry. These formulas can be converted to the appropriate time-dependent /temperature dependent equations by replacing the elastic modulus with the apparent time-dependent modulus and assuming Poisson's ratio to be a constant.

For practical purposes, Poisson's ratio is assumed to be constant with time. The other major assumption is that the stress distribution is initially linear and remains linear with time.

The radial displacement and the mean hoop stress of a casing under an induced load may be calculated using the following equations:

(Equation 6)

$$\text{Radial displacement} = Y = f(r, Et)\ (1 - f(\mu, 2))\ f(PjR, t)$$

(Equation 7)
Mean hoop stress = Sb = (f(PjR,t))

Geometry of the case:

Mean radius of case = R = 0.50"
Wall thickness = t = 0.10"

Apparent modulus
Et (f(5 years,100 F)) = 100,000 psi (assumed from similar composite type materials)

Assumed Load = 150 psi = Pj

Poisson's ratio = 0.40

Y = f(0.50,10 x 104) [(1—0.20) f(150 x 0.50,0.10)]

= 0.0029 in.

Sh = f(0.50,10 x 104) = 750 psi

Œ = f(Sh,Eo) = f(750,175.000) = 0.0043 in.in.

or 0.43%

The calculation shows that the radius of the casing could increase by .0029" if exposed to this condition. The radial displacement is considered a realistic estimate since both the initial stress and strain did not exceed the modulus accuracy limit for this specific material (assumed to be 1400 psi, 0.85%).

Using the above equations, we can also demonstrate some useful properties:

A) The radial displacement is a function of the case radius. This means that small diameter cases, such as mini engines and standard size motors are less likely to experience significant displacement than larger diameter cases, such as the Estes D12 and FSI F100.

B) The increase in internal pressure is proportional to the amount that the grain diameter increases during expansion. Since the amount of increase in diameter is a function of the initial grain diameter, it follows that the smaller the grain diameter, the less likely case deformation and/or creep will take place.

C) Increasing the thickness of the case will minimize the displacement, if all other variables remain constant. However, there is a certain value above which increasing the thickness adds little margin. Figure 9 shows radial displacement as a function of wall thickness.

D) Older motors are more susceptible to creep. This is evident in the time dependent apparent modulus, which is lower than the elastic modulus

E) Obviously, a material with a higher apparent modulus or a higher Poisson's ratio will be more resistant to creep.

OBSERVATIONS

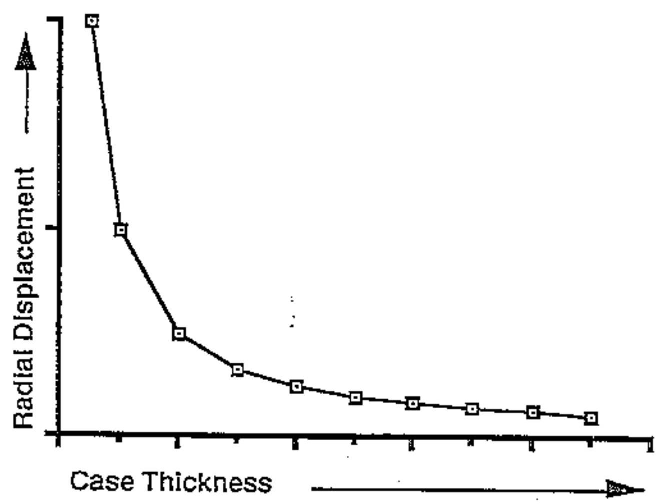
Generalized Failure Mode Scenario
As a result of these thermal and structural characterizations, the following generalized scenario can be developed:

1) If a motor is exposed to high temperatures, the grain will expand at a rate greater than the case. This induces an additional load on the case.

2) If the motor then returns to ambient temperatures, the grain contracts. The casing also contracts, but it may not contract all the way, due to the phenomena of creep.

3) The resulting gap between the propellant and casing may initiate a catastrophic failure.

This agrees closely with Shector's observed results.



Other Observations

Some other interesting observations can be made about this scenario:

1) A motor that has been exposed to warm or hot conditions, but has not returned to ambient, is likely to work, as no gap in the propellant/grain is present. This was also verified in Shector's tests.

2) A motor exposed to cold is unlikely to fail, unless the motor is exposed to a low enough temperature that the grain cracks or contracts away from the case wall.

3) Cored motors are more likely to fail than end burners, due to the effect of ignition pressurization and increased hoop stresses in the core.

4) Motors with a small ratio of grain radius/casing thickness will be less likely to cato, due to the smaller amount of thermal expansion and a higher resistance to creep.

5) Any increase in temperature would tend to reduce the strength of the adhesive used in the casing. This would result in the apparent modulus value being lower than the elastic modulus.

Catastrophic Motor Failure Prevention

As a result of this analysis, there are two basic approaches that can be taken towards preventing catos in black powder motors. One involves what the modeler can do to prevent problems in motors available on the market today. The other is what current manufacturers can do to minimize the problem in future designs.

It is obvious from this analysis that the modeler should strive at all times to keep black powder motors at temperatures near ambient. Any significant temperature excursion can cause a motor failure, particularly in FSI motors and the Estes D12. If motors do get hot, it would be best to use them then, rather than allowing them to cool off. If motors are suspected of being hot cycled, re-heating the motors prior to flight might minimize catos (but this is only for the very brave). And, it can be seen that cold weather flying may induce catos, although this is not as likely to cause problems.

When black powder motors were designed, no one sat down and tried to determine the apparent modulus or Poisson's ratio for the case. What probably happened was that a case thickness and material was chosen from commercially available products. So, the design of a black powder model rocket motor is more likely the result of trial and error testing than of a carefully considered structural analysis.

If the designer is looking to improve the reliability of the black powder model rocket motor, the first approach might be to increase the case wall thickness and reduce the propellant mass. This is exactly what Estes did with the infamous D13, which was extremely cato prone. Even with these changes, the D12 (which is the reincarnated D13) still suffers from cato problems.

In some cases, reducing the propellant mass isn't practical. And, as Figure 9 demonstrates, increasing the thickness of the case wall will only help the situation to a point.

That leaves the designer with two other choices -- find a material that has a coefficient of expansion that is closer to black powder's or find a casing material that is less resistant to creep. A quick review of common materials reveal that most non-metalic "structural" materials have low coefficients of thermal expansion, so the possibility of finding a material that would be suitable does not appear extremely likely. Rather, it would seem that the ideal course would be to attempt to find a casing material that is less susceptible to creep. With the advent of high strength plastics and elastomericised ablative resins (i.e., rubber compounds mixed with binding resins), it would seem that such a material might be available at a competitive commercial price and availability.

FURTHER WORK

Further effort in this area would include:

1) Finite element analysis of the black powder motor.

2) Thermal coefficient of expansion characterization of the black powder grain and case.

3) Experimental determination of the apparent modulus and Poission's ratio.

4) Characterization of alternate case materials for apparent modulus and Poisson's ratio.

5) Possible development of a black powder motor with an alternate case material.

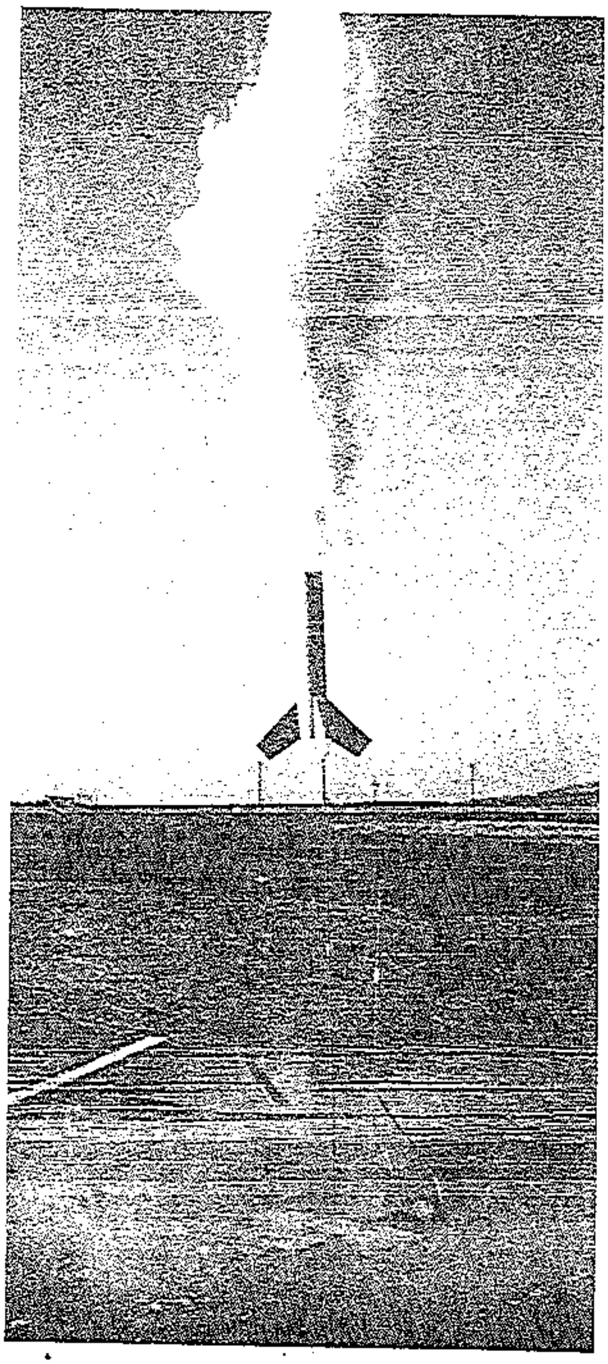
6) Testing to see if "re-heating" temperature cycled motors reduces catos.

CONCLUSIONS

The basic design flaw in most black powder motors is the fact that the effects of temperature and time have not been adequately accounted for in the motor case and motor grain design.

If it can be shown that the case and grain expand significantly when exposed to high temperatures. It is theorized that the casing suffers from creep, and does not totally relax when cooled. This creates a gap between the propellant and the casing, which can initiate a catastrophic failure. This scenario agrees closely with experimental observations.

It is suggested that black powder motor manufacturers investigate possible alternate casing materials in light of the new understanding. Until then, modelers are advised to keep their motors protected from temperature extremes, especially heat.



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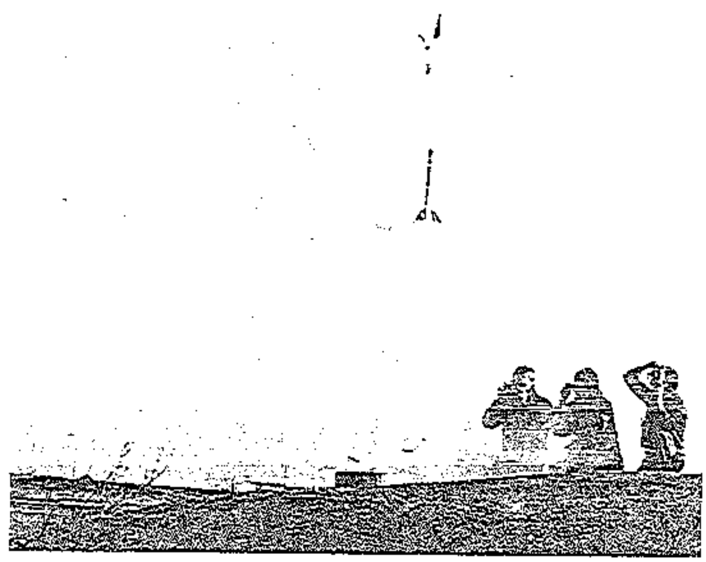
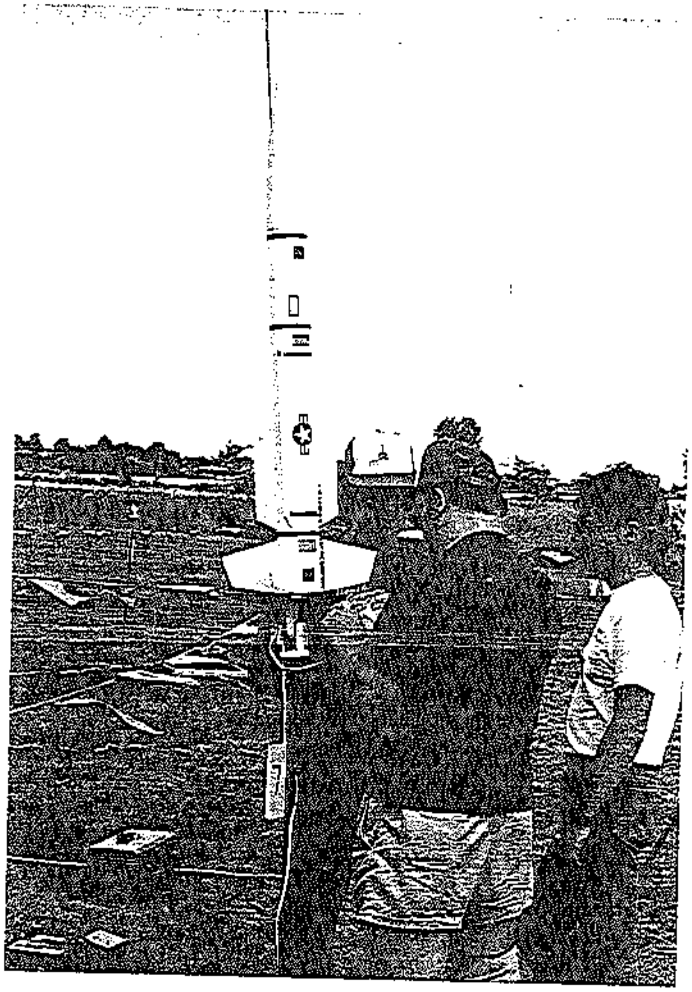
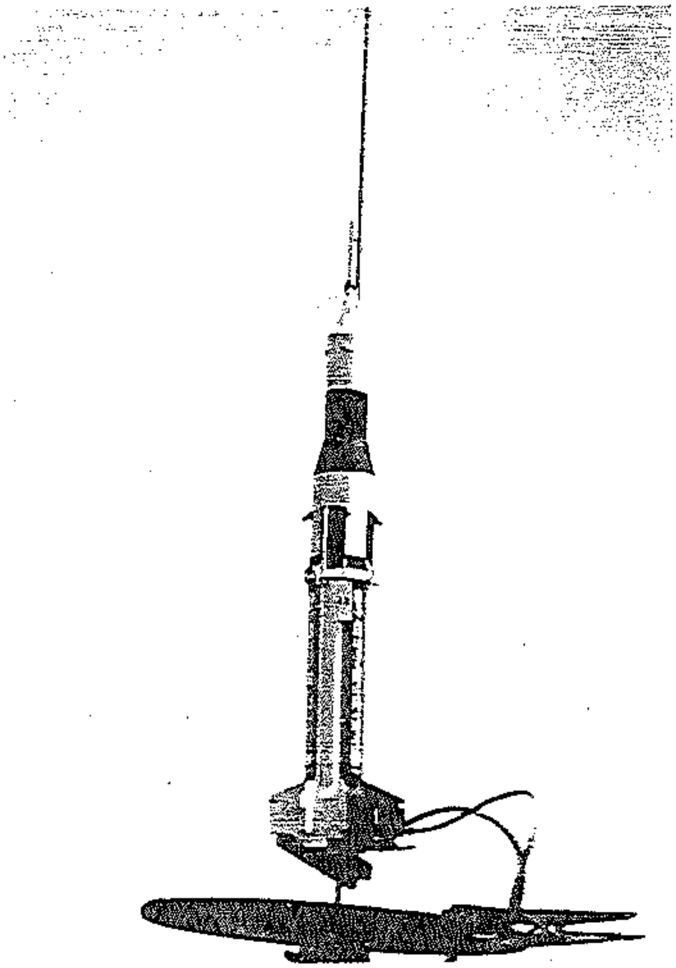


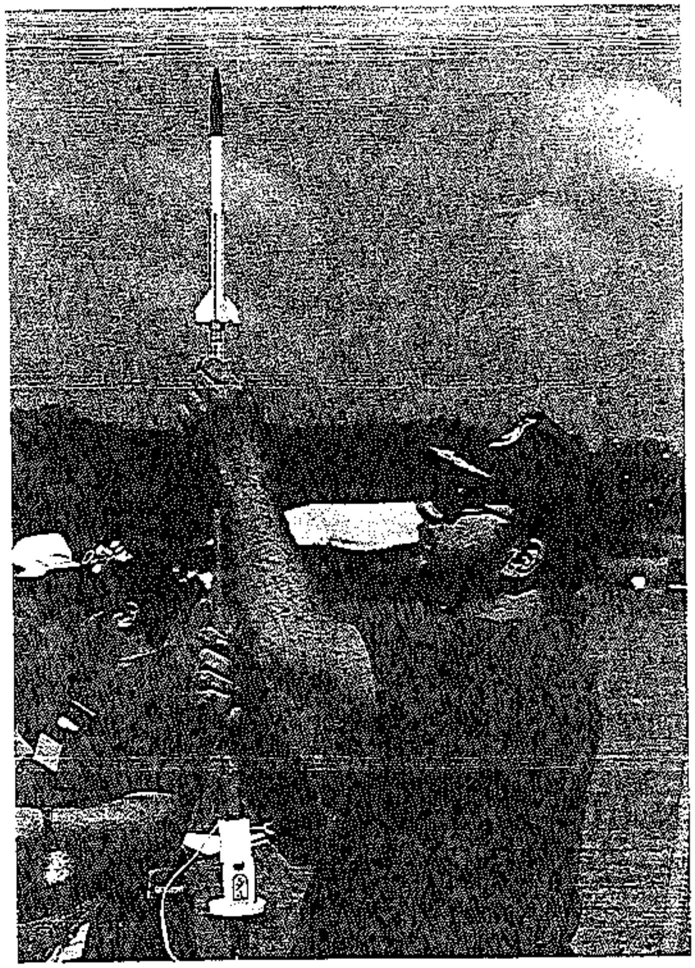
NARAM-33 Highlights

Top Left: Connie Pursley poses with the Southern Comfort Team's 8" diameter Little Joe II. Top right: Chris Pearson, Matt Steele, and Gary Rosenfield prep the SA-14 Archer before it's ill fated flight (which got caught in nearby power lines). Below: Jay Apt and Matt Steele present the A Division National Championship trophy to Matt Whymark.



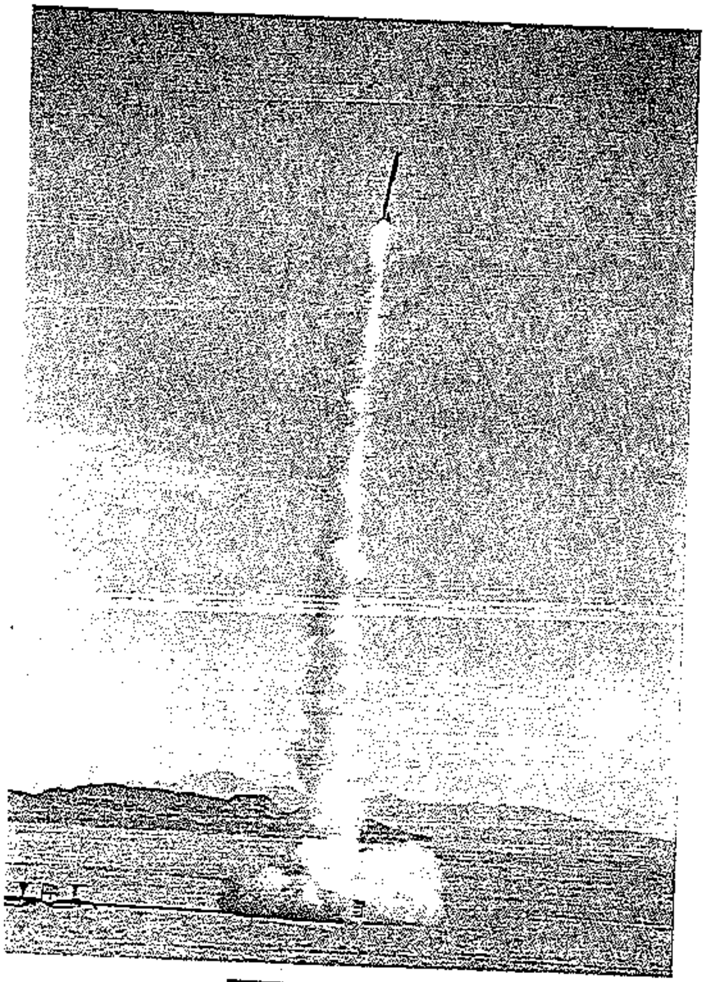
Top Left: Roger Wilfong had a great Saturn for Peanut Scale. **Top Right:** Matt Steele loading up an IQSY Tomahawk, one of the more popular Peanut Scale prototypes. **Below:** The repeating National Champion Section, the Rocket City Aces (with former SNOAR members Matt Steele and Chas Russell)

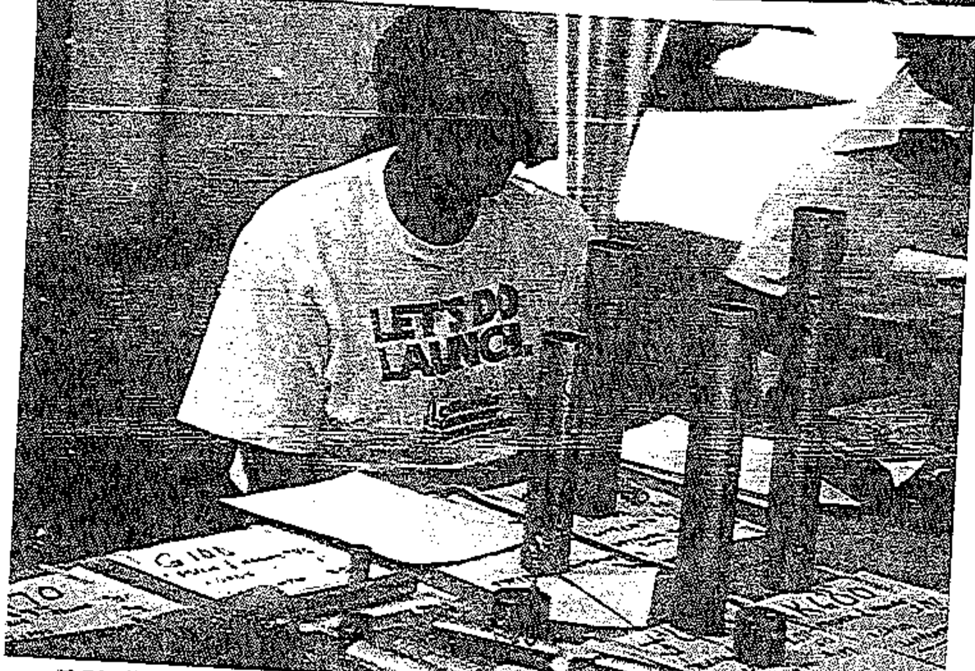




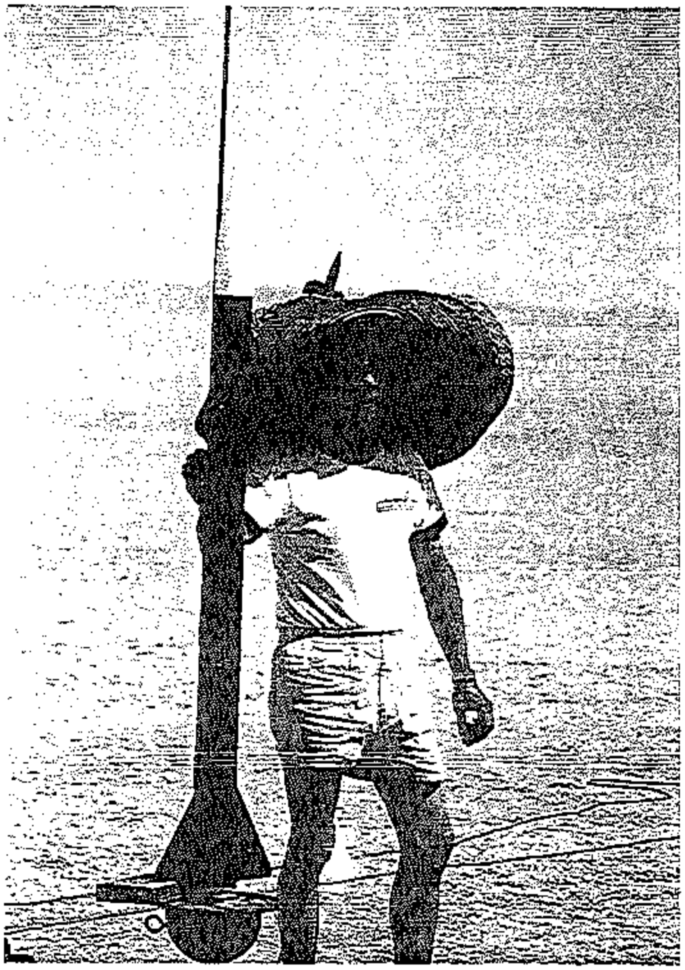
LDRS: Ten Years After

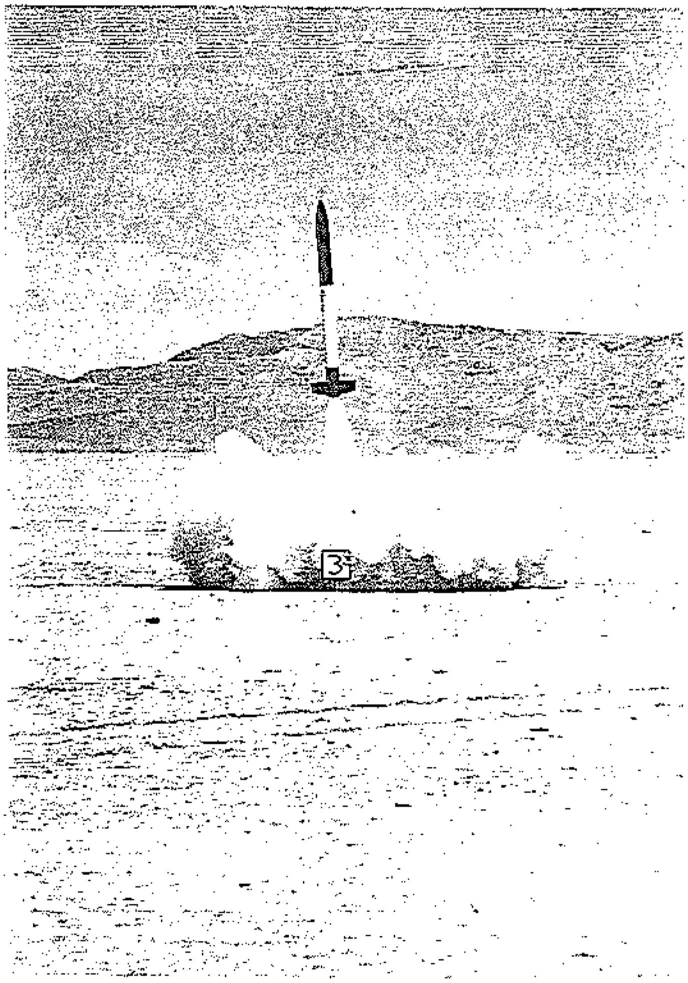
LDRS-X had some of the highest flying rockets ever, including this L powered altitude attempt **(Top left)**. Chuck Mund, a veteran of early LDRS meets in Ohio, had a minimum diameter altitude attempt also **(Top Right)** "Uncle Bob" was busy selling the Kosdon reloadable motors **(Below)**





Top Left: No one was sure whether Frank Hunt was flying the hat or the rocket with a J motor. The rocket flew. **Top Right:** This monster had six or seven 1.5" motors in it and stood over ten feet tall. **Below:** Randy Redd brought his flying tank out (probably to tease Jon Randolph!)





BULL SHEET

There is a new company on the horizon... one that intends to give Estes a run for the money. QUEST ROCKETRY, run by Bill Stine, formerly of MRC fame, made its debut at the November RCTHA show in Chicago, IL. Supposedly, the company is well financed and will be offering a complete line of rocketry products. Black powder motors have been tested at Standards and Testing. The company also has Dane Boles, Jeff Flygare, Ed Lacroix, Harry Stine, and Grant Boyd on the staff. The bulk of the kits are "deja vu all over again", as the parts look to be the long lost (and not necessarily loved) MPC parts from the late 1960's. The models are inexpensively priced and are aimed at Estes's low end and educational market.

Quest motors will be A6-4, B6-0, B6-4, C6-0, C6-3, C6-5, and C6-7. The prices for the motors are three for $3.29 for the A's, $3.59 for the B's, and $3.99 for the C's. The motors feature a new variant of the Aerotech Copperhead called the Tiger Tail. It's like a tape cover for a Copperhead igniter. The igniters are available separately, six for $2.29

The rockets feature either 24" streamers or 12" parachutes for recovery and the parachutes have adhesive plastic tabs onto which the shroud lines are tied. They have combination kevlar/elastic shock cords, with the kevlar portion tied to the front of the motor mount. The launch controller looks familiar ($11) and a launch pad which appears to be a tripod made from PVC pipe and fittings ($13).

Prices for the kits are:

Antari	$4.49
Sprint	$3.99
PipSqueak	$2.99
Falcon	$7.49
Tracer	$5.49
Astra 1	$4.99
Apollo	$7.99
Nike-K	$6.49
Evader	$5.49
Aurora	$7.49
Intruder	$7.49
Navaho AGM 20	$7.99

Estes is also had a few surprises at the RCTHA show, including the revival of clusters. Estes has developed a new igniter holder that makes clusters easy to ignite. A new, larger kit of the Patriot are in the works, as well as E, F, and G composite motors. Also in the works is a 3.5" long black powder E22 motor to go with the introduction RC "Astro Blaster" glider. Most of the product will not be available until spring.

Estes has discontinued the following motors and kits: A10-3t; B4-2; B4-4; C6-3; Micron; Jammin; Alpha III; Astro; Laser; Blazer; Liberty; Blue Star; Eggspress; Javelin; Meteor; Cajun; Menace; Dark Star; and Surveyor.

The US Team had good success in the Soviet Union, where the coup was over before the team left. The Soviets won three events: SD, Scale, and Altitude. Dave O'Bryan won PD and Bob Parks won B BG and E RC RG. It was an even split as far as first place finishes.

The Soviets flew flop-rotating wing boost gliders. They weight about 18 grams, are about 22" long, have a wing span of 24", and feature balsa wings, a fixed fiberglass engine pod, drop weight DT, and a carbon fiber tube fuselage. The Russians flew flop wings in RC RG also. Bob Parks took first with the bird he flew at the '91 Flyoffs. Karen Dillon, Bob's wife took second, missing a max by 8 seconds in the final round! She was flying her 1983 ship! Phil Barnes took 4th place.

Here's a tip from Kevin Stumpe at NAR HQ that will help you use Copperhead igniters with your conventional launch controller. Fold the bottom 1/4" of the copperhead back on itself (no need to crease it). Then fold that back about 1/2" to make 3 thicknesses of igniter. Fold this then another 1/4" back to 90 degrees (not 180). The second fold should look like a "Z". What you have is (from the pyrogen down) a long straight igniter with 2 arms sticking out of the bottom. Hook the micro-clips to the arms (without letting them touch each other. Each arm only exposes one side of the Copperhead. It does work. and you don't have to rummage around looking for tape!

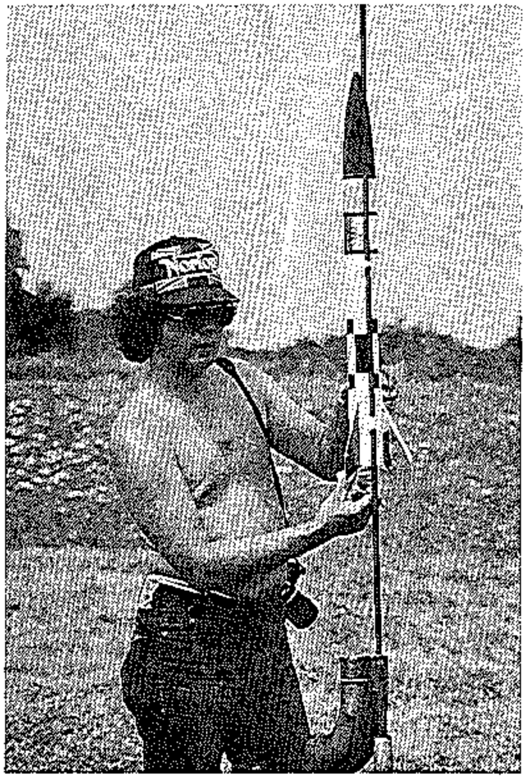
NASA named Jay Apt as a crewmember aboard Endeavour on STS-47. And Jay said he didn't know when he'd be flying again! For Endeavour's second flight, NASA has scheduled the Spacelab J mission for August 1992. Spacelab J is a joint mission with the Japanese Space Agency and is dedicated to materials processing and life science experiments. Other crew members are:

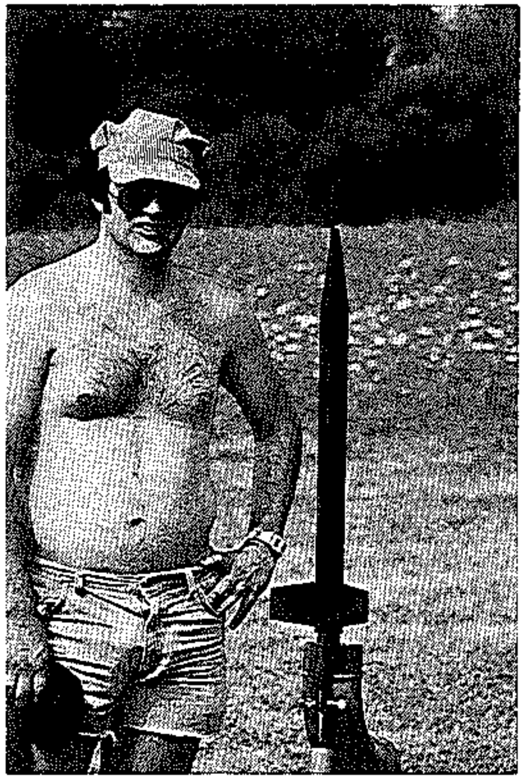
Robert L. Gibson, Capt. U.S. Navy, Commander
Curtis L. Brown, Jr., Maj. U.S. Air Force, Pilot
N. Jan Davis, Ph.D., Mission Specialist
Mae C. Jemison, M.D., Science Mission Specialist
Mark C. Lee, Lt. Col. U.S. Air Force, Payload Commander
Mamoru Mohri, Ph.D., NASDA (Japan) Payload Specialist

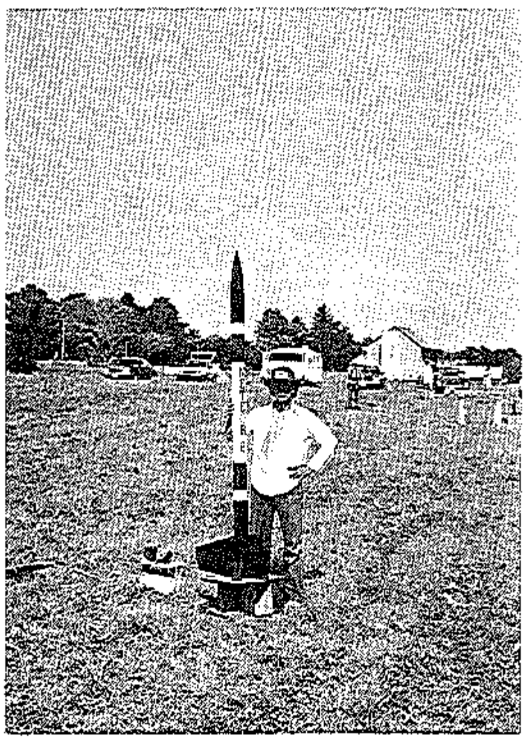
Of interest, "Hoot" Gibson, the commander, is an active RC flyer, AMA member, and attended the 1980 World Space Modeling Championships. Lee and Davis are to become the first married couple to fly in space together.

There have been reports in the media that a helicopter may have been "shot down" by a model rocket in the Phoenix area this summer. However, our resident rocket expert in the area, G. Harry Stine set the record straight: "No rockets of any kind were involved. Period."

Go Back in Time! Early LDRS Photos







Top Left: Chris Pearson displays a Mini Mongrel; **Top Right:** Mike Wagner stands next to a Vulcan J motor; **Lower Left and Right:** Chris Pearson stands with the before and after of Meteor 6, flown with 20 D12s.

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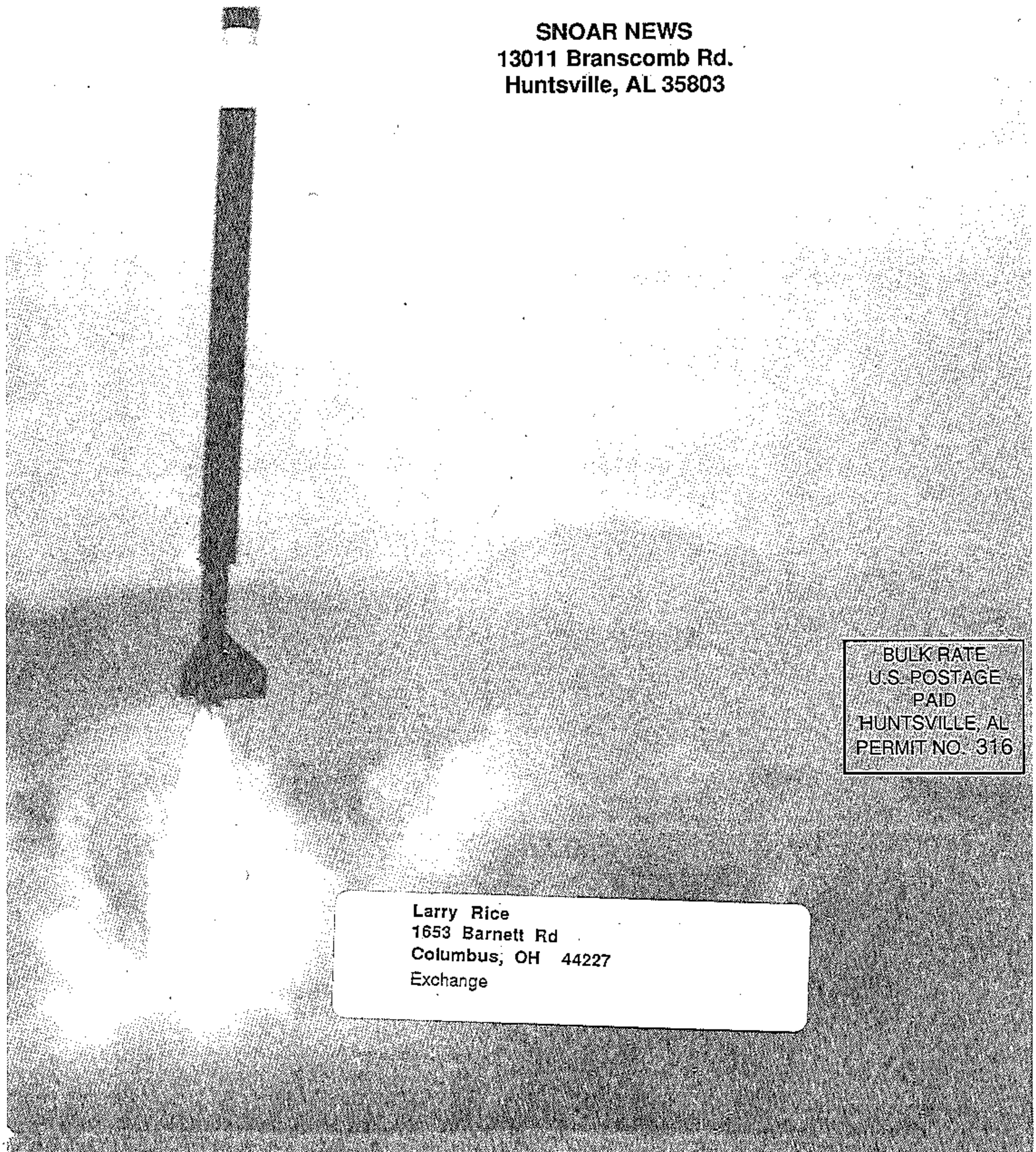

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