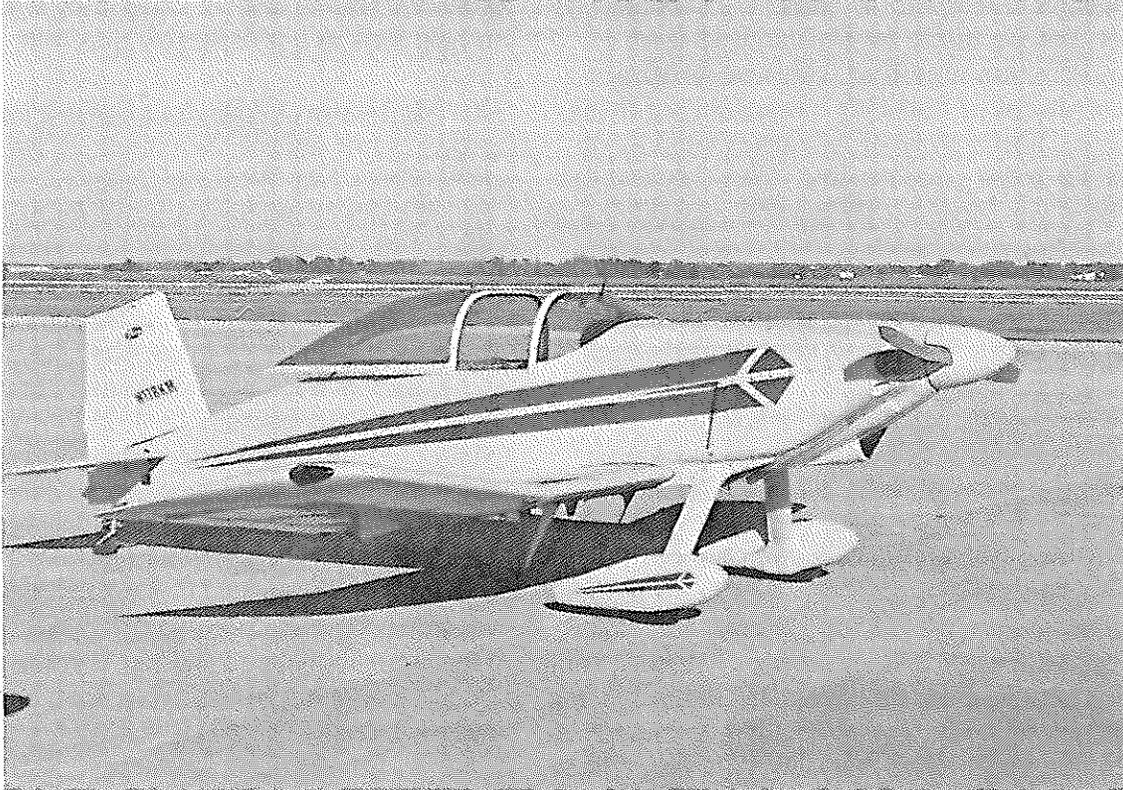


T-18 NEWSLETTER



N118KM IS KEN MORGAN'S THORP T-18

IN THIS ISSUE:

NUTS & BOLTS by Ed Lambert

KEEPING WARM/STAYING COOL by Tom Kerns

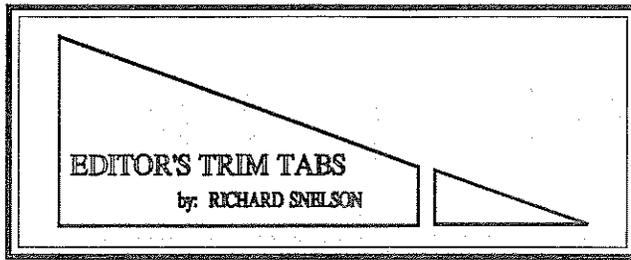
PROTECTING YOUR IGNITION SWITCH by Bill Benedict

STARTER RELAY WOES by Bill Benedict

PUBLISHED T-18 ARTICLES from the EAA

KENTUCKY DAM '94 PHOTOS

***NOTICE: (STANDARD DISCLAIMER)** As always , in the past, present, and future newsletters, we would like to make you aware that this newsletter is only presented as a clearing house for ideas and opinions, or personal experiences and that anyone using these ideas, opinions, or experiences, do so at their own discretion and risk. Therefore, no responsibility or liability is expressed or implied and is without recourse against anyone.*



Oh well! There wasn't a Thorp T-18 on the cover, but the inside of the March 95 issue of Sport Aviation was filled with wonderful air action photos of Earl Ody's beautiful red flying machine. Earl's story of adventures and flying made for some good reading. Earl Ody and Pat Candon, you have our thanks and congratulations for building a fine airplane, bringing it to Oshkosh 94', and getting it in Sport Aviation in front of the large EAA audience. That really helps to keep the Thorp T-18 fresh in everyone's mind!

New individuals call me and talk T-18s weekly. Many are looking to buy, other are thinking of joining the ranks of those that spend hours of time and effort to someday be able to step into and fly an airplane that they built, a special feeling that has few parallels. Lucky for the folks wanting to buy, we "Thorp Owners" still don't realize what airplanes are worth. I think some of this comes about due to the builder selling his Thorp based upon what it cost him to build it 15 to 20 years ago. Back then \$3000 would put an airplane in the air. Today it won't buy the engine. If you plan to sell your Thorp, check to see what the other types of metal airplanes are going for. Don't lose sight that the Thorp is as fine as anything being built. Proof of that comes each time I talk to someone who has sold his Thorp to fly greener pastures, and is now looking for another Thorp T-18. Give yourself credit for the 2000-3000 hours of work and then set the price. As I watch the market, most Thorps sell quickly. What does that tell you? It tells me the asking price maybe low.

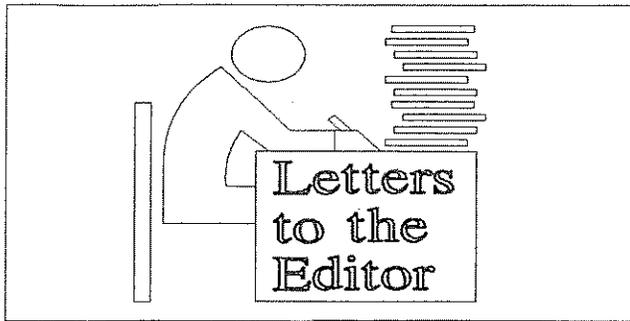
I find an occasional individual that rushes out to buy a Thorp without any knowledge of what he is buying. Buyer beware, buying a homebuilt is quite different from buying a factory job. No two homebuilts are equal!!! Most buyers will ask questions and read all of the old newsletters to prepare themselves for inspecting and checking out their prospective airplane. Others don't and

end up buying an airplane that needs a lot of expensive work, often by \$40 an hour plus professionals. Even with all the reading without Thorp flying and building experience you may not be prepared to make a good evaluation. That means it's time to get some help from members of "The T-18 Mutual Aid Society". We are all here to help. Just get out the membership list and call someone who is near. I know they will be glad to help look at a prospective purchase.

Our McAlester, Oklahoma Spring get-together is just around the corner. Remember it's on Mother's Day Weekend, May 12, 13 and 14. This is a fun event, with a lot of flying taking place. For our new members this would be the time to spend three days learning about the Thorp and getting some air time with our friendly flying family. Please join us! Call the Holiday Inn in McAlester now, to make your room reservation. Their number is (918-432-7766). Leroy and Mary Holt have been our wonderful hosts at this event in the past and this year I'm sorry to say, Mary has not been well. I called Leroy last evening, and he hopes that Mary may be able to come out to the airfield and visit sometime that weekend. We sure hope so too, Mary! Coming to McAlester without seeing our favorite "Red Head" would not be the same. You both have our prayers and thoughts.

My Thorp is flying well, after a lot of work to find the problem. I think the fuel flow problem was solved by installing a longer ram air vent that extends about 3 inches below the belly. I flared the front of the tube to gather additional air. I'll let you know final results after some additional flights with lower levels of fuel.

Since my job is now 3 miles from the airport, it allows for afterwork hops during the winter months. That has allowed me to build 300 plus total hours on N295RS. RoxAnne and I are planning a trip in June to Prescott, AZ. So look for a black and white Thorp over the city of Phoenix this summer. We're really flat-landers, get a nose bleed when we cross an overpass out here on the prairie of Illinois, so we are planning to go the southern route. RoxAnne doesn't like the red orange colors on the sectionals out that way.



December 29, 1994
Dear Friends,

Many of you are aware that my father, Mac Booth, Sr., has been in ill health for some time and suffers from a terminal brain tumor. I regret the necessity of this form-type letter but Dad is unable to write to you all personally and we've received cards from some of you who are not current with his condition.

In late September this year, Dad and I packed his belongings in Alabama and moved him to our home in San Jose, CA, where he is currently being cared for by my wife and myself. He has been examined by specialists at Stanford University with the same results; nothing can be done.

His attitude and his spirits are good. The only noticeable decline so far is his physical ability to get around on his own. He is visited daily by either nurses, physical therapists, health aids or spiritual counselors. We have done all we can to provide him with the best possible care to insure that his short time left is comfortable and painless.

Our family is grateful to all of you who have sent your prayers and best wishes. We welcome you to write to him at our home address:

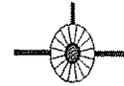
Mac E. Booth
295 Jagers Dr.
San Jose, CA 95119

Again we thank you for all your prayers. Mac Jr. and Rena Booth.

Editors Note: Mac has been one of our greatest supporter, coming to all events, flying through what ever kind of weather it took to get there, then when he couldn't fly anylonger, he drove for hours to get to McAlester. We love you Mac!

Dear Richard,
Please find enclosed a cheque for \$30 for my 1995 subs. I really enjoy the newsletter and look forward to each issue.

I expect to be at Oshkosh this year. I am traveling with my son and about 300 other aviation enthusiasts, mostly pilots, in a chartered Qantas B747-400 which will be landing at Wittman Field. **Can you imagine an airliner having 300 pilots on board!** I hope I can meet you again and many other T-18ers during the convention. Regards. Brian Olney 28 Brian Ave Mt. Pleasant W. Aust 6153 Australia.



Dear Richard,
February 4, 1995

I am writing a short note to update you and our fellow members on my S-18 project.

Since first declaring my start date of March 1991 things have been happening at rates of progress that could be considered as very slow to very fast. I think the project is going to be completed in the five years that I very naively targeted as a building period.

The structure lacks the completion of the outer wings along with the flaps and ailerons. A canopy is yet to be acquired. Beyond that most other parts are here for completion. Power will be supplied by a Lyc.0320 turning a constant speed prop. The color will be white with red and blue trim. The seats will be blue and white. Controls are helped by an electrically operated stabilator trim.

Dual Com. / Dual Nav + Loran will grace the panel. I won't be filling the panel with the exact radios that I had intended but I know that all builders will understand when I say "the price was right."

I am unfortunately going to have to hang a venturi tube on the plane. The vacuum pad on the engine being taken up by the needs of the constant speed prop. If anyone has an alternate solution to this I would like to hear other possible answers.

An ATTA BOY is due to Frank Roncelli for his constant help and guidance on this project. Without him I probably would have sold this project. Frank is a fine example of the spirit of EAA in general and Thorp builders in particular. Thanks again Frank.

I have been very fortunate in finding parts etc. for my project and have many extra parts. I will inventory them later and offer them for sale. Meanwhile I have a complete airframe for sale.

FOR SALE

Thorp T-18 project including fuselage, wings, stabilator, vertical stabilizer, controls, seats, canopy. The project is on wheels and there are many other parts that would be available. I would be willing to offer the project with a newset of Thorp plans for \$5500.00.

Call Dave 805-259-9423

Thank you again for your newsletter efforts Richard. It is a very important part of our T-18/S-18 family. The hope is to be flying with you before too long. My coming retirement on March 20, 95 will I am sure help this goal on it's way. Keep Em Flying! Dave L'Heureux



February 3, 1995

Dear Richard, Along with sending in the dues, I thought I'd sent along a report. It's the kind of report none of us like to do, an accident report on my T-18 (N29II). The occasion for this infamous event was in early October on a beautiful clear 50 degree night at Kenosha WI. After flying most of the evenings with friends in their planes, I figured to finish off the evening with a turn around the patch with my 25-year old T-18.

This was to be three take offs and landing for night currency. You can imagine my surprise, when the engine quit cold at 100' in the air after take off. In 700 hours of flying behind the O-320 it had never so much as hiccuped so now the instant silence was a real wake up call. I put the plane back on the runway but went off the far end with plenty of speed and wound up flipping it over in a field.

The roll bar, seat belts and shoulder harness all did their job - I walked away without a scratch. Wish I could say the same for the plane. The canopy, rudder, fin and top of the fuselage took the bulk of the damage, which is all repairable, almost no damage to the engine, prop and spinner. I drove home that night trying to image what stupid thing I did to cause this whole mess. I didn't have a clue. The next day we went over the accident with the FAA Inspector. The engine ran just fine. Even though a little fuel had run out, there was still 12 gals in the tank, They blamed it on carb ice. The dew point at 9PM was 47 degrees an idea set up for making induction ice. I guess this makes a good case for an ice detector. It will be flying again but it's going to take some time. Bernard J. Thalman

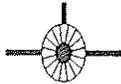


Dear Richard,
Thanks for another great year with the newsletter. Just received No. 93! Hardly seems possible does it? I'm sure Dick Cavin and Lou Sunderland never dreamed it would reach that number when they started it in the early 60s!

Mike Hernden and I still plan to complete our T-18's — someday!! Work has been slow on mine and non-existent on Mike's. At least he has a good excuse, can't say that I have. In addition to his working continually to improve the C-170, Mike now has a C-195 project as well. Now that's a BIG PROJECT! I was very interested in seeing your mention of Enmail, Internet, etc. I just recently signed on with AOL and have been using it for Enmail, etc. I think it could be a big

boost to any group and many others are on there is a big way. It sure is an excellent stage for exchanging ideas and information. Could also be used for locating, buying and selling of parts as well.

Well, this is about it for now. Hope you and your family had a Merry Christmas and have a Very Happy New Year 1995, full of health, wealth and happiness and many joyful and safe hours in your T-18. Best regards, Wallace G. Hunt AOL = T 18 WGH Internet = T 18 WGH@aol.com

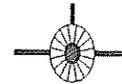


Hi Rich- I fly it as much as possible. In the air it's an incredible plane. I took it to Bakersfield yesterday, almost got trapped when the clouds closed up but found a hole.

I sloshed my tank and thought it worked but it leaks still when the tank is full and I put it in a slight pitch down attitude. I'm thinking that perhaps it could be leaking from the vent or wet wing to main tank fittings on the tank top. I'm going to try to visualize the fitting with a fiberoptic scope that I have but I'm starting to gird myself mentally to drop the tank out the bottom of the floor(it is nutplated like you said) I am going to call you sometime soon, but first I'm going to fly it 3/4 full to see if it still leaks. Another thing I want to do is embark on a drag reducing program and focus on 1) Relocating the upright pitot to a under the wing piper style. 2) Put some farings on the tailwheel and a few other things, but right now my hands are full just keeping up with keeping it airworthy.

I talked to someone who knows alot about welding and he said it's no surprise that an aluminum tank would start leaking after about 10-15 years of age. He says the beads on the weld start to crysatallize and come apart(or crumble) and that does appear to be whats happening. Should I face the inevitable or jump the bridge? When I told Gus Gordon that I thought I would have to pull the tank he said "!!@@!!@@!!" I wish we could get all the Thorper's in the newsletter here on AOL, we would really have a grand old time! With you and Tom Kern's, we got the best advice anywhere. Take Care- Don Schindler

Editor's Note: Message downloaded from America On Line. Don's Computer Handle is Thorp T 18

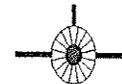


3 January, 1995

Dear Richard:

Thanks for another great year of newsletters! I got a kick out of your account of navigating the world of "re-engineering" corporate America. I got re-engineered nine years ago and had to leave Ohio for Minnesota for work, only to join a defense contacting company which has been downsizing for the past seven years. Another 25% reduction is scheduled for this month, sure is an adventure! Hang in there....

I have not been building any modifications into my T-18 lately . , I just fly it a lot and spend my "spare" time scratch building a 260 HP Pitts derivative. The fire breathing Pitts will be only 10 to 15 MPH faster than my 135 HP T-18 at full throttle, but I am looking forward being able to use full control deflections up to 160 MPH! Best Wishes, Tom Kerns T-18 N10TK



Monday, Dec. 26

Dear Mr. Snelson:

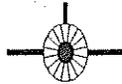
Thanks very much for my first issue of the T-18 Newsletter. I already have met two T-18 builders right here in Eugene (very nice guys — Ron Gerrard and Bob Furrer), and I look forward to meeting you and other T-18 builders at Oshkosh 1995. I'm jotting out this note to introduce myself and ask for some advice from the many other T-18 builders out there.

I am a business reporter at the daily newspaper in Eugene (The Register-Guard), and I'm learning to fly in a 65-hp Taylorcraft. I recently bought a T-18 project from a nearby homebuilder who hadn't worked on the project for several years. The fuselage is mostly built, as well as the vertical fin, the motor mount and the landing gear. I've started to work on the rudder, and I'm trying to make some basic decisions before I get to the bigger items: the wings and the engine.

I'm thinking about sealing off some bays for wing tanks but need some feedback from other T-18 builders to get a better idea of my possible options. Here's what I already have for

the wings: prepunched skins from Ken Knowles' company (0.025 thickness, I believe) and preformed ribs (Sunderland style). At this point, I'm planning to build the wings according to the original plans (no folding wings), but I'm hoping to find out what it would take to build tanks in the center wing panels. I'm assuming the best place would be in the bays between the leading edge ribs. Am I on the right track? Would I have to use thicker leading edge ribs and thicker skins for the center wing panels if I did this? And how should I route the plumbing for fuel lines and valves? I have the conventional 29gallon header tank, but it seems like extra fuel capacity would be a real plus.

I would enjoy hearing from other builders/flyers to find out about their experiences with wing tanks and what the most common wing tank design has been for T-18s. Please include this in an upcoming edition of the newsletter if you think it's appropriate. Thank you. sincerely, Joe Kidd 1995 Pierce St. Eugene, OR 97405 (503) 687-8473



Richard,

Just a note about N8RK now that it's back in circulation. I've had the proverbial rough engine condition, even after checking the fuel cap gasket and re-connecting the fuel vent line. It had been disconnected when I bought the airplane and for how many inspections before Lord only knows. Non-accessible hose connection are a bad deal. Any how, increasing the nozzle by .0035" took care of the lean mixture problem. I am also adding a parallel electric fuel pump in conjunction with a new fuel selector valve so that I can gravity flow just as it is now or select pressure feed. With 5 gals of fuel remaining my fuel pressure calculates out to .34 psi at 100mph. That's head and dynamic pressure. Also making padded wooden block jack pads for under the wing at the tie down fitting for tire changing etc. Haven't seen much on jacking the T-18. Looking forward to a T-18 fly-in anywhere south of here. Preferably far south! Charles Russell, Cassville, WI.



Richard,

Happy '95 to you and yours. I trust RoxAnne and you spent an enjoyable, blessed Christmas even considering the company "restructuring". I'd like

to commend you on the last dozen or so Newsletters; super jobs. Sorry I haven't been to many meets this past year- other obligations & commitments.

Still plugging away on the T-18. Just finished the vertical tail assembly. I reverted back to an early newsletter article (1-12; pgs 13 thru 16) that Dr. John Shinn had described for his "FIN JIG". I am quite pleased the way it turned out. I had bought two of the ribs with a partial project buy several years ago, then purchased the remaining rib and beam (small) from Sport Aircraft. I "plans built" the rear beam and bent up and formed the skin. I had previously built the rudder and when I fit the two together it was like "hand & glove". Even so, I ended up (in clecoed condition) with about a 1/4" twist in the top 6" or 8". The trailing edge is as straight as a stretched string but it still looks a bit cattiwhompus in those top 6" or 8". I'm looking for a thought of a "jig" that will accept the trailing edge to keep it straight, then align the front upper and lower beams so I can take that little twist out of there. I "plans built" everything except the two lower ribs. The front upper and lower beams proved to be rather nasty but after a mistake here and there, they were finally mastered. With the brake I was using, I couldn't quite satisfy myself with skins, so after a few tries, I cut some of my mistakes apart and made each side with three sections. Suprising how they came out. Some builders that have viewed it never saw it until I commented about it.

I certainly was glad to see the two articles on the Horizontal Stabilizer in N.L. 93. I expect that I will be in contact with Roy Farris and David Newstel to pick their brain while their recent tasks are still fairly fresh in their heads. Since that was scheduled to be my next component project, for me, the timing could not have been better. I had intended to include an update on the "NEWSLETTER INDEX" for N.L. #81. It will honestly follow soon but I decided to get this "dues letter" out first to relieve you of that nasty repeat, repeat, repeat chore. Take care Jim Strickengerger Erie, PA.



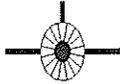
Subj: Greetings from Ohio Date: 95-03-09
17:19:32 EST From:
KROUPAJL@ml.wpafb.af.mil
From: KROUPAJL@ml.wpafb.af.mil Reply-to:
KROUPAJL@ml.wpafb.af.mil To:
rsnelson@aol.com

Hi There Richard,

Jim Paine gave me your Email Address, so I thought I might give it a try.

My project (#800) is coming along. With the cold weather, I have not been spending too much time in the garage. Most recently, I have been "cleaning up" the horizontal stablizer. That means filling-in pop-rivets with epoxy and micro-ballons. I have also been piecing together the rudder and stick controls.

I found that the project I purchased had the short loading gear, so I plan to make gear-extensions, as per Jim Frank's drawing. The \$1000 question is whether the fiber-glass cuffs supplied by Phil Tucker will fill properly over these extensions. I have a feeling that they will not. Do you recall any easy solution to this potential problem? Meanwhile, So Long Joseph L. Kroupa, Equire.



Subj: Gathering of T 18'ers Date: 95-03-08
23:48:27 EST From: Thorp T 18 To: Rsnelson1
CC: APILIT, Speedyll, JRSULLIVAN, NLOTK

Hi All — I extracted my leaky main tank and Phil Tucker graciously agreed to weld up a new one for me. I put the tank in the back seat of my buddy's Skylane and we agreed to meet at Fox Field in Lancaster, Ca. I had never met Phil before and there were alot of people at the airport, but somehow he had no trouble picking me out as I was the only one lugging a Thorp main tank around. My friend Bill Melly flew his Thorp out with us and treated us to some spectacular flying blasting circles around the Skylane. With Phil was a fellow T 18'er named Frank Roncelli. Frank owned and built serial # 33, so you know he treated us with some early Thorp history, like before there were flaps and cano-

pies. Thats one thing you can say about a Thorp, it's got history and legend behind it, which for me, is a meaningful source of pride. Bill Melly's Thorp is very interesting. It is orange and white and we call it the orange banana. What makes it unique is that it is extremely clean(no box air intake, upright pitot, strobes, or anything else too draggy), but it has an air of mystery about it. The data plate on the engine is not the original(not of Bill's doing). It is supposedly an IO-360 helicopter engine of 180 HP, but doing a little research, we find that there is no such thing as a 180 HP injected helicopter engine, only 200 Hp. You ought to see it bore holes in the sky! When Im at full throttle he usually carries 3 inches less than me to stay slow enough to stay with me and I have 180 HP with CS prop. He can get right up to VNE anytime he wants but he doesn't push the limit and he hangs out with old slo-poke me. Hope you are all well. Regal us with some of your Thorp adventures. Take care-Don

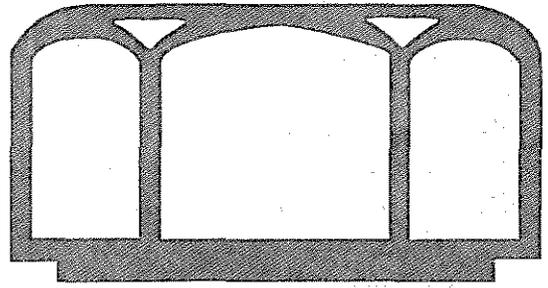


From: JRSULLIVAN
Flew my first flight since November in N2357, the first one since the new gear, etc. Was it ever good to be back in the air. The new A-D prop gave me 170+ mph at 2,500 rpm (full throttle, not thrilled about not getting full revs out of it) and 2,200 fpm climb rate, thanks to light weight. Tom Kerns' stall strips (thanks for that article, Tom) yielded a pussycat stall: mild buffet at 65, full stall at 62. That's with one aboard. With my heavyweight erstwhile instructor on, before the stall strips, the nose dropped violently at 70 mph ias.

Can't get used to the new prop. First approach floated all the way down the runway; second, 2/3 down; third, halfway; fourth halfway. Finally, after four go-arounds, I pulled the power on short final, pushed the nose over and touched down smoothly, but permanently, halfway down the 3,000 ft runway at EZF. Don't know why it seemed so hard before. Alvin— you have every right to be lightheaded. Glad you love it. John Sullivan

NUT & BOLTS

by Ed Lambert



WHERE TO BUY HARDWARE

For the new builder, the most obvious way for hardware procurement may be to open a dealers catalog, fill out the order form and write a check. One stop shopping can be done at a local dealer or jobber. But there is an alternate that I have found to be superior.

We have all seen the headlines in our local papers: "Major aerospace manufacturer to close, lay-offs in the thousands". It's a fact of life in this business. The good side is that when these facilities downsize (or rightsize, or consolidate operations etc.), the contents of their factories get liquidated. Even if they don't close completely, excess 'stuff (raw material, nuts and bolts, tools and more) is frequently eliminated in the search to reduce costs, recover capital, and enhance shareholder value. They sell this material to just about anybody who wants it. Sales come in two forms: auctions and on site sales.

Auctions at these companies are just like any other auction. Merchandise is divided into lots or groups, prospective buyers are allowed to inspect the lots, then bids are taken. Notices for auctions are published in the local papers.

Company sales come in two flavors: one time sales, and continuous sales. The one time sales are generally on site (but not always). Notification is usually by flyer and word of mouth. The gates open (at a portion of the plant so designated) and the buyers file in. Make your selection and pay for it. Continuous sales have been around for quite a while. Many companies operate a Salvage Sales yard at one of their sites. For example, I have been to Boeing Surplus sales at their yard near the Seattle airport. Also, Rockwell International operates sur-

plus sales yards at most of their facilities in Southern California. My experiences at a variety of these places has been very positive. Most of the items are priced at cents on the dollar.

Whatever your opportunity, it pays to have a shopping list available to you. It is no bargain if you don't need it. Make a list of the tools and material you are looking to buy. As part of my project, I have put together a bill of materials for the S-18. In addition, I have gathered together a list of alternate parts that can be substituted in the event of shortage. Then go out and look around. The worst that can happen is that you end up back at your local nuts and bolts dealer.

A FEW THOUGHTS ON SUBSTITUTES

GENERAL

There are a number of locations on the T-18/S-18 airframe where AN bolts are specified. These include AN3, AN4, AN5, AN6 and AN7's. In all cases, bolts are specified for their higher strength capability as opposed to screws or rivets. In some of these bolted applications, there is a requirement to disassemble the subject joint for maintenance (for example walking beam attachments). In other cases (like wing attachment fittings), disassembly is not routine. In any event, there are a few alternatives to the plans bill of material that can be safely used (having an equal, or in most cases greater, strength than the specified bolt). The ability to substitute is a powerful ally as the builder goes out to procure hardware. In just about all cases, the substitute fasteners will cost more if purchased from your friendly nut and bolt dealer. However, given the ability to procure

hardware from surplus stock of large companies, a choice of what to buy can make the process simpler. In addition, the ability to substitute can relieve a lead time problem for just about any fastener.

ments, it is necessary to drill and ream. Much has been written on this topic and I don't intend to reproduce it here. Suffice to say that prior to putting holes in your production parts, try it out on a mock-up. Prove to yourself that you can do it. If you need to resort to drilling aids, use them. Practice makes perfect. If you should blow a hole on a

TABLE 1
BOLT COMPARISON

Bolt P/N	Diameter	Shank Dia	Thread Length	Shear Strength ^a
AN3	10-32 UNF-3A	.186/.189	.406	78.2 ^b
NAS1003	.1900-32UNJF-3A	.1870/.1895	.481	95.0
NAS6303	.1900-32UNJF-3A	.1885/.1895 ^c	.323	95.0
AN4	1/4-28UNF-3A	.246/.249	.468	77.4 ^b
NAS1004	.2500-28UNJF-3A	.2470/.2495	.544	95.0
NAS6304	.2500-28UNJF-3A	.2485/.2495 ^c	.370	95.0

a- x1000 lbs per inch sq.

b- Calculated value based on minimum diameter. Per AN spec, shear capability is given in lbs.

c- Dimension given is for cadmium plated corrosion resistant steel.

AN3, 4: Bolt- Machine, Aircraft. Material: Steel or Corrosion Resistant Steel

NAS1003, 1004: Bolt- Machine, Hex Head, Non-magnetic & Heat Resistant. Material: A-286 steel, with ultimate tensile strength=140 ksi at room temperature.

NAS6303, 6304: Bolt, Hex Head- Close Tolerance, A-286, Self Locking. Material: A-286 steel, with ultimate tensile strength=140 ksi at room temperature; 95 ksi ultimate shear.

BOLT HOLE SIZE REQUIREMENTS

As detailed in previous newsletters, anytime a bolt is installed in a hole, there must be some measure of a tight fit for the fastener to properly carry the load it is intended to carry. For an application that requires high shear capability, the bolt to hole clearance should be .000 to .0015 inches. That means the hole should measure no more than .0015 larger on diameter than the actual diameter of the bolt. For the AN series of bolts (AN3, AN4 etc.), the bolt shank has a tolerance of .003 (a nominal 3/16 bolt will measure from .186 to .189 in diameter). See Table 1 for other bolt size information. Therefore, to obtain a nice tight fit, each bolt should be miked, and the hole prepared with that shank size in mind. No problem if all the bolts are the same. But if you buy your bolts here and there (from different manufactured lots), it can be a bit of a chore sorting and segregating.

To produce a hole of these require-

production part, stop. Do not proceed! Assess the impact of the goof, get the advice of an expert, if required. Document what was wrong, and what you did to fix it. Discrepancy reporting is a pain, but if you ever want to go back to do something to that part of the airframe, you are going to want to know the as built configuration. No fastener, no matter how strong it is, will carry the intended load if the hole is not prepared as specified. I don't care how much extra torque you might care to put on a bolt to try to snug things up real good. This goes for any fastener- rivets, screws, bolts whatever.

NAS BOLTS INSTEAD OF AN

One viable alternative to the AN bolt series is to buy a bolt that has a closer tolerance on the shank dimension. No problem. A number of NAS (National Aerospace Standard) bolts are avail-

able that will provide the same performance as the AN bolts. As shown in Table 2, NAS bolts can provide as little as a total of .001 tolerance (a nominal 3/16 bolt will measure .1885 to .1895 in diameter). A selection of NAS bolts are shown that can be used as a substitute for the AN bolts. Please note: the ability to substitute does not always go backwards. If a drawing calls for a high strength fastener, do not, under penalty of death (your own), use an AN bolt. Going to a higher strength capability is O.K., but not visa versa.

of the AN365 nut. Both possess a higher strength rating than the AN, and are both .080 shorter. Notice the strength rating notation. Do not use a shorter nut that does not have an equivalent or higher rating than the bill of material calls for. For example, the AN345 nut is shorter than the AN365. However, the AN345 spec calls for 50 ksi steel and the AN365 calls for 95 ksi steel. Obviously, the AN345 should never be used for primary structural applications.

**TABLE 2
NUT COMPARISON**

Nut P/N	Diameter	Overall Height
AN365-1032	10-32NF-3A	.234
MS21042-3	.1900-32UNJF-3B	.154/.188
MS21043-3	10-32UNJF-3B	.154/.188
AN365-428	1/4-28NF-3	.312
MS21042-4	.2500-28UNJF-3B	.204/.219
MS21043-4	.2500-28UNJF-3B	.204/.219

AN365: Self Lock nut- superseded by MS20365
MS21042: Self locking nut; Cadmium plated steel, max temp 45

Other differences to consider is that the NAS fasteners typically have a shorter thread length (that portion of the fastener that is threaded to accept a nut). This is great as far as I'm concerned, as it means the bolt weighs less. The only problem you could run into is that this thread length doesn't permit drilling a hole for safety wire or cotter key installation. Using locking nuts can solve this. As in the case of all threaded fasteners, do not resort to cutting additional threads. You violate the corrosion resistant plating, among other things. Measure the parts going together to get the total grip length, and use the correct length bolt.

Short thread length can be helped some by using an MS21042 or MS21043 nut in lieu

As a matter of fact, most companies specify the MS21042 (or MS20365) as a superseding part for the AN365. It is a bit easier to find the MS nuts in surplus sales yards (these are not used nuts, but "inventory excess to continuing operations" nuts). The MS21042 is cadmium plated and rated for use to 450 "F (limited by the strength at temperature of the steel used), while the MS21043 is rated to 800 "F, and has a silver plate that looks real cool. I got a big bag of these nuts surplus for \$12.

Cost may be a factor for these fasteners. From what I have seen quoted at supply houses, you will pay about 20% more for the close tolerance bolts. Same for the MS nuts. But the surplus parts are a way to beat that. As stated

before, most major aerospace companies have gotten away from the AN standard parts, and have gone to MS and NAS standards.

PERMANENT STRUCTURAL FASTENERS

There is a class of fasteners that are known in the world of Rocker Science as 'Permanent Structural Fasteners'. Even though rivets are permanent, they are not included in this class of fasteners. Why? Rivets are used in shear, and shear alone. No tension applications, please. Tension load tends to rip their little buck tails right off. Don't worry, though. Skin is a shear carrying member, and rivets are just fine there. In applications that require a fastener to transmit a tension load, a positively retained collar is required. Hilocks and Lockbolts (AKA Huck) both provide this.

As the name Permanent Structural Fasteners (PSF) implies, these are intended for installation once. Disassembly is possible (see below), but not without some difficulty. The attractions here are many: even further reduction in fastener weight (compared to bolts); no need for washers to adjust grip length (less weight); even tighter tolerances on the shank diameter; faster installation time compared to bolts; and no need for a torque wrench. Now I can just imagine you jumping off the couch, hooting and hollering. There are a couple of negatives: cost, and an installation tool of some kind is still required.

Depending on the application, PSF's can be installed in a clearance hole, or an interference hole. The interference hole is used to transmit shear in an efficient manner. Interference is on the order of .0005 to as much as .0030, or the hole is that much smaller than the fastener shank. A light tap with a mallet (no, not that 3 pound mallet) will seat the fastener. The clearance holes are for tension and low grade shear loads. On note of caution: in any given fitting, it is not advisable to mix clearance and interference fit fasteners. Pick a standard, and stick to it. My own wing fittings will be sized for interference fit fasteners. Drilling to just undersize, then reaming to full size will be done on installation. With only .001 total hole tolerance, even matched hole tooling won't deliver the accuracy required.

These fasteners are designed for spe-

cific grip ranges. The collar provides the ability to clamp down over the entire grip range the fastener is designed for. No need for washers. But measurement of the stack-up to verify grip requirements should be accomplished.

Removal of the PSF is possible by breaking off the collar. The collar material is aluminum or steel. Down at the Rocket Science Ranch, a 'Nutcracker' tool is used. It has three chisel type cutter blades that fracture the collar when the tool is given a gentle tap. A small chisel and mallet are a good substitute. After the collar is removed, the pin is removed, and both are discarded (always, always, always).

HI-LOCKS

Hi-Locks are a patented product of the Hi-Shear Corporation (see Figure 1). They are similar to a bolt in form. They have a head, shank and threads. The main difference is there is no wrenching surfaces on the head, but a wrenching recess in the threaded portion of the shank. The pin is typically made from titanium or one of the high strength steels. They are designed to work with a collar that is a high tech nut.

The basic installation sequence is to make a hole, insert the pin into the hole, and thread the collar on. The collar incorporates a hex portion on the end for turning. There is a necked down area on the middle of the collar. The threaded portion of the collar incorporates a locking feature, for positive retention. As the collar is threaded onto the pin, the joint is preloaded (Oust like tightening up a bolt). At a predetermined torque level, the portion of the collar with the wrenching flats breaks off, leaving a nice smooth retaining collar. Now the big aerospace companies use a gun that allows the operator to perform this installation with the zip of a trigger. Fear not if you can't find one of these guns (or need to spent the money on Valentine's goodies). Installation can be accomplished satisfactorily with a wrench (open or box ended preferred) and an Allen wrench. The recess in the shank is hex, and will receive a standard Allen wrench. Verify your Allen wrench has nice sharp comers (not all

rounded off) before use. It helps to clamp your work pieces together before you start fastener installations.

LOCKBOLTS/HUCKS

These are a step up in structural capability from the Hi-Shear rivet used on portions of the T-18. There are related, but do not try to infer that they are similar enough to use "pin" rivets in place of a Huck or a bolt. Don't do it. The Hi-Shear rivet (as the name implies) is related to the rivet family, and has little tension carrying capability. Huck, on the other hand, are capable of carrying shear and tension, similar to bolts.

The Huck pin consists of a head (round and featureless like Hi-Locks), a shank (with a nice tight tolerance) and some grooves that kind of look like threads (see Figure 2). But they are not threads. These grooves are actually a series of bumps, formed parallel to one another. The Huck collar is smooth on the inside, without any threads like a Hi-Lock collar.

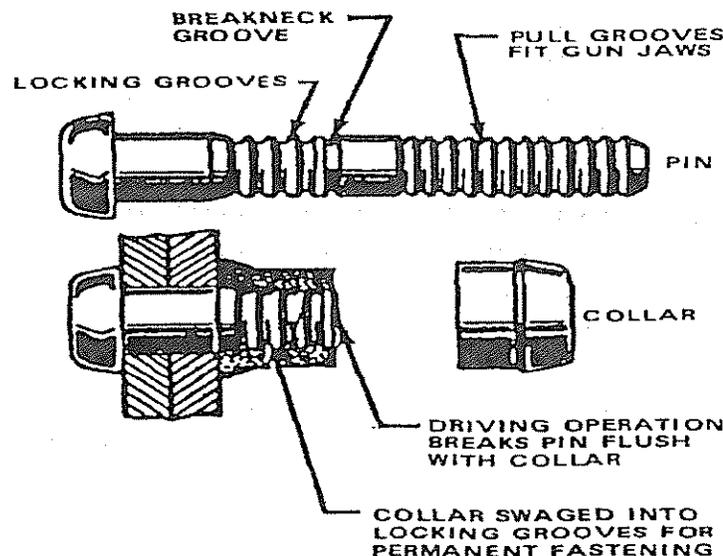
Installation involves the following: produce a nice tight hole (drill and ream to size specified), insert the pin portion into the hole, slip a collar into the gun, position the gun over the stem to engage and pull the trigger. Bang! One perfect installation. The gun forces the collar over the

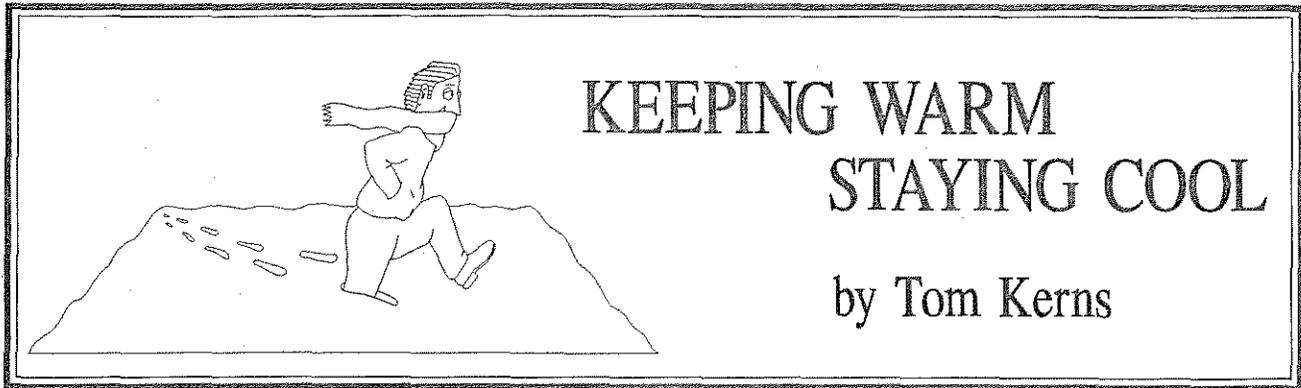
locking grooves, and swages it in place. There is just about no way to go wrong. Yes, there is a penalty here. No make it work tooling will do. An official Huck gun is required. Cost is a bit more than a good rivet gun (I said a good one, not a cheap one). Used ones are available for a fairly attractive price (who would want them except some airplane builder?). Finding one is not easy, but the surplus sales yards are the places that will have one.

SUMMARY

The T-18/S-18 is an aircraft with a structure that has demonstrated reliability. But being 30 years old, the state of the art in Rocket Science today is a bit better, or perhaps, in some cases, just different than when first built. By taking advantage of the parts available today, it is possible to make it cheaper, faster, lighter. However, any changes to the basic plans should not be taken lightly. Compare any proposed changes to the as designed configuration before you do anything. Also, fully document any departures from the basic plans. If you need the services of an engineer, by all means do so. I would welcome any comments on this subject. I can be reached by electronic mail at: 75462.3645@compuserve.com sincerely, Ed Lambert. 2166 Farrington Drive, El Cajon, CA 92020 Phone 619-562-5635

**FIGURE 2
HUCK/LOCKBOLT AND COLLAR**





KEEPING WARM STAYING COOL

by Tom Kerns

Following are my observations on making the T-18 cockpit comfortable across a range of climates. I first flew my T-18 in Arlington Texas 12 years ago, followed by moves to Ohio and Minnesota. My first concern was clearly fresh air, with a later interest in heat, lots of it!

I am fully satisfied with my heating system, but still would like more ventilation for sunny 90 degree plus days. With a reasonably draft free cockpit, the T-18 can be made very comfortable down to sub-zero conditions. I fly in Minnesota in my shirtsleeves or a sweatshirt, but no more. Gloves in the cockpit are absolutely not required. The key is to minimize cockpit leakage, canopy seals and flap actuator tube seals are the two biggest culprits. Sealing these will permit a simple heater to keep up with the remaining air leaks.

COLD WEATHER OPERATION;

Defrosters: Unless you can shovel snow without sweating and fly without breathing, a forced air defroster is necessary for the T-18 in cold climates. Without forced air, keeping the windshield and canopy clear will be require cracking the canopy open while taxiing, and wiping the canopy beside you should you exhale while facing the plexiglass. I have two defroster slots in my glare shield about 5 inches long and 1/4 inch wide. Four small (2 inch) 12 volt muffin fans supplying forced air to the slots resulting in a flow aft from the base of the windshield and along the sides of the canopy. I have not found it necessary to supply heated air to the fans, I just draw air from behind the panel. Warmth flowing up from the cockpit heater is adequate. Two small muffin fans would probably be adequate.

Heater: My heater air source is a 2 inch SCAT tube from the back of the engine baffles. This feeds a homemade tailpipe muff similar in size to the unit sold by Richard Vangrunsen for the RV series, followed by a homemade stainless steel air valve on my firewall forward of the co-pilots left foot. The air valve is designed to keep air flowing through the heat muff even with the heat turned off to prevent overheating the muff and tailpipe. This set-up provides very warm air at flow rates that make my pant legs ripple. An adjacent and independent cold air valve bringing air from the engine plenum is used to regulate temperature. I open both valves as fully as possible to flood the cockpit, assuring relatively uniform temperature anywhere in the cockpit. Temperature is regulated by closing down either the cold or hot air inlet as required.

Air taken from within the upper plenum is at maximum static pressure, having reached near zero velocity (full dynamic pressure recovery). I installed a contoured scoop within the left engine cooling inlet in an attempt to recover air pressure as a cold air to mix with the heater. It works, but is not nearly as powerful as the simple 2 inch SCAT tube off the aft baffle. Simple works.... Electric engine pre-heaters are essential. I use mine when the airplane will sit at temperatures below 20 degrees F or so. The Tannis heaters are great but very expensive, I use an inexpensive westwind Zero start system from Wag Aero. If I plug my cowl inlets and exits, and let the heater run for two to three hours, the oil sump will be over 100 degrees and the cylinders will be pleasantly warm to the touch. A blanket over the cowl helps when temps drop to zero and below.

Pre-heating permits easy starts with no priming and no undue engine wear. My heater runs on a seven day light timer to minimize electrical use but keep the engine warm at times when I might fly.

Oil coolers must be closed down in cold weather. I completely cover the inlet surface of mine with aluminum tape for the winter. I can operate with the cooler completely covered up to about 65 degrees OAT.

I restrict my engine cooling air inlets when OAT on the ground drops below 10 or 15 degrees. Fancy inlet plugs would be nice, but I just use a couple of strips of duct tape to close down the inlets to about 1/2 of their normal size. This maintains cylinder and oil temperatures in sub-zero conditions, permitting deadstick landings without dropping CHT below 200 degrees. The tape strips and engine pre-heating will do a lot for protecting engine life!

FRESH AIR: Most T-18's use a fresh air inlet on the aft end of the canopy skirt. The pressure differential is large at that location, yielding a powerful inflow of air which washes forward and over the pilots shoulders. I have experimented with a series of doors to control and enhance the airflow. An open inlet with no door, 6 inches wide and 1.8 inches fore and aft provides substantial flow. Adding inward opening doors with forward or aft edge hinges will restrict flow quite a bit, with the aft hinged door being least restrictive. I tried external slats and turning vanes to direct more air down into the slot with little success. My current installation which provides a very powerful inflow is an aft hinged door which opens outward, creating a scoop for air. Yes, I am sure it is draggy when deployed, but the cool air is well worth it! I have a curved deflector mounted on the inner surface of the door at the hinge to deflect the airflow forward and to counterbalance the air door loads.

I also have inlets in the leading edge of my center section similar to Cessna inlets but located at the outboard end of the centersection to stay clear of engine fumes. In the event of a smoking engine (I had one when an oil pressure switch disintegrated) these vents can be left open to provide

clear air to the cockpit. My inlets pressurize the entire leading edge of the centersection allowing air to enter the cockpit via We-Mac vents in the fuselage sides adjacent to the wing. Flow rate is very low compared to the canopy vent, and I would not recommend them in this configuration, but the potential can be improved. I flew a Mustang II which used small NACA ducts just forward of the main spar underneath the wing. This is a high pressure high flow rate area, and the result was a REALLY impressive ventilator. Use of the lower surface NACA duct should improve flow, and a bit of ductwork directing the air to panel mounted vents which can be directed toward your face as in the Mustang II provides very effective use of the air available. I plan on trying this with my T-18; however, it may take a while as I am currently scratch building a two seat Pitts.

In decreasing order of effectiveness, the canopy vent works very well, especially with an outward opening scoop door, air direct from the upper plenum aft baffles is at a very high static pressure, providing an effective source, and my wing leading edge vents are the weakest. NACA ducts under the wing are worth a try..Sincerely,
Tom Kerns T-18 N10TK EAA 58496 —

PROTECTING YOUR IGNITION SWITCH

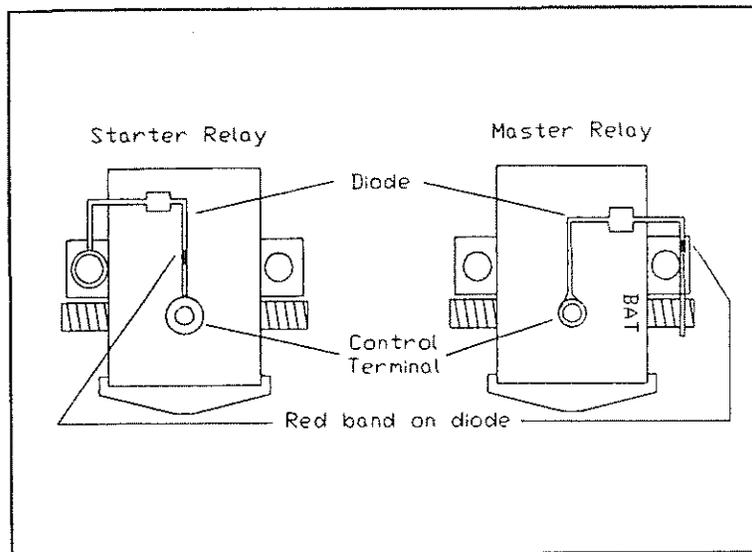
by Bill Benedict

Every time a switch is turned on or off, a certain amount of deterioration occurs. Most of the time this occurs due to the current in the circuit changing rapidly, as when turning your landing light on or off. The higher the current being switched, the more the contacts will be affected. There are two switch contacts which are affected in a different manner. These are the MASTER SWITCH and the START position of the MAGNETO SWITCH. These switches control a relay which has a different characteristic than a light bulb. The relay has a coil of wire which forms a magnet when voltage is

applied across the contacts. When the voltage is first applied, the current ramps up in the coil causing very little degradation of the switch contacts. However, when the switch is turned off, the magnetic field collapses, causing a very large induced voltage across the coil. This voltage spike will exceed hundreds or even thousands of volts which are applied to the switch contacts. If the switch was rapidly turned off, there is no problem, however switches are not faster than electricity. This voltage spike will create pitting and burning on

the switch contacts which will eventually lead to a switch failure. Some switches are relatively inexpensive and changing one every few years is not an issue. However, if you price a magneto switch, you will probably want to protect this device. They are fairly spendy. We recently

had to replace the mag switch in the RV-4 at about 10 years of service. The symptom was intermittent operation. There is an easy resolution to the problem. This is called a "catch" diode. They are available from Radio Shack and other electronic supply houses. A 100 volt-3 amp diode will work great in this application. The



The starter relay is shown at left. The diode is connected between the small stud where the wire from the starter switch is connected and the mounting bolt, which is ground. Note the end of the diode with the red band is connected to the relay control terminal. At right is the master relay. Here the diode is connected between the relay control terminal and the lared terminal marked BAT. Note that the end of the diode with the red band is connected to the BAT terminal.

mag switch we offer comes with a diode to protect it. To make it easy, we are offering diodes for both the master relay and for the starter relay. These diodes have the proper lugs for installing directly on the relay. The master relay diode is: ES DIODE MASTER \$1.50 The starter relay diode is: ES DIODE STARTER \$1.50

Editor's Note: These parts can be ordered from Van's Aircraft Inc. P.O. Box 160 North Plains, Oregon 97133. Phone is 503-647-5117

STARTER RELAY WOES

by Bill Benedict

From The RVator Oct 94.

In the last issue, we discussed the protection of the switches that control both the MASTER RELAY and the STARTER RELAY. What we did not talk about was the devices those relays control, and how to protect them. We recently received a letter from a customer whose STARTER RELAY malfunctioned, fried the starter and overheated the cables going from the STARTER RELAY to the starter. In this customer's case, he was performing an acrobatic maneuver and became disoriented as the plane fell out of a particular maneuver. During the recovery, he pulled several G's to regain level flight.

He lost electrical power and felt the battery box next to his leg begin to heat up. He immediately headed for the nearest airport, and shortly before landing, the electrical system recovered.

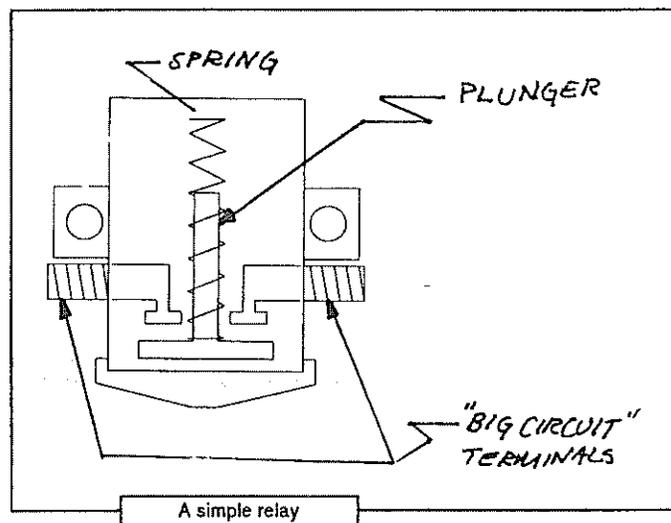
He pulled the cowl as soon as the airplane rolled to a stop and found the starter had been fried and

the cables to it were still very hot. His diagnosis is that the G forces moved the starter relay plunger, engaging it. For whatever reason, it stayed closed, engaging the starter while the engine was running and drawing down the battery. To understand what happened, we must understand the relay.

The MASTER RELAY and STARTER RELAY are composed of four basic components sealed within the body. The first item is a

set of contacts capable of handling over 50 amps. These contacts are connected to the two large terminals on the RELAY. The second component is a plunger which is moved into contact with the contacts just described. It is a shorting bar and is also capable of conducting over 50 amps. The third component is a spring which holds the plunger away from the contacts. The fourth item is an electromagnet which will displace the plunger, causing it to make contact with both of the contacts.

If the STARTER RELAY is mounted as shown above, the coil must have enough magnetic force to overcome the strength of the spring to pull the plunger up and conduct current from the battery to the starter. If high G forces are encountered during the flight, the plunger (being the only moving part within the relay) is forced away from the contacts and all is well. If the relay is mounted with the pointed end up, the G forces experienced



in flight can and will overcome the strength of the spring and activate the starter, causing much havoc and pain to the wallet.

The MASTER RELAY is in a different situation. If this relay opens during flight, the electrical system will momentarily disconnect the battery but the alternator will continue to supply energy to the electrical system. If the voltage regulator and avionics are of modern vintage, there probably will not be any grief. If the MASTER RELAY is inverted, the posi-

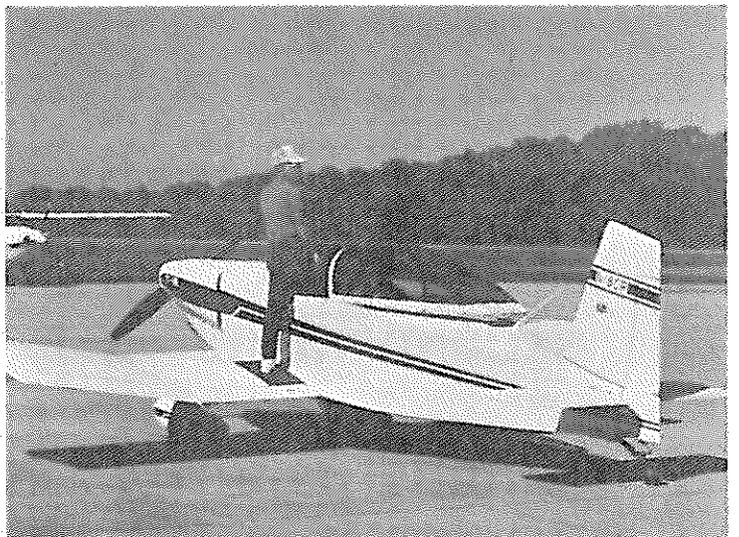
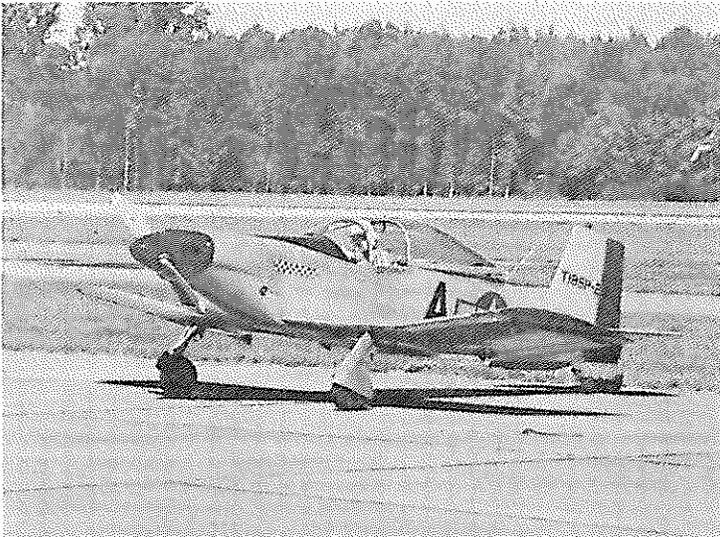
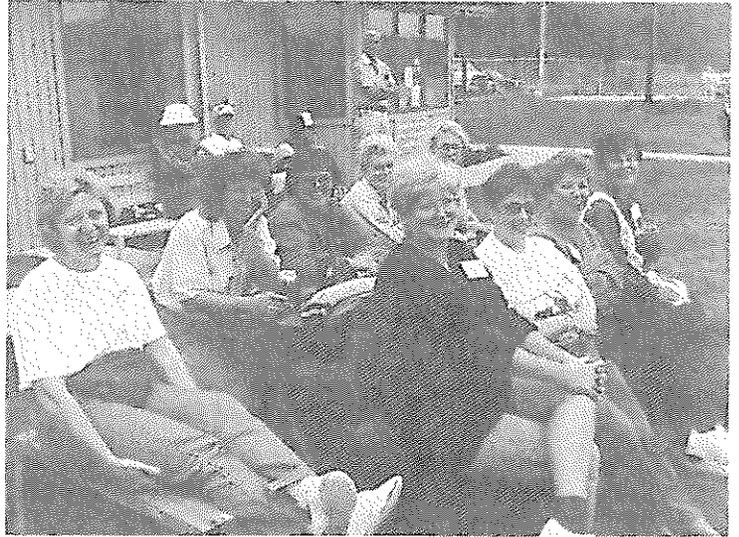
tive G forces will be helping the magnetic field keep the relay active. Of course, if negative G maneuvers are performed, then our mounting system is backwards. Fortunately, most of us do not have inverted oil and fuel systems so it is just an academic exercise. The safest system is to mount both RELAYS on their side. It is extremely difficult to create a high side load using a slip or slide.

THORP T-18 ARTICLES IN EAA PUBLICATIONS

YEAR/MONTH/PAGE/MAG.	TITLE
62 02 34 SA	Thorp T-18
67 06 08 SA	T-18 Hatchery, Part 1
67 08 19 SA	T-18 Hatchery, Part 2
68 03 31 SA	"Komet"
68 04 44 SA	Lloyd Toll T-18
69 08 11 SA	New Look in All Flying Tails - T-18
71 01 04 SA	John Wallace T-18
71 01 05 SA	Milwaukee High School T-18
71 02 20 SA	T-18 Sly Tiger
71 11 29 SA	Fast T-18
71 11 29 SA	Mexico T-18 Crash, First Flight
73 01 07 SA	Thorp T-18 (note - supplier organization)
73 01 07 SA	Thorp Aircraft, fabricate parts
73 03 24 SA	Around World T-18
73 04 19 SA	T-18 Around Australia
74 02 42 SA	T-18 100 Flies
74 06 18 SA	Retractable Gear T-18
74 06 29 SA	Around the World in a T-18 - Almost PART 1
74 07 19 SA	Around the World in a T-18 - Almost PART 2
74 08 27 SA	Around the World in a T-18 - Almost PART 3
74 11 73 SA	Take Home T-18, folding wings
74 12 37 SA	George Laider's Family Airplane, T-18
75 02 24 SA	IFR Flight and the Homebuilt
75 09 29 SA	First Flight Procedure
75 12 30 SA	T-18 Fuel Injection
76 08 43 SA	Solo to Private License in T-18
76 09 44 SA	New Cowling for More Efficiency
76 10 09 SA	Notice on rudder attach bolts (Use safety wire on heads rather than relying on elastic stop nuts.)
77 02 13 SA	T-18 Around the World Flight Completed
77 03 17 SA	Study of Cruise Performance of T-18
77 07 65 SA	Save Energy with Cross-over Exhaust
78 07 49 SA	Latest T-18 Developments
79 02 23 SA	Kong
79 03 08 SA	Dick Cavin, New T-18 Newsletter Editor
80 07 07 SA	Don Taylor and T-18 - First to Fly Across U.S. Nonstop in Homebuilt

80 07 08 SA T-18 Mutual Aid Society Holds Dinner at Oshkosh
 80 11 06 SA Don Taylor Continues Pacific Flight in T-18
 81 04 25 SA Don Taylor Reaches Australia and Comes Back
 81 05 43 SA Don Taylor Reaches Australia and Comes Back
 81 10 72 SA Peter Hodgins Reserve Grand Champion
 82 06 07 SA T-18 Fly-In Banquet at Oshkosh
 83 01 84 SA John Kenton's folding wing, 150 hp
 83 06 09 SA T-18 Group has Banquet @ Oshkosh 83
 83 07 07 SA T-18 Group has Banquet @ Oshkosh 83
 84 01 38 SA To North Pole & Back (Don Taylor)
 84 02 67 SA Mutual Aid Society announcement
 84 06 05 SA Annual T-18 Oshkosh Banquet announced
 85 06 06 SA T-18 Forum & Activities at Oshkosh 185
 85 12 24 SA Hockenbrook 125hp T-18
 86 02 27 SA Lipscombe T-18 with 180 Lyc.
 86 09 97 SA Bors' T-18 with Lyc. 150
 86 09 24 SA S-18 Variant of T-18
 86 09 19 SA History of T-18
 86 10 39 LPW Buzzing Causes Fatal Accident
 87 02 97 SA Kasten T-18 with 180hp
 87 03 11 SA Early T-18 Newsletters Reprinted
 87 03 05 LPW Early T-18 Newsletters Reprinted
 87 06 07 SA Lu Sunderland, T-18 Redesigner, Dies
 87 10 105 SA Eby Award-winning T-18
 88 01 97 SA Christian T-18 Restored
 88 02 92 SA Eby T-18 with Lyc. 160, Electric Trim, Auto Pilot
 88 03 57 SA Ed Poe's 11 Year Old T-18
 88 07 38 EXP Gust Causes Hard Landing & A/C Damage
 88 12 38 EXP 20mph Crosswind Causes Crash
 89 03 93 SA Silver Anniversary of T-18
 89 04 94 SA Swedish T-18 - 10 Year Project, 160hp
 89 05 94 SA Redden T-18 with 150 Lyc.
 89 06 95 SA Pira T-18 on Skis in Sweden
 89 11 09 SA Lectro Prop (Electrically Controlled Adjustable Prop) Flown on T-18
 89 12 94 SA Ross 150hp T-18
 90 09 65 SA Magnusson T-18 with 0320 - Swedish
 90 11 47 SA Uncontrolled Spin Cause Fatalities
 92 09 94 SA Repeta T-18 painted like Spitfire
 92 10 119 SA Ranta T-18 w/0320
 93 06 67 SA "The New Antique"

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