SPORT AVIATION

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The PAZMANY PL-4A AFTER 180 HOURS

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A Progress Report

THE PROTOTYPE PL-4A (N44PL) now has accumulated 180 hours of flying. This has been logged by 31 different pilots.

The airplane has proved to be easy to handle even for pilots with only few hours of tail dragger time. My standard question for a new pilot flying the PL-4A for the first time is: "Can you make a decent landing in a Luscombe?" If the answer is yes, you are qualified for the PL-4A!

So far, the worst landing was made by one pilot who tried to compensate a bounce by pumping alternately the stick and the throttle, getting out of phase until the last "bounce" was a two point landing — right wheel and right wingtip. Although everyone on the field thought that the end of the airplane was imminent, nothing else happened. I am very satisfied with the landing gear which absorbed this punishment without any damage.

On the way to Oshkosh several problems with the engine installation showed up. In my opinion most of these problems can be attributed to the worn-out driver (small) sheave in the "V" belt reduction. The belts were slipping and the engine was running rough due to the lack of "fly-wheel" effect of the propeller. This caused the failure of the starter gear. The starter would rotate the engine until the first ignition, but, due to spark advance, the piston would not reach top dead center, thus stopping the rotation of the crankshaft and sometimes even rotating the engine backwards. Of course, this was too much punishment for the Bendix drive in the starter and it failed. It is just as trying to attempt to start an engine without a flywheel.

The other serious problem was the failure of the micarta drive gear of the alternator. All teeth on this gear were broken. Noel Becar explains this failure in a separate report. After Oshkosh, Noel Becar came down from Northern California and completely disassembled the engine for a minute inspection of every component, including magnafluxing the crankshaft and the connecting rods. The only problem he found was the ovalization of two pin holes in the rear starter ring gear, which again indicated that the lack of fly-wheel effect due to slipping belts was producing an extremely rough running condition. This was repaired and instead of two pins, we now have four. The engine was reassembled and a new hard anodized aluminum driver sheave was installed. The hard anodizing produces a dark finish. As soon as this hard surface finish wears out, the shiny aluminum will show up, and then it will be time to do something, although this hard anodizing should last many more hours than the first sheave without any surface treatment.

The "V" belts are working very well. The first set was replaced after 70 hours of running. One belt (out of five) was loose and since these matched belts, it was decided to replace all five at an approximate cost of $10.00. The second set now has 110 hours of usage and does not show any sign of wear or slack.

The airplane itself is working beautifully. Nothing has failed, cracked or shown excessive wear. I had to replace the tires at 110 hours . . . they were getting smooth. The only additional work was the installation of two radios (communication and OMNI) before the flight to Oshkosh. Also, an extension to the fuel shut-off valve underneath the fuel tank was installed to make the valve easier to reach.

The airplane is never left at the airport. Instead, it is trailered from my home. The unfolding of the wings and preparation for flight takes about 15 minutes, and this is also the time required to put the airplane back on the trailer, fold the wings, secure the tail surfaces, and be ready to go home.

My good friend Walt Mooney also did flutter tests up to 150 mph . . . with no signs of flutter. The reason for the 150 mph limit is that this is as far as the presently installed airspeed indicator goes. So, until I have another indicator with a higher range and more testing is done, the airplane is limited to V NE - 150 mph. See accompanying Flight Test Report by W. Mooney.

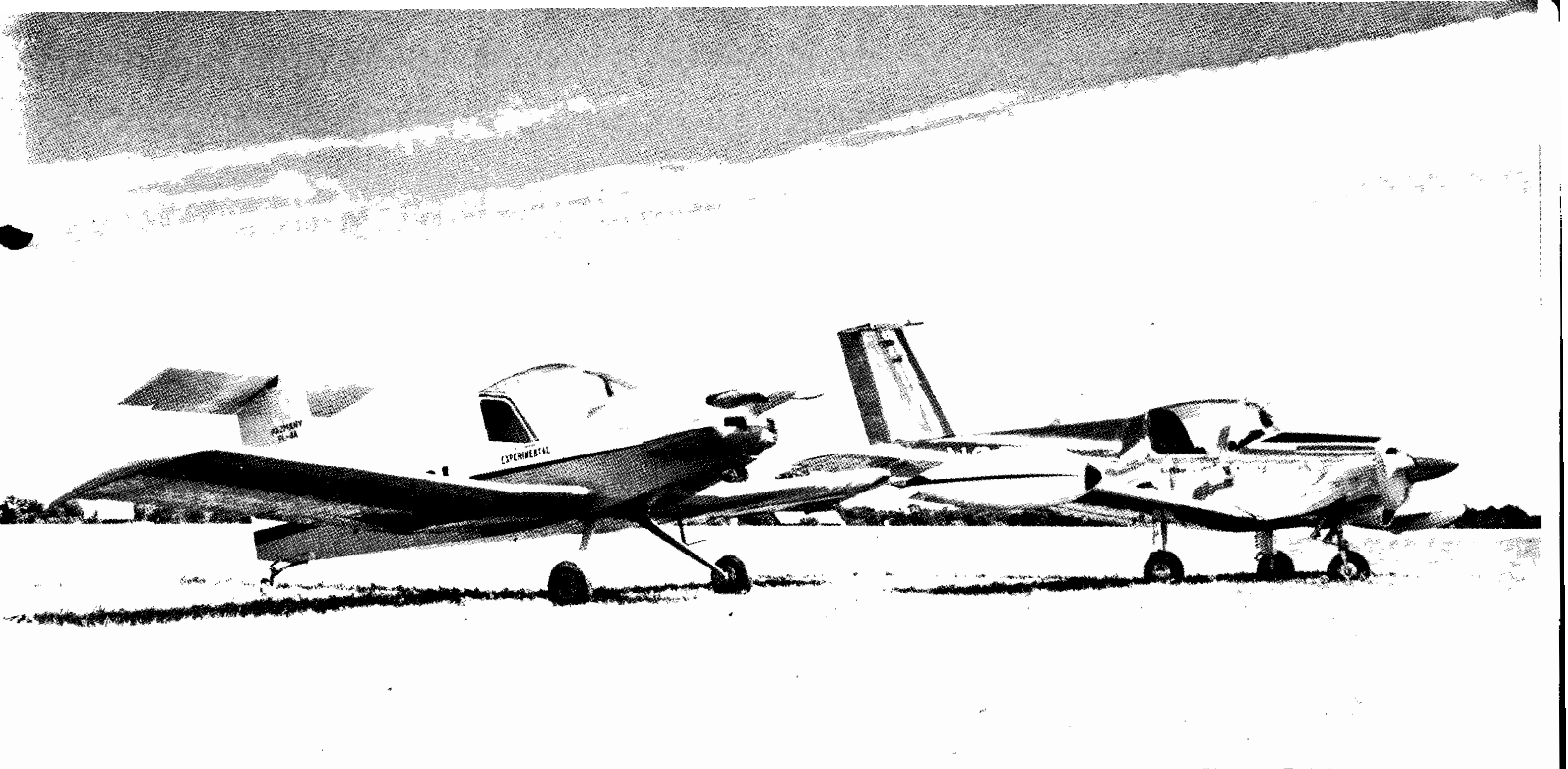
I have had to answer many times the question about "deep stalls." Well, there is no deep stall with the PL-4. The airplane has been stalled many times in every possible manner and the recovery is always immediate and smooth. The airplane has no vices.

Last November, I was visited by Lt. Col. Roy Windover, Director of the Canadian Air Cadets Program (equivalent to USA Civil Air Patrol). This program involves 22,900 young men located throughout Canada and is organized into 385 squadrons. The program is flying oriented and includes gliders and airplanes.

Because of the widespread locations of the squadrons, it is not practical to bring the cadets to some central spot to fly, so there is a great need to provide aircraft at the squadron locations. The goal is that the air cadets obtain their commercial licenses while in the program. Funding of flight training through the private pilot level is by the Department of National Defense. All flying activities are available to the cadets at no cost.

Last year the program trained 250 private power pilots and 180 glider pilots. Next year's goal is 250 power pilots and 300 glider pilots. Glider training is done in Schweizer 2-33 sailplanes; the cadet program is the largest customer for Schweizer 2-33 sailplanes.

In an effort to provide appropriate aircraft for the program, they needed to find a low cost, cheap-to-operate airplane that is all-metal and has aerobatic capabilities. Lt. Col. Windover made two 45 minute flights in my prototype PL-4A. He started cautiously by feeling out control response, stability, stalls, landings, wingovers, chandelles, glides, etc. At the end of his flight evaluation, I was happily surprised to see the PL-4 doing five con-



(Photo by Ted Koston)
The PL-4A and it's predecessor, the PL-1.

secutive barrel rolls, three loops and two clover leaves, with almost no loss of altitude. This demonstration and the comments of Col. Windover prompt me to modify previous comments about the marginal power for aerobatics with the present 1600cc VW engine. Although it is not the best engine for this purpose, it was proven to me to be completely adequate when the aircraft is in the hands of a competent aerobatic pilot. The larger 1800cc and 2200cc VW using the same "V" belt reduction or direct drive will make the PL-4 really perform!

Everyone should be aware that Col. Windover was the original Royal Canadian Air Force solo jet aerobatic pilot — known as the "Red Knight" — also, he is a private pilot and sailplane pilot, and has flown many amateur built airplanes. He was very impressed with the PL-4 design and considers it perfectly safe for low time pilots — no vices, roomy cockpit which will permit the handling of maps, complete instrument panel, strong — in other words, exactly what he was looking for. Therefore, the program is moving ahead using the PL-4A design.

The construction of the PL-4A's will involve civil prisoners. They already have an A & P mechanical vocational training program in their prison system, but the program could be enhanced by the involvement with the construction of complete aircraft.

The initial plan is for the inmates to build 2 complete PL-4A's, one powered with a larger direct drive VW engine and the other with a Continental A-65 type engine. Flight evaluation of the two versions will be made and one engine configuration will be selected. (Although it should be kept in mind that the A-65 is not in production).

Then the prison labor will fabricate PL-4A kits that will be given to the squadrons for assembly as homebuilts. The planes will be licensed and operated as ultralights (experimental) and the cadets must comply with the requirement of doing at least 51% of the work.

The initial plans call for the construction of 50 PL-4A's and then a decision will be made whether to continue. If they decide to continue, up to 200 PL-4A's will be built. Pazmany Aircraft Corporation will receive a royalty for each airplane built.

The cadets will fly the PL-4A's from their 36th to 150th flying hours to prepare them for the commercial pilot license.

I guess this is the first time in the history of aviation that an airplane will be used for the multiple purpose of rehabilitating prisoners, preparing young men in the skills of aircraft construction, and giving them the opportunity to improve their flying skills in the most economical way. The PL-4A's will be used mostly for cross-country, instrument flying and aerobatics training. I just hope that other countries and other flying organizations will follow this wonderful example — now more than ever before due to the world-wide fuel crisis.

Another PL-4A is under construction by the students of the Aero Department of Chung Cheng Institute of Technology in Taiwan. This airplane will be exactly as the prototype, using the 1600cc VW with the "V" belt reduction. The complete engine has already been shipped to Taiwan by Noel Becar.

Meantime, the "civilian" customers for the PL-4A are not idling. As of the end of December 350 sets of plans have been sold. A newsletter is published regularly by one of the builders, U.S. Army Major J. C. Treager of Gahanna, Ohio.

The PL-4A design is being reviewed by the Australian CAB for amateur construction. Approval is expected any time. All stress analysis reports have also been submitted to the Popular Flying Association in England for review and eventual approval for amateur building.

Another bit of good news for PL-4A builders is that Aircraft Spruce and Specialty of Fullerton, California now has complete materials and hardware kits available. Several time consuming or hard-to-find items such as fiber-glass and plexiglass molded parts, welded engine mounts, extrusion kits, wheels, brakes, machined parts for the elevator trim control are available from Pazmany Aircraft Corporation.

The writing of the Construction Manual is almost done. Major Treager kindly took over the task of reviewing the manuscript. Hopefully, in another 2 or 3 months it will be printed. But, again, I am asking all interested persons **not** to send any money until this book is published and announced in the pages of *SPORT AVIATION*.

Due to the increasing cost of printing and mailing, the price of the PL-4A plans will be increased soon, so if you are interested in buying your set, do it now while there

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are still a few left from the original printing at $60.00 per set. The next printing will cost $80.00 per set. I have also prepared plans for the trailer which I use to carry my airplane. The plan incorporates some improvements and also uses lighter beams. The present configuration works perfectly, but it is too heavy. The cost of these plans is $15.00.

As soon as I finish with the Construction Manual, I will prepare the plans for the Continental A-65 engine installation. Just recently I had news from the Franklin Company indicating that they will soon be back in production. The 60 h.p. A-120-C, which has a type certificate, is lighter than the present VW installation but is 20% more powerful. This engine could be just perfect for the PL-4. We will see.

PL-4A FLUTTER FLIGHT TESTS October 28, 1973

By Walt Mooney, Commercial Pilot 1254332

THE PAZMANY PL-4A aircraft was flight tested to determine if it were free from flutter and to determine its critical flutter speed.

The tests were conducted at an altitude of 6000 feet above mean sea level using the altimeter installed in the airplane as the indicator of test altitude. Ground temperature at Montgomery Field, San Diego, California (field elevation 420 feet msl) was in the mid 70s. The tests were conducted at trimmed airspeeds starting at 60 mph and increasing at 10 mph intervals to 90 mph and then increasing at 5 mph intervals up to a speed of 150 mph. The airspeed indicator as installed in the airplane was used to determine the speeds for each test. The top indication on this ASI is 150 mph which is 10 mph above the marked redline speed of 140 mph.

Power settings for each test were whatever was required to maintain level flight at the trimmed airspeed of the test up to approximately 110 mph, which was the maximum speed at which level flight could be maintained. Full power was maintained at all higher speeds and an altitude loss as required to reach the trimmed airspeed accepted. In all cases, the actual test was made at approximately 6000 feet msl.

Test procedure was to trim the airplane for each speed and then to apply a sharp impulse to the free stick in a direction to excite flutter in the desired component.

In the case of the ailerons, the impulse was sharp enough to make the ailerons contact their limit stop at airspeeds up to about 110 mph (aileron stick forces are relatively light) and were applied both to the left and to the right.

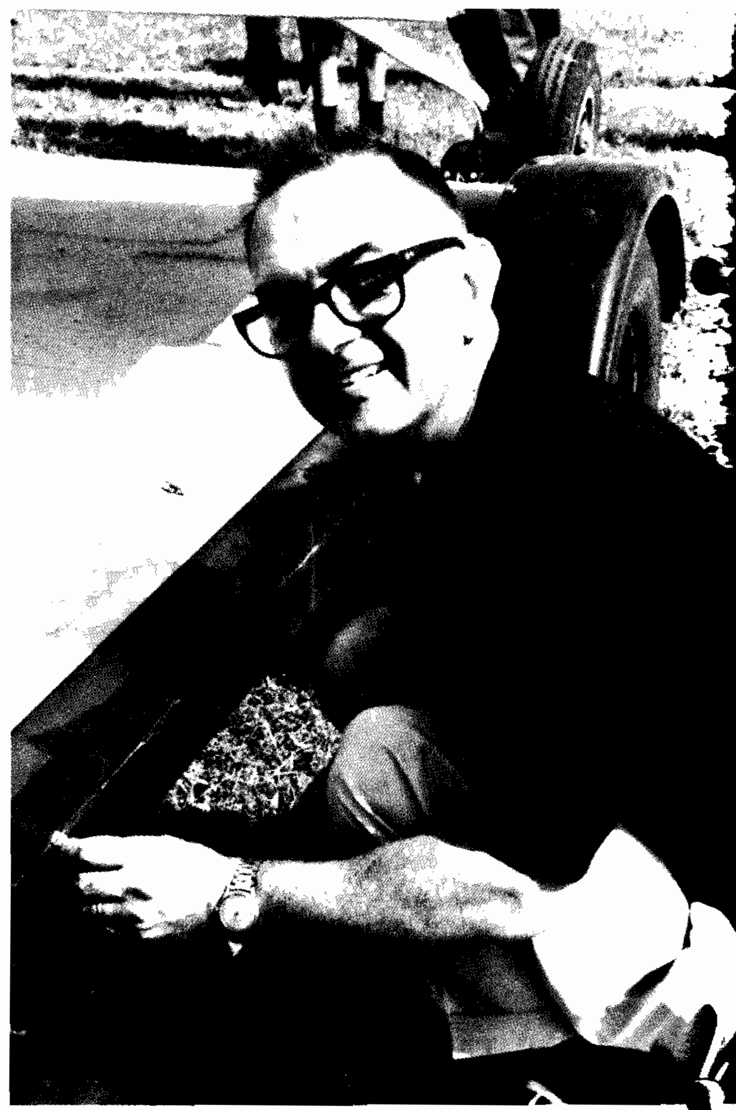
The ailerons demonstrated no tendency to flutter throughout the entire range tested and were, in fact, dead beat damped at all speeds up to 140 mph (red line). At the maximum airspeed tested, 150 mph indicated, the aileron motion damped out in about a cycle and a half.

The elevator stick forces, especially at the higher airspeeds, are considerably higher than the aileron forces. The impulse applied to the free stick was applied both in a forward direction and in an aft direction. It was the same magnitude of impulse as that applied for the aileron test, however, in no case did the elevator deflection reach the limit stops as would be expected considering the higher forces to move the elevator.

The elevator is actually an all moving horizontal "T" tail with an anti-balance tab which also doubles as the trim tab. This installation was dead beat damped at all airspeeds tested.

The rudder system was pulsed by kicking the rudder pedals to supply the sharp impulse. The pilot foot reflexes did not seem as sharp as the ones applied to the stick, but were as sharp as could be applied. The rudder was also dead beat damped throughout the speed range tested.

In conclusion, all of the movable surfaces of the Pazmany PL-4A were tested for their tendency to flutter up to 150 mph indicated. All are very heavily damped and show the airplane to be free of flutter. The airplane tested was the prototype N44PL.



(Photo by Ted Koston)

Ladislao Pazmany

RE-DESIGN PROBLEMS OF THE MODIFIED VOLKSWAGEN FOR THE PL-4

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THIS IS INTENDED as a candid summary of the design research and associated problems of an "engine modifier" with a discussion of the remedies of "fixes" as applied. It is set down here in the hope that others wishing to tread this same path may be able to evade the roadblocks and pitfalls which are part of the "re-design" experience.

The modified Volkswagen engine as used on the PL-4 was conceived from verbal specifications and discussions with Mr. Pazmany while the PL-4 was in it's early design throes. One of the basic design parameters specified that the engine was to be lightened up as much as possible but must still retain it's primary function of reliability. Therefore, every part when undergoing design was considered in the light of this criteria. The specs called for single magneto, shielded ignition, including shielded harness and sparkplugs. Also, an electric starter, with provision for a commercially available alternator to keep the battery charged after it's efforts in turning over the starter. Last, but not least, was the provision of a 2 1/4 to 1 ratio speed reduction drive for the propeller.

As I favor the method of disposing all of the accessories to the rear of an engine so as to leave the frontal area as clean as possible, this put "off limits" the expedient of hanging a starter on the front of the engine with either a gear driving off the front of the crankshaft or a positive drive, (PD) belt for this purpose. The decision to locate all accessories at the flywheel end demanded the designing of an accessory case for enclosing the large cranking gear. I am allergic to the idea of exposed gears rotating at high speed, where one might amputate a finger while trying to make some fine adjustment to the carburetor or magneto. The price, anatomically speaking, is too high.

It seemed a ring shaped casting, lightened as much as possible, might be the best answer after machining it so that it would fit neatly around the crankcase to transmission case ring, at the flywheel end of the engine. This casting weighed 7 pounds as received from the foundry but after machining it for lightness this resulted in the elimination of 5 1/2 pounds of dead weight for a completed weight of 1 1/2 pounds. This 5 1/2 pounds of dead weight was probably exchanged for a similar amount of seat and body weight lost in the machining process! This item has proven to be a "joy forever", aside from the efforts required to fabricate it, as it ties in the whole rear section of the engine as a unit.

The completed ring had to have a cover, of course, so for a couple of valid reasons, the cover was made in two parts; a left and a right half. The first reason for designing it this way was because my lathe could only swing a maximum diameter of 15 inches over the bed, so this precluded the turning of a one-piece cover. The other reason was that a two-piece cover allowed the proper setting, with a minimum of effort, for the necessary backlash in the driving gear train.

I concluded that a cranking motor, such as used with an outboard type of marine engine, (the example being a 40 h.p. Evinrude) would afford the best compromise in weight and power, so began with it. To make a long story shorter, I ended up with: a Prestolite, — or an Auto-Lite, — or a Delco Remy cranking motor, as these are all equipped with a standard Bendix type drive engagement pinion. Incidentally, all of these motors have essentially the same power and weight, within a matter of ounces. The ring gear, to be fastened to the crankshaft, was a replacement for the 40 h.p. Evinrude, mentioned previously, but how to "hang it" on the VW engine in as light a manner as possible, was the next problem. I finally settled for a web made of .200" thick magnesium plate connected to a hub fabricated from 7075-T6 aluminum alloy. This hub sutstituted for the original flywheel center, providing a means for adjustment of crankshaft end play, which should be between the limits of .003" to .005". This hub also provided a means, (similar to the original flywheel hub) of sealing off leaks from the rear main bearing by means of an oil seal which rides on the outer diameter of the hub. Originally, we allowed the oil seal to rub on the basic aluminum alloy material of the hub, but after some 50 hours of operation we found that the rubber seal was wearing a groove in the hub material. The final "fix" was the pressing on of what is known as a "wear sleeve." This is a commercially obtainable tough steel sleeve about .060" thick made in various diameters, one of which is just right for the hub. After turning down the hub diameter to be a light press fit for the inside of the sleeve, the sleeve is pressed on with a coating of Locktite cement applied first to seal any fine openings that might exist between the sleeve and the hub. The idea of this is to prevent any seepage of oil out from under the sleeve.

The best part of this whole assembly was that it weighed the same when riveted together, as the bare steel ring gear did when it was first obtained. The steel shavings I turned off the ring gear proved to weigh the same as the magnesium web and the aluminum alloy hub, or a total weight for the whole assembly of 4 pounds. Now, for a little baring of the soul! I had originally stress-analyzed the assembly for rivet size and spacing and concluded that 1/8" diameter rivets could handle the probably loads, but SHOCK LOADS are the key words that spell dissappointment. Shock loads produce something in the nature of load values that no one seems to have recorded for our benefit. The result was, that after some 50 hours of repeated starts, with one or two backfires thrown in, our rivets very neatly sheared off at the web to hub junction. Luckily, this did no damage to the engine

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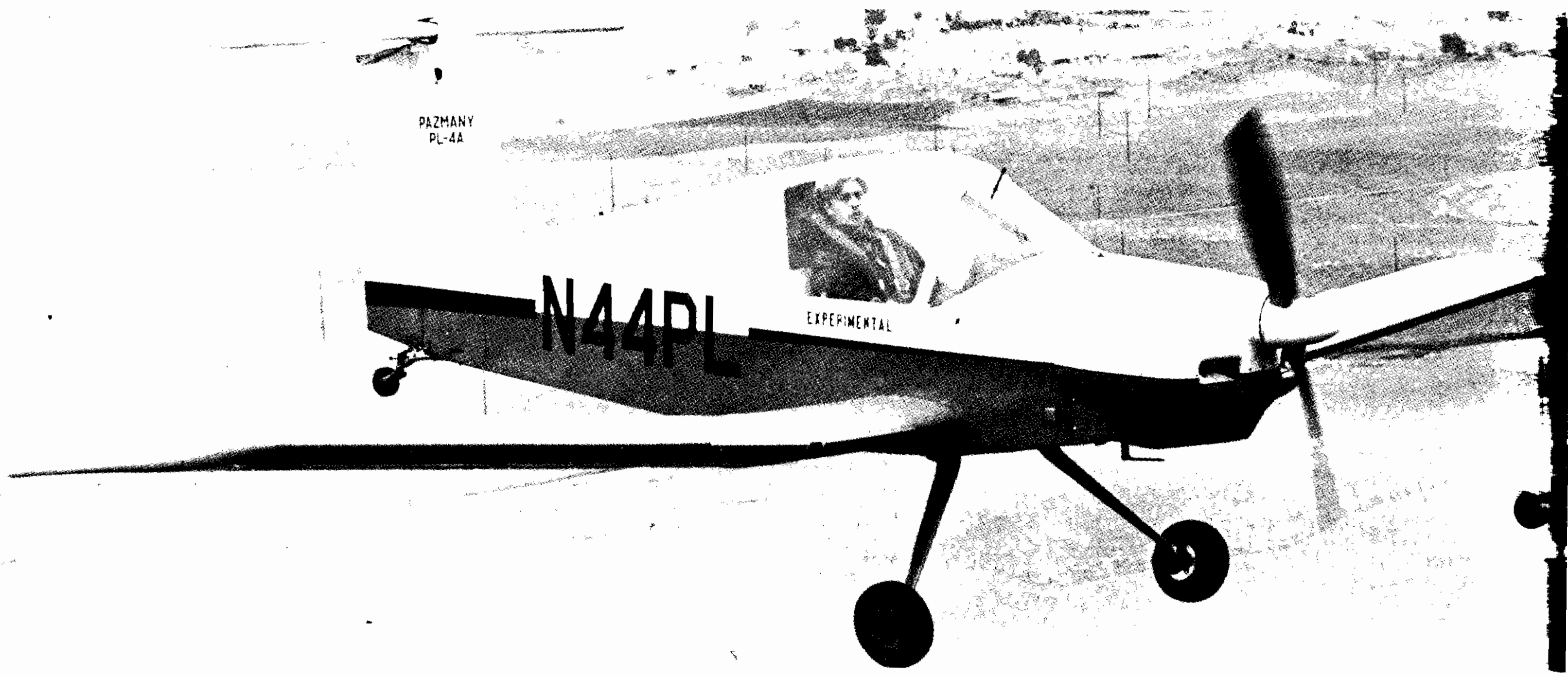
but divorced the ring gear from the crankshaft! The obvious remedy was larger rivets and more of them, so we changed to 5/32" diameter and doubled the quantity. This has apparently been the proper "fix", for during a thorough engine check, recently, after 175 hours of flying, including the round trip to Oshkosh, I could find no signs of looseness or reason to downgrade the integrity of the assembly. Incidentally, for the benefit of anyone trying to duplicate this design, have a professional **dynamically** balance the assembly for smooth running at 5000 rpm's. $10 is all I had to pay for an accurate balance job, although I had **statically** balanced it on knife edges first, so that a piece of tissue-paper, one inch square, would unbalance it.



(Photo Courtesy of Pazmany Aircraft)

The Pazmany PL-4A.

When the accessory case was finally finished and the ring gear bolted in place, I tried cranking over the engine with the Bendix drive on a Prestolite cranking motor. This was probably the biggest disappointment during the entire project, for it turned out that these 12 volt cranking motors normally put out an armature stall torque of about 2 1/2 foot-pounds while the need was for about 5 foot-pounds at this point, as measured on the engine. What to do?? That night and the two following, I probably endured more than my share of nightmares, for I would wake up in the morning all tired out from mentally cranking over the engine. During this period I exhausted all the possibilities of obtaining a stronger cranking motor without having to pay too heavy a price, from a weight standpoint. The "fix" finally occured to me in the using of STOCK gears, (for a reasonable price) and the detailing of a small planetary reduction drive built into the cranking motor. In it's final execution, this gave a speed reduction of 3 to 1, but tripled the torque to a usable 7 1/2 foot-pounds.

This remedy, in itself, created it's own "jungle" of problems, all of which have now been successfully solved. I would like to state right here, unequivocally, that the single most important consideration in designing any of these devices is the use of a POSITIVE LOCKING feature wherever a friction type locking device might be considered. As an example, the sun gear on the armature shaft of the planetary group, was originally held in place by a pilot detail which threaded into the end of the armature. The starting forces all tended to tighten up this right-hand thread, BUT — when the engine fired up and spun the Bendix pinion back for disengagement, this force was carried through the planetary assembly in a direction which loosened the pilot! The "fix" for this was to drill and tap the base of the pilot for a small machine screw and then "stake" the head of the screw so it could not loosen.

Another example was the junction between the Bendix drive shaft and the planetary carrier, which was screwed into the driveshaft. Reversal of forces, as mentioned above, unscrewed the assembly. Again a screw inserted at the junction of these parts, with it's head staked, as before, proved a definite and permanent remedy.

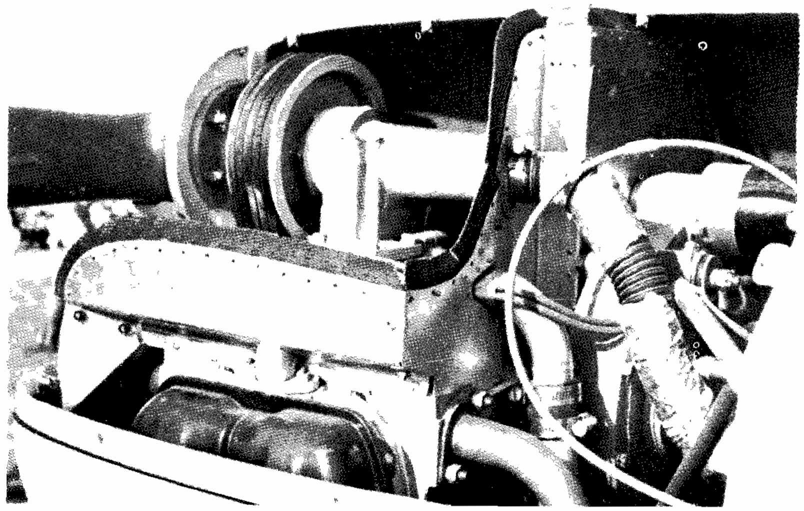
The starter re-design probably suffered more than it's share of troubles, as we found the original Bendix design, which included a tapered cap, a castellated nut and cotter pin originally used to lock up the outboard end of the drive, just would not stand up, as the nut castellations eventually pounded out of shape and the cotter pin would shear off. This was cured by machining a new combination cap and nut out of one piece of No. 4130 steel, (without castellations) then drilling and reaming the assembly and shaft for a No. 0 taper pin.

Up to this point, we had suffered some annoyance from a 1/4" bolt that served as an outboard support journal for the Bendix drive, as this bolt would persist in coming loose, in spite of lockwashers and a liberal application of Locktite cement. The "fix" for this condition, was to cut off the head of the bolt, file a half-round depression into the opposite (threaded end), then screw it into the end of the Bendix drive shaft and drive in the taper pin so that it locks the bolt from rotating by it's engagement with the half-round configuration. Last of all, stake the large end of the taper pin. Now it CAN'T loosen up!!

Another example of the need for positive locking occurred in re-designing the alternator drive. The commercial automotive version of an alternator relies on a nut which is torqued up to about 60 foot-pounds and which bears against the entire rotor, fan, pulley and a lockwasher. I reasoned that if this worked on a car satisfactorily, why wouldn't it be feasible for use on the VW, as described? The answer is "NO", as we finally had to use keys for the fan and gear which replaces the pulley and then positively lock the nut by means of a ball-bearing type lockwasher. This has peripheral fingers that can be bent up against the flat faces of the nut. One of these fingers is bent down for insertion into a drilled hole in the hub to prevent rotation of the washer, which replaces a "tang" originally built into the washer, but which cannot be used when applied in this manner.

Regarding spark plugs, we found that the single copper washer provided with them was too thin to prevent the threads at the firing end of the plugs from projecting slightly into the combustion chamber. The trouble this causes is recognized when one tries to remove the plugs after some hours of running. Carbon deposited in the combustion chamber will deposit onto these threads, thus enlarging and distorting them so that removal of the plugs can ruin the threads cut into the aluminum head. We found, by experimenting with a head removed from the engine, that two of the copper washers furnished with the plugs, provide the correct spacing to prevent the plugs from being screwed in too far.

One thing that turned out to be a surprise, was the amount of inertia represented by the lightweight (4 lbs.) ring gear with it's associated web and hub. I realized that four dowel pins, as provided on the original crankshaft end to fasten the 19 pound flywheel with it's additional weight of clutch, etc., on the car, was necessary, as well as the specified 217 ft/lbs. of torque to be applied to the flywheel securing bolt holding the cast iron flywheel to the crankshaft. However, the comparatively soft 7075 T-6 hub, with it's total weight one-fifth that of the flywheel seemed that it would not require more than two dowel pins and about 65 ft/lbs. of torque applied to the holding bolt. After 175 hours of running, we found that the combination of this torque and the two dowel pins was insufficient to prevent the dowel pin holes from wearing oblong in



(Photo by Kevin Stouffer)

Noel Becar's VW conversion mounted in the PL-4A.

both the crankshaft end **and** the hub. We have, therefore, had to resort to use of the original four dowel pins and raised the torque value to 120 ft/lbs. for the bolt. Four new dowel pin holes were drilled for, between the original ones in both the crankshaft end and the hub, so as to not have to use the original holes worn oblong. As it is common practice to redrill in this manner in order to provide for eight dowel pins on engines used for "hot rod" and drag racing, we anticipate no trouble from this source. . .

Mr. Pazmany advised me that someone had suggested the use of a Brillo type pad or one of those plastic scrubbing pads used in washing pot and pans, to be used inside the oil fill pipe body that serves to vent the crankcase. We found that this very successfully prevents oil from leaking out through the vent tube but allows free passage of air from the crankcase, so is a very practical idea.

(Photo by Ted Koston)

Paz revs up the VW at Oshkosh. A new lower cowling that encloses the oil cooler has been built since this photo was taken.