

Pulsar News

News, Updates, and Developments for Pulsar Builders and Owners

Issue No. 8

Published by the Pulsar Builders' Association

January, 1991

Opening:

In this issue I have included a current listing of all Pulsar builders and owners as well as several would-be builders who are anxious to talk to you about building a Pulsar. My apologies in advance for not having a better print-out of everyone's name and address, however, but the holiday season has really caught me with too little time to "pretty" it up. I'll plan to include a listing approximately every 6 months as we're adding builders at a rate of 1 per week. I'd like to thank Harry Jones for sending us some pictures of his Pulsar. Due to the space required for the Pulsar builder/owner listing, we will be including the photos in the next issue. Also, I've accidentally separated a picture of an unpainted Pulsar (parked in a fenced-in back yard) from its letter and I don't know who it belongs to. My apologies.

Builder Input:

Derek Ferris (Westerly, RI): "The finishing and prime-painting of our Pulsar is complete, and it is now being painted by a professional -- Dupont IMRON. (A picture of Stan's and Derek's Pulsar will be in the next issue- ed.) Some questions we would like to see answered by other Pulsar flyers:

1) Let's hear from anyone who is regularly using AVGAS (assume 100LL). Also, from any of you who are using MOGAS and can't obtain it at their local airports, how do you handle the problems of fuel storage, transportation, and dispensing? After all, we're not talking about a few pounds-- 16 gallons equals 96 pounds!

2) Is anyone flying a tri-gear Pulsar regularly (or has flown), in and out of a grass strip? We (and I'm sure other builders) would be very interested in a report. There is a fairly good 2,500' grass strip near us which we would like to fly into from time to time.

3) Re: Bob Murawski's suggestion on J.C. Whitney strobe units: Have these strobes been tested by anyone for possible interference with a plane's avionics? My Piper Arrow has Whelen strobes and at idle I can hear a faint noise in my headset when they're turned on. It's something to be concerned about."

Alan Gill (United Kingdom): "Thought I'd drop you a line on the progress on my Pulsar. So far I have spent 275 hours building. The fuselage is almost complete and I have just started building both spars. I must say that the canopy takes a lot of patience to build and fit, but it's worth it in the end because I made a small error and such a mistake eats up time in trying to jig it so as to give the best fit.

One thing I like about this kit is that I have yet to get my hands dirty. For all the epoxy work, I use vinyl surgical gloves.

Just out of interest, my Pulsar was the first to be registered with the "Popular Flying Association" (PFA) after I requested Mark to send them the technical details. I do know of at least 5 kits that are about to arrive into the UK/Ireland, so it looks like we are about to become a "European Squadron".

Miscellaneous Items/Notices:

Pulsar for Sale: Arthur Cooke (407-286-0547) has told me that he would be interested in selling his Pulsar fuselage and wing kits. They are almost finished and he would sell them for \$9,900. Please call him if you know of anyone who might be interested.

Rotax's 583 engine: Just a quick update for a few builders that I've talked to about the Rotax 583 engine which various Rotax dealers are selling as aircraft engines. The December, 1990 issue of *EAA Experimenter* has just published a warning to homebuilders about this engine. Apparently misrepresentations by various Rotax dealers relating to the 583 engine is wide-spread. According to Kodiak Research, Ltd. this engine is for use with snowmobiles and they warn all aircraft homebuilders to not use this engine. The advertised increased horsepower was drawing considerable interest among homebuilders, but Kodiak warns that "the Rotax 583 engine is NOT designed for use in aircraft....Any users of a Rotax 583 engine in an aircraft should discontinue use immediately."

From The Factory:

Well, the big news this time is another first flight. Bill Buffe's Pulsar was flown by a local flight instructor from the Akron, Ohio area. Unfortunately, the Pulsar was apparently severely out of trim. Immediately after takeoff, the instructor said that he ran out of roll control and had to chop the throttle to try and get back down. The Pulsar apparently stalled at that point and hit the ground very hard. The impact cracked the landing gear and one wing hit a runway light damaging the leading edge. The instructor was unhurt (Thank you Lord!) and the Pulsar will be repaired with a new gear and wing repair. When Bill checks the wing twist, we'll know more about why the airplane seemed to have such a roll problem. We'll let you know what the results are.

In the meantime, all I can advise is that you double check your wing twist with the twist blocks used during the wing skin installation. On your first flight, use only enough power to just break ground and then immediately chop the power to avoid getting more than a few inches off the ground. This should give you a chance to determine if your Pulsar is in roll trim or not.

I want to reiterate how important inspections are, including double checking things like wing twist. Also, the pilot for the first flight should be very proficient in many different types of airplanes.

Besides Bill Buffe's incident, another Pulsar suffered a hard landing last month. In this second case the landing gear cracked just above the axle back plate. I checked the loads again and the stress level at that point was within the limits of FAR part 23, so no action is required on the other Pulsars. However, we are changing the manufacture of the gear to add additional strength in that bend just above the axle because that point is stressed higher than the rest of the gear leg. If you want to reinforce your gear to match the strength of the new production, you can wrap two layers of 2" glass tape around the gear in the bend area just above the axle.

During an inspection of a Pulsar that already has over 60 hours of flight time on it, I found a frightening condition on one of the spars. The lower uni-directional spar cap was cut about a third of the way through! The builder told me that he had to "file" the spar down some to get it into the fuselage on the initial installation. If you have any such interference during construction, PLEASE call us for help! This type of problem is very easy to solve, but extremely dangerous if done wrong.

Another problem I found on a Pulsar under construction was a very poor bond between a layup and a bulkhead. The bulkhead was apparently not cleaned or sanded prior to doing the layup. Be very careful to prepare every surface prior to bonding. To check yourself, do a test layup with a layer of 2" glass tape on a scrap piece of bulkhead material. When your test layup has fully cured, try to peel the glass tape off the bulkhead. The tape should tear before it pulls off.

You guys (and gals) don't get so focused on the construction process that you lose sight of what you're building. An airplane is only as strong as its weakest part and if one fails in flight, I don't have to tell you what happens to whom. The Pulsar has some nice margins of safety but they won't cover gross errors. From now on, every time you go out to work on your "project", imagine what it will be like at 2000' going 130 mph and you hit some really bumpy weather. It's not a truck!

On a more positive note, Harry Jones has developed a cabin heater that seems to work really well. He runs a 2.5" duct from the left radiator to an opening in the firewall. He uses a pivot door behind the firewall controlled with a bowden cable to regulate the hear. His real secret is a little wooden box in front of the radiator in the area where the duct picks up the air. The box is thin plywood (probably wing skin material) 4"x4" and 1" deep. It has only 3 holes (1/4" diameter) in the front. Harry says that lets in plenty of air. The box forms a plenum so the air spends more time in the radiator before it enters the heater duct. Also, he has a heater control valve in the coolant system to keep the water temperature up around 150 degrees.

I need to clarify a pricing policy stated on the Purchase Order for those people who chose to buy their kit in stages. The top of the PO states that sub-kits ordered after the initial shipment are subject to price increases. To be more specific, the price of the wing and engine kits will be the current sales price of that sub-kit at the time it is shipped. I wish as much as anyone that the world economy was more stable, but due to the very weak US dollar, our costs have increased over 17% on some major items (like engines). If we tried to sell sub-kits at a constant price while our costs go up 17%, we wouldn't be in business very long. The current price of the wing and engine kits are: \$4,890 and \$5,820 respectively including crating. However, Rotax has informed us that the engine price can change at any time without notice due to the exchange rate so we must say the same thing. Even all the people that ordered a full kit shipped all at once have been informed that engine prices can not be predicted and they would have to buy their engine early to get a certain price.

For your general information, our production schedule is now sold out through November, 1991 and we are still building one kit per week. However, we are growing slowly and carefully and plan to increase our production rate to reduce the long backlog.

I want to ask you all once again to be very careful in your construction and operation of your Pulsar. That's not just a casual desire. It's essential for your future and ours.

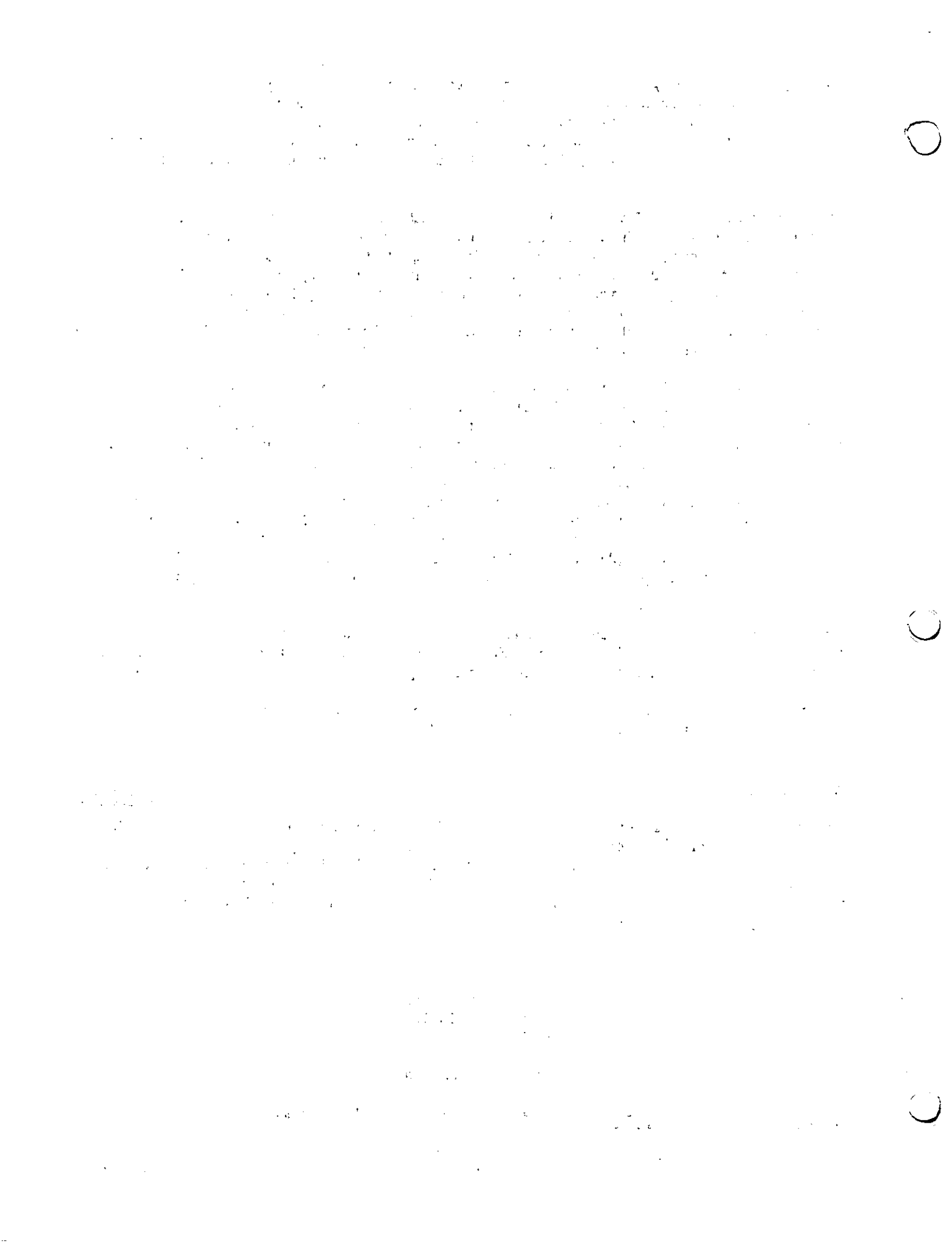
Builder List:

The accompanying "builder list" shows all registered members of the Pulsar Builders' Association, some of which are not currently building a Pulsar. To help you use the list, at the end of each person's address, a "Y,N,?" is noted indicating whether the person is a builder or not. There are numerous individuals who are currently thinking about building a Pulsar and have joined PBA. This list is provided to encourage all current or would-be builders to contact each other directly. I hope you find the listing useful.

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Mike McCann, Editor

Pulsar News is published 6 times a year. Subscriptions are available for \$10.00 per year (U.S.) and \$15.00 (foreign). All correspondence and subscriptions should be sent to the above address.



Pulsar News

News, Updates, and Developments for Pulsar Builders and Owners

Issue No. 9

Published by the Pulsar Builders' Association

March, 1991

Opening:

We've got a lot of information to pass along to all the builders in this issue. In fact, I'll have to include some of the builder tips/updates in the next issue due to space limitations. As always, I appreciate hearing from all of you and value your information/suggestions.

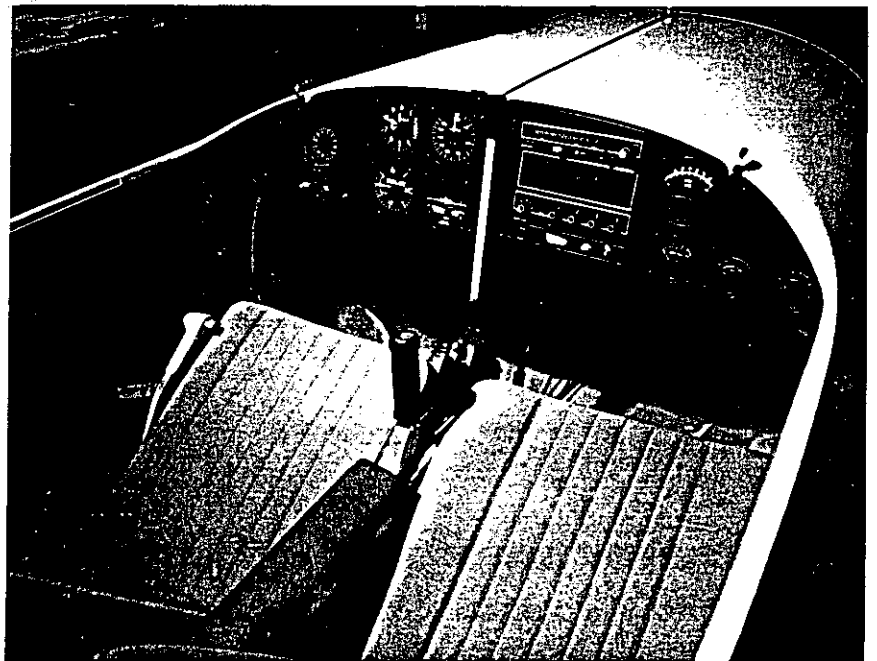
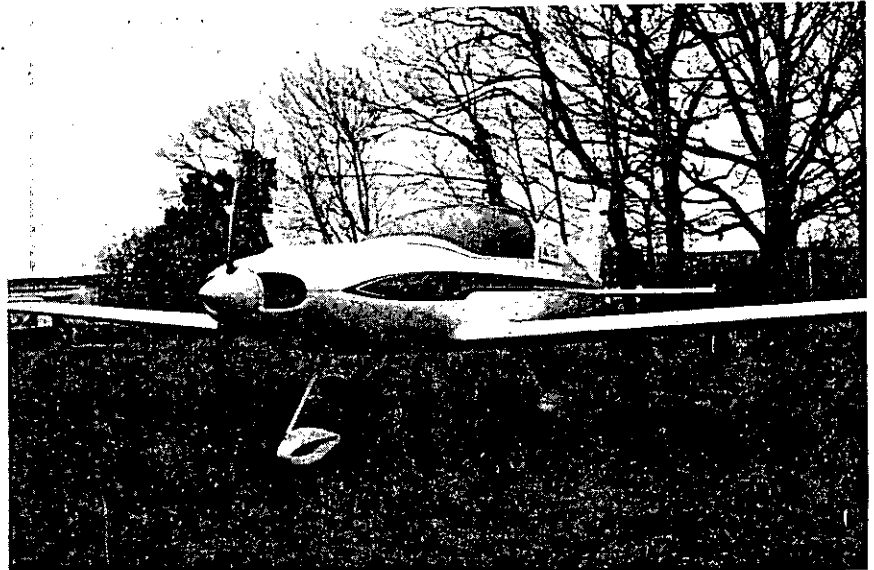
Pictures:

As promised in the last newsletter, I am including the pictures submitted by Harry Jones. While our reproduction does not do justice to Harry's fine work, it's always exciting to see another Pulsar completed.

Of special interest to many of you is the photo of Harry's instrument panel. Like me, many of you are always looking for ideas/examples of instrument lay-outs. Harry has mounted his radio stack comfortably in the center position just right of the fuel sight tube. As is clearly shown, the Pulsar panel has adequate room for a radio stack and instrumentation.

Nice work Harry!

Pulsar by Harry Jones



Sun N' Fun:

Since this will be the last issue prior to Sun N' Fun, I want to let everyone know what Mark Brown's airshow schedule (at this point) is for 1991. Shown below are the dates Mark and his crew will be attending and the forum times (where applicable):

Sun N' Fun 4/7-4/12 Forum: 4/8, 9:00am, Tent 1
Oshkosh '91 7/26 - 8/1 Forum: 7/29, 8:30am, Tent ??
Southwest Regional Fly-in, Kerrville, Texas (See *Sport Aviation* for dates).

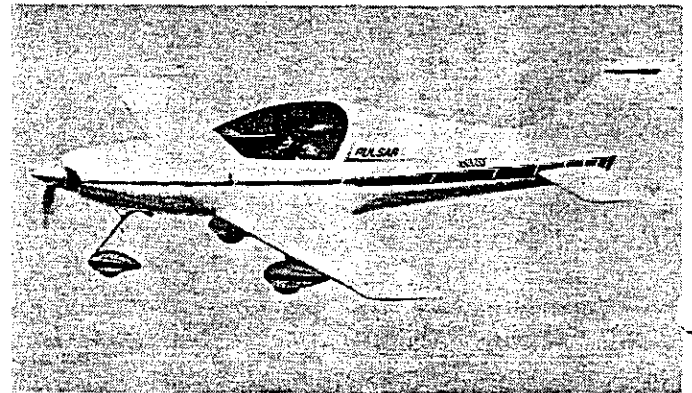
Mark hopes to see many of you during the fly-ins.

Something Different: During my recent visit with Everett and Alice Collier, Everett passed along an article about the Pulsar found in his EAA Chapter Newsletter. It's always interesting to hear what other people think about the Pulsar. I'm reproducing the article for your reading pleasure.

NOVEMBER MEETING REVIEWS PULSAR PROJECT

Approximately twenty five members attended this month's meeting which was held on November 17th at the home of Everett and Alice Collier. Everett has jumped with both feet into a Pulsar project from Aero Designs Inc. The Pulsar is another in the recent trend toward light weight composite aircraft which utilize the higher-power two stroke engines. They seem to me to be somewhat of a cross between a sophisticated ultra-light and a Lancair.

The result appears to be relatively low cost, attractive airplane, capable of transporting two people, with reasonably good comfort and performance. The Pulsar, and other, similar designs, demonstrate to me just how much technology and home building have changed over the last couple decades. Contrasting the Pulsar with my Bekeng Duce; it weighs about half as much, has half the power, yet carries almost as much useful load, both higher and faster (according to the designers specifications).



I have learned not to believe all that I read when, performance specs are provided by the designer. They frequently seem to claim that their aircraft cruise at 300 MPH on two gallons an hour and have full STOL capabilities. I sometimes think that aircraft designers are even bigger liars than fisherman. However, the specs on the Pulsar do not seem to be too far from the realm of possibility.

I made two additional observations regarding building the pulsar. **You** don't need a hanger to build it in and it does not require a fully equipped shop. Conspicuous by their absence were welding tanks, metal brakes/sheers, band saw, table saw, etc. Oh, how I wish my shop could be so clean and organized.

Builder Input:

Geoff Webb (England - Kit 189): This kit was delivered on 1/18/91 and is being built by Terry Baker and myself in every waking hour. We have completed the majority of the fuselage kit plus tail fin/stabilizers, elevator/rudder plus controls, brakes, wheels, canopy, engine cowling and have now started on the wings. No major problems have been encountered and our local engineer has signed off on everything to date without criticism. A major point for UK builders is heat unlike the sunny climates of the southern U.S.. It gets cold here (-15° F) and we have constructed a large trailer (covered) which with mobile heaters acts as an oven and can achieve 80°F for fiberglass curing. We estimate that around 400 man hours have been taken up so far. If anyone has information on the following, we would be very interested:

- 1) Cabin Heaters.
- 2) Vacuum Pump installations: Has anyone any ideas about vacuum pump installations coupled with artificial horizons/direction indicators for a 912 installation.
- 3) Flying information: cruising, landing speeds, take-off/landing rolls, etc.

(Editor Note: I will attempt to include a sketch of Harry Jone's heater installation in the next newsletter [hint to Mark or Harry]).

Martin Faro (England): With regards to building, I think it is worth mentioning the following:

1) Landing Gear - the gear legs where the axle plates are bolted is convex. Therefore, I drilled the holes as per the instructions. However, I then put 2 layers of glass mat between the leg and the plate. The point of this exercise is to stop the gear leg from cracking when the axle plate bolts are torqued up.

2) Has anybody yet devised an internal mounting system for venturis? Bill Todd's Starlite has such a system. I have used a similar system in my Starlite and it works very well. Obviously, this system cannot be copied exactly in the Pulsar because of the location of the radiators. I am not happy about mounting venturis on the outside of such a beautiful aircraft as the Pulsar.

[Martin also told me that he has sealed the air vent intakes and then drilled 3 vertical holes in the seal to allow air in. The holes create a natural water dam which might otherwise come in. Note also that other builders have built up a small fiberglass dam on the bottom of the air inlet to stop water from flowing down the base of the air inlet. Either method should stop incoming water].

A.H. Brown (England): Part of my preparation was to build a trailer to transport the kit to my house as access for a semi trailer truck delivery would not be feasible. I got the trailer built in time (thank goodness) and it will be eventually finished as a covered trailer and used to house and transport my Pulsar. My tow car is a sub-compact but it handles the trailer and Pulsar OK. The basic trailer shape is tapered in plan and elevation. Dimensions are 20' long (less towing hitch), 5' x 5' high at the front and 7' (wide) x 6' at the rear and 7'5" wide over the wheels. The door forms the loading ramp.

It is difficult at many gas stations here to fill portable tanks and to get lead-free MOGAS on airfields, so the trailer will have a built-in fuel tank(s) fillable from each side of the trailer. This will cause some eyebrow lifting! The tanks will be under the floor boards, 20 gallon capacity. Fuel will be transferred by on-board battery driven pumps.

Mogen Jansen (Denmark): I have encountered the first real problem--a mismatch of the aft edge of the flap and aileron with the wing tip. I have been very careful with the wing twist and re-checked it. The problem relates to the fact that the flap and aileron do not have the same twist (wash out) as the wing. [Mogen raises a good point. Be careful when riveting the flaps and ailerons to insure that the completed component has the right twist. I used lots of masking tape to tape the position of the flaps/ailerons to make sure prior to drilling/riveting. Ed.]

I have had a problem working with epoxy as I have developed an allergic reaction to it. I knew it as a hazard and took the precautions with gloves, ventilation, carbon mask, etc., but it certainly is not enough for me. Now I use a protecting cream on hands and face, thin cotton gloves under some good quality rubber gloves [thin gloves alone may be worse than nothing as the epoxy may get through and the skin will be damp and hot with open pores], an air-tight overall, enclosed helmet with fresh air supply via hose/filters from a compressor, so I look like a spaceman, but I hope this will enable me to finish the aircraft. Please let this be a word of warning for other builders.

Thomas Gibbons: Please remind all the builders that you can get a rash or itch when grinding or sanding the epoxy lay-ups so WRAP-UP! I also use a mini-hack saw blade holder to cut the fuselage cut-outs. Start with the Dremel fiberglass cutter then use the blade holder. This allows for a straight and accurate cut. So far I have have about 170 hours into my project. Most of the time has been on the wings, and the fuselage is together. Factory support is great!

Larry Eubanks (Lawrence KS - Kit #165): Here's one thing I thought would be of help to other builders. The manual doesn't cover what to do with the space left above the top hinge in the vertical stabilizer. This is an area that could allow water to run into the rear of the airplane. My solution was to use the top of the rudder as a mold by covering it with masking tape, waxing that, then putting a couple of layers of 3oz. cloth over that. After curing and prying it off, I sanded it to shape and then just glued it in place with construction adhesive. This, of course, is done after fitting the rudder to the stabilizer so that the edges are tapered for clearance before this piece is installed.

Stan Buchholtz (Mystic, CT): A couple of hints: access to the brake pedals (ours are hydraulic) is a real plague from the cockpit. With a flash of inspiration, I took out the battery and cut a 4"x6" access panel right behind the battery location. It is built the same as the rudder control access panel in the tail, and can't even be seen with the battery in place.

Also a good amount of silicone under the muffler, on the stainless heat shield, should dampen metal-to-metal chatter. [Note: I haven't had a chance to ask Stan about heat generation from the muffler and the effect on silicone rubber. This may be a factor. Ed.]

Rick Meyer: Things are going fine here with the 912. I will send some information concerning the plane and some pictures for the newsletter as soon as I can get it all together. [Those of you who attended Oshkosh '90 remember Rick's plane on display as the first completed Pulsar XP. Rick has been using the Pulsar for some flight instruction and I am told all is working nicely. We will anxiously await the flight information and pictures].

Miscellaneous Items/Notices:

Fuel Tank Cap Grounding: Everett Collier provided an interesting article from *The Canard Pusher* (issue No. 55) which discussed grounding of fiberglass fuel tank caps/rings on Long EZs. Everett has decided to ground his fuel tank ring by hooking a piece of grounding cable to the fuel vent tube. During refueling, a ground wire will be clipped to the vent tube to ground all metal components in the fuel tank. While this modification is certainly not required, it is an interesting modification. I have reprinted a portion of the letter written to Burt Rutan and Burt's response for the benefit of all the Pulsar builders:

"I knew it was possible, but surely it wouldn't happen to me. How many thousands of times have EZ's been refueled without any incidents of fire? One reported in Norway....and now me. Why does it happen? Is it carelessness, and is it preventable? Gary, the fuel truck driver, unreeled the ground cable and clipped it

to the exhaust stack, just the same as we had done about 30 times before. Eleven gallons of fuel was pumped into the tank and it was about 1.5" from being full. He then shut the nozzle down to slow the flow and with both of us looking directly at the fuel tank opening, the fumes from the tank started burning. No explosion. The flame above the tank was a couple of feet high. By very fast reaction and a dry powder extinguisher from the rear of the fuel truck, we had the flame out in about 12 seconds from the time it started. Damage was mostly cosmetic. A large area was smoke blackened from the filler ring to the trailing edge."

Comment from Burt Rutan: (note that Burt reported in his initial comments that only 2 fuel tank fires have ever been reported among the hundreds of fiberglass canards). "We can learn from this. We are equipping our Long EZ's with a ground lug which is connected to the gas cap ring. This is where the gas truck will connect his ground strap instead of onto the exhaust as he usually does. We believe that a ground wire should go into the tank from this ground lug or the gas cap ring such that it is immersed in fuel even when the airplane is parked nose down with minimum fuel in the tank. When we get ready to take on fuel, the procedure will be this: A short cable with alligator clips will be kept in the EZ and will be connected to the ground lug and to the gas truck's fuel nozzle BEFORE opening the gas cap. The gas truck's grounding cable will also be connected to this ground lug BEFORE the gas cap is removed. This will drain any static off the airframe out of the inside of the fuel tank and also off the surface of the fuel in the tank where static can build up. THEN we will open the cap and pump the fuel."

While most of us Pulsar builders will not be regularly fueling from fuel trucks, metal gas can nozzles should demand the same respect if you pursue this grounding idea.

Engine Shipment: An important reminder needs to be made to Pulsar builders regarding shipment of the Rotax 582 which is part of the engine kit. As Mark has mentioned in previous newsletters, builders can order the engine kit *less engine*. This is useful for those builders who are building at a slower pace and do not want the engine to sit for several months. You can order the engine when you are ready to install it thereby preserving most of the warranty period. You can deduct US\$3,160.00 (today's price) from the engine kit if you wish to do this. The US\$3,160 represents the Company's cost, but Mark wanted me to state that you do not have to purchase the Rotax 582 from Aero Designs. As the Company sells the engines at cost, it is left to the builder to choose the source for their engine. As always, Mark is happy to help each builder as much as possible with engine shipments, etc.

PLEASE note, however, that engine costs are subject to the wide fluctuations in foreign exchange. Since the engine kits come from Austria, foreign exchange plays a more substantial part in price changes than even price increases from Rotax. If a builder chooses to wait on engine shipment, engine prices can not be guaranteed. Weigh both options carefully when you make the final decision.

From The Factory:

Pulsar sales are continuing to out-pace production, causing our backlog of orders to stretch all the way into January, 1992. That's certainly an encouraging sign for the future, but an 11 month backlog does have its problems. Not only is it too long for many of you to wait for your kit, we just can't predict our costs that far out to be able to quote a firm kit price. Therefore, we are gradually accelerating production to try and work off some of that backlog. We hope to start moving up some of your shipping dates within a couple of months.

Really, the key factor in accelerating production involves finding good, qualified help. We are very pleased to announce that Rick Meyer, who many of you already know, has recently joined our

team to help in this effort. Rick's experience in building the first Pulsar XP along with his excellent communication skills means that you'll probably be hearing his friendly voice on the phone soon. He'll also be handling some of the mail and so you'll start to see more computer output.

The subject of oil injection for the Rotax 582 has come up again and I think I should clarify my position. I never meant to imply that the Rotax system was unreliable. My objection to the system has always been based on my opinion that the extra complexity was not worth the presumed convenience. I fully realize that some people don't agree with my opinion and that's fine. Each builder is welcome to decide for him/herself if they want to use oil injection. They'll just have to source their own oil tank and plumbing parts. (Try California Power Systems or Leading Edge Airfoils for parts).

In the last few months we've sold so many Pulsars in England that we've made arrangements with one of our English builders named Alan Gill to provide builder support for that country. He is in the process of locating local sources for some materials. Also, we will be sending him a small inventory of spare parts to provide quick availability to the English builders. Alan is eager to start helping the builders immediately and his Pulsar is already more than 50% complete so he'll be able to help most of you. His home number is: (44) 628-22631.

I've received a bulletin from Rotax that the rubber manifolds supporting the carburetors need to be inspected regularly (whenever the cowling is off). Rotax has received a couple of reports of cracks developing in these rubber parts which could result in engine failure.

Keep up the good work. Everyone seems to be building with great care lately and calling us when any problems or mistakes come up. Keep remembering what you are building and concentrate on safety. Thank you!

Wrap-up:

In the next issue I will share some of the builder logs shown to me by a couple Pulsar builders. I also encourage any photos of specific construction aspects/details which would be of help/interest to other builders. If anyone sent in builder tips and didn't see them in this issue, my apologies. We are racing to get this issue into everyone's hands and Kim and I have papers all over the house. Please don't let the wind blow!!!

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P.O. Box 13941
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Mike McCann, Editor

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Issue No. 10

Published by the Pulsar Builders' Association

May, 1991

Opening: This issue is devoted to Harry Jones who has provided me with a great deal of information on his Pulsar performance. Mark Brown asked Harry to detail his experiences with the Rotax 532/582 which are found in this newsletter. In addition, Harry contacted me with several construction tips/queries. Thanks Harry for all your time!

Builder Input:

Russ Woodland (Ireland): "Work on my Pulsar goes well and I'm 2/3rds of the way through the fuselage manual. I am building a tail dragger and have come across a couple anomalies from the manual:

1. Position the forward seat bulkhead before glassing in the forward spar fittings or else it won't fit in.
2. The position for the spar attach pins has to be different from that shown in the manual else they interfere with the binding gear tabs." [Russ indicated in this letter that builders should check with Mark Brown on this last point if you're building a tail dragger].

Rodney Sebby (Kansas City, KS): "Most of my fuselage is done and horizontal stabilizers complete. The rudder is complete but no cables run yet. Two antennas embedded in the vertical stab. area. Both my wings are skinned, but only the upper skins and no pushrods or linkage in place. At the moment, I'm just getting ready to insert the wings into the fuselage to trim for length. No canopy work done yet (I'm saving that for last!)

My builder tip: When lining up the spar tube in the horizontal stabilizer shell halves, I inserted the aluminum tube in the fuselage tube then put the shell half on the spar, set your alignment for perfect fit with the fuselage, then take a small bit in the Dremel Tool and drill through the shell and into the spar tube 3 or 4 places, and press fit toothpicks through the holes. Now you can remove the whole thing, mix your structural adhesive, remove the toothpicks, apply the adhesive, and then reinsert the toothpicks. After all of this sets up, you can break off the toothpicks flush and sand smooth. This works well in several areas where it is hard to maintain alignment and have everything fit properly. It sure helped me and I hope it helps someone else as well."

Harry Jones (Vineyard Haven, MA): "Three items from a telephone conversation between Mark and myself which we think should be in the newsletter:

1. Prop bolt torque: After numerous prop changes I know it really is true that the wood compresses so that pressure is reduced after 5 minutes and much more after about a day. Down from 100 in./lbs. to about 45 lbs. So I now torque to 100 lbs., wait for 5 minutes and torque again. Then I fly once in the next 24 hours or more, after which I remove the safety wire and torque again. After each seasonal weather change, I'll check it again.

2. Nose wheel lubrication: At final assembly of the nose wheel, lube the caster bushing with waterproof grease. If subsequently you allow any coolant to run down the gear leg, or leave the aircraft out in heavy rain, be aware that the lube can wash out and the bushing seize as mine did with ordinary grease.

3. The axle bearings are in a dirt collecting area. Be sure to pump the hub full of bearing grease until some oozes through each bearing. Wipe them clean and dry so dirt won't stick. Periodically, push more grease through to reduce dirt working in. During your annual, remove and wash caster and axle bearings.

Here's an idea for all of us: As each builder finishes construction, he/she should begin noting down items they'd like to inspect at annual. It's hard to dream up a complete list when you embark on this important, FAA-required task. I, for one, could sure use a list created by all of us sending in ideas." [Harry's right and this is a great idea! I will be happy to act as a central collection point for all inspection ideas and then will print them in batches as they come in. Over time, a very detailed list will be created which I will organize into categories and also print in the newsletter. Ed.]

Harry's comments on using a venturi: (re: Martin Faro's note in the last newsletter): "I tried a venturi inside the cowling for my bank & turn indicator but it didn't work. I have a drawing and test model of one designed to intake and exhaust through openings in the bottom cowl, but I need more practical information on what is required to make a venturi work efficiently. Detailed information on the efforts of Bill Todd and Martin Faro thus far would be very helpful for me to proceed with my trials. (as well as sketches).

Re: Mogen Jansen's remarks on lining up flaps & ailerons: Be aware of the need to match the wing twist and everything should go well!

Miscellaneous Items/Notices:

Missing Newsletters??? I've been contacted by a few builders who have found that the Post Office is much less than perfect (i.e. they never got their *Pulsar News*). Please be aware that *Pulsar News* is published 6 times a year without fail (thus far!) during May, July, Sept., Nov., Jan., and March so if you don't see your copy in the mail, let me know. Be sure to check the address on the mailing label. If anyone wants to make changes to the mailing address, drop me a line.

OK, I will publicly admit it. One of you have ordered 4 Pulsar hats from me last month, but I have misplaced ("lost") your address and I fail to remember who sent the order in. Accept my apologies and please call or write. Your hats are ready to be shipped. For anyone needing Pulsar hats for Oshkosh, we finally got our new shipment in. They're professionally printed and cost \$7.00 + \$1.50 shipping.

Cabin Heaters!!! Many of you have been wondering about the infamous cabin heater for the Pulsar. Harry Jones has recently provided me with a sketch for his cabin heater. Due to other information provided by Harry, and the waning days of winter, I've decided to post-pone including the sketch until the next issue. I hope this doesn't set anyone back. On a similar note, I haven't forgotten about the sample Pulsar builder logs. Again, space was short for this issue so we'll include it next issue.

Rob Blamires has asked if we could put together a list of tools that Pulsar builders are using in the construction process. If any of you have found certain tools (unusual or otherwise) which greatly helped in the construction process, please let me know. I will include a listing of "must have" and "nice to have" in an upcoming issue.

J.D. Holden (Rt.1 Box 44 Slaughter, LA. 70777) has asked if anyone has built an enclosed trailer for their Pulsar? He'd like to talk to you as he would like to build one as well.

"Rotax Notes & Comments" by Harry Jones

When I was ready to order my engine kit in 1989, I was too early for the 582 and had to settle for the 532. I had a good bit of trouble with it as many of you have heard. After endless consultation and help from Mark, I switched to a 582. I started with little experience with 2-cycle engines but now have several hundred work hours and 80 flight hours on them, so Mark has asked me to comment on all of this for all of you who are new to the water-cooled Rotaxes. If any of you Rotax experts out there have better methods or information, please send them to Mike McCann so we all can benefit.

In spite of all the vibration and other problems with my 532, I still have acquired confidence in the ability of these engines to stay running. They are hypersensitive thoroughbreds which react badly to negligent treatment, but they seem always to bring you home. I just returned from a 2200 mile round-trip to Sun N' Fun without a single falter from my engine in spite of the fact that with my inexperience it was poorly tuned and not developing full power.

The 582 is a real aircraft engine. Not only are dual ignition, oil injection and elimination of points and condensers great steps forward, but many details have been brought up to aircraft standards: Wiring has been bundled and supported, anchor holes for proper safety wire have been added, and the list goes on.

When it finally came time to give up on my 532 and call it one of Rotax's rare lemons, Mark, and to a lesser degree, Rotax-Kodiak stood right with me and made a fair, prompt exchange. I can't say enough about the help and support I've had from Mark and his people. We are all very lucky to have him.

Here are some items which I wish I'd known when I first fired up a Rotax:

1. Install it so it's easy to remove from service.
2. Figure out good access to the gear-box oil-level plug and the drain plug including safety-wiring with engine in place. I put a big hole and plug-bottom in the lower cowl to drain through.
3. Engine mounts should be tightened until you feel "fetch-up" against the steel ferrules in the rubber mounts.
4. There will be heavy vibration during the break-in procedure especially during the one-minute idle periods. I suggest removing gyro instruments and the compass until you're ready to fly.
5. Make a record of O.A.T., water temperature, and EGT at each RPM level during break-in. If O.A.T. is 40°-70°F you should see roughly as follows:

3000 - 4000 RPM: W.T. rising to 150°, EGT rising to 1100° or 1150°
4500 - 5000 RPM: W.T. 150°, EGT 1200°
5500 - 6000 RPM: W.T. 140°, EGT decreasing to about 1000° at 6000RPM.
6. You may get a max static RPM during break-in of only 5800 or so. You should not be able to exceed 6100 RPM. After an hour or two of taxi testing you should get 6000 +/- 100 RPM.
7. As you start a take-off run you may notice a drop to 5800 RPM or less. EGT should be about 1000°.

8. During a long taxi, W.T. may rise; 170° or 180° is ok. W.T. should drop during climb-out; in 80° OAT to 150°, in 45° OAT to 140°. EGT should be 1000° or less at full throttle.
 9. Cruising RPMs can be from 5000 - 6000 wide a wide fuel consumption range. W.T. from 135° - 180° is acceptable and will depend on OAT. If your winter-summer temperatures vary a lot, you should block off one radiator front and back. I strongly recommend installing a Ford heater valve with push-pull cockpit control. I have boarded off one radiator and valved the other to maintain 145° when OAT is below 30°F.
- EGT should be about 1100°; less at high cruise, more at 5400 RPM. Be alert to an EGT surge when you reduce throttle below 6000 RPM. It may rise above 1200° which is ok for 10-20 seconds, but you may have to pull back to 4200 RPM to get the EGT down and ease back up to a cruise in the 5000 RPM range. Maximum continuous EGT should occur between 5200 and 5900 RPM and remain below 1200°.
10. When you level off and settle into a fast cruise, watch for over-speeding. Note that 6900 RPM is max and this slippery airplane will produce 7500 RPM if you don't watch it.
 11. A Pulsar with 10 gallons or more fuel will barely take off and climb at 5000 RPM. I suggest aborting any take-off with less after reaching 50 MPH.
 12. Adjust the carburetor air screws (small) to one turn out. Synchronize the throttle slides (valves) as follows: Push your throttle all the way forward until you just hear one slide hit top. Feel inside each carb to see if you can push either slide higher. If so, adjust with knurled screw on carb top until both click to the top together. Make sure both slides will bottom when throttle is full aft. Set the big idle screws to give you 1600 RPM at idle and be sure both screws hold the slides at the same height. You must have not more than 1600 static idle to slow down for landing.
 13. Get a copy of the Rotax diagrams of main jet correction and of idle jet, jet needle, main jet effectiveness at various throttle positions. You may have to change main jets to accommodate your airfield altitude and/or OAT. If your EGTs tend to get up over 1200 in mid-range, you may have to change jet needle "plate" position. "Leading Edge Airfoils" has these diagrams. [Ed. note: I will get copies of these diagrams and include them in the next couple of issues].
 14. LEARN TO READ your plugs. The center porcelain insulator and the electrodes should look quite red-brown. Orange is ok, but EGT has been over 1200°. Clean, light gray means you're approaching seizure, whitish means there is actually some aluminum on the plug which melted off the piston. A sooty plug means too rich a mixture as is one which looks brownish overlaid with light soot. A combination of mixture, timing, and EGT inter-relatedly makes these colors. The 582 timing is supposed to be fixed. I haven't found anyone who knows how to check it even though the manual suggests you do it.
 15. The fuel gage is pitch-sensitive. I marked mine with the aircraft sitting on its wheels. Straight and level, it reads exactly two gallons less -- a good "reserve system" but don't count on that last visible gallon. Occasional bubbles can distort this. When I get halfway down on that last gallon (2.5 gallons actual) I want to be in the pattern or on the ground. My fuel consumption has been about 4.1 GPH at about 6000 RPM. I expect to get Mark's 3.8 GPH at about 5600 RPM.
 16. The air cleaners must be washed with detergent and water every 25 hours to prevent the engine from running rich. I didn't know this and at 50 hours I could hardly get 5100 RPM for takeoff and was burning over 6 GPH.
 17. Change or clean plugs every 10 hours.
 18. De-carbon pistons and rings at 75 hours.

19. Kodiak says the fuel pump should be mounted flat, not on edge and with center vent-side down.
20. I'd recommend a dual EGT.
21. I strongly recommend a volt meter! It tells you the exact condition of your battery. It should read 12.5 volts when you flip the master on (13 volts after shutdown shows the temporary surface charge). Less than 12 volts means it's run down for some reason which you'd better find. With engine running 14.5 volts shows that the battery is being properly charged, 12.5 volts means no charge, and 16 volts means the voltage regulator is overcharging.
22. First flight: If you're a lowish time pilot trained in 150s, 172s and Cherokees, take care with the Pulsar's pitch control on take-off and landing. After you get accustomed to it, you'll love it, but in the beginning relax and be very *S-M-O-O-T-H*.
23. Mark has found AV-2 oil to be the best. Whatever you use, it must be 2-cycle, air-cooled type.
24. Be sure that everything on the engine has plenty of clearance to any parts connected to the fuselage. There's a lot of vibration movement which can do real damage.

I'd like to thank Harry for spending the time to put his experiences on paper for all of us to use. Harry's right in saying that this type of information is really valued, especially when you're reading the manuals but aren't quite sure what to expect or look for. I encourage others to share their experiences and detail what they're finding with the various aspects of Pulsar construction/operation.

From The Factory:

With the spring weather upon us, a Pulsar in Sweden is spreading its new wings. Congratulations are in order for Kenneth Holm on the first flight of his new Pulsar which is also the second tailwheel-type Pulsar to fly. He reports that the ground handling is very easy even in a cross wind. He does report that the prop has a little too much pitch that "bogs" the engine rpm down on takeoff. Also, he already has some small cracks on the lower bend of the main gear like the case mentioned in the January '91 newsletter. I now think that everyone who received their kit before December 1, 1990 should go ahead and "wrap" the lower bend of each gear leg with two wraps of 2" glass tape. Kenneth is an old friend because he also built and flew the first Star-Lite in Sweden a couple of years ago. We wish Kenneth all the best.

We just returned from another very successful trip to the Sun N' Fun airshow in Lakeland, Florida. This year I flew Rick Meyer's Pulsar XP to the show because Dave Martin of Kitplanes wanted to do a flight evaluation for an upcoming article. The Rotax 912 in the "XP" performed flawlessly all the way even when I had to burn some 100LL fuel. I averaged 3.5gph fuel flow at 135mph TAS. We know the two bladed prop will do 140mph at the same rpm but we didn't have the spinner ready so I just took the three bladed prop. Of course, the XP kits will be shipped with the better performing two bladed prop.

I was greatly encouraged to find another Pulsar already at Lakeland when I arrived. Harry Jones flew his beautiful bird from Vineyard Haven, Massachusetts and I was very impressed. He did a wonderful job of construction and has a beautiful paint job. He even let me fly it and it flies as great as it looks. If you remember, Harry is the creative gent that came up with the neat little cabin heater and I was really impressed with its simplicity. Also, he said it worked great on the trip from MA.

Including the orders we took at Lakeland, our production is now backlogged into March, 1992. However, as I mentioned last time, we are accelerating production and hope to deliver these latest orders at least a couple of months ahead of schedule. Therefore, if you have a kit on order, please accept this notice that we will be calling or writing you about 6 weeks before the date on your acknowledgement letter to arrange the shipping and payment details. Also, the serial number assigned on your acknowledgement letter may change due to some last minute shipping schedule adjustments depending the order that the kit payments are received.

About one year ago we started using a special anodizing process on some of the aluminum plates in the kit because we learned that many of the major airframe manufacturers have started using this process. However, the surface preparation for the anodized aluminum requires a strange sounding cleaner called 1-1-1 Trichloroethene. We have finally found a good source for this cleaner and we are now sending a bottle with every kit. If you haven't been able to find the 1-1-1 at your local paint store, then give us a call and we'll be happy to send you some. If you received your kit prior to May, 1990 you don't need the 1-1-1 because you don't have anodized plates.

I've just received some early information about a Pulsar accident involving Glen Huff in Kansas City. The best news is that he's going to be ok, thank God. He has five broken ribs, a gash on the leg and a separated shoulder. Glen said that the engine quit right after takeoff and he landed in a very soft field straight ahead. The landing gear dug in and flipped the Pulsar on its back. Glen had his shoulder harness on and that probably prevented head or back injuries. The primary damage to the airplane is the separated main gear, bent nose gear, shattered prop. and a wrinkle in the fuselage around the wing fillet.

The cause of the engine failure has not been determined. The only information I have so far is that Glen just installed the oil injection system 4 flight hours earlier and the FAA found some fiberglass particles in the carburetor float bowl. We really don't know which if either of these factors lead to the failure. The investigation will continue and I will report anything we learn.

I really don't think Glen is ready to take calls or answer letter for quite a while so please just send a card if you want. I'll make sure you get all the details through the newsletter.

Phone/FAX:

Thanks again to all who participated in this issue. Regarding builders who need to call me please call me at my home (602) 482-7882. Also, although I have a fax machine at work, I'm not supposed to receive personal faxes and a couple of Pulsar faxes have raised everyone's eyebrows in the office. As such, I can no longer accept faxes at work but I'll try to locate another fax machine for anyone who wishes to send me a fax. Someday I'll catch up with the 20th century! Take care.

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Mike McCann, Editor

Pulsar News is published 6 times a year. Subscriptions are available for \$10.00 per year (U.S.) and \$15.00 (foreign). All correspondence and subscriptions should be sent to the above address.

Pulsar News

News, Updates, and Developments for Pulsar Builders and Owners

Issue No. 11

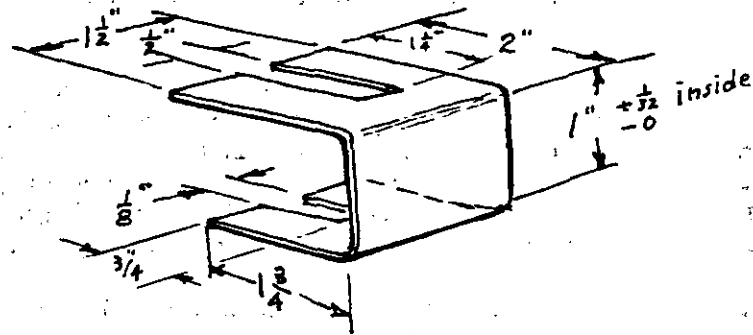
Published by the Pulsar Builders' Association

July, 1991

Bing Carburetor Spring Clip (Harry Jones):

In order to remove or re-install the throttle cable in the slide barrel, or change the jet needle setting, one must hold the big spring under the carb. cap fully compressed in order to produce enough slack in the cable to gain access to the inside of the slide-barrel. This can be very frustrating as the spring just won't cooperate. This clip will hold it compressed tightly against the cap. Place the longer fingers of the clip on top of the cap, astride the cable bushing. Cram the spring neatly between the cap and the short fingers.

I think Mark Brown watched me change my needle settings on both carbs at Sun N' Fun in about 10 minutes in spite of an audience of about one dozen. You should make this clip from 18 ga. steel or heavier. Only the 1" dimension is critical.



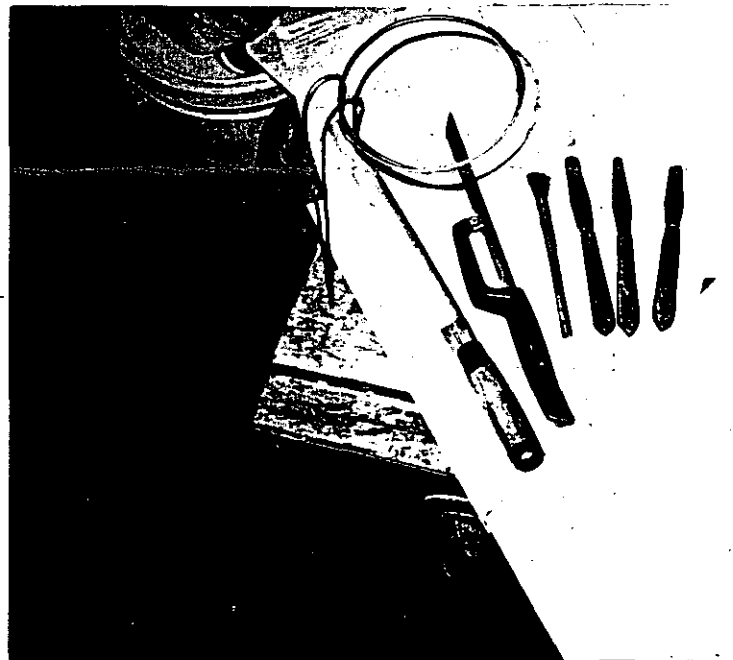
Tool Listing:

Re: Bob Blamire's note in the last newsletter asking about tools:

Here's a photo of some simple ones which repeatedly made life easier and/or the work better.

1. A 10" half-round bastard file with a good handle. Remember, the 1/2 round side is for course, fast cutting such as removing globs of epoxy as much as it is for concave surfaces. It will cut through epoxy with a sticky surface better than sandpaper and can be cleaned quickly with a file card.

2. The hack saw blade holder is available at most hardware stores. It beats holding a



bare blade in your hand and works much better. Grind a point on the end to stab right through composites.

3. The wire ring with vertical leg holds a zip-loc bag wide open with its bottom resting on the bench so you can load *micro* into it. See item 1, page 12 or the wing manual. If you are by yourself, it's hard to hold the bag open with one hand and pour with the other without getting *micro* on the zipper. This is a real speeder-upper. I drilled 1/8" holes in several places in my benches to receive this.

4. Acid brushes: I buy 1/2" wide brushes from an industrial hardware store by the gross for about 8¢ each. They're great for wetting out small pieces of glass, pushing them into place and stabbing out the air bubbles.

5. Artist's pallet knives: Much better than sticks for mixing epoxy in paper cups, placing *micro*, cleaning up fillets, etc. I have a fairly stiff knife for small fillets and two flexible ones, one with the tip ground off at about an 8° angle which is my real work-horse. After screeding a big fillet, remove all excess with this knife and it looks great. You'll be an instant expert. Wipe the knives clean before the epoxy sets, but if you forget and a film hardens on them, use #1 steel wool to remove the film and burnish up a slick surface. Three knives are also ideal to cut sand paper.

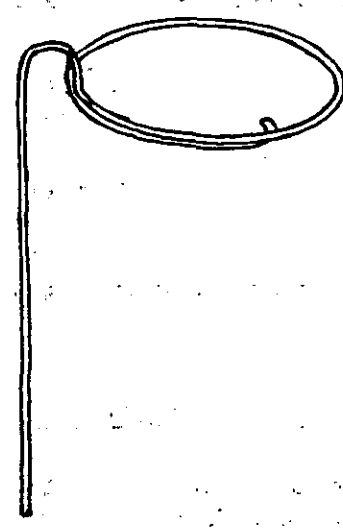
6. I think Norton Nofil Adalux (Pink) sandpaper clogs much less when sanding fillers, primers and surfacers than does other steared papers. When clogs do appear, stab an old paint brush into them to remove the clogs easily.

Editor's Note: Harry asked that I put an information request out to the builder group. As you may recall, we published a detailed account of Harry's finishing/painting experience. Harry would now like to hear from other builders as to the names of the best primer-surfacers to go under Imron and the reasons why they are thought to be the best. I absolutely agree that this information would be very helpful to the growing numbers of Pulsar builders approaching that stage of completion.

Also, any input on avionics installations would be useful. Give us the details of your installation: avionics equipment, intercoms, control stick mic buttons, antenna locations, etc. Send a picture of your panel so we can share it with everyone. All input is encouraged and appreciated.

Miscellaneous Items/Notices:

Kim and I are disappointed that we will be unable to attend Oshkosh this year due to the move to Arizona. If I can ask a favor, I'd like to ask that any of you builders attending Oshkosh with a camera could you please take a few photos for the next issue of Pulsar News and let us know what went on. A picture of the "Pulsar Flight Line" would be great if a few Pulsars make their way to Oshkosh. Thanks in advance for your input and help. As an aside, Kim and I are planning to spend a couple days at Arlington '91 (to escape from the heat!) If any of you are planning to be at Arlington give me a call (602-482-7882) as we would love to get together with you.



Missing Newsletters:

As requested in the last newsletter, anyone who is missing a newsletter should contact me directly so that I can send you a replacement copy. The international mail is especially bad (as I am quickly learning). A few people have contacted the factory about missing issues of *Pulsar News* which is ok, but I may not get notified in a timely manner. Please direct all questions or correspondence about the newsletter directly to me at the address shown on page 5. Thanks.

Corrections to: "Rotax Notes & Comments" (printed in Issue #10)

Harry Jones has contacted me with a couple of corrections to his article on Rotax operation. For cohesiveness, I've included the sections in question and have underlined the corrections. You can compare this to the information contained in the last newsletter.

5. Make a record of O.A.T., water temperature, and EGT at each RPM level during break-in. If O.A.T. is 40°-70°F you should see roughly as follows:

3000 - 4000 RPM: W.T. rising to 150°, EGT rising to 1100° or 1150°.

4500 - 5000 RPM: W.T. 150°, EGT 1200° maximum.

5500 - 6000 RPM: W.T. 140°, EGT decreasing to about 1100° at 6000RPM.

7. As you start a take-off run you may notice a drop to 5800 RPM or less. EGT should be about 1100°.

Visit with Alex Strojnick:

During the Memorial Day weekend, I was visited by Alex Strojnick who wanted to inspect the Pulsar design and construction methods. Alex has been around homebuilding for a long time, has published 3 books on low power laminar flow homebuilt aircraft, and has designed 4 different homebuilt aircraft. Some of you may have seen his magazine articles on homebuilding. He recently read a magazine article on the Pulsar and wanted to examine one up close. I thought I'd pass along some of his comments on the Pulsar.

- Alex was most impressed with the simplicity of the fuselage and wing. He is also a big fan of using a lightweight fiberglass covering on the wooden wing skin to improve durability and strength.

- He thought the construction manual was very easy to follow and very straight forward (which sure made me feel pretty dumb given all the time I've spent pouring over the manual diagrams!) Alex even stated that the manuals were better than those he produced for his own designs.

- He is very concerned with ANY play in control linkages. Alex spent quite some time examining the rudder, aileron and flap linkages. He stresses the point that flutter is a valid concern at 130+MPH and can be avoided with special attention to the entire control systems. Alex shares Mark Brown's views on attention to any play in linkages.

- Alex told me that he examines every homebuilt design possible (up close) since he learns from each design. His feeling was that the Pulsar was an excellent design and a top choice for any homebuilder. What did impress me was that Alex stood up at our recent EAA chapter meeting to tell everyone of his Pulsar inspection and recommended the Pulsar to any member who had not already made a homebuilt purchase! It's nice to know that others share our enthusiasm for building and flying a Pulsar.

From The Factory:

I suppose Pulsars must hatch out better in warm weather because we have three new Pulsar pilots to congratulate this time: Jim Devorak of Glencoe, MN, Bob Townsend of Ada, MI, and Bill Baltes of Sandusky, OH have completed their projects and from all the pictures I've seen they look fantastic. I must say that I'm almost as excited as the builder when a new Pulsar flies.

More good news: Our kit production is finally up to six full kits a month and that should improve our shipping schedule to many of you. Currently, we are working about 8 weeks ahead of the date we assigned on your initial letter and we are gaining about 2 weeks per month on that schedule. Therefore, we will be sending out a new shipping date proposal to many of you in the next few months. Since some people elect not to change their schedule, others may receive a shipping option several months earlier than originally assigned.

On the subject of oil injection for the Rotax 582, several builders are proceeding with the installation of the oil tank, plumbing, and throttle hook-up. We have no objection to the oil injection system, but be aware that the system is gravity feed so the oil tank must be mounted above the oil pump for all normal flight conditions. Chuch Stroh of OKC, OK pointed out that an oil tank mounted on the firewall might not gravity feed in a high angle climb. However, the stock Rotax oil tank that mounted on the engine will not fit under the Pulsar cowl.

The last newsletter explained a change that we've made in the bonding process that involves an adhesive plastic sheet that covers the anodized surface of some of the aluminum plates. We've recently noticed that when the adhesive sheet is removed from the aluminum prior to bonding, the adhesive stays on the aluminum. Of course, this sticky adhesive must be completely removed prior to bonding. However, the only approved cleaner for the anodized plates (1-1-1 trichlorethene) does not remove the adhesive very easily. The only solution is to keep wiping the plates with the 1-1-1 until all the sticky film is removed. No other solvent is approved on the anodized surface and no abrasive should be used at all. In June we started covering the plates with a thin layer of epoxy and fiberglass instead of the adhesive plastic to eliminate the problem. Just follow the procedure in the standard procedures section of the fuselage manual to prep the aluminum for bonding.

One important tip that I failed to include in the brake installation section of the wing manual concerns tightening the brake cable into the brake band. To prevent the clamping barrel from turning in the brake band you should drill a 1/8" hole through the brake band and barrel at a convenient location to allow a 1/8" drill bit to be placed in the hole to prevent the barrel from turning as the cable is clamped.

Bob Townsend (Ada, MI) has uncovered a rudder control detail that requires special attention. The cotter key that secures the clevis pin that connects the rudder cable to the actuating bellcrank broke off and fell out, TWICE! The only way we can imagine this happening is if the "bent" legs of the cotter key hit the side of the fuselage repeatedly until the legs break off. The cotter key could fall out. The obvious next step would be for the clevis pin to fall out which would not only cause a total loss of rudder control but also a forced rudder deflection because of the return spring on the rudder peddle.

The solution is to flatten the "head" and "legs" of each cotter key so that no part of the cotter key can touch the side of the fuselage. If interference can not be avoided, you'll have to grind away some of the inside of the fuselage shell around the cotter key. Grinding is acceptable in this area.

Another serious problem that occurred on one of the Pulsars recently is a rivet failure on the flap bellcrank connection to the flap torque tube. This builder accidentally used some aluminum rivets that came with the rivet puller that he bought. We have never supplied any aluminum pop rivets. They are all stainless steel. Make sure you don't make the same mistake. If one flap retracts unexpectedly, the result could be uncontrollable roll.

We've received two reports of cracked radiator fittings. Both cases were discovered during routine inspections which probably saved an engine failure. Both cases were on new airplanes and both cracks were on the brass tanks of the radiator. I suspect that the radiator hoses were installed in a way that pulled on the fittings too much because no one else has had such a problem. My radiators, for example, have over 400 hours on them.

None of the new engines seem to be able to turn the stock 56 x 44 propeller so we've been loaning out a break-in prop with a 43" pitch. This seems to solve the problem and when the engine has 40 to 50 hours on it then it seems to turn the stock prop just fine.

If your engine doesn't turn at least 5800 rpm static with 140° water temp, then first remove the air filters to see if that helps, then call us for a break-in prop.

Builders are still having trouble getting the trailing edge of the flaps and ailerons to match the wing tip and fuselage fillet. We are going to revise the wing manual to recommend the following procedure: With the wings on the fuselage, stretch a string between the wing tip and fuselage fillet. Then hinge the flaps and ailerons to the wings and tape the front side of the flaps and ailerons together so that the trailing edges line up with the string. Then remove the flaps and ailerons and install the pop rivets as per page 44 and 48.

Lee Klaus has pointed out a problem with the way the inner tubes fit the wheels. The valve stem on the inner tube is off to one side of the center line of the wheel. This situation has the potential for causing a fold in the tube that could result in a flat tire at a dangerous time. To prevent folds in the tube, we partially inflate the tube before the tire is installed so the tube will "roll" into position as the valve stem is aligned with the hole in the wheel. You must follow this same procedure when you change tires.

On the subject of Glen Huff's engine failure mentioned in the May newsletter, Glen has reported that a thorough inspection of the cylinders has shown no sign of scuffing that would indicate a problem with the oil injection system. Glen hasn't tried to run the engine yet, so he may yet uncover an explanation for the failure but at this time we still don't have an answer. We'll continue to keep you posted.

We've recently installed a fax machine at our shop to improve communications. The number is: 512-650-3398. It is a dedicated line and is operational 24 hours a day.

The Oshkosh schedule is starting to shape up so let me give you the latest. The general Pulsar forum is set up for July 29th at 8:30 in the morning. The Pulsar Builders meeting is set up for July 26th at 8:00 in the evening. We are trying to encourage several of the Pulsar owners to bring their airplanes to Oshkosh and we will reserve some tie down spots on the north end of the exhibit area. We won't have an exhibit tent in the commercial area this year because of some lost mail so we'll see you on the flight line.

Mark Brown

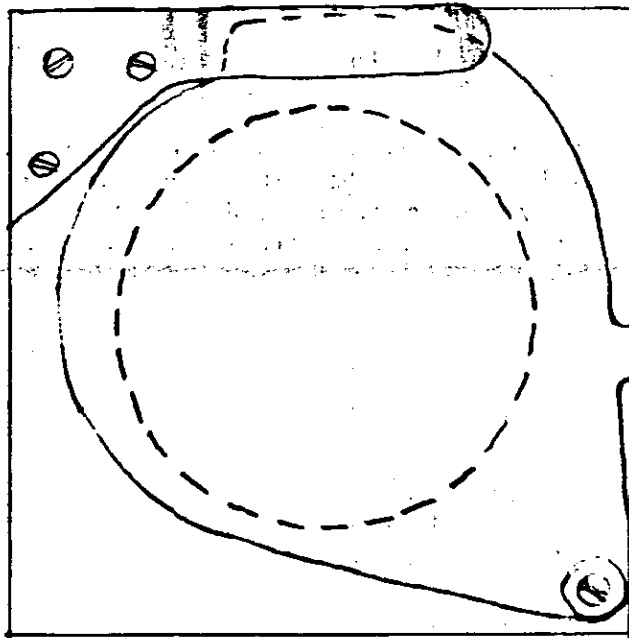
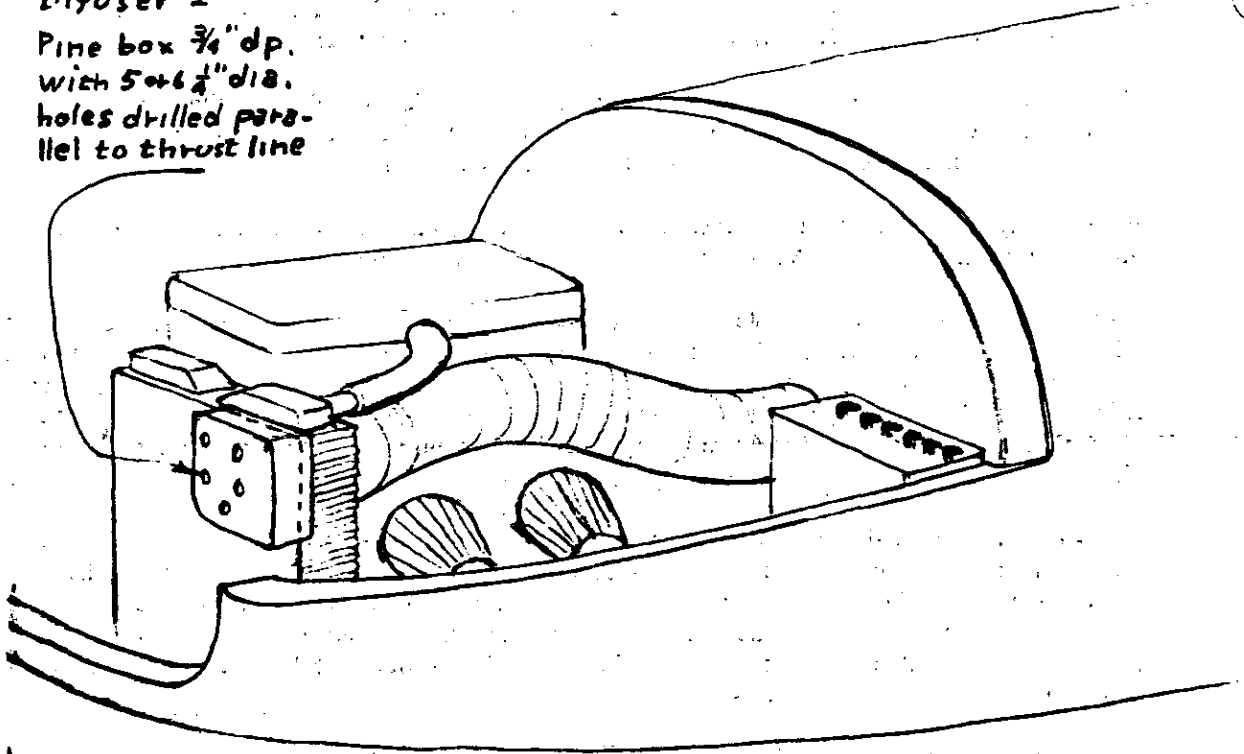
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Mike McCann, Editor

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As promised in the last issue of *Pulsar News*: Harry Jone's cabin heater assembly:

Difuser =
Pine box $\frac{3}{4}$ " dp.
with 5 or 6 $\frac{1}{4}$ " dia.
holes drilled para-
llel to thrust line



- Upper left corner of L.H. radiator is hottest.
- $2\frac{1}{2}$ " Aeroduct "Cat" from Aircraft Service may need to be wrapped with Insulation
- Quick-disconnect attach'm't of duct to radiator must be quite air-tight.

- Bowden wire & pivoted door inside fire wall.
- Actual Size
- Water temp must remain $\geq 155^{\circ}\text{F}$. Suggest cockpit-controlled ball-valve to close R.H. Radiator

Harry Jones 10-10-90

Pulsar News

News, Updates, and Developments for Pulsar Builders and Owners

Issue No. 12

Published by the Pulsar Builders' Association

September, 1991

Oshkosh '91:

Thanks to Les Price for responding to my request for photos from this year's Oshkosh gathering. I understand that Oshkosh '91 saw 4 builder Pulsars. Please see Mark Brown's write-up for a recap of Oshkosh and the "Pulsar Review".

Photo 1 (top right): Jim Devorak's Pulsar from Glencoe, MN.



Photo 2 (lower right): Les sent in this picture showing Mark Brown busily explaining the finer points of aircraft design!

I thought I'd include it since most of you have only talked to Mark over the telephone or through the mail and have never met him.

By the way, he's the one with the goofy hat and sunglasses on the left!



Photo 3: Bill Bates' Pulsar
from Sandusky, Ohio.



Miscellaneous:

Dave Bennett (England) has written asking if anyone can share any information regarding Pulsar operations from grass strips. Dave questions whether grass strip operations should be left to tail wheel Pulsars only or whether tricycle gear Pulsars can operate with comfortable safety margins. Anyone with any thoughts can either contact Dave directly (7 Baronsfield Rd., St. Margrets, Twickenham, TW1 2QT, England) or can send the information to me for forwarding to Dave and inclusion in *Pulsar News*.

FOR SALE: Pulsar XP Kit (Fuselage and Wing kits with wing tanks). Fuselage is 50% complete. Wing kit untouched. vertical stabilizer is constructed with antenna installed. No engine--will take either 582 or 912 Rotax. Best offer. Ron Bradley (708) 985-6095.

(Ed. Note--Ron contacted me with the above announcement noting he has developed a severe allergy to the epoxy adhesives and will be unable to continue construction on his Pulsar.)

Marc Kenyon (of Micro Flight Products) has asked me to inform all Pulsar builders that he will be offering all Pulsar builders a 10% discount on all Micro Flight products. Marc told me that he would be sending a catalog to all builders so it should be arriving soon at your door. Our thanks to Marc for passing this savings along to all of us.

Harry Jones has passed along some information on UV barrier paint and its affect on antenna performance. Harry has learned from a source that the UV barrier paint may slightly degrade antenna performance. Harry suggested that builders avoid areas where the antennas are located when applying the UV barrier. I agree with Harry that this should work for all antennas except the com antenna located in the vertical stabilizer. Since most builders are installing their nav, g/s, etc. antennas in the wing next to the lower skin, the UV barrier is not crucial on the underside of the wing (unless someone tries a lot of inverted flight on sunny days!) The vertical stabilizer will, however, get substantial sun exposure so I feel the UV barrier is very important. I will attempt to perform some field strength tests on the com antenna to assess the amount of antenna performance change. I must state that builders already flying with antennas installed in the vert. stab. (and UV barrier) report excellent antenna performance, so this should not be a real problem for anyone.

BUILDER INPUT:

Gary Polizzotto (Atlanta, GA): "I've taken some of my experience in building my Glasair II and have made some changes in the Pulsar to more suit my needs. The plane is now being prepared for painting, the interior and panel are completed and the engine has been test run completely. The major changes are as follows: wings shortened and strengthened with winglets at the tips (I'm hoping for better roll rate and top end), a long dorsal fin, stabilizers bonded to the fuselage, and lexan rear windows. The interior is finished out and includes a machine turned aluminum panel, artificial horizon and arm rests which really make a huge difference in perceived interior room. The engine compartment has a stainless steel firewall with a layer of fiberfrax behind it. Fuel lines are also stainless. The carbs have been replaced with a single Ellison Throttle Body unit which is really simple, slick and effective as it also has a mixture control. I have also taken the liberty of closing the cowling intakes about 30% and opening the exhaust area. Also, I've found that a builder can get a transponder waiver for the Pulsar (which can save a builder a lot!)

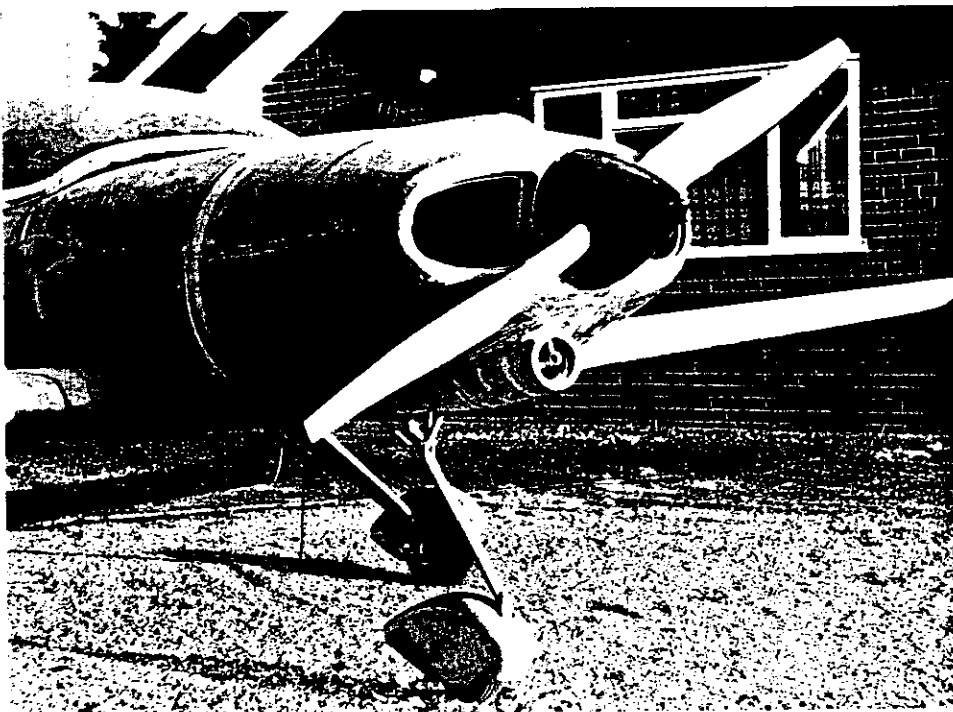
Some tips on finishing: don't use reducer when in the squeegee stage. The primer is thicker unthinned, fills better and doesn't run all over the place. In the later stages, a small spray gun shooting small areas (2 sq. ft.) followed by the squeegee works well. In the early stages of belly prep, a wide chip brush (3") followed by a squeegee does the job".

(Ed. Note: Gary has sent some photos of his Pulsar under construction which will be included in the next issue).

Bill Thomas (Livermore, CA): "This idea has to do with the construction of glass bearings used in the Pulsar. Take a piece of tubing that you want to fit a bushing to. Then cover part of it with waxed paper using one layer for each 1/1000" clearance on the radius. On the main tube of the cockpit control, I used 2 layers of waxed paper and the clearance is just fine. As you wrap the waxed paper (and then the fiberglass cloth) make sure you go in the same direction so as to always be tightening the wrap. And use enough waxed paper so you can secure the paper to the tube with tape. Don't use any external heat on the assembly as you could possibly melt the waxed paper (creating both a mess and possibly bonding the entire bearing to the tube."

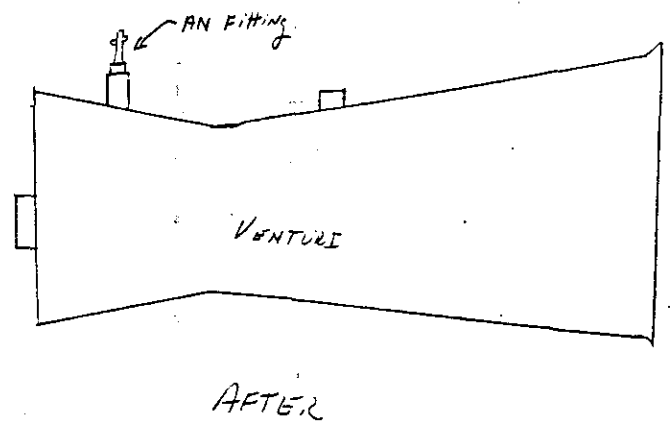
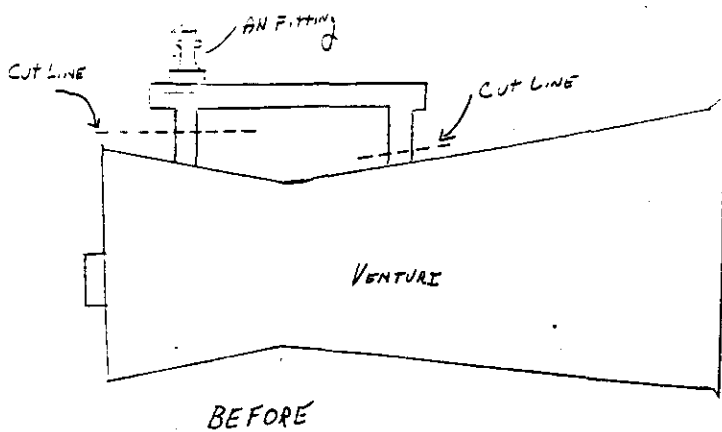
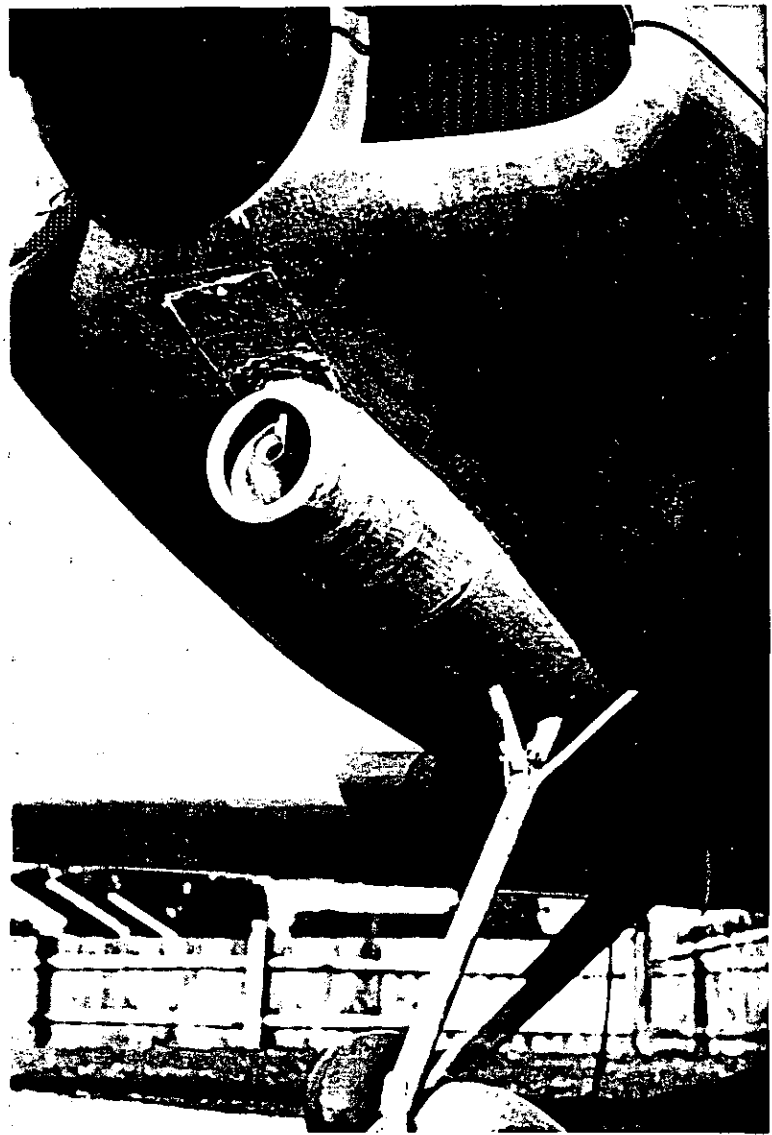
Martin Faro (England):

The venturi in my Starlite is located inside the cowl and air passes through the front inlet and then through the venturi. I can't locate the venturi in my Pulsar because the radiator gets in the way. Therefore, it is necessary to locate the venturi elsewhere. Obviously, it could be bolted to the side of the fuselage but that wouldn't look very pretty. Therefore, I decided to make an inlet which sits on the underside of the cowl and the venturi sits inside this. The photos of my modification (right) show the rough molding which is in the finishing stage. Small slots were cut in the underside of the cowl



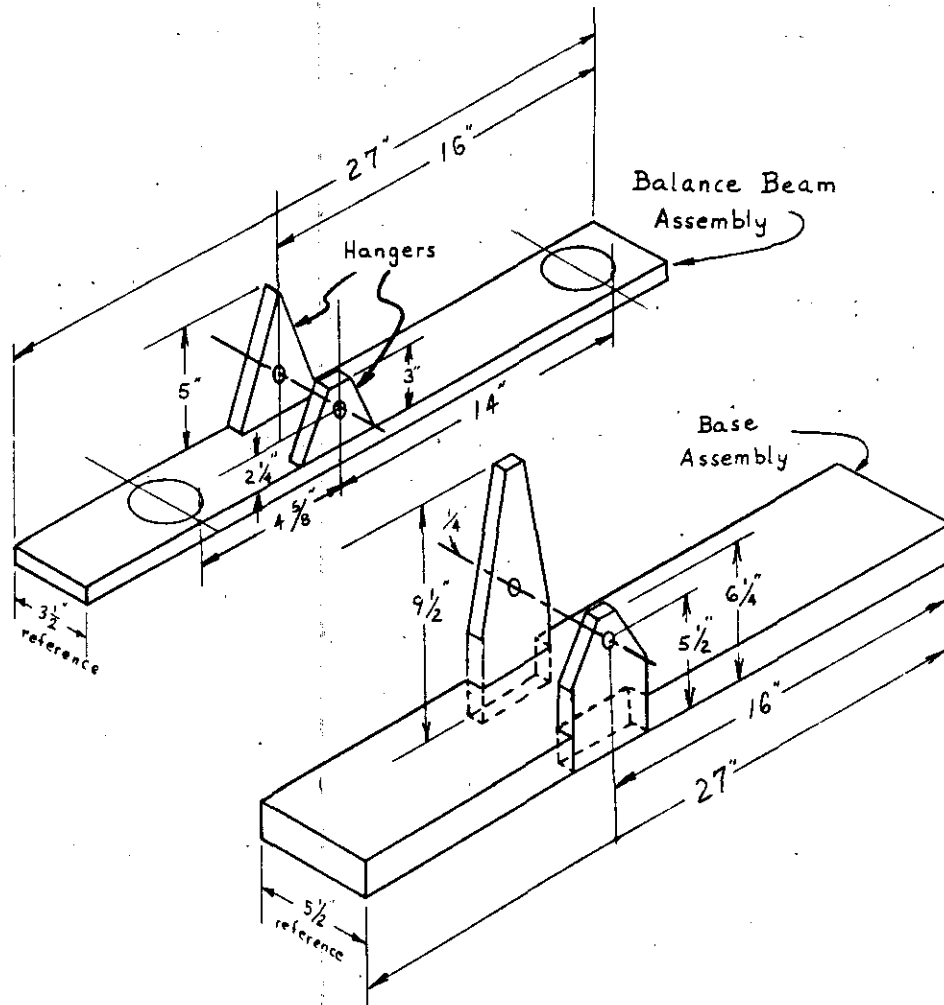
so that the necessary plumbing can be joined up to the instruments. If other builders consider using a similar method, it is very important that holes in the cowling are kept to a minimum. Apparently, the composite between the engine mount acts as a shear web and is absolutely necessary. Therefore, I have laminated uni-directional glass between the wooden gussets so as to reinstate any strength that was degraded by the cutting of the venturi holes. I have removed the venturi mounting bracket and tapped a new thread in the remaining part of the bracket (see drawings). This enables the venturi to sit closer to the cowling and also enables it to sit under the gear box.

The venturi will be sealed with silicone caulking which will (1) hold it firmly in place and (2) stop air flowing around the venturi but inside the inlet.



Epolite Balance Beam:

I have received notes from several Pulsar builders who built their original balance beam for the Safe-T-Poxy system supplied with all of the early Pulsars. Since that time, the factory has switched to the new Epolite 2315 system (which requires a different mixing ratio). To answer those requests, I have included below a reproduction of the new balance beam for a 100:33 Epolite mixing ratio:



From The Factory:

The excitement of Oshkosh is over, so I'll review the Pulsar highlights. First, I'd like to congratulate Jim Devorak of Glencoe, MN for winning the Outstanding Workmanship Award for his brand new Pulsar. That's quite an honor to bring home from the top aviation event in the world, but I have to say that Jim's Pulsar is as much a work of art as it is an airplane. Great work Jim!

Actually, I don't want to overshadow the other three Pulsars at the show. Bob Townsend from Ada, MI., Bill Baltes from Sandusky, OH., and Rick Meyer from our factory all brought beautiful airplanes. Oshkosh is a very gratifying place to bring a new airplane because the wows from so many thousands of airplane lovers is quite an encouragement after the long hours in the garage.

We really enjoyed visting with many of you at Oshkosh and appreciate your help in answering the thousands of questions from so many interested people. I would especially like to thank Mark

Burrow for his excellent program and leadership of the Pulsar Builders meeting and also at the Pulsar forum.

I learned from the Rotax people at Oshkosh about a new development for the 582. A liquid damper that attaches to the starter ring gear was designed to reduce the vibration level at idle. I've recently completed flight tests and idle tests and confirmed that the damper does help somewhat. Without the damper the minimum acceptable idle rpm was 2500. With the damper the minimum is 2200. The damper adds 2 lbs. to the Pulsar and its costs \$129. It can be retrofitted to any 582 and will become standard equipment in 1992. Personally, I think it is worth the 2 lbs. and the \$129.

Another Rotax 582 option that I've recently tested is the High Altitude Compensating Carburetor Kit. This option works so well that I almost got myself in trouble. The Pulsar was still climbing 600 ft/min at 16,000 ft and the EGT was indicating the same mixture as sea level. Unfortunately, my body wasn't doing as well as the engine. I was slowly losing consciousness when the air traffic controller called and I realized that my response was very slow and garbled. I started down immediately, but still had a difficult time landing and afterward developed a pounding headache.

My conclusion is that the Pulsar with H.A.C. carbs will definitely climb higher than the pilot can breath and the mixture will remain constant all the way up. These carbs are now available from Rotax either through us or any Rotax distributor for \$495. However, the standard carbs are good to about 12,000 ft, which is high enough for most of us low landers.

Another builder has accidentally installed aluminum pop rivets in his flap bellcrank and this time they sheared on the ground. Please make sure and throw away the aluminum rivets that come with the pop rivet puller so you won't mix them up with the stainless steel rivets that come with your kit. To shear these rivets in flight could be catastrophic.

Several Pulsar pilots have reported excessive tire wear. This problem seems to always be related to a toe-in condition caused by the way the axles bolt to the main gear. The solution is to shim the forward side of the axle backplates so the axles are parallel. One standard washer between the backplate and the gear on both the forward bolts seems to be enough.

The procedure described in the last newsletter for matching the ailerons and flaps to the wing tip and fuselage fillet seems to be impractical. Holding the flaps and ailerons in a precise position before they are riveted together is just too tedious. Therefore, we measured the necessary twist in the flap and aileron so they could be riveted together off the wing and still match the wing tip and fuselage fillet. Therefore, with the aileron and flap lying on a flat table, top side up, block the trailing edge up at the outboard end 1/4" for the aileron and 3/8" for the flap. This will provide enough twist in each of these parts to match the twist in the wing and provide a good match.

Also, in the last newsletter, I printed the wrong number for our fax machine. The correct number is: (512) 650-3231.

Mark Brown

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Mike McCann, Editor

Pulsar News is published 6 times a year. Subscriptions are available for \$10.00 per year (U.S.) and \$15.00 (foreign). All correspondence and subscriptions should be sent to the above address.

Pulsar News

News, Updates, and Developments for Pulsar Builders and Owners

Issue No. 13

Published by the Pulsar Builders' Association

November, 1991

MISCELLANEOUS: To all builders, please take special note in the "From The Factory" article to see that Aero Designs will be moving effective November 1, 1991. New addresses and phone numbers are included.

Lots of builder input this issue so we'll get right to it. Thanks to everyone who submitted. I get numerous letters from other builders each month stating how appreciative they are that builders supply their modification/building method information for everyone to use. Keep it up!!!

BUILDER INPUT:

Alan Gill (England): "At this time my Pulsar is being filled and cleaned up prior to the paint shop. I am expecting to have it complete and "flight permit" approved by Fall '91. There are several extras I have done. I have made a full dual control which entailed installing an extra throttle and heel brake pedals. I have also installed a parking brake. We have to have an external canopy release and this is being installed now by using a simple latch at the upper rear and center of the canopy/fuselage. This permits the canopy to be opened from either inside or outside. At the same time, I have installed a canopy lock. The baggage door has been relocated aft into the fuselage to permit a tray to be installed. It also gives the impression of a larger cockpit. Extra instruments are include: voltmeter, 2nd EGT gauge, carb temp. thermometer, VSI, hour meter, a hole for an artificial horizon (future), lamp cluster containing warnings for fuel cock off, hand brake on, fuselage strobe off, and starter key off. Wiring is to GA standards where I have a Battery and Rectifier Master Switch, +ve and -ve bus bar with a bank of 8 fuses. Avionics to include an Icom A20 with audio panel and transponder. In the engine compartment, the firewall is .021 stainless steel (the P.F.A. requires a stainless steel firewall of at least .015) and a statuary gascolator. The upholstery material has now been purchased and it will be done out in charcoal grey/black/red.

I've built a trailer to transport my Pulsar to airshows. The trailer is of my own design and followed a simple "A" frame design. The Pulsar rode very well on it for the first time out. However, a few small modifications need to be done." (Ed. Note: Alan may be able to supply some information on his trailer to those of you requesting trailer design details).

Ken & Shirley McWhinney (N. Ireland): "I have a few mods to describe for a future newsletter and think they will be worthwhile. Mark Brown thought my ideas were neat and would be beneficial to other builders. I have built a dual throttle which is very lightweight and hides under the instrument bulkhead neatly and is totally unobtrusive. I am also a heavy broad person and I found the flap lever inconvenient in its original position so I have come up with an idea which I think will be beneficial to larger pilots like myself. I intend to reduce the width of the center console and to offset it 0.5" to the right. I also intend to enclose the flap lever inside the console and operate it by cable.

Shown below is a description of the dual throttle installation and photograph:

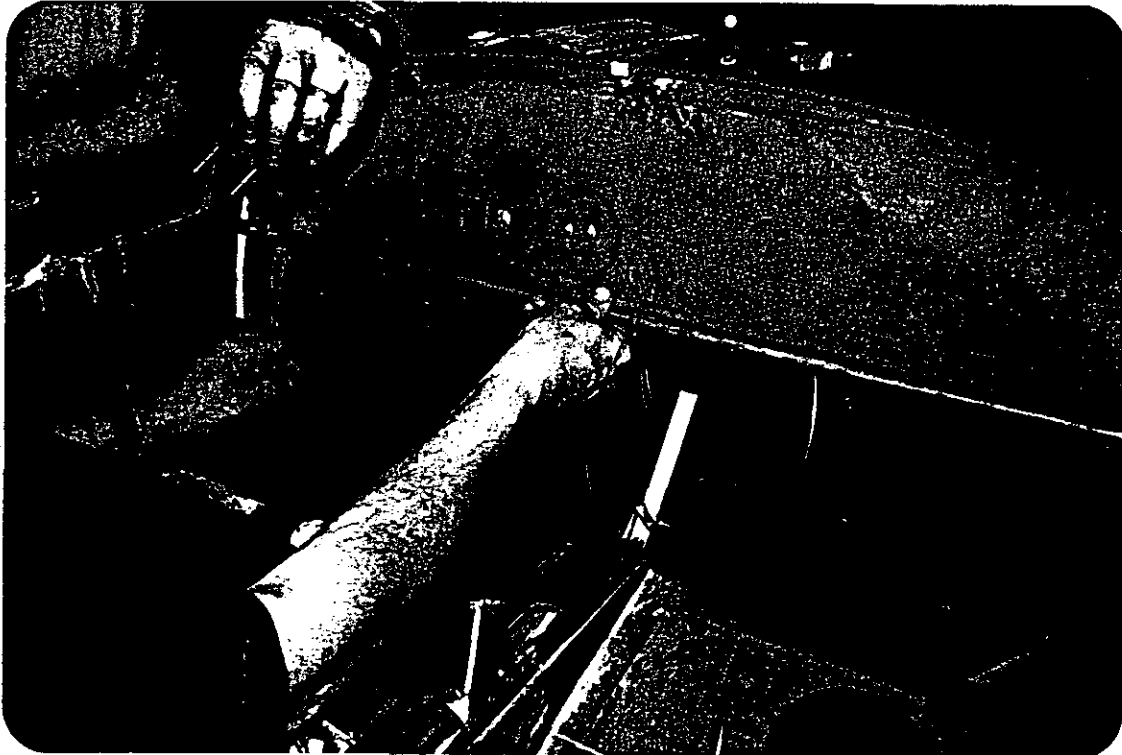
"I obtained a 40" length of lightweight 5/8" aircraft alloy tube which I cut to fit neatly between the fuselage sides behind the instrument bulkhead and the lower edge of which would be 1/2" lower than the lower edge of the bulkhead itself when fitted. I then obtained some 1/2" thick

nylon and made two bearings similar to the bearing which is used to support the center of the rudder pedals (only one hole). I fitted 2 alloy hardpoints on the instrument bulkhead to support these bearings.

I fitted the two bearings to these hard points and obviously to the tube. I fitted the bolts in each bearing so that the top bolts are pushed through from the cockpit side and secured with locking nuts, the lower bolt is pushed through from the other side and fitted with a wing nut so that either side can be used as a throttle lock nut. I then drilled and reamed a 5/8" hole in the original throttle lever at the fulcrum point 2.5" centers between it and the hole for the throttle cables. I then cut off the long leg of the throttle lever and shaped it neatly and fitted it to the 5/8" tube. I next made two L shaped legs from 1/8" thick alloy plate, the bottom of the L following the radius. I made the long leg of the L 1" wide and the radius leg 3/4" wide. The long leg of the L is 6" and the shorter radius leg is 5". I drilled and reamed a 5/8" hole in the outer end of the long side of the L to fit the alloy tube this hole centered at 5/8" in from the end. I now cut two rings from the 1/8" plate, the inner diameter of the ring 3/4" and the outer diameter 1.125". These rings are then welded to the outer end of the short radius leg for finger holes. These two legs and the piece of the original throttle lever are now fitted to the alloy tube so that the legs hang down and backwards and the small piece of the throttle lever sits upwards and outwards sufficiently to allow full travel of the throttle cables when the lower legs of the L are pushed forward. The small piece of throttle lever is fitted to the tube so that the throttle cables have the straightest possible run and the cables have to bend very little. I bonded two small pieces of outer cable to the bottom of the fuel tank to prevent them from cutting into the fuel tank.

Two slots have to be cut in the sides of the instrument bulkhead for the lower legs of the L to protrude through and these can be fitted fairly close to the edge and will probably need reinforcing. The whole arrangement can now be welded together and final fitted to the throttle cables so that the finger rings sit just clear of the bulkhead when pushed in for full throttle. A fine hole has to be drilled in the long leg of the L at 2.5" center from the 5/8" hole to fit the compensating spring and then this spring stretched and anchored in a suitable position on the fuselage. A small piece of wire looped and bonded to the fuselage is sufficient. In my case this whole arrangement only weighed an extra 9 oz."

SEE PAGE 6 FOR DIAGRAM OF MODIFICATION



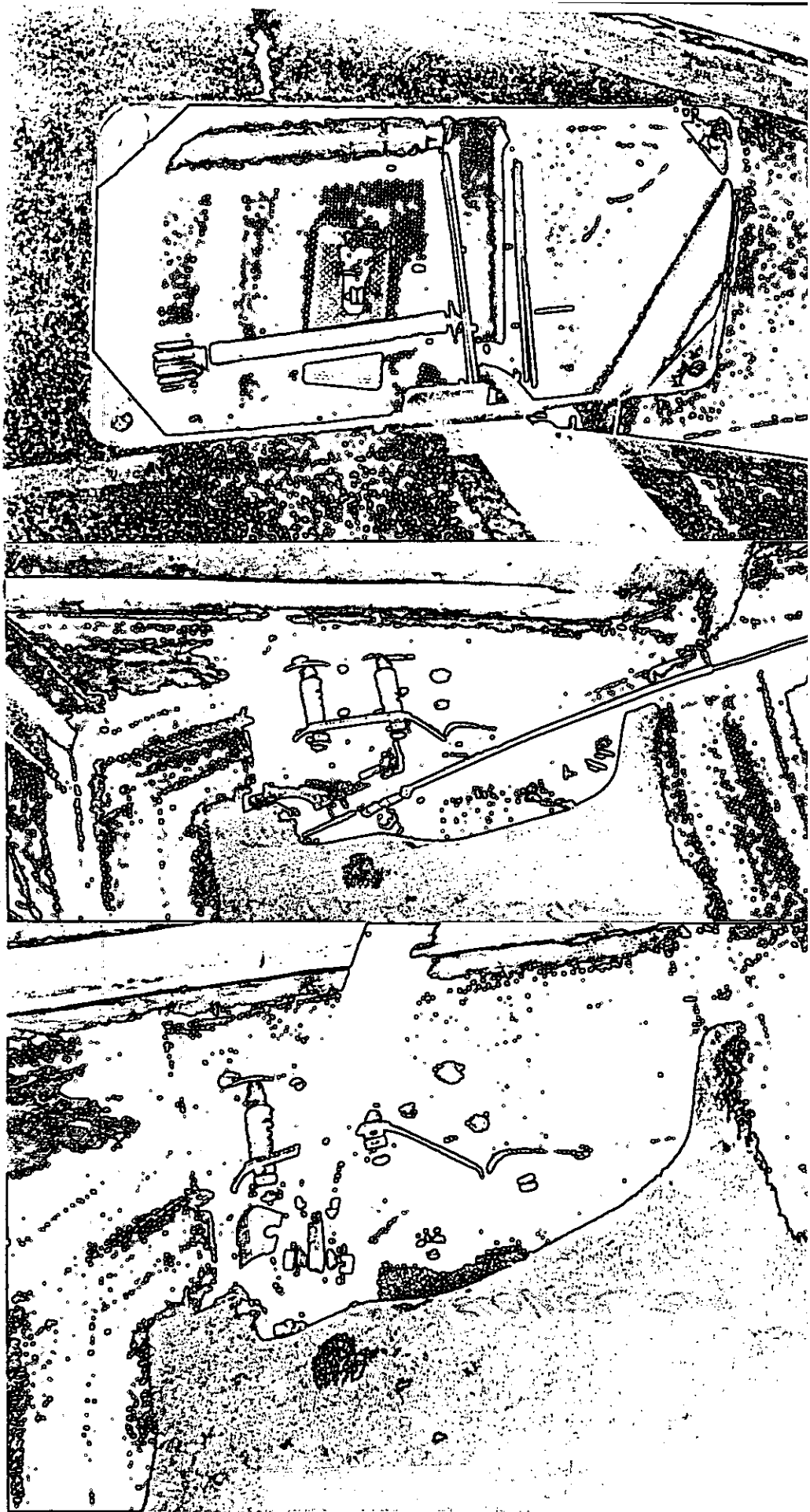
Gary Polizzotto (Atlanta, GA):

(Ed. Note: Gary has made numerous modifications to his Pulsar. I am including several of his photos which show some of the modifications. It is my understanding that Mark Brown has approved some of these modifications based only on Gary's previous composite building experience. These modifications are not universally endorsed for all Pulsar builders.)

Modification 1: Gary has added a bob weight to the elevator attach assembly to provide 100% mass balancing. Photo 1 is looking through the opened access plate on the rear fuselage. Gary notes that any slop in the control systems can prove to be trouble (i.e. flutter). This point continues to be stated by builders and designers due to the grave consequences of sloppy linkages. Gary has also built a front and back plate which he has riveted to the elevator attach brackets to create a single unit.

Photos 2 & 3: These two pictures show Gary's modification of the Pulsar flap actuation assembly. Gary has replaced the standard flap handle and installed a Glasair-type spring-loaded flap ratchet actuator. Photo 2 shows the flap torque tube coming into the side of the fuselage and the 4 cut grooves for various flap settings.

Photo 3 shows the same assembly from a greater distance to show more of the



handle and its location vis-a-vis the pilot seat.

Photo 4 shows Gary's full width canopy retainer/weatherseal lip laminated to the fuselage instead of the 2 curved aluminum hooks provided with the Pulsar.

Other modifications not shown here include a custom top cowl mount that will use only 2 front camlocs. The rear of the cowl will engage under a fiberglass lip along 80% of its length. Gary has also installed an electric trim system and is building rear windows similar to the Lancair 320 concept.



Gary has also sent in a couple of building suggestions. "The seat belt attachment bolts on the armrest could be replaced with one long bolt that goes all the way through the console. This will provide a counter pull against the opposite seat belt in the event of a sudden deceleration. If this modification is made, remember to keep the right seat belt buckled tight all the time. When making "glass bearings", one layer of polypropylene tape works great as a release agent instead of waxing. Also, the armrest bearings are much easier to make before the console is glassed into the plane. Simply run the long seat belt bolt (previously mentioned) through the 2 side pieces (make sure there is an aluminum tube spacer between them) and tighten up. Then take the front armrest bulkhead, position and clamp in place. Lay the whole thing in the plane, put the control tube through then glass the bearings in place. When cured, disassemble and finish off the bearings. You can glass in the front bearing bulkhead to the side pieces prior to installing the armrest. You will then have a rigid unit to simply lay into place in the plane. Another idea is to glass in the lower cowl and motor mount strips before installing the 2 lower firewall bulkheads. This greatly simplifies a critical lay-up".

FROM THE FACTORY:

The best news this time is mixed with a little disappointment. Derek Ferris and Stan Bucholtz completed their Pulsar just after the last newsletter and its really a beautiful airplane. Congratulations are greatly deserved. Unfortunately, after about 12 hours of flight time, the nose gear castor pivot bolt broke off during taxi operations and caused some serious damage to the engine mount and cowling not to mention making splinters out of the prop. A metallurgic evaluation of the bolt revealed a low cycle fatigue failure which is caused by several loads exceeding the yield limit of the bolt. I'm currently gathering more information about the c.g. of Stan and Derek's Pulsar and the taxiway conditions to determine why the bolt was overloaded because the bolt's allowance load does meet FAR Part 23 requirements.

As frustrating as this bolt failure is it doesn't affect more than a couple of Pulsars because very early in the production schedule we changed to a larger bolt and started heat treating all nose gear struts. We did this only because Lavern Lawrence and Jim Brewer experienced a bent bolt while operating on a very rough taxiway. The way to determine if you have the stronger gear strut is to measure the diameter of the bolt that is welded to the bottom of the strut. The original bolt was 1/2". The stronger strut has a 5/8" bolt. If you have the 1/2" size, then send the strut back for exchange.

In an unrelated incident, Bob Townsend lost one of the bolts that attach the nose gear strut to the aluminum lugs on the firewall. Of course this caused the nose gear strut to twist which damaged Bob's engine mount and used up another prop. Bob believes that he may have forgotten to use "lock-tight" on that bolt as the manual directs. Therefore, everyone should make sure that he either uses lock-tight or safety wire to secure these bolts.

To finish up the bad news, Hertriono Kartowisastro lost a spinner screw next to the propeller which caused a piece of spinner to crack off in flight. The vibration was so bad that Hertriono decided to make a precautionary landing along side a highway. He made a good landing but ran into a small ditch on the rollout. He and his son were unhurt but the Pulsar suffered extensive gear damage. Hertriono said that a couple of other spinner screws were also loose and discovered that the self-locking nuts on the screws were not holding tightly. Therefore, everyone should check these locknuts and make sure that they are holding tight. In general, locknuts are not supposed to be used more than once. Therefore, if you remove your spinner you should use new locknuts to re-install.

We'll, I'm sorry for all the bad news but I just thank the Lord that no one was hurt in any of these incidents and I hope we can all learn something valuable that might help us to be more careful. I know that I'm probably worse than any of you about doing a good pre-flight inspection so I should realize how some really small failures can lead to major damage or injury and a thorough pre-flight might save a lot of trouble.

I have encouraging news for those Pulsar builders who will be operating on grass runways with the tricycle landing gear. We have designed a new larger nose gear caster fork that will accept a 5" wheel and tire. Also we set up spacers for the main gear axles to accept 6" wheels and tires that use the same simple brake systems that comes in the kit. We recently installed these larger wheels and tires on our prototype and the results are encouraging. On a smooth solid sod runway the g-meter only recorded 1.5 g's on a takeoff and landing which is quite acceptable. On a grass runway with clumps of grass and some dirt the g-meter recorded 3 g's which is unacceptable. Therefore, operation off grass is ok for the tricycle gear if the grass is solid and smooth.

If you decide you would like the larger tires, we will exchange your standard unused set for \$50 plus shipping. You should send back the entire nose wheel assembly and the main wheels, tires and brake drums including wheel bearings. If you haven't received your kit yet, you can request the large tire option for \$50.

The large tire option adds no extra weight to the Pulsar because we chose a plastic nose wheel and light weight main wheels and tires. However, the extra drag from the larger tires does reduce the cruise speed about 5 mph. So far we haven't found any wheel pants that will fit the larger tires, but if we do we will exchange wheel pants for whatever the difference it costs us.

A couple of perceptive builders have called in some good ideas this time. A Gates #21169 automotive radiator hose has just the right curves to cut and fit for the Rotax 582 installation. By using a 90 and 45 hose you can eliminate 2 fittings and 4 clamps.

Some of the aft spars were apparently marked incorrectly at our factory. Some of the left spars are marked 'right' and visa versa. The way to check your spars is to make sure the bevel on the spar matches the ribs.

For builders of the taildragger Pulsar, the location of the main spar wing attach pins is too low and interferes with the landing gear lugs. Therefore, drill the 5/8" wing pin holes 1" higher than is called for in the standard wing manual.

The last bit of news is that we are moving our factory to a new location. We will have more room and a much better layout so we are very excited. However, moving all of our equipment and

inventory is a chore that we're not so excited about. We plan to have our phone and fax and shipping transferred to the new location on November 1st.

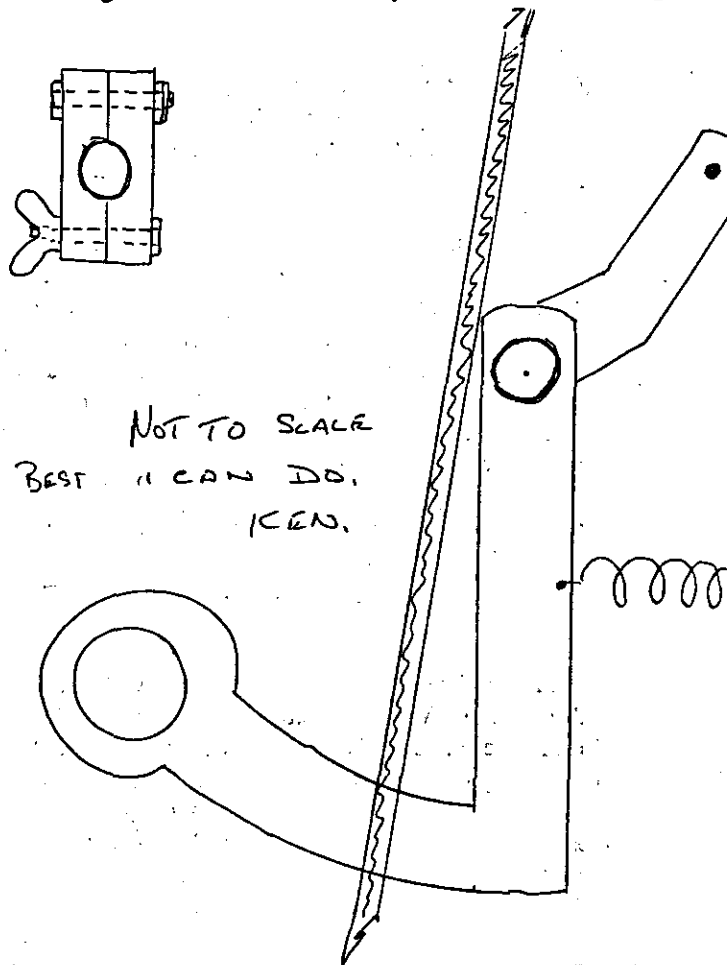
Our new address is:

Aero Designs, Inc.
11910 Radium
San Antonio, Texas 78216

(512) 308-9332 Phone
(512) 308-9329 Fax

Mark Brown

Drawing from Ken McWhinney's dual throttle design:



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Mike McCann, Editor

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