TECHNICAL TIPS MANUAL

VOL. II

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TIPS II INDEX

PROPELLER SURVEY REPORT

In the January 1979 issue of *Sport Aerobatics* there was an IAC Technical Safety article on propeller service life. Part of this Technical Safety article included a tear-out propeller questionnaire which all members were asked to complete and submit with the intention of using the information in the questionnaire to try to establish the service life of fixed pitch aluminum propellers used on aerobatic aircraft. Membership response to the prop questionnaire has been very poor and very slow. Forty-four (44) members (slightly over 1% of IAC members) returned questionnaires on fixed-pitch aluminum props, seven (7) returned questionnaires with constant-speed info, and one (1) member sent in info on a fixed-pitch wooden prop. The last questionnaires returned were received in August. Below we will try to summarize what we did receive. However, the prop survey did have its very positive side. Several members sent in propeller tune-up tips, Sensenich and a metallurgist we contacted advised us about corrosion control on aluminum propellers, a Sensenich propeller engineer critiqued/commented on the January Propeller Service Life article, and Hoffmann Propeller Co. sent a copy of their report entitled "Propellers for Acrobatic Flight."

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The input received from IAC members on the question of service life of fixed-pitch aluminum propellers can probably best be represented by Figure 1 which plots all reports on a "total time in service" vs. "total aerobatic time" graph. The data points that are circled indicate that the propeller represented by that "dot" has been reconditioned at least once. The radial percent lines on the graph show percent of acro time vs. total time on prop $\left(\frac{\text{acro time}}{\text{total time}} \times 100\right)$. For example, any dot falling on the 50% line would represent a prop that has spent half of its total time flying aerobatics. Dots lying between the 50% and 25% lines would represent props having between 50% and 25% of their total time in use in aerobatics. No reports of any fixed-pitch aluminum prop failures were received.

Note that 43% of the total prop reports fall inside a box bounded by 300 total hours and 200 acro hours. If this survey is representative of service life of fixed-pitch aluminum props used on acro aircraft, one might conclude that you would be fairly safe using a prop that

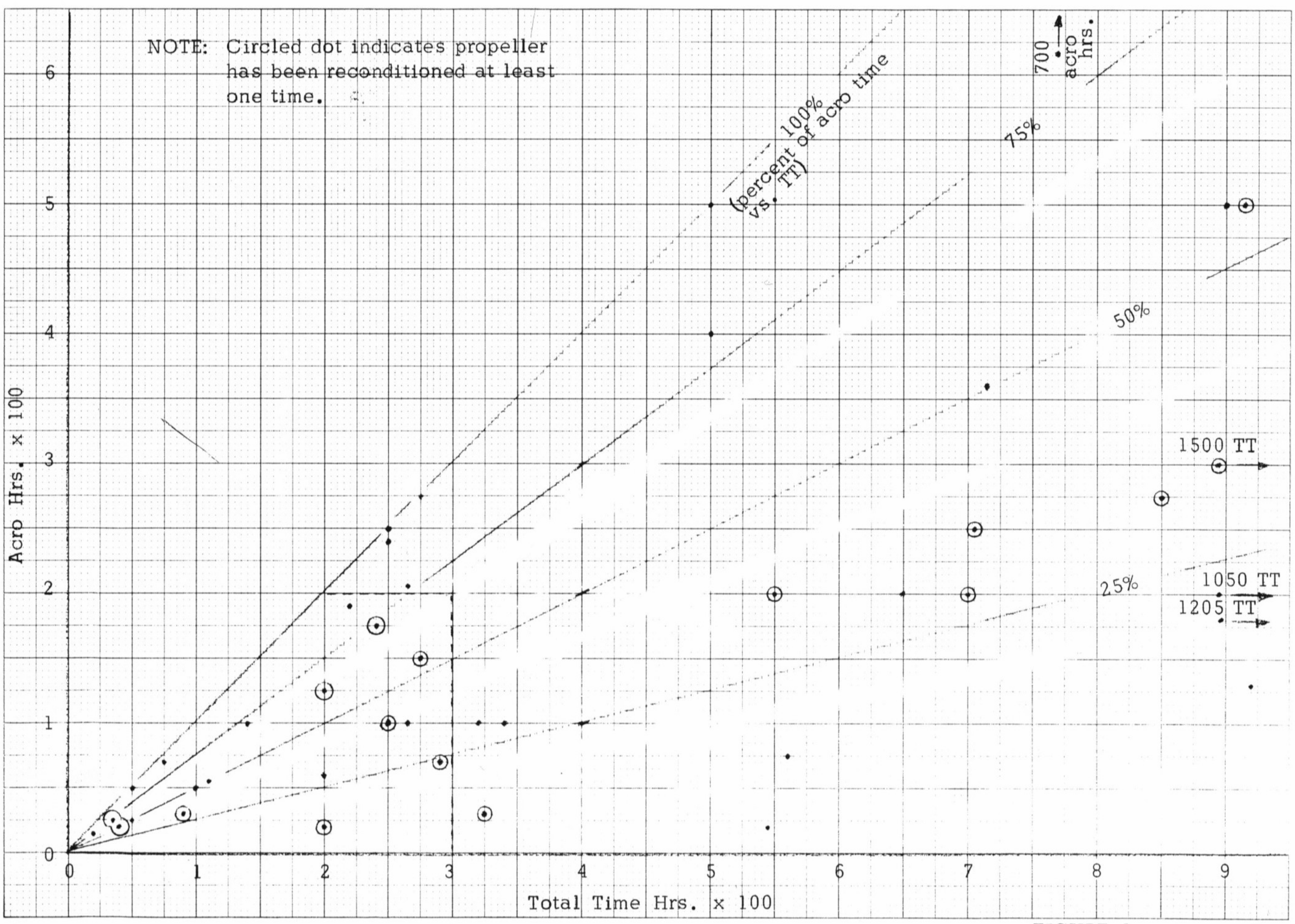

FIGURE 1

has less than 300 hours total time and of that time has been used in aerobatics for less than 200 hours. Below, in Sensenich's comments on the January 1979 Technical Safety prop service life article, note that Sensenich believes that the key factor in service life for acro props is the time the propeller was used in aerobatics as opposed to total flight time. A possible problem here might be defining what is meant by "total time engaged in aerobatics:" A precise definition here might have made the IAC prop survey more meaningful.

In the portion of this report covering the material IAC received from Hoffmann Propeller Corp., note that Hoffmann states, "The most critical condition to propeller life is **OVERSPEED**." With this in mind, the IAC T.S. Committee graphed the max. engine/prop speed reported for fixed-pitch aluminum props by engine models, i.e., Lycoming 0-235, 0-290, 0-320, and 0-360 (See Figures 2 through 5). One of the questions on the IAC propeller questionnaire asked what "type" of aerobatic flying on prop: Primary, Sportsman, Intermediate, Advanced, or Unlimited. As a general rule, reports listing use in the

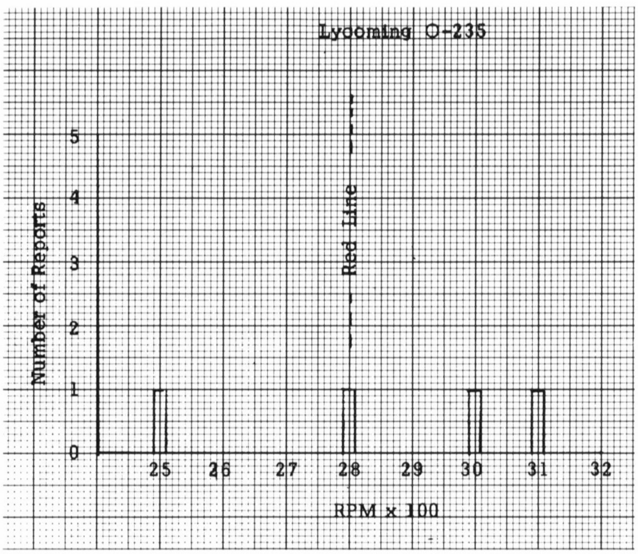

FIGURE 2

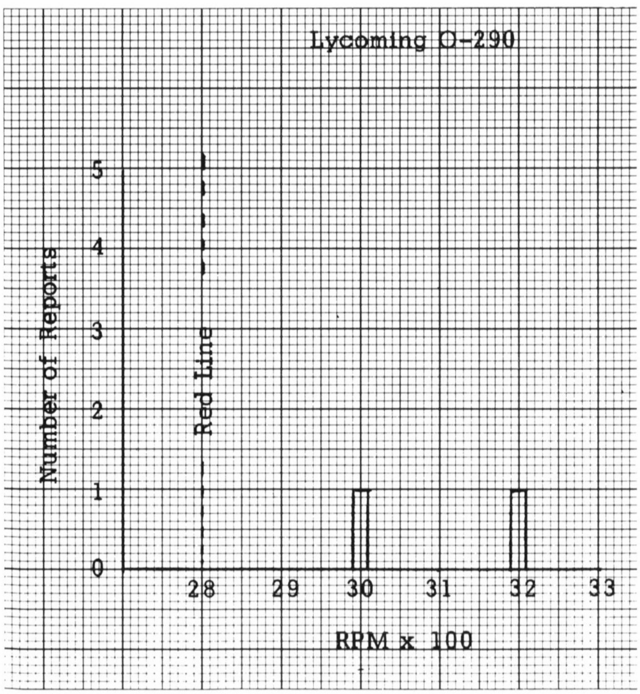

FIGURE 3

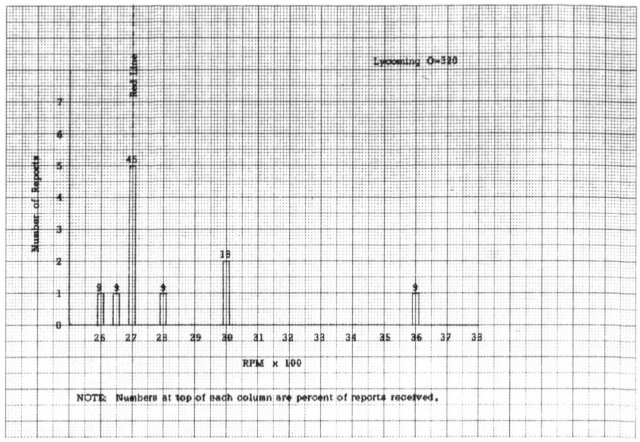

FIGURE 4

higher categories usually also showed aircraft having larger displacement and higher horsepower engines — and higher max. engine/prop speeds.

Of the seven (7) members sending in reports of constant-speed props, two (2) reported occasional surging during vertical maneuvers with Hartzell C.S. props, one (1) member noted "slinging grease" on a Hartzell, and one (1) member reported that "blades became loose at hub at 200 hrs." on a McCauley C.S. and required "re-shimming". Interestingly, one member reported that because of being advised of Hartzell C.S. problems incurred by another member, he removed the prop from his S-2A Pitts every 200 hours and had it disassembled and inspected at a propeller repair station. When he sold his plane he had a total of 1,122 hours on it and never had any prop problems. He attributed this to good maintenance and inspection.

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Several members sending in reports asked about possible detrimental effects of polishing ("mirror finishing") aluminum propellers. The IAC T.S. Committee asked Sensenich Propeller and a metallurgist about corrosion protection of aluminum by anodizing, and their thoughts on polished aluminum props. The following are Sensenich's comments on the subject.

"In answer to your question, chromic-acid anodizing could be considered as a type of corrosion since it is a controlled oxidation of the aluminum surface — creating an aluminum-oxide skin which is harder than the aluminum alloy. Here the key word is **controlled.** That is, the anodizing process creates a thin, hard oxide coating which will protect the underlying aluminum from corrosive substances. We know that airplanes based near a sea coast or near cities where industry used sulfur-bearing fuels and spray airplanes dispersing phosphorus compounds require special protection against corrosion of their aluminum alloy components. When surface protection is not adequate, corrosive chemicals can attack 'at the interfaces of the grain structure'. This takes the form of corrosion stringers leading into the blade which are seen from the surface as corrosion pits. It is this corrosion which affects the interfaces of the crystal structure and causes impairment of the mechanical properties of the metal equivalent to that of the sharpest possible V-notch.

"A bright polish finish protected by waxing has been accepted for many years as an alternative to anodizing. However, the bright polish with only a wax protection certainly removes one line of corrosion protection and adds increased responsibility for proper maintenance.

"After all has been said, the fact remains that no way has been discovered to give total protection against corrosion. Any aluminum propeller which is neglected will almost certainly corrode — more or less rapidly according to its environment.

"The purpose of reconditioning is to periodically remove the fatigued layer of surface metal and the unavoidable accumulation of minor cuts and corrosion."

The metallurgist who we contacted loaned the T.S. Committee several books and papers that were helpful. Probably the most informative single piece of information was a book entitled "Corrosion and Corrosion Control" by Herbert H. Uhlig. For any members who would like further info on the subject of corrosion than will be covered in this article, the fore-mentioned book is recommended.

The following is the IAC T.S. Committee's summary on the anodizing process. This dissertation is rather lengthy, and perhaps slightly tangential to the rest of this T.S. article, however, in checking on the anodizing process, there seemed to be a bit of confusion/misunderstanding about what anodizing actually is, and since anodizing/corrosion control should be important to all IAC members, now, perhaps, is the time and place to present this material.

Anodizing is the popular term referring to the coating of certain metals with a stable oxide film. This coating may be formed on aluminum, magnesium, titanium, and zinc. However, the anodic coating of aluminum is by far the most common application and the following will be confined to this process.

Aluminum, when exposed to air, will combine with oxygen in the air and gradually form a thin stable protective layer of aluminum oxide on its outer surface. This tight skin of aluminum oxide prevents further oxidation, i.e., corrosion, of the aluminum. The anodizing process artificially and more rapidly forms this coating on aluminum and to a greater thickness than occurs through the natural oxidation process. This additional thickness gives some abrasion protection and, because of the way it is formed, allows other possibilities — dyeing and sealing.

Simply, the anodizing process consists of making the aluminum part to be anodized the anode in an electrolytic bath and applying a voltage. Many different electrolytes may be used, but the two most common are chromic acid and sulfuric acid. Both of these electrolytes have the property of slowing dissolving the oxide formed and, therefore, making a porous coating permeated by the electrolyte. Sulfuric acid is used mainly in commercial/industrial applications because the oxide films are usually 5 to 20 times as thick as those formed in the chronic acid process and are more porous and lend themselves better to color dyeing. An aqueous chromic acid solution is used for protecting metal aircraft parts. This process is covered by U.S. Patent No. 1,771,910 (Bengough & Stuart).

The chromic acid method is more expensive and time-consuming than the sulfuric acid method but has two important advantages. First, after the anodizing process, if there is any entrapment of the electrolyte perhaps due to poor rinsing in a crevice or corner, sulfuric acid may result in a serious corrosion problem while chromic acid is **non**-corrosive and in fact has the corrosion-inhibitive characteristic of hexavalent chromium. Secondly, chromic acid anodizing provides a nondestructive

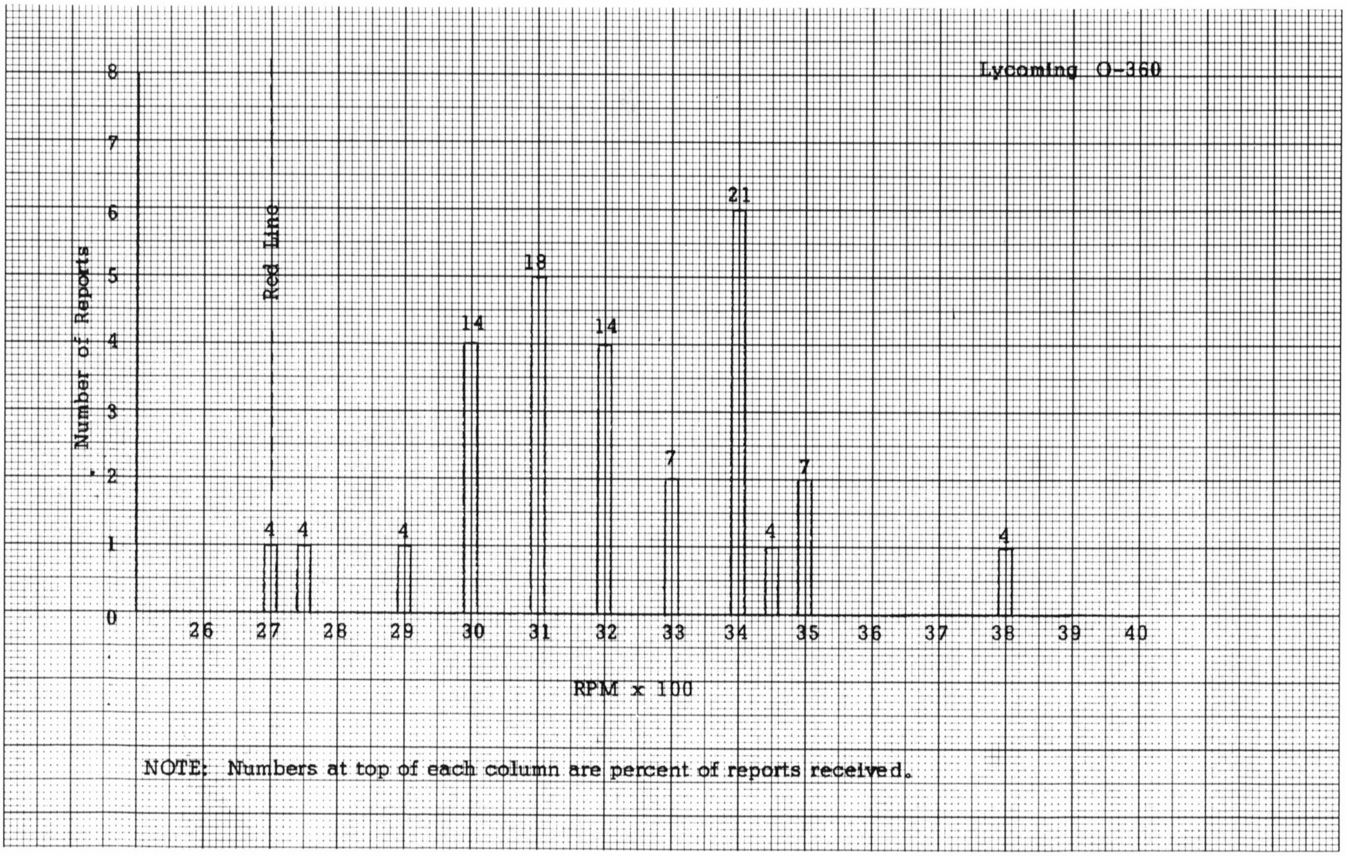

FIGURE 5

inspection technique for detection of cracks and other surface flaws. This is done following the anodizing treatment by rinsing the part in cold water for 3 to 5 minutes and then drying the part quickly — preferably with an air blast. The part is then allowed to stand for at least 15 minutes before examination. Cracks will appear as brown stains caused by chromic acid bleeding out onto the surface and flaws will appear as fine black lines.

The foregoing has been history and background material helpful to understand what actually happens "in the tank" during the electrochemical anodizing process.

(1) As previously mentioned, the part to be anodized is made the anode (the positive electrode) and the tank itself is made the cathode (the negative electrode). (A lead-lined tank is used with a sulfuric acid electrolyte and a steel tank is used with a chromic acid electrolyte.)

(2) The part is then immersed in an **aqueous** acid solution. The two acids covered in this discussion, diluted sulfuric acid and diluted chromic acid, have **two** functions. First, since pure water is practically a non-conductor, the presence of an acid gives a conducting solution. Secondly, as stated above, both sulfuric and chromic acid have the property of slowly dissolving aluminum oxide.

(3) A suitable voltage is applied with the resulting electrolysis of water. Here, pure hydrogen is liberated at the cathode and pure oxygen is liberated at the anode. $2H_2O$ + electric current = $2H_2 + 0_2$ The pure oxygen liberated at the anode (the aluminum part being anodized) combines with the aluminum to form a dense "barrier layer" of aluminum oxide. If this film of aluminum oxide were insoluble in the electrolyte, the growth would stop at this point. However, if the oxide film is **slowly soluble** in the electrolyte, as in the cases of sulfuric and chromic acid solutions, pores form in the outer face of the coating and the growth of the coating continues. The oxide layer will continue to grow as long as the electrolyte can reach the barrier layer through the pores. The longer the process continues the larger the diameters of the pores near the surface of the coating and, in fact, the coating near the surface may have a honeycomb structure because of breakdown of the walls between the pores. The final result (depending on several variables) is, therefore, a very thin and very dense film which provides a corrosion barrier and on top of this film a relatively thick section of porous aluminum oxide which gives abrasion protection.

There are several other points to consider in anodizing. There is the preparation/cleaning of the part prior to anodizing. Smoother, i.e., polished, parts anodize better than rough parts, e.g., a casting. Therefore, any parts that can be polished before anodizing will result in a better job. Also, all dirt and grease must be removed before anodizing. There are several dips and washes which can be used — detergents, etching or non-etching cleaners, nitric acid, etc. — and this process will vary. Copper-aluminum alloy parts having above 5% copper alloying agent do not anodize well. However, copper-aluminum alloys, such as 2025 aluminum — 3-5% copper, can be dipped in nitric acid (50% solution) prior to anodizing to "wash off" the copper and give a better anodizing job.

Depending on the alloy being anodized, the area to be coated, and the desired end result, there are several variables to consider, namely, the type and strength of the aqueous acid solution, the temperature of the bath, the applied voltage, and the length of time of the treatment.

The color of the anodic coating on the aluminum will vary depending on the alloy or aluminum being treated. The colors usually range from clear to white to gray and aluminum copper alloys may have a greenish cast. The anodized part may also be colored with suitable dyes which "take" in the porous top layer of the anodic coat.

One last point to consider is "sealing." As mentioned, the barrier layer is very thin and is mechanically protected by a relatively thick porous coating of aluminum oxide. The protection of the barrier layer can be supplemented by several procedures known as sealing treatments which plug the pores in the outer coating.

The most popular sealing method is to immerse the anodized part in hot (180°F.-212°F.) water for approximately one-half hour. This transforms the aluminum oxide into aluminum monohydrate ($Al_2O_3 \bullet H_2O$). The appearance of the coating is not changed but it is no longer absorptive.

Another way to seal the pores is by the use of a hot nickel or cobalt acetate bath. Here, colloidal hydroxides of the metals are formed by hydrolysis in the pores and seals them.

That should answer almost all questions about the anodizing process. However, if we consider corrosion as being undesirable, and if anodizing is a form of corrosion — which it really is (aluminum oxide) — isn't anodizing a propeller supposedly for corrosion protection kind of a contradiction? This question has already been answered above by the people from Sensenich Propeller, but maybe a little more detail would make things even clearer. There are two main points to keep in mind when thinking about anodizing/propellers/and corrosion control: (1) The object under consideration, an aluminum propeller, is not made of pure aluminum but is an aluminum alloy, and (2) Aluminum uniting with oxygen to form aluminum oxide is just **one** of the chemical reactions which we call corrosion.

Pure aluminum is soft and weak; it is alloyed, therefore, largely to obtain increased strength. The usual alloying additions to aluminum in order to improve physical properties include Cu, Si, Mg, Zn, and Mn. The duralumin alloys (which include the alloys of which aluminum propellers are made) contain several percent copper, deriving their improved stength from the precipitation of $CuAl_2$ along slip planes and grain boundaries. Now here is where the destructive corrosion "at the interfaces of the grain structure" that Sensenich talks about comes into play. It is called intergranular corrosion. This is a localized type of attack at the grain boundaries of the material, resulting in loss of strength and ductility. Grain-boundary material of a limited area, in this case the copper ($CuAl_2$) which was precipitated on the grain boundaries, acting as an anode, is in contact with large areas of grains, aluminum, which are acting as a cathode. If this situation is supplied with an electrolyte (some type of electron conductor) electrolysis will occur — another type of reaction which we sometimes classify as corrosion. Specifically, in this case, intergranular corrosion. To prevent intergranular corrosion, the electrolyte must be prevented from coming into contact with the potentially anodic and cathodic material. On aluminum props this is done by "sealing" the surface of the prop by anodizing/painting/waxing. In aluminum propellers the component, copper, which gives the material its strength is also potentially the component which could cause its failure through destructive corrosin. And one form of corrosion, stable aluminum oxide (anodizing) is used to prevent the occurrence of a destructive form of corrosion, intergranular corrosion.

The above rather long discussion concerning prop polishing/anodizing/corrosion hopefully will answer most questions on some often asked questions on these subjects.

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PROPELLER SERVICE

(Continued from January S. A.)

The first portion of Sensenich's reply to the IAC Technical Safety Committee's inquiry concerning corrosion protection of aluminum propellers was quoted earlier. The second portion of Sensenich's letter commented on the January 1979 *Sport Aerobatics* Technical Safety article entitled "Propeller Service Life" and is as follows. (Before reading the following, IAC members may want to review the January 1979 T.S. prop article.)

"In reference to the article in the January issue of *Sport Aerobatics* compiled by the IAC Technical Safety Committee, we have the following comments:

"(1) The introduction to your article included a letter from a member who had returned a propeller to us which had been flown for nearly 1000 hours in aerobatic use. It was surprising to the author that the propeller was returned 'with a clean bill of health' and 'supposedly could go another 915 hours'.

The propeller was accepted for reconditioning because it was within the minimum repair dimensions and because a careful visual inspection using a caustic etch revealed that there were no fatigue cracks. When the propeller was returned to the owner, all that he could rightfully infer was that our reconditioning process had removed the collection of small cuts and scratches and the thin layer of surface metal which had endured the greatest fatigue damage, and that the blade angles had been properly matched and the propeller was within balance and track tolerance.

THERE IS NO HUMANLY PERFORMABLE TEST BY WHICH THE REMAINING FATIGUE ENDURANCE LIFE OF A PROPELLER BLADE BEFORE THE APPEARANCE OF A SURFACE CRACK CAN BE PREDICTED. Another popular misconception is that a fatigue crack may originate in the interior of a solid aluminum alloy propeller blade, and suddenly surface just before failure. A FATIGUE CRACK ORIGINATES AT A BLADE SURFACE SOME DISTANCE FROM THE AXIS OF FLEXURE AND PROGRESSES INWARDLY. Laboratory evidence indicates that the first fatigue cracks in metal specimens undergoing fatigue cycling may not appear until approximately 90% of the expected endurance life has been exceeded.

"(2) This is in reply to the letter from the Citabria owner with a fixed-pitch McCauley propeller.

Before we begin to discuss a statistical approach to propeller service life, let us agree on the following fundamental facts of the fatigue endurance life of aluminum alloy propellers subjected to alternating loads.

(a) As everyone who has read an S-N diagram knows, AT EACH LEVEL OF ALTERNATING LOCAL STRAIN THERE IS A CORRESPONDING NUMBER OF FATIGUE CYCLES WHICH WILL CAUSE FAILURE. In some S-N diagrams, it is the total strain (the sum of plastic and elastic strain) which is plotted against the number of cycles to failure. In regions where the total strain is nearly all elastic, conversion to stress can be made by using the appropriate modulus of elasticity. The data from which S-N diagrams are constructed characteristically show a wide scatter band. Therefore, the diagram should be used conservatively.

(b) Failures which occur due to large values of total strain (where deformation is predominately plastic) can occur after a few cycles and are known as 'low-cycle fatigue failures'.

(c) The vibratory stresses in a propeller blade are principally induced by the alternating torque pulses of the piston engine which drives it. These torque pulses are usually produced in integral multiples of the number of cylinders which fire per revolution of the crankshaft, and excite the various symmetrical bending modes of the propeller. Wherever an alternating torque pulse coincides in frequency with that of a natural mode of the propeller there will be a resonance condition which may result in high vibratory stresses.

(d) The momentary propeller roughness which occurs at a certain rpm in a closed throttle dive has been noted by many pilots. This roughness results from a resonance between the fundamental symmetrical bending mode frequency of the propeller and a large alternating torque produced by an in-phase combination of gas and inertia forces in the engine. These high stresses can be tolerated under the assumption that only a limited number will occur during the life of the propeller.

(e) Due to the fact that an airplane engine/propeller is operated over a range of rpm and flight conditions, the number of fatigue cycles at a significant vibratory stress level cannot be directly related to number of hours of flight.

(f) Other causes of propeller vibration are aerodynamic (yaw) and gyroscopic bending. Since these are induced once per revolution per blade they are in the nature of asymmetrical forced vibration, and in a fixed-pitch metal propeller are not usually troublesome. However, they can cause high stresses in the crankshaft flange.

"The conclusion which the author of the statistical study of propeller service difficulties has drawn is that he will have confidence in a second-hand 'proven' propeller rather than a new one. We disagree.

"We have devoted a substantial part of this letter to a discussion of metal fatigue as it affects the service life of fixed-pitch aluminum propellers. The table which formed the basis for the statistical study shows a column of lowest time difficulties. Obviously these difficulties (with one exception) could not have resulted from blade failure due to metal fatigue.

"Also, an unwarranted assumption in the analysis is that if any of those propellers which did **not** fail had been used on the same airplane and by the same pilot during the same flights as a propeller which did fail, the failure would not have occurred.

"We agree with your idea to gather propeller data from your membership. However, we believe that propeller service life on an aircraft used for aerobatics would show a closer relationship to number of hours spent doing Lomcevaks, snap rolls, and closed-throttle windmilling dives through the resonance as described in subparagraph (d), etc., rather than to total flight time.

"We are enclosing copies of the introduction to the present revision of our Metal Propeller Repair Manual, the present Use and Care Bulletin included with each metal propeller, and a resonance spectrum for our 76EM8 propeller. This resonance spectrum chart shows only those resonance conditions above rated engine rpm calculated on the assumption that the propeller itself is the entire elastic system. It is possible at these higher rpm's that modes involving the engine crankshaft, crankcase, and engine mounts, etc., of which we have no knowledge could exist."

The printed matter referred to in the Sensenich letter is shown in FIGURES 6 through 8.

METAL PROPELLER REPAIR MANUAL

INTRODUCTION

The purpose of this Service Manual is to provide the repair information necessary to maintain a fixed-pitch metal propeller in an airworthy condition.

The types of service-damage which may render a fixed-pitch metal propeller unairworthy are mainly mechanical injuries such as cuts, nicks, and dents caused by the impact of stones, gravel, sand, etc. Usually a displacement of the metal is involved and the void is roughly V-shaped in cross-section with the sharp point of the "V" pointing inward, away from the surface of the metal. There is also a type of chemical damage which involves corrosion at the interfaces of the grain structure of the metal. In this manual it is called corrosion pitting. The mechanical effect of this on the strength of the metal is like that of a "V" notch with the sharpest possible edge. It is the objective of all repair techniques to remove this V-shaped notch and to leave the repair area in a smooth, rounded well-faired condition. It is worthwhile to understand the reasons behind these procedures.

A metal propeller is subjected to two kinds of loads or stresses. A stress is merely the load or force which acts across a unit area of the blade cross-section. The first of these stresses is steady and continuous and due to the combination of the centrifugal forces associated with the rotation of the propeller, and forces which are the reaction of the airload on the blade. These centrifugal forces are very large when a typical light-plane propeller is operating at its rated rotational speed. A particle of metal near the tip of the blade may exert an outward pull roughly 7500 times greater than its own weight. The forces due to the reaction of the blade to the airload tend to bend it out of the plane of rotation and the centrifugal forces tend to straighten the blade and bring it back into the plane of rotation, so that in operation the blade will seek some intermediate or equilibrium position. The sum of the stresses caused by these steady forces constitutes the total steady stress to which a blade is subjected at a given rotational speed, power input, and forward speed of the propeller. It varies, of course, along the radius of the blade in a manner which is determined by the shape of the blade. At rated conditions of power, rotational speed, and forward speed, it is possible, by proper design of the blade, to hold the maximum value of these steady stresses below a value of about 7500 pounds per square inch. This is about one-fourth of the yield strength of aluminum alloy 2025, heat-treated to Specification T6, which is the metal universally used throughout the light-plane propeller industry.

The second type of stress is an alternating or vibratory stress. In this type of stress, the blade is subjected alternately to loads which tend to stretch the metal and then to compress it. The sequence of events which occur as the load on a portion of the blade section varies from the point of maximum tension thru maximum compression and back to maximum tension is called a cycle of vibration. The time which elapses during a cycle is called the period of vibration. The number of cycles per second, or other unit of time, is called the frequency of the vibration. The number of cycles per revolution of the propeller is called the order of the vibration.

The forces which shake a propeller and cause it to vibrate arise mainly in the piston engine which drives it. A piston engine does not produce a smooth and constant torque. The rated torque of a direct-drive engine is merely the mean value of the torque impulses taken over a period of one revolution of the crankshaft. The orders of the torque impulses are determined by the number of engine cylinders and their arrangement. These orders are usually integer multiples of the number of firing impulses per revolution of the engine crankshaft. For example, a four-cylinder engine, with the cylinders in two banks, arranged at an angle of 180^{0} to each other, will produce torque impulses at frequencies which are 2, 4, 6, 8, . . . times the rotational speed of the engine.

A metal propeller, like a tuning fork, has a set of natural frequencies of vibration. These frequencies are determined by the shape of the blade — its length, thickness distribution, and width distribution. When one of the natural frequencies of the propeller coincides with the frequency of a shaking force put out by the engine, a resonance peak occurs. At this condition, depending upon the magnitude of the shaking forces coming from the engine and the damping forces in the propeller, vibratory stresses may become very large. During the design of a metal propeller intended for use on engines of a particular model, an effort is made to tune the propeller so that dangerous resonance peaks will fall outside the operating range of engine rotational speed.

Over the period of many years in which forged aluminum alloy propellers have been in use, service records have shown that a propeller can operate safely, provided the values of steady stress and vibratory stress are held to certain well-established levels. When a combination of steady and vibratory stresses is allowed to exceed these levels, after the accumulation of a sufficient number of vibration cycles, or fatigue cycles as we may call them, the strength of the metal begins to deteriorate and a fatigue crack may develop which can quickly lead to a failure of the propeller. Much test work has been done to determine the number of fatigue cycles required, at a given level of stress, to produce a fatique failure. Metal propellers are not type certificated until it has been demonstrated that the steady stresses and vibratory stresses for each propeller-engine combination are at a satisfactory level.

The values of allowable steady and vibratory stress which experience has shown to be satisfactory apply to well-faired undamaged blades. When a propeller blade sustains damage in the form of a sharp-bottomed notch, the stress level at the root of the notch may be increased by an amount many times greater than the stress at the same location in an undamaged blade. The notch effect or stress concentration factor, is dependent upon the depth and the sharpness of the bottom of the notch. This local stress may increase to a level at which very little more flight time is required to initiate a crack which may propagate rapidly and lead to an early blade failure. It is for this reason that frequent inspections and prompt repair of damage of this type are urgently recommended.

There is another way in which, during the service life of the propeller, the vibration characteristics of an engine-propeller combination may be altered so that vibratory stresses rise to dangerous levels. This situation is brought about by a shift of one or more of the resonance peaks into a frequently used range of engine rotational speeds. When the thickness and width of the blade have been reduced by repeated repairs, the stiffness and therefore, the natural frequencies of vibration are also reduced. The effect of a diameter reduction of the propeller is to increase the natural frequencies of the blades. Any alteration of the original blade dimensions large enough to cause a significant shift, either up or down, away from the set of natural frequencies originally designed into the propeller, may bring an undesirable resonance peak into the cruising range of engine rotational speeds. This is why minimum repair dimensions and diameter limits are established for each engine-propeller combination.

Alternating stresses are the cause of metal fatigue. It is the number of fatigue cycles and the stress level at which they have been accumulated which determines the endurance life of a propeller. Research has shown that the life expectancy of metal specimens, which have been fatigue-cycled to 50% of their endurance life, can be extended by the removal of a thin layer of surface metal. It is good practice then, periodically to remove the layer of fatigued surface metal and the accumulation of small cuts and scratches by reconditioning the entire blade.

In summary then, it may be said that the general policy behind safe blade repairs is to hold reductions from the original blade dimensions to a minimum, and to remove any "V" notch type of damage as promptly as possible by rounding-out, fairing, and polishing the area of damage. It is intended that the methods, techniques, and practices of FAA Advisory Circular 43.13-1A be followed, however minimum blade dimension after repair shall be governed by the data in this manual.

DEFINITIONS: COMMON TYPES OF SERVICE DAMAGE TO ALUMINUM ALLOY PROPELLERS

CORROSION PITTING — Tiny deep cavities extending inward from the surface of the metal; may tunnel under the surface, reappear at another location.

CRACK — Physical separation of adjacent portions of the metal, which may extend far below the surface of the blade. Usually initiated by a nick, scratch, or corrosion pits in an area of the blade subjected to continuous vibration.

CUT — Loss of metal over a relatively long and narrow area, sometimes extending to an appreciable depth, caused by a sharp-edged object striking the blade a glancing blow.

DENT — A depression in the blade surface produced by direct impact of a hard object.

EDGE ALIGNMENT — Blades out of edge alignment are bent about an axis nearly perpendicular to the chord so that a line through corresponding stations of the two blades no longer cuts the center of the hub bore.

EROSION — Loss of metal from the surface by mechanical action of small foreign objects such as grit or sand; usually found in the area of the leading edge and flat side of the blade.

FACE ALIGNMENT — Blades out of face alignment are bent about an axis nearly parallel to the chord so that the blades do not "track".

FRETTING — Breakdown or deterioration of a metal surface by a vibratory or chafing type of action.

GOUGE — Deep grooves in a blade caused by contact with a foreign object under heavy pressure.

INCLUSION — Scale or other foreign material embedded in the metal.

NICK — A sharp bottomed notch involving displacement of metal, usually found on the leading and trailing edges of a propeller blade.

SCORE — A tear or break in the metal surface intermediate in size and depth between a gouge and a scratch.

SCRATCH — A small and superficial cut in the metal surface. Usually found on the flat side of the propeller blade.

SURFACE CORROSION — Loss of metal from the surface by chemical or electro-chemical action. The corrosion products can easily be removed by sanding.

FIGURE 7

Sensenich Corporation **Lancaster, Pennsylvania 17604**

P.O. Box 1168 **September 1978** **(717) 569-0435**

FIXED-PITCH METAL PROPELLERS INSTRUCTIONS FOR USE AND CARE

Supersedes previous Use & Care Instructions
Service Bulletins and Airworthiness Directives are not affected by these instructions

Your Sensenich propeller has been manufactured under closely controlled conditions to the approved design in accordance with applicable FAA Regulations. Stamped on the propeller hub face are the Model and Serial Number, the Type Certificate Number, and the Production Certificate Number (Sensenich Corp. P.C. No. 1).

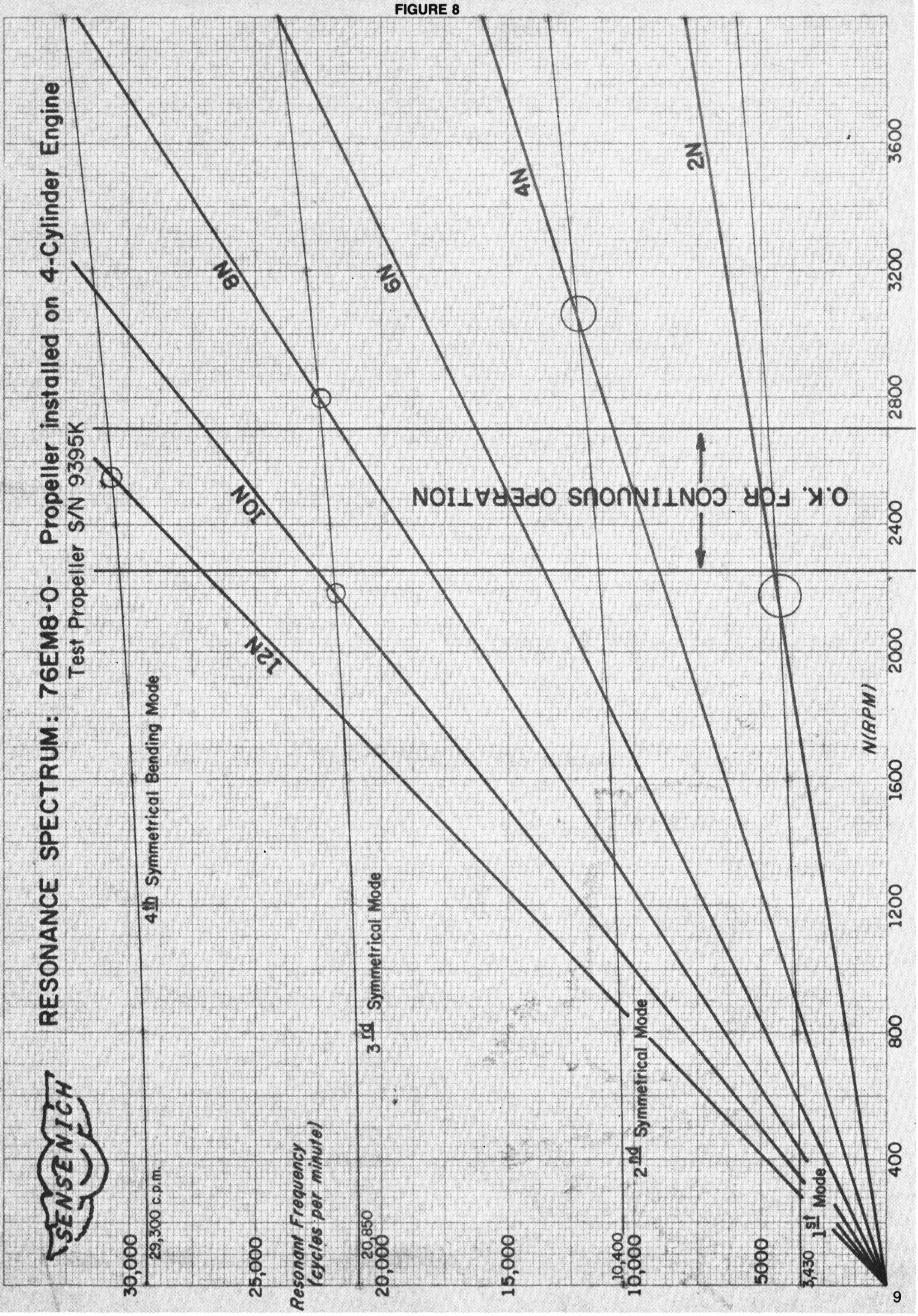
DO

1. Have your propeller installed by an A.&P. mechanic. For convenience, the proper installation bolt torque is shown on the blade decal near the hub. Always have blade track checked after the hub bolts are tightened. **Note:** Every propeller is accurately balanced at the factory. If the propeller-engine combination feels rough in flight, ask your mechanic to remove the propeller, rotate it 180 degrees on the engine crankshaft flange, and re-install. Again check blade track. If the blades track, this will verify trueness of the crankshaft flange.
2. Inspect the blades of your propeller before each flight for nicks, cuts, and stone bruises. Have minor repairs* promptly performed by an A.&P. mechanic. **If a crack is discovered, THE PROPELLER MUST BE IMMEDIATELY REMOVED FROM SERVICE.**
3. Have major repairs* performed by an FAA Certificated Propeller Station or by the factory.
4. Conform to applicable RPM limitations and periodically have your tachometer checked for accuracy.
5. Frequently wipe the propeller blades clean with an oily rag. This oily wipe will remove corrosive substances, and the oily residue will repel water and corrosives.
6. The recommended flight-time between reconditioning for your Sensenich fixed-pitch metal propeller is One Thousand hours **PROVIDED IT HAS NOT RECEIVED PRIOR DAMAGE REQUIRING IMMEDIATE ATTENTION.** This accomplishes the removal of fatigued surface metal and the accumulation of small nicks and cuts too numerous to be repaired individually.

DO NOT

1. Permit installation of a propeller unless it is the model approved under the Aircraft Type Certificate and has been obtained from a reliable source. **Beware** of a propeller of unknown service history.
2. Push or pull on the propeller when moving an aircraft by hand.
3. Run up your engine/propeller over loose stones or gravel.
4. Paint over corroded or damaged blades. This hides the defect and may deter needed repair.
5. Permit repair of blade damage by peening or welding. **These practices will lead to early blade failure.**
6. Fly your aircraft under any circumstance before a thorough inspection by qualified personnel if the propeller has been subjected to impact.
7. Have your propeller straightened except by an FAA Certificated Propeller Repair Station or the factory: Even partial straightening of blades for convenience of shipping to a repair station may cause hidden damage which, if not detected, could result in the return to service of non-airworthy propeller. **Report anything of this nature before repair is initiated.**

FIGURE 8


SENSENICH
RESONANCE SPECTRUM: 76EM8-O- Propeller installed on 4-Cylinder Engine
Test Propeller S/N 9395K
4th Symmetrical Bending Mode
3rd Symmetrical Mode
2nd Symmetrical Mode
1st Mode
29,300 c.p.m.
20,850
10,400
3,430
Resonant Frequency (cycles per minute)
30,000
25,000
20,000
15,000
10,000
5000
12N
10N
8N
6N
4N
2N
O.K. FOR CONTINUOUS OPERATION
400
800
1200
1600
2000
2400
2800
3200
3600
N(RPM)

Several IAC members who returned the T.S. propeller questionnaire passed along "propeller tips".

One member advised of a fretting problem between the spinner and forward support "causing much loss of metal to surface". This was on an S-1C Pitts but it may be an area to check closely on all a/c.

A Pitts S-1S owner advised that most of his operation was below 3400 rpm. (0-360 Lycoming, 76-56 Sensenich) He said that 180 IAS (std. day) gave around 3300 rpm and noted that **small** increases in speed above 180 gave **large** increases in rpm.

Another member advised that he kept his prop well waxed and after each flight he would apply a fresh coat of wax to the leading edge. He said that this was especially important in a climate like Miami. And, he further stated that if he did not wax the prop after each flight, on the following day there would be salt crystals along the leading edge. Apparently good preventive maintenance paid off for this member for when he exchanged his prop for a new prop, the people at Sensenich allowed him **more** credit toward a new prop than they had originally quoted him over the phone.

Another Pitts owner advised that after a brief initial test flight following the rebuilding of his a/c (0-360 Lycoming, 76-60 Sensenich) he leaned against the prop spinner and noticed that it moved slightly. Checking further he discovered a small gap between the prop and crankshaft flange. This was a new prop on the plane and the bushing holes in this prop were not as deep as the holes on the former prop thus the new prop was not seated against the crank flange. A good point for all of us to check when changing propellers.

Previously, an IAC member advised of prop bolts "losing" their torque because of the soft aluminum spinner bulkhead against which the bolt heads seated, and had, with time and vibrations, extruded out from under the bolt heads. In earlier correspondence with Sensenich on this problem, they advised using large flat washers to more evenly distribute the load. One IAC member recommended making a 4130 steel insert for aluminum spinner bulkheads. He said he had made this modification to several aerobatic aircraft that he had worked on and it is a proven fix. The IAC T.S. Committee tried, without success, to locate an old propeller service letter which advised removing the soft aluminum "Standard of the Nation" Continental nameplate from under propeller mounting bolts because of the same bolt loosening effect when the aluminum "mushed" out from under the bolt. This is another good check point/area for all of us to examine.

***** ***** *****

Some unsolicited, but very much appreciated, response to the January 1979 prop service life article came from Hoffmann Propeller. Their letter stated:

"We read with interest your comments of propeller service life in the January 16 Issue of the *Sport Aerobatics* magazine.

"We are producing since 25 years now our fixed pitch wooden Composite propellers and a lot of them are used in acrobatic airplanes. The German champion, Manfred Strössenreuther, was using our propeller during flying his Pitts S1 with great success.

"You probably know that the Zlin Z 50 is using our 3-bladed propeller HO-V 123. Also, the Russians are using wooden blades on their Yak 50 airplanes.

"Enclosed you will find report E 167 about some ideas of props for acrobatic flying. We enclose also leaflets of the HO-V 92 propeller. Kermit Weeks is flying the HO-V 123, now also appearing in your area and the fixed pitch Composite propeller, well known also in the U.S.

"If you have any question on the subject, please don't hesitate to contact us."

The Hoffmann Pitts fixed pitch and HO-V 123 prop info is shown in FIGURES 9 and 10. The following is Hoffman Report E 167 on Propellers For Aerobatic Flight which all IAC'ers should find very interesting and FIGURE 11 is a schematic of an accumulator used in conjunction with Hoffmann constant speed props.

PROPELLERS FOR ACROBATIC FLIGHT

"1) Fixed pitch as well as variable pitch propellers are available with metal and wooden-composite blades and are used on different airplanes, performing acrobatic flight maneuvers. Extreme high loads in the blades and the hub are the results of high power, high RPM and rapid changes of attitude. Consequently, the life of such propellers, using load carrying metal parts, is limited due to fatigue and overstress.

"2) Two different flight missions are used with different results to the propeller life. The training flight with limited flight maneuvers and lower acceleration forces and the competition acrobatic flight with all possible positive and negative 'g' forces within the structural limits of the airplane. There are no special designed propellers for the extreme part of the flight envelope. This means, that standard propellers are used, after tests, showing acceptable safety figures, on both types of missions.

"3) All propellers, used on airplanes for competition acrobatics, are also installed in airplanes for training purposes. Therefore, the following information is applicable to both, but in view to the high performance competition acrobatic planes. The operation philosophy in acrobatics has been changed in the past, too. Some years ago, it was normal to use fixed pitch propellers with pitch for climb and power reduction in 'down' maneuvers to avoid overspeed with altitude compensation in 'up' maneuvers, because of the high thrust of the 'climb' propeller. When airplanes appeared, using high speeds for extreme vertical 'up' maneuvers, this philosophy was no longer practical. The situation today is, that fixed pitch props are used with a moderate pitch to avoid heavy overspeed during speed pickup for vertical 'up' maneuvers resulting in a smaller amount of altitude loss because of the higher efficiency at high speeds, from coarser blade angles. Some operators of airplanes with variable pitch propellers have increased the max. RPM setting beyond the normal rating.

"4) The most critical condition to propeller life is **OVERSPEED**. The increase of **centrifugal forces** with the square of RPM is creating damage to the material and in consequence reducing life. If 2700 RPM is 100%, the load only from centrifugal forces is 80% at 2400 and 125% at 3000, at 3800 the CF is 200% and exact the design requirement, without any vibratory and bending loads, and they are existent.

Vibrational loads from resonances, resulting in blade stresses far beyond the design load limits for

fatigue stress can occur, especially on propellers with RPM restriction placards.
Bending loads from the gyroscopic forces acting on blades, hub and structural parts of the engine, engine mount and airframe. These loads will increase also with the square of RPM.

"5) Now the difference starts between metal and wood-composite blades:
Centrifugal forces at f.i. 2700 RPM are for an existing metal blade approx. 175 000 N (38,500 lbs.) and for the similar wood-composite blade approx. 98 000 N (21,500 lbs.).
Vibrational loads are extreme on some 4-cylinder non-dampened engines beyond 2700 RPM with metal propeller. On fixed pitch wooden composite props as well as on composite blades in variable pitch props, no problem exists up to 3000 RPM. One reason is the excellent internal dampening characteristics of wood.
Gyroscopic forces of wood-composite blades in comparison with metal blades are only approx. 50% from metal blades.
Weight difference is great between wood-composite and metal props. In the 200 HP range, the metal fixed pitch prop weighs 17,3 kg (38 lbs.), the wood-composite fixed pitch weighs 10,8 kg (24 lbs.), incl. mounting kit.
The Hoffman 3-blade prop weighs with its wood-composite blades approx. the same, 24,6 kg (54 lbs.) as a comparable 2-blade prop with metal blades. 2-blade Hoffman props with composite blades are approx. 2 kg (4 lbs.) lighter than with original metal blades.

"6) The previous part discussed loads and life, for both fixed and variable pitch propellers as well as desired/accepted overspeed.
This section should introduce the pitch control philosophy of variable pitch propellers no matter what type of blade used.
The requirement of controlling RPM via blade pitch to avoid undesired overspeed is clear. The solution is simple: Oil pressure in the engine has to be maintained in all attitudes.
With some inverted oil systems, maintaining engine oil pressure is not always possible under certain flight attitudes, such as 90° bank. Also, during transition between figures with zero g, oil supply might be interrupted. In these cases the propeller governor cannot maintain constant speed because of the continuous leak between the oil transfer means to the propeller. A pitch change is the result.

"7) One philosophy says that in case of oil pressure loss the propeller blades should go into high pitch to avoid overspeed. This is basically true. But what happens if the oil pressure is coming back? The governor signal is "underspeed" and the prop blades will be pushed against low pitch stop with the result of momentary overspeed.
The other (Hoffmann) philosophy says oil pressure has to be maintained with the propeller system all the time. Therefore, we recommend the installation of an accumulator which, in fact, can maintain for a certain time oil pressure in the propeller system. In this case non-counterweighted props can be used together with the acceptance that 10% overspeed can be tolerated for a short moment.
The accumulator system is used with success on both counterweighted and non-counterweighted propellers. It probably can be improved by using check valves to avoid the oil flow back to the engine or larger volume accumulators or installation of such an accumulator direct into the engine lubrication system.

"8) TBO, the magic figure.
Nobody would expect from a racing car engine that it will last 100,000 miles because of the extreme operational characteristics. A similar situation exists with acrobatic flying, especially competition acrobatics. The standard TBO ranges between 500 and 1000 hrs. for the metal propeller. Hoffmann variable pitch props are limited to 500 hrs. when used in competition acrobatics. Hartzell says unofficially also 500 hrs. The only one exception are fixed pitch Hoffmann wooden Composite-propellers with no specified TBO, but those should be maintained 'on condition'.
For safety reasons it seems to be practical to make an annual tear down inspection when the flight season is over."

***** ***** *****

As noted in the beginning of this article, we did not accomplish our intended goal of establishing the aerobatic service life for fixed-pitch aluminum propellers. However, it is apparent that very much useful technical safety information relating to propellers has come about because of the January 1979 *Sport Aerobatics* prop article. IAC owes a very large thanks to the members who did submit their propeller questionnaires, a very special thanks to Sensenich Propeller Engineer Robert E. Bristol for his critique of the January 1979 prop article and the info on anodizing/corrosion, and a very special thanks to Hoffmann Propeller Chief Engineer Gerd Mühlbauer for his interest and concern and all the information relating to propellers for aerobatic use. Thanks to all who contributed.

INTERNATIONAL AEROBATIC CLUB
Experimental Aircraft Association
I.A.C. ®

FIGURE 9

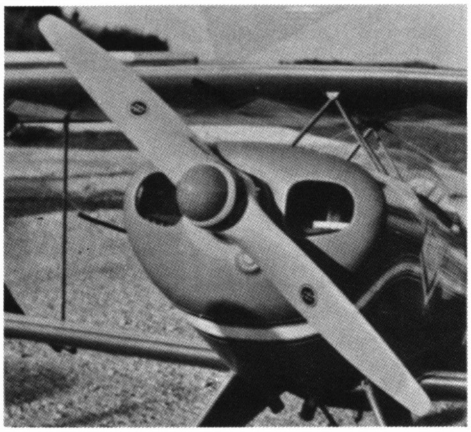
PROPELLERWERK HOFFMANN ROSENHEIM

Kuepferlingstraße 9 · Postfach 265 · D-8200 Rosenheim 2
Tel. (08031) 32011 · Telex 05-25811 HOCO D

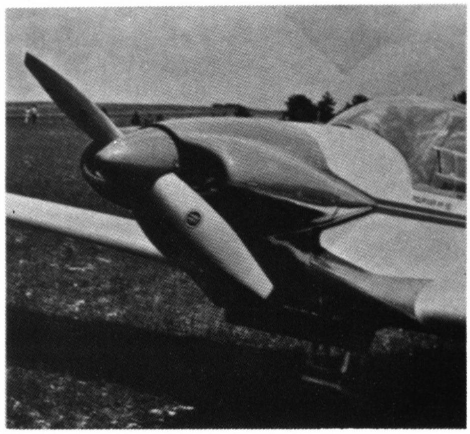
HOFFMANN-COMPOSITE-PROPELLER

Feste Propeller der Baureihen HO ( ) – und HO ( ) HM –

Fixed Pitch Propeller Models HO ( ) – and HO ( ) HM –



Pitts S 1 S



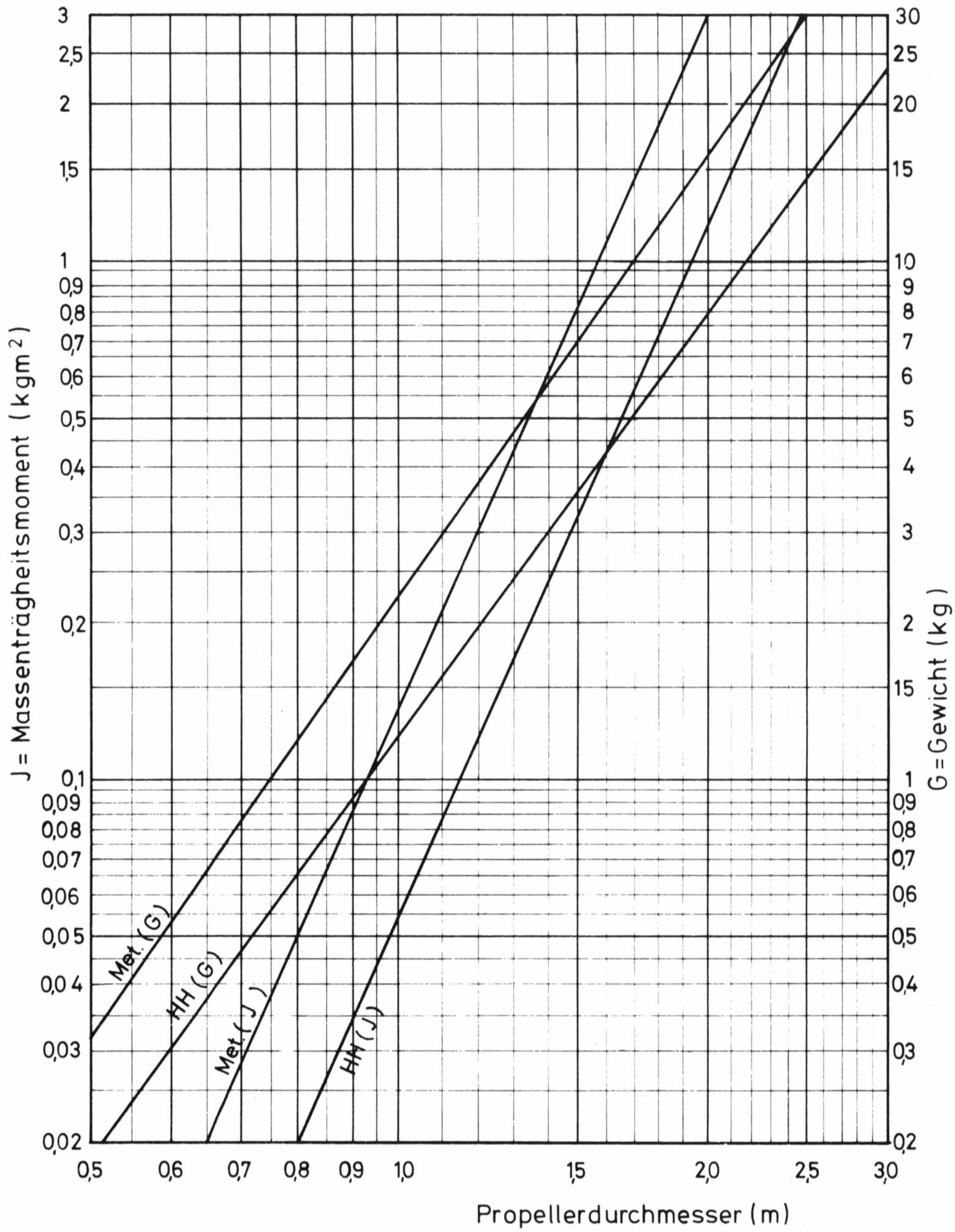
Sportavia RF 5 B

Material: Material:	Hartholz, in Lagen verleimt Hardwood glued together
Kantenschutz: Tipping:	Messing oder Edelstahl, vollständig in das Profil eingebettet Brass or stainless steel totally integrated into the airfoil
Oberfläche: Surface:	PUR-Lack, Baureihen HO ( ) HM zusätzlich Epoxi mit GFK-Mantel PUR-lacquer, model HO ( ) HM additionally with glass fibre epoxy covering
Anwendung: Use:	Sportflugzeuge, Boote, Schlitten, Luftkissenfahrzeuge, Leistungsbereich bis ca. 250 kW Light Aircraft, Boats, Sledges, Hovercraft, power range up to approx. 400 hp

Besondere Vorteile:
Special advantages:

1. Geringes Gewicht Low weight	Geringes Trägheitsmoment, siehe Diagramm auf der Rückseite. Low moment of inertia, see diagram on backside.
2. TBO – Grundüberholungszeit TBO – time between overhaul	Keine Begrenzung! Unbeschädigte Propeller können unbegrenzt im Betrieb bleiben, siehe Betriebs- und Wartungshandbuch. No limits! Undamaged propellers may remain in service unlimited, see owner's manual.
3. Reparaturfreundlich Easy to repair	Abgebrochene Spitzen können ersetzt werden. Der Kantenschutz kann ausgewechselt werden. Broken tips can be replaced, the tipping can be replaced.
4. Unveränderter Wirkungsgrad nach Reparaturen Efficiency remains unchanged after repair	Die Blattdimensionen bleiben bei jeder Überholung erhalten. Dimensions of the blade remain unchanged.
5. Schwingungsdämpfend Vibration dampening	Keine Gefahr plötzlicher Blattbrüche wie bei Leichtmetall. Keine gesperrten Drehzahlbereiche. No danger of sudden blade failures. No restricted RPM-range.
6. Unempfindlichkeit gegen Kerben Not sensitive against nicks	Keine Gefahr plötzlicher Blattbrüche. No danger of sudden blade failures.
7. Sicherheit bei Überbeanspruchung Safety at overloads	Schäden sind frühzeitig erkennbar durch Risse in der Oberfläche. Damages are visible in an early stage because of cracks in the surface.
8. Motorschonung bei Bodenberührung Careful treatment of the engine in case of groundstrike	Brechende Holzspitzen schaden dem Motor weit weniger als der schwere Schlag eines Metallpropellers. Cracking of wooden propeller tips are causing much less damage to the engine than the heavy hit of a metal propeller

Massenträgheitsmomente, Gewichte zweiblättriger Propeller



J = Massenträgheitsmoment
Moment of inertia

D = Propellerdurchmesser
Propeller diameter

G = Gewicht
Weight

MET = Metall
Metal

HH = Hartholz
Hard wood

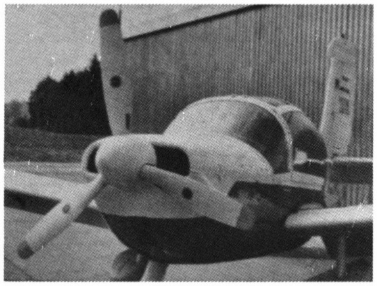
FIGURE 10

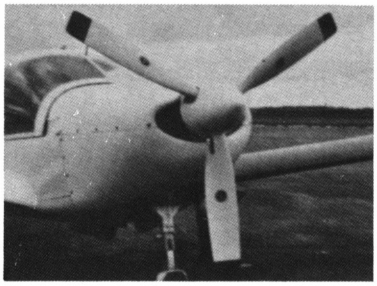
PROPELLERWERK HOFFMANN ROSENHEIM

Küpferlingstraße 9 · Postfach 265 · D-8200 Rosenheim 2 · Telefon (08031) 32011 · Telex 05-25811 HOCO D
Banken: Bayer. Vereinsbank Rosenheim (BLZ 71120077) Konto 3831256 · Dresdner Bank Rosenheim (BLZ 71180005) Konto 2406111
Postscheck: München 9038-802

HO-V 123

HYDRAULISCHER VERSTELLPROPELLER
Constant Speed Propeller, hydraulically controlled





Nabe: Dural
Hub: Aluminum alloy

Blätter: Holz - Composite mit GFK und Metallbeschlag
Blades: Wooden - composite with fibreglass and metal tipping

Einzelheiten:
Details:

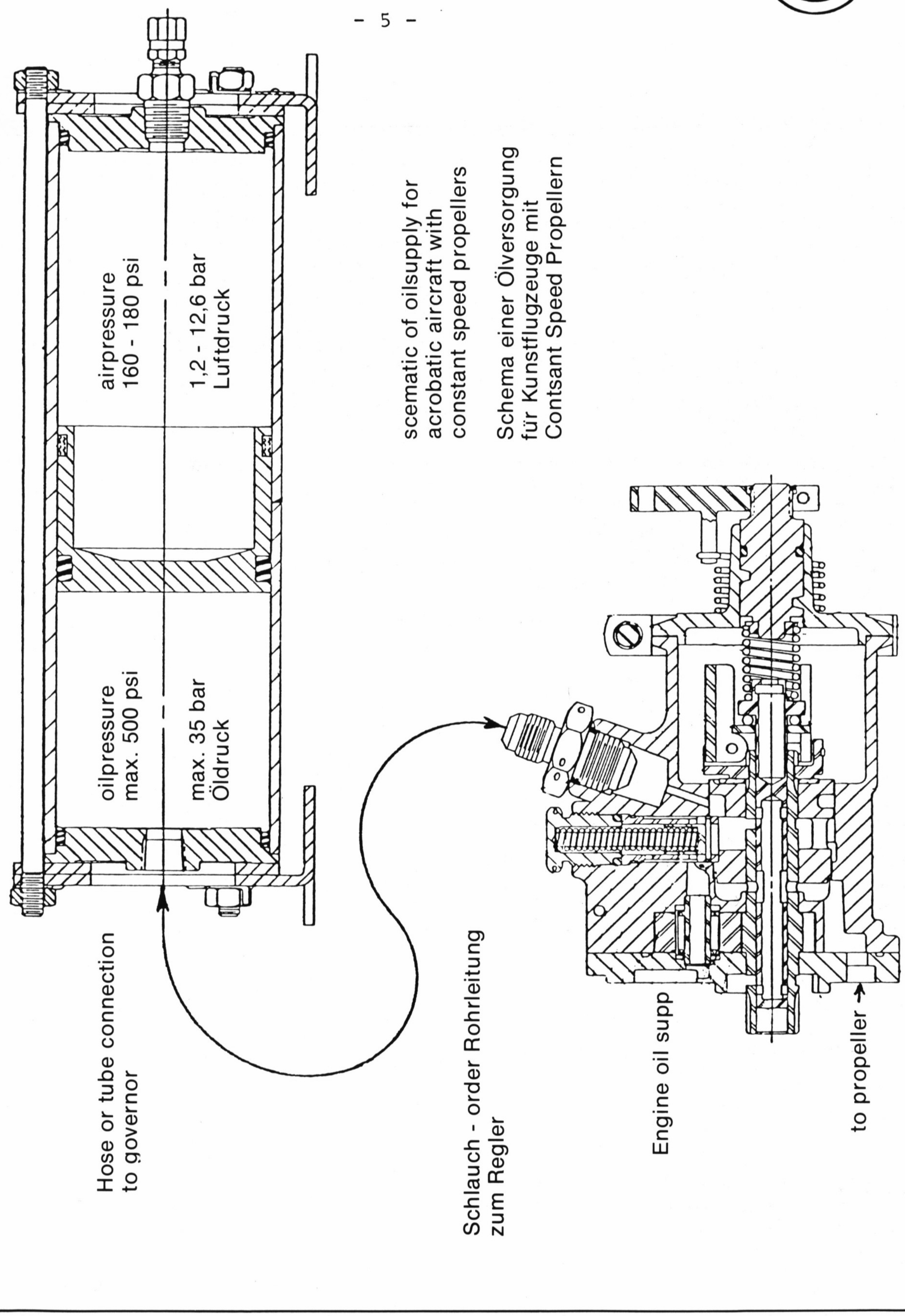
N max ca	: 320 PS
n prop max ca	: 2800 $\frac{1}{\text{min}}$
Blattzahl Number of blades	: 3
Durchmesser max. (abhängig von Drehzahl) Diameter (depends on RPM)	: ca. 230 cm
Verstellbereich für konstante Drehzahl Pitch range constant speed	: ca. 20°
Verstellbereich für Segelstellung Pitch range constant speed and featherring	: ca. 70°
AF wählbar AF as desired	: 80-140
Polares Trägheitsmoment mit Blättern s. u. Polar moment of inertia with blades as below	: 0, 1845 mkp · s^2
Gewicht mit Blättern 200 cm Ø, AF 123 Weight with blades	: 22, 9 kg
Gewicht der Haube Weight of spinner	: 1, 7 kg
Propeller-Regler, Woodward Propeller governor, Woodword	: 210 6xx Serien

Einbauzeichnung: siehe Rückseite
Installatindrawing: overleaf

FIGURE 11

PROPELLERWERK HOFFMANN ROSENHEIM

Küpferlingstraße 9 · Postfach 265 · D 8200 Rosenheim 2 · Telefon (08031) 32011 · Telex 05 25811 HOCO D



BENDIX
Airworthiness Directive
Volume I

79-21-08 **BENDIX ENERGY CONTROLS DIVISION:** Amendment 39-3593. Applies to the below listed fuel injection systems installed in aircraft certificated in all categories:

Model No.	Parts List No.
RSA-5AB1	2524199-9, 2524216-8
	2524254-7, 2524262-6
	2524378-7, 2524712-3/-5/-6
RSA-5AD1	2524054-7/-8, 2524147-9/-10
	2524171-7/-8, 2524189-7/-8
	2524213-7/-8, 2524242-6/-7
	2524243-7/-8, 2524291-7/-8
	2524297-6/-7, 2524307-6/-7
	2524328-6/-7, 2524341-6/-7
	2524348-7/-8, 2524359-6/-7
	2524450-5/-6, 2524459-5/-6
	2524475-4/-5, 2524550-4/-5
	2524575-4/-5, 2524590-4/-5
	2524592-4/-5, 2524623-4/-5
	2524634-4/-5, 2524640-4/-5
	2524673-4/-5, 2524682-4/-5
	2524723-4/-5, 2524742-4/-5
	2524752-3/-4
RSA-7AA1	2524347-4/-6
RSA-7DA1	2524624-1/-2
RSA-10AD1	2524030-7/-8, 2524152-6/-7
	2524163-10/-11, 2524175-6/-7
	2524255-6/-7, 2524256-8/-9
	2524311-6/-7, 2524757-3/-4
RSA-10DB1	2524267-6/-7, 2524275-11/-12
	2524276-7/-8, 2524593-4/-5
	2524649-6/-7
RSA-10DB2	2524501-5/-6, 2524708-4/-5
RSA-10ED1	2524273-8/-9, 2524298-8/-9
	2524366-6/-7, 2524420-7/-8
	2524422-5/-6, 2524477-7/-8
	2524491-5/-6, 2524492-4/-5
	2524500-5/-6, 2524556-5/-6
	2524582-4/-5, 2524601-4/-5
	2524693-4/-5/-6/-7, 2524709-3/-4
	2524733-3/-4
RSA-10ED2	2524791-1/-2/-3

These fuel injection systems are installed on, but not limited to, the engine models listed below:

Lycoming	IO-320 Series	IO-540 Series
	AIO-320 Series	HIO-540 Series
	AEIO-320 Series	AEIO-540 Series
	IO-360 Series	IGO-540 Series
	HIO-360 Series	IVO-540 Series
	AIO-360 Series	TIO-540 Series
	AEIO-360 Series	TIO-541 Series
	TIO-360 Series	TIGO-541 Series
	IGO-480 Series	IO-720 Series
Continental	TSIO-520-L	
	TSIO-520-LB	
	TSIO-520-WB	

Compliance is required within the next twenty-five (25) hours of aircraft time in service, or within the next thirty (30) calendar days from the effective date of this AD, whichever occurs first.

To prevent a fuel flow cutoff to the engine and subsequent loss of power, inspect the lock nut for proper engagement and crimp the stem in accordance with the following Bendix Energy Controls Division Service Bulletins:

1. Service Bulletin No. RS-68 dated August 20, 1979 applicable to the Series RSA-5 and RSA-10 models;
2. Service Bulletin No. RS-69 dated August 20, 1979 applicable to the RSA-7AA1 model; or
3. Service Bulletin No. RS-70 dated August 20, 1979 applicable to the RSA-7DA1 model.

This amendment becomes effective October 24, 1979 as to all persons except those to whom it was made immediately effective by the airmail letter dated August 28, 1979, which contained this amendment.

BELLANCA
Airworthiness Directive
Volume I

79-22-01 **BELLANCA:** Amendment 39-3596. Compliance is required within the next 30 days or 10 hours of aircraft time in service, whichever occurs first, after the effective date of this AD, unless already accomplished. To prevent exhaust system cracking, accomplish the following on Bellanca Model 7ECA (S/N 985-74 thru 1319-79), 8KCAB (S/N 120-74 thru 550-79 equipped with Lycoming AEIO-360 series engine), and 8GCBC (S/N 1-74 thru 323-79) aircraft:

1. Remove the upper and lower engine cowling.
2. Inspect exhaust system with particular attention to the welded area between the riser tube and the exhaust flange, for cracks, fractures or evidence of exhaust leakage. Remove the heater shroud and inspect the muffler body for cracks, fractures or evidence of exhaust leakage. If any exhaust system component is cracked or otherwise damaged, remove the exhaust system and repair/replace damaged parts in accordance with FAA Advisory Circular 43.13-1A.
3. Loosen exhaust port stud nuts several turns; check bead clamps for tightness such that the clamps cannot rotate on the exhaust system with hand pressure. The riser flanges (1) must have equal spacing to the exhaust port pad at both studs (a small amount of flange bow is acceptable), (2) must be free to move up and down on the exhaust port studs without binding and (3) must all contact the exhaust port pads together.
4. If any of the alignment checks are unsatisfactory, determine the cause for the misalignment and repair or replace the part as required.
5. Assemble exhaust system and install on engine with loose exhaust port stud nuts and bead clamp bolts. Torque exhaust port stud nuts to the correct value. Tighten bead clamp bolts until clamps secure risers to exhaust system but allow clamps to rotate with hand pressure; the bead clamps **should not be rigidly clamped to the tubes** but should be able to rotate on the tubes with moderate hand pressure on the clamp assembly.
NOTE: Torque all exhaust port stud nuts evenly and tighten bead clamp bolts evenly to insure uniform loads within the exhaust system parts; torquing bolts individually can cause very large stresses.
6. Inspect exhaust system for proper clearance between ducts, wiring, controls, etc. before reinstallation of the cowling. Install lower cowling and inspect for proper clearance between exhaust outlet and cowl.
7. Reinstall the lower and upper engine cowling.

Bellanca Service Letter Number C-138 covers this same subject.

Any equivalent method of compliance with this AD must be approved by the Chief, Engineering and Manufacturing Branch, FAA, Great Lakes Engine.

This amendment becomes effective October, 29, 1979.

AIRCRAFT OF THE WORLD CHAMPIONSHIPS

By Don Berliner
Photos by Author

The 1980 World Aerobatics Championships will be mainly a contest among pilots. But it will also be a contest among airplanes. For without the best of airplanes, the best pilots are severly handicapped.

As the competition grows stiffer, the need for superior equipment increases dramatically. Once upon a time, a stock Zlin was enough. In the early days of the World Championships, good pilots bravely flew Tiger Moths and Stampes and Jungmeisters. And as long as no one had a significantly better airplane, then no one really needed anything out of the ordinary.

But that has changed for good. Today, as much effort is going into the development of better and better airplanes, as is going into the perfection of flying skills. You may not agree with the philosophy, but it's happening.

In the last World Championships, there wasn't a standard, old-style Zlin among the top 30 in the Men's standings, or anywhere at all in the Women's. The top 9 men and all 13 women flew airplanes which had been developed in just the past few years. And who has the courage to buck such a strong trend?

There are four main airplanes which have been chosen by the top pilots in recent Championships: Laser 200, modified Pitts S-1S, Yak-50 and Zlin 50-L. Add to this the CAP-20L and the Acrostar and you have a set of flying machines which neither look nor act much like the classic craft of bygone years. With a little bit of luck, we should be seeing all of them at Oshkosh.

ZLIN 50-L

This is the latest development from the world's busiest aerobatic airplane factory. Located in Otrokovice, Czechoslovakia, it has been turning out successful competition airplanes since 1946 . . . well over 2,000 of them.

It all began with the Zlin 26, winner of a nationwide design competition. It was a tandem two-seater of mixed wood and metal construction, and was powered by a 105 hp Walter Minor straight-four engine. The Z-26 had a fixed-pitch wood prop and an inverted fuel system.

Zlin 50-L of the Polish Team.

Zlin 526AFS of the Hungarian Team.

From the '26 there was a steady stream of improvements. The Zlin 226 Trener placed second in the 1956 Lockheed Trophy contest, and then a 226 won the 1957 Lockheed, which was the first series of international competitions and was held in Britain from 1955 through 1965. Other Zlins carried pilots to Lockheed wins in 1958, 1961, 1963, 1964 and 1965.

The first World Championships, in 1960, saw Ladislav Bezak win with a Zlin 226. The second sent to Jozsef Toth in a Zlin. The third went to Tomas Castano in a Zlin 326. And the fifth saw Peter Kahle win in a Zlin 526A. In the Biancotto Trophy contests (more or less the European Championships), Bezak won in a Zlin 526 in 1965, Neil Williams won in a 526 in 1967 and Kahle won in a 526 in 1969.

But as the 1970's dawned, the Zlin factory's latest 526AFS wasn't enough. It had less wing and more power and bigger ailerons than its predecessors. But its rival was a chubby little biplane from south Florida that was quicker, lighter and more powerful. The steady drop from the heights told the Zlin engineers that something had to be done if they were ever to regain their high ranking.

The "something" turned out to be the Zlin 50-L. It wasn't just another improvement on the old theme, but an entirely new airplane. All metal . . . spring gear . . . 260 hp Lycoming . . . three-blade Hoffmann constant-speed prop . . . blown bubble canopy . . . 30 sq. ft. of ailerons.

The Zlin 50-L was introduced at Kiev in 1976 amid a flurry of rumors that had it doing astounding things in an aerobatic box. The truth, as is so often the case, turned out to be considerably less than rumor. But it was — and still is — a potent competition airplane, capable of all the maneuvers in Count Aresti's catalog, and with an initial roll rate which is almost beyond belief.

Wingspan — 28' 1¾"
Length — 21' 9"
Wing Area — 134½ sq. ft.
Empty Weight — 1,257 lbs.
Aerobatic Weight — 1,588 lbs.
Rate of Climb — 2,350 ft./min.
Maximum Level Speed — 180 mph
Takeoff Distance to Clear 50' — 650'

The Zlin 50-L is expected to equip the teams from Czechoslovakia, Poland, Romania and any other Eastern European countries that participate. There will be one with the West German Team.

YAK-50

The distinctive Soviet aerobatic airplane is a direct descendant of the standard military trainer of the post-war era — the Yak-18. It first appeared in a contest in 1960, when a Soviet pilot flew a Yak-18P to fifth place. Two of the Soviet pilots flew Zlins that year, but ever since then, they have always flown Yaks.

The Yak-18 developed into the lightened and more powerful Yak-18PM in 1966, and then the tail-dragger Tak-18PS in 1970. By 1972, all the Soviet pilots were in this lightest version.

After the four-year gap between the 1972 and 1976 World Championships which gave everyone time to create new airplanes, the Soviet Team appeared with the current Yak-50. At first glance, it looked almost exactly like the Yak-18PS, but turned out to be not only smaller, but more powerful. Moreover, the flat-bottomed airfoil of the Yak-18 had been replaced with one having a cambered undersurface. And the old radial engine had been replaced by a 360 hp Ivchenko M-14P.

Ever since the Soviets entered international competition in 1960, they have consistently flown airplanes that are larger and more powerful than anyone else's. They regularly have trouble staying in the box, but show no sign of changing their philosophy. The Yak-50 is a surprisingly nimble airplane, in view of its size, but is reported to have a 200-hour air frame life.

Getting information about new Soviet aerobatic designs is about like getting data on the latest improvement to the MIG-25 Foxbat: You have to wait until they're ready to show it off in public before they even admit that such a machine exists. Rumors during the 1978 World Championships focussed on a possible Yak-55, which is supposed to look like a Yak-50, but with a fixed landing gear and mid-mounted wing . . . sort of a Laser-Yak. One of the Soviet women pilots was wearing a T-shirt with a cartoon of such an airplane, complete with the word "aerobatic" in English.

Wingspan — 31' 2"
Length — 25' 2"
Wing Area — 161 sq. ft.
Empty Weight — 1,685 lbs.
Aerobatic Weight — 1,980 lbs.
Rate of Climb — 3,150 ft./min.
Maximum Level Speed — 185 mph
Take-off Distance to Clear 50' — 650'

Yak-50 of the Soviet Team.

CAP-20LS-200

The French entry in the aerobatic design race displays the obvious signs of its having arisen from the drawing board of Claude Piel, who is responsible for such popular homebuilts as the Emeraude, as well as the successful CAP-10 two-seat aerobatic trainer.

The CAP-20 first made its existence known in the 1970 World Championships, though it was over-shadowed by other new designs. At that time, it was just too much airplane for its 180 hp Lycoming to toss around the sky effectively. By 1972, the entire French Team had CAP-20's, but they were basically the same as the prototype, and simply not very competitive.

This was as obvious to the French as to everyone else, and so a major effort was begun to improve the machine. This has resulted in the CAP-20L (for "leger", meaning lightweight). Still entirely wooden, it has two feet less length, two feet less wingspan, 400 lbs. less empty weight, 20 more horsepower, less dihedral, more vertical tail and bigger ailerons than the prototype. It is clearly a better airplane, but still lacks good snap-rolling characteristics, and has failed to gain on its rivals.

The latest CAP-20LS-200, with a 200 hp Lycoming and Hartzell constant-speed prop, was flown in the 1978 World Championships by the French, and is expected to be flown at Oshkosh by the French, Italians and maybe the Spanish. It may be accompanied by the new CAP-21, which is the same fuselage and tail with a completely new wing which is supposed to snap better.

Wingspan — 24' 10"
Length — 21' 2½"
Wing Area — 112 sq. ft.
Empty Weight — 1,100 lbs.
Aerobatic Weight — 1,435 lbs.
Rate of Climb — 2,550 ft./min.
Maximum Level Speed — 200 mph

HIRTH ACROSTAR

This was the technical hit of the 1970 World Championsips, and is still in a class by itself. Designed by Swissair Capt. Arnold Wagner who had previously competed in a Danish KZ-VIII, it was financed by West German competitor Josef Hossl. Both flew it in 1970, and despite limited testing and practice, Wagner placed fourth behind only Egorov, Herendeen and Hillard.

It is unusual from nose to tail. The engine is a 220 hp, six-cylinder Franklin. The wing spar is fiberglass. The ailerons, flaps and elevator are interconnected like those of some control-line model airplanes, from which the idea was taken. When the stick is pulled back, not only does the elevator come up, but the flaps lower and the ailerons droop for extra lift.

It has an excellent power-to-weight ratio, and fine maneuverability. But there is an obvious lack of lateral area aft, and not even the addition of a ventral fin has not completely cured its tendency to lose directional control at low speed. The Hirth Co. which built about eight Acrostars in West Germany is no longer in business, and so no more can be expected.

The Swiss Team is the strongest supporter of the Acrostar, but others have been used by the West Germans and Spanish. In the sort-of 1979 European Championships, an Acrostar flown by Eric Muller, of Switzerland, was barely edged for first place by a Pitts S-1S.

Wingspan — 26' 3"
Length — 19' 8¼"
Wing Area — 114 sq. ft.
Empty Weight — 990 lbs.
Gross Weight — 1,390 lbs.
Rate of Climb — 3,000 ft./min.
Take-off Distance to Clear 50' — 425'

CAP-20LS-200 of the French Team.

Hirth Acrostar of the West German Team in 1972

PITTS SPECIAL S-1S

What more can be said about this well-known machine? It's the grandchild of Curtis Pitts' 1943-vintage 65 hp midget biplane, with more power, more weight and more ailerons. Stock S-1S will be flown by Teams from Canada, Great Britian, Australia, West Germany, Switzerland and who-knows-where-else. Due to severe governmenet regulations, the modifications now so popular in the U.S.A. have yet to be seen on any Pitts from other countries. But they are inevitable.

Wingspan — 17' 4"/16' 10"
Length — 15' 5½"
Wing Area — 98½ sq. ft.
Empty Weight — 750-800 lbs.
Aerobatic Weight — 1,150 lbs.
Rate of Climb — 2,600 ft./min.
Maximum Level Speed — 175 mph
Take-off Distance to Clear 50' — 1,000'

MODIFIED PITTS SPECIALS

These range from the "standard" modifications of spring landing gear, cleaned-up pressure cowl and bigger vertical tail . . . to the extremes (so far, at least) of Henry Haigh's pioneering "Super Pitts" and Kermit Weeks' radical "Weeks Special". More and more S-1S are getting 200 hp Lycomings, 3-bladed props by Hoffmann of West Germany, and cross-over exhaust systems.

Henry Haigh's machine, which first competed in 1975, is both lighter and cleaner than stock. He went to great lengths to build fairings for every little junction and protruberance, with highly impressive results.

Kermit Weeks took the idea one step further, clipping both wings and sweeping the lower panels. His honest 5½ vertical rolls was the talk of the 1978 Championships. Now, he is hard at work on a new Weeks Special, to be powered by a 310 hp Lycoming and including who-knows-what additional changes to the 37-year old design.

PITTS SPECIAL S-2S

This is the newest idea from the Pitts factory in Wyoming, clearly inspired by all the interest in the Christen Eagle. It is a two-place Pitts S-2A airframe with but a single seat and a 260 hp Lycoming engine. The prototype, with its old-fashioned Pitts landing gear, will be flown by Patti Johnson, while a newer S-2S with factory spring gear will be flown by Tom Collier.

Wingspan — 20'/19'
Length — 17' 9"
Wing Area — 125 sq. ft.
Empty Weight — 1,100 lbs.
Aerobatic Weight — 1,325 lbs.
Rate of Climb — 3,200 ft./min.
Maximum Level Speed — 185 mph

EAGLE 1

This obviously had its origins in the Pitts Specials, but has been developed in a somewhat different direction by Frank Christensen. It is roomier, with a better cockpit layout, and is considerably cleaner than a stock homebuilt or factory Pitts. The single-seat competition version has a 260 hp Lycoming and Sensenich fixed-pitch prop. It will be flown by American alternate pilot Gene Soucy.

Wingspan 19' 11"/18' 10¾"
Length — 17' 11"
Wing Area — 125 sq. ft.
Empty Weight — 978 lbs.
Aerobatic Weight — 1,243 lbs.
Rate of Climb — 2,600 ft./min.
Maximum Level Speed — 189 mph

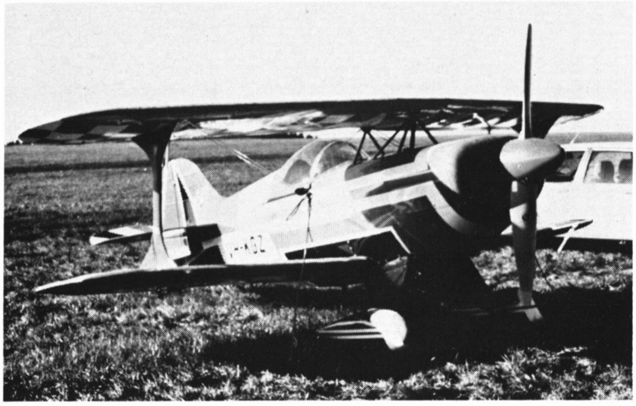
AMERICAN MONOPLANES

This is mainly the tale of Leo Loudenslager's all-conquering Laser 200, which began life as a Stephens Akro. The changes have been so extensive that you are implored NOT to call it a Stephens. It neither flies nor looks like one. Now with a 3-bladed Hoffmann constant-speed prop on its 200 hp Lycoming, it performs as well as any aerobatic airplane in history.

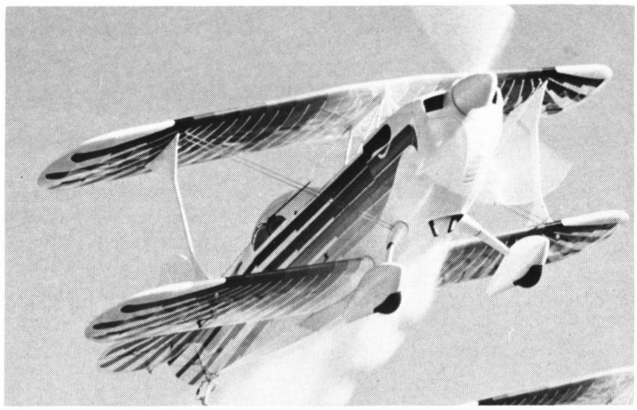
Wingspan — 24' 6"
Length — 20'
Wing Area — 99.8 sq. ft.
Empty Weight — 842 lbs.
Aerobatic Weight — 1050 lbs.
Rate of Climb — 2700 ft./min.
Maximum Level Speed — 205 mph
Take-off Distance to Clear 50 ft. — 500 ft.

Another American monoplane is Henry Haigh's "Super Star". It has less development time than the Laser, but has profited considerably from Leo's experience. Henry flew it to 8th place in the 1978 World Championships with, unbeknownst to him, a cracked spar. It has since undergone major changes including a new, stronger wing, and may be flown by current U.S. Champion Haigh at Oshkosh.

Yet another variation on the Stephens Akro theme



Pitts S-1S (stock) of the Australian Team.



Christen Eagle

that may be seen at Oshkosh is the Stephens built by 1972 U.S. Team mechanic Nick Mardis and now owned by Bob Mitchell of the British Team. He had major modifications planned for this past winter, and could start a European trend.

Bernie the Quill's Terrific Super Deluxe Acro Special

This is 1980's long-awaited dark horse! In order to maximize intrigue and encourage espionage, few details will be revealed at this time. But you can count on something genuinely different, to the point of total irrationality.

We have been permitted to reveal that it will probably be powered by a stock 1938 Pontiac six, which will be fueled with Fresca and equipped with a one-bladed folding prop having almost no weight or structural rigidity.

Despite rumors to the contrary, it will almost certainly have wings, though their number, location, construction, planform and airfoils have not yet been finalized, as the designer considers such matters to be frightfully boring.

In a marked departure from common practice, this daring and fascinating craft will employ wing-warping instead of ailerons. Then again, it may end up with ailerons on one side and wing-warping on the other, because the engineer in charge of flight control design isn't very good at making decisions.

First test flights of totally new designs seem to make a lot of people nervous, and so this phase of development is to be skipped. Instead, some raw materials and a lot of used parts will be shipeed directly to Oshkosh, where they will be assembled and flown during the first really good party.

No construction drawings will be made available to amateur builders (or to the guys in the shop, for that matter). But if you want to draw your own and sell them to each other, go right ahead.

Bob Mitchell's American-built Stephens Akro.

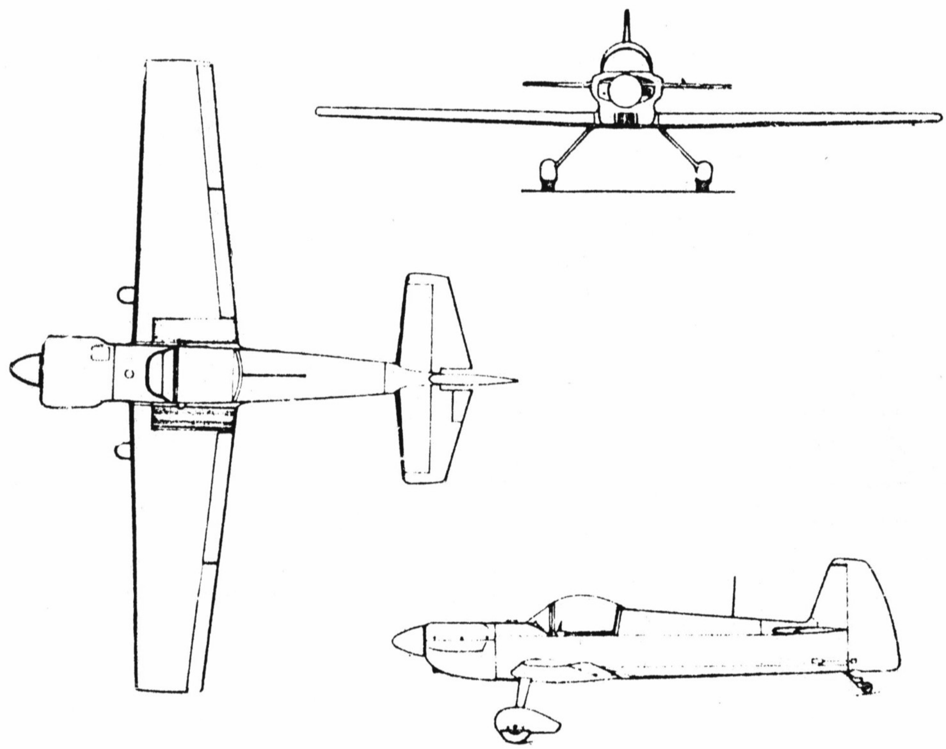
Leo in his famed Laser 200

CAP-21

Below is an addition to "Aircraft of the World Championships" by Don Berliner featured in March Sport Aerobatics.

The latest development of the CAP series is the CAP-21, which contains more changes than previously rumored. Its wing not only has a more nearly symmetrical airfoil, but less area, greater span and a tapered planform similar to that of the Laser. Nothing is known of its performance, as it was only in the early stage of testing when we went to press.

Wingspan — 26' 6"
Length — 21' 2½"
Wing Area — 99 sq. ft.
Empty Weight — 1,045 lbs.
Aerobatic Weight — 1,320 lbs.



AIRWORTHINESS DIRECTIVE'S SLICK MAGNETOS

February 4, 1980

Pursuant to the authority of the Federal Aviation Act of 1958, delegated to me by the Administrator, the following Airworthiness Directive (AD) is issued and applicable to all owners and operators of aircraft with magnetos manufactured by Slick Electro, Inc., Rockford, Illinois with model and serial numbers as follows:

MODEL NO.	RANGE OF APPLICABLE MAGENTO SERIAL NUMBERS*
447	9040001 thru 9040049
447R	9040001 thru 9040049
662	9020462 thru 9070000
662R	9020462 thru 9070000
664	9040001 thru 9040086
664R	9040001 thru 9040086
680	9020462 thru 9070000
680R	9020462 thru 9070000
4151	9020017 thru 9070000
4151R	9020017 thru 9070000
4152	9020017 thru 9070000
4152R	9020017 thru 9070000
4181	9020017 thru 9070000
4181R	9020017 thru 9070000
4201	9020210 thru 9070000
4201R	9020210 thru 9070000
4230	9040001 thru 9040197
4230R	9040001 thru 9040197
4251	9030001 thru 9070000
4251R	9030001 thru 9070000
4281	9030001 thru 9070000
4281R	9030001 thru 9070000
6210	8090073 thru 9070000
6214	8050001 thru 9070000

*Any magneto serial number between and including the lower and upper numbers shown are affected by this AD.

These magnetos are installed on, but not limited to, the following engines:

LYCOMING	AEIO-360
	AEIO-320
	IO-320
	O-235
	O-320
	O-360
CONTINENTAL	A-65-8
	A-75-8
	C-85-8
	C-90-8
	O-200
	O-200-A
	O-300-A, -B, -C, -D
	O-470
	O-470-U
	IO-360-KB
	IO-470
	IO-520-A, -B, -F
	TSIO-470
	TSIO-520
	TSIO-520-T

This directive is effective immediately upon receipt of this letter.

There have been incidents in the field that have resulted in magneto failures caused by rivets with reduced strength properties. Hardness of rivet is to be determined as follows. Action requires a comparative metal hardness test procedure on the impulse coupling assembly to determine if the rivets that retain the pawl counterweights have been properly heat treated. Compliance as indicated. To prevent failure of the referenced Slick Magnetos, accomplish the following:

Prior to the next ten (10) hours of aircraft time in service, or within the next (30) calendar days from the date of this AD, whichever occurs first, complete the following comparative metal hardness test procedure:

1. Remove the impulse coupling magneto(s) from the engine, and then remove the impulse coupling assembly from the magneto frame per appropriate maintenance and overhaul instructions.
2. Establish a reference level for metal hardness by sliding the flat surface of a fine cut mill file over the flat surface of either of the pawls. File will only burnish hard surface of pawl.
3. By a similar filing action, test for hardness of the two rivet heads.
4. If material is removed from the rivet head during filing, the rivet has not been heat treated, and the coupling assembly must be replaced. Return the defective coupling assembly to a Slick Electro, Inc. distributor.
5. If hardness of the rivet heads and pawls are equivalent, reassemble and identify AD compliance by metal stamping a letter "C" on the Slick insignia located on the left side of the magneto identification plate.

If the results of the comparative hardness test on the rivet(s) are questionable, the coupling assembly must be replaced.

A special flight permit may be issued in accordance with FAR 21.197 to fly the aircraft to a base where the inspection may be performed.

WILLIAM S. DALTON
Acting Director, Great Lakes Region

FOR FURTHER INFORMATION CONTACT:

Cornelius Biemond, Engineering and Manufacturing Branch, AGL-217, Flight Standards Division, FAA, 2300 East Devone Avenue, Des Plaines, Illinois 60018, telephone (312) 694-4500, extension 460.

LUSCOMBE AIRWORTHINESS DIRECTIVE Volume I

79-25-05 **LUSCOMBE** (LARSEN LUSCOMBE): Amendment 39-3630. Model 8 Series, certificated in all categories. Compliance is requried as indicated, unless already accomplished.

a. Within the next 10 hours time in service from the effective date of this AD, accomplish the following:

(1) Remove the vertical stabilizer forward attach fitting, P/N 28444 or 28453, from the airplane.

(2) Using a dye-penetrant method, inspect the fitting for cracks around the aft flanges which attach to the vertical stabilizer. If cracks are found, replace the fitting with an approved serviceable part before further flight.

b. Within the next 100 hours time in service after the inspection in item a, and at intervals not to exceed 100 hours time in service thereafter, remove the vertical stabilizer fairings and visually inspect the aft flanges of the vertical stabilizer forward attach fitting, P/N 28444 or 28453, for cracks. If cracks are found, replace the fitting with an approved serviceable part before further flight.

This Airworthiness Directive does not apply to airplanes with steel fittings installed.

An equivalent method of compliance may be approved by the Chief, Engineering and Manufacturing Branch, FAA, Southern Region, P.O. Box 20636, Atlanta, Georgia 30320.

This amendment is effective December 17, 1979.

CITABRIA AILERON HINGE BRACKET

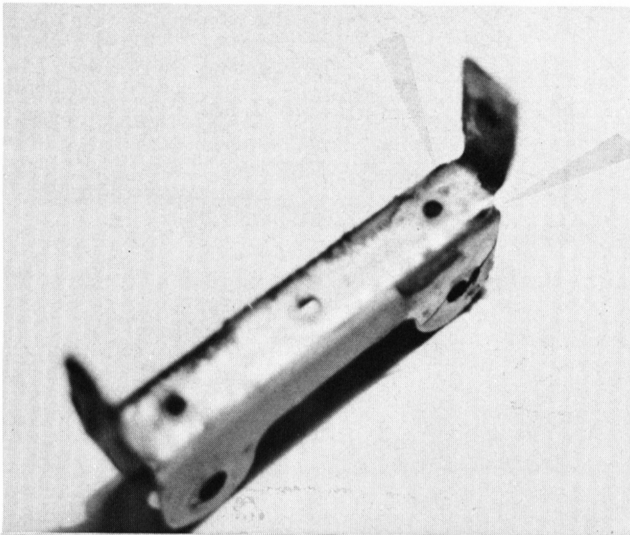
An IAC member just recently forwarded the following report to the IAC Technical Safety Committee:

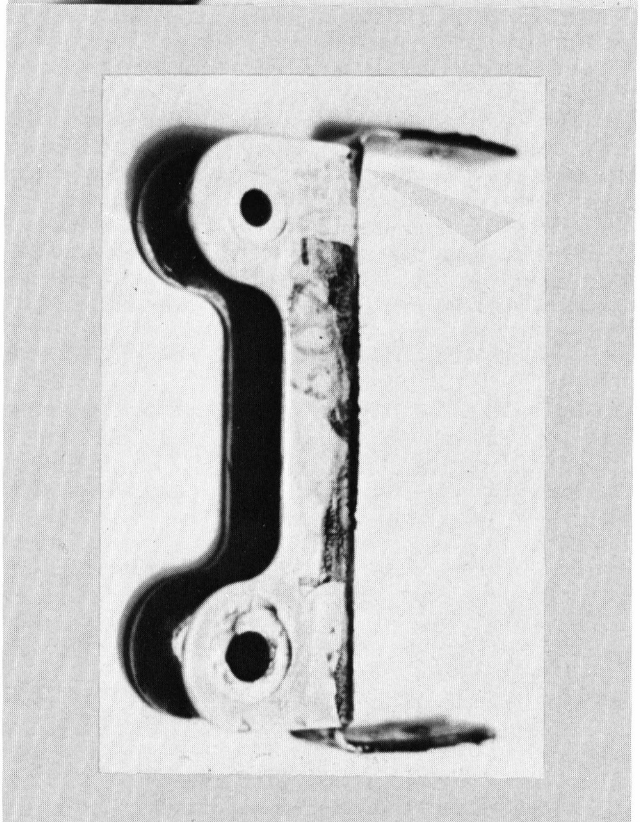
"The right aileron hinge of my 1975 Citabria 7KCAB developed two cracks, requiring replacement. This may have been initiated by flapping during a storm, when the controls had not been locked; and, therefore, may not be fairly classified as being due to normal flying. Nevertheless, I felt you should know so that others would be warned (1) to lock their controls when parked, and (2) to inspect their aileron hinges for cracks." (See accompanying photographs and FIGURE 1.)

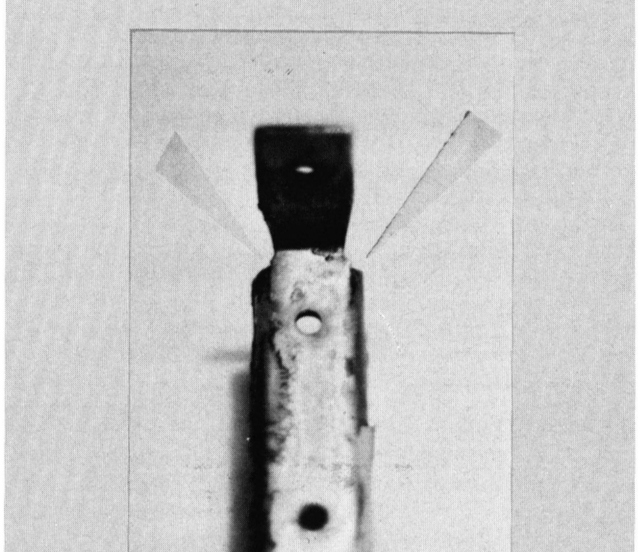
This "member" of the IAC T.S. Committee not only submitted the above report but also forwarded the broken inboard aileron hinge. The hinge was subsequently stripped and magnafluxed and two more cracks — at the end of the bracket opposite the first two noted (larger) cracks — were discovered. Bellanca Chief Engineer Andy Vano was contacted on this matter and he advised there have been no problems with aileron hinge breakage and felt, as mentioned in the above report, that the damage was probably due to the wind slamming the unsecured control surfaces. Note also that IAC M&D files have no other reports of Citabria or Decathlon aileron hinge damage. Later, the hinge fracture was studied under a high power microscrope and it appeared to be an overload fracture as opposed to a fatigue fracture. This evidence kind of supports the "wind damage" theory.

It is suggested that all IAC Citabria pilots make a thorough inspection of the aileron hinges on their a/c. If any problems are uncovered, please make an immediate report to the IAC T.S. Committee.

Many thanks to the IAC member who submitted the report (including photographs, part numbers, and the broken part) which was the basis of this T.S. article and to Bellanca Engineer Andy Vano for his usual interest and help. The purpose of the IAC T.S. Program — the pooling and sharing of technical/safety information — is truly exemplified above.







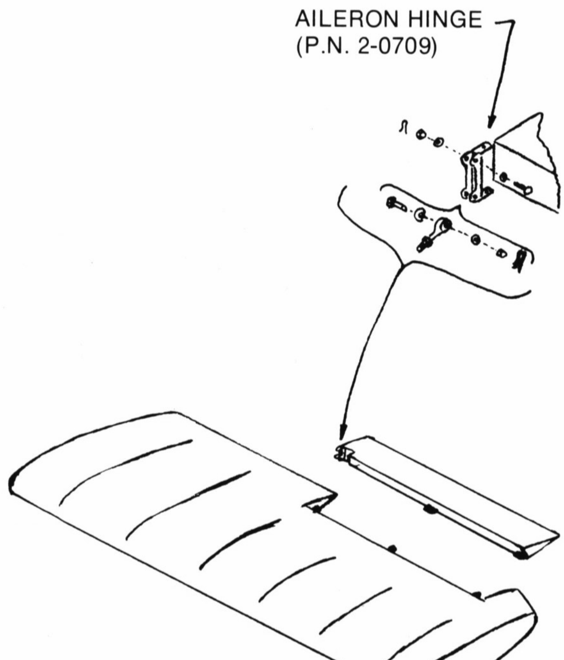


FIG. 1

AIRCRAFT C.G. AND MEAN AERODYNAMIC CHORD

By Jim Young, President
and
Dan Rihn, Chief Engineer
Worldclass Aerobatics, Inc.

A question often asked during any gathering of aerobatic pilot is, "How much does your aircraft weigh?" It's a good question for we've all seen how important it is to have a light fuel/pilot/aircraft package powered by high horsepower. But have you ever thought of walking up to a competitor and asking, "By the way, where is your competition C.G. on your mean aerodynamic chord?"

Well, dropping a question like that just before someone buckles up for their shot at the box might be thought of as psyching out the competition. But in fact, the location of the competition C.G. on the mean aerodynamic chord of the wing can be more important than the operational weight of an aircraft for a given size engine.

Now let's try to clear the fog and explain just what we're talking about. First, as you fly your competition sequence, your aircraft's wing or wings are creating three forces: aerodynamic lift, drag, and pitching moment. Everyone knows about the lift created by the wings and the resultant aerodynamic drag, but what about the pitching moment force? Let's take a look at a classic diagram from our private pilot's text:

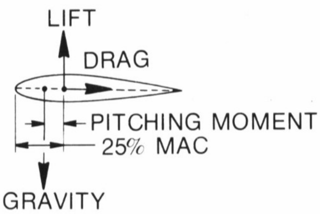


FIGURE 1

1. The straight dotted line drawn from the center of the leading edge to the trailing edge is called the Aerodynamic Chord.
2. The Aerodynamic Center is that point on the Aerodynamic Chord at which the force of lift and drag act. The Aerodynamic Center is usually at the 25% point on the chord line aft from the leading edge of the airfoil.

For every wing or combination of wings, there will be an imaginary aerodynamic chord line that will represent the mean position of all of the component airfoil stations on the aircraft. This is the Mean Aerodynamic Chord (MAC) and its Aerodynamic Center is the mean center of lift of the aircraft. Now if the competition C.G. lies forward of the Aerodynamic Center there is a positive pitching moment force. The aircraft is positively stable in the pitch axis and will tend to seek level flight.

Well, for the hot stick who has no interest in engineering what does it mean if his competition Belch Fire Special has positive pitch stability? Well, it means the pitch axis stick forces will be heavier; a clean stall into a spin and a clean, tight snap roll will be more difficult to achieve; more of the aircraft's energy will be dissipated in the pitch to the vertical; and the radius of the pitch will be greater. It means that for this aircraft there will be less energy to project the vertical line once the vertical is established and it will be tougher to fly a tight sequence with sharp corners that establish the horizontal quickly.

If the aircraft C.G. falls aft of the Aerodynamic Center there is a negative pitching moment; the aircraft is negatively stable and will tend to go flat in a spin and stay flat. Locating the aircraft C.G. at the Aerodynamic Center is the configuration to aim for. One caution though, doing so is fine for competition but be careful when you load in the luggage aft of the pilot for the cross country to the contest. You may find yourself flying with a difficult to manage negative pitch stability.

Now before the aerodynamicist in the audience leaves New Balance prints all over these humble authors, this is a simplified evaluation as we have not taken into consideration the effect of the lift from the horizontal tailplane upon the final Aerodynamic Center point on the Mean Aerodynamic Chord. But suffice it to say, the 25-26% point of the aircraft's Mean Aerodynamic Chord is the best placement of the competition configuration C.G.

Now let's get down to cases. How do you figure where your aircraft's MAC is so you can calculate what percent of the MAC your C.G. is flying at during competition? Finding the MAC on a constant chord, straight wing monoplane like the Citabria or Decathlon is easy. The MAC, in this case, is the same as the actual wing chord, Figure 1, and is located halfway to each wing tip from the aircraft's centerline. To calculate the percent of the MAC that you're flying at, first, calculate the competition C.G. in inches aft of the datum. Subtract from this number the distance that the leading edge of the MAC lies from the datum. Divide the resultant number by the length of the MAC, multiply by 100 and you have the percentage of the MAC you're flying at in competition.

A swept wing aircraft of constant chord is measured the same way, see Figure 2. A taper wing type aircraft is slightly more difficult as seen in Figure 3. The biplane configuration requires you to find both upper and lower wing MAC leading edge points. Measure the distance between these two points; half of this is the point where the MAC representing both wings can be plotted and then compared to the aircraft competition C.G. This, of course, assumes that both wings have the same chord, as with the Pitts series aircraft.

Well, there you have it, you're ready to charge about the ramp spouting commentary about aircraft C.G. and MAC. As this is our first theory article, Worldclass Aerobatics, Inc. would like to announce that each month we hope to present a pure theory article such as this for education, discussion, and counterpoint development. We think the WHY can be as interesting as the HOW, and it will make all of us sharper enthusiasts, designers, and competitors.

BIPLANE CONFIGURATION (Pitts Type)
*Swept Upper Wing
*Straight Lower Wing
*Upper and Lower Wings With Equal Chord

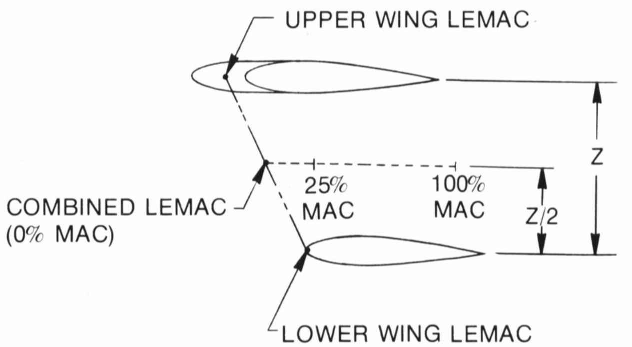
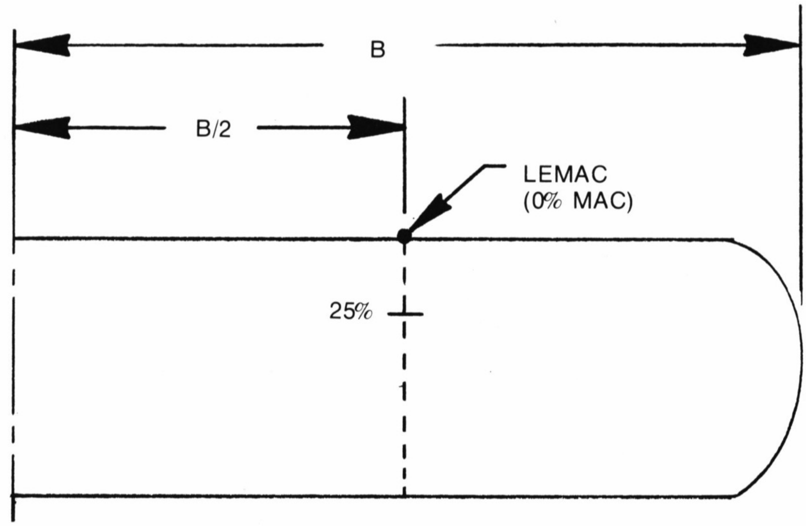
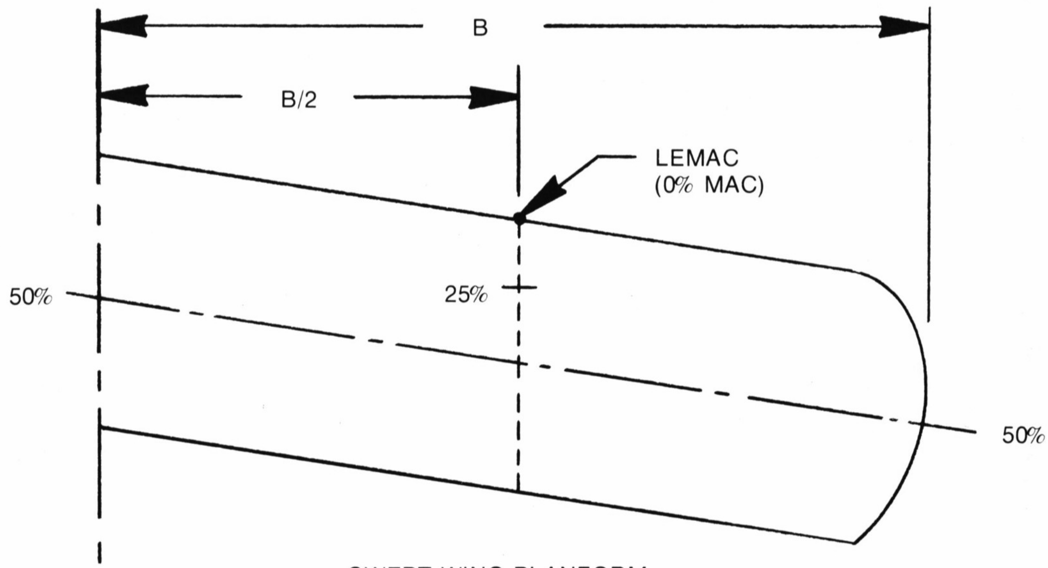


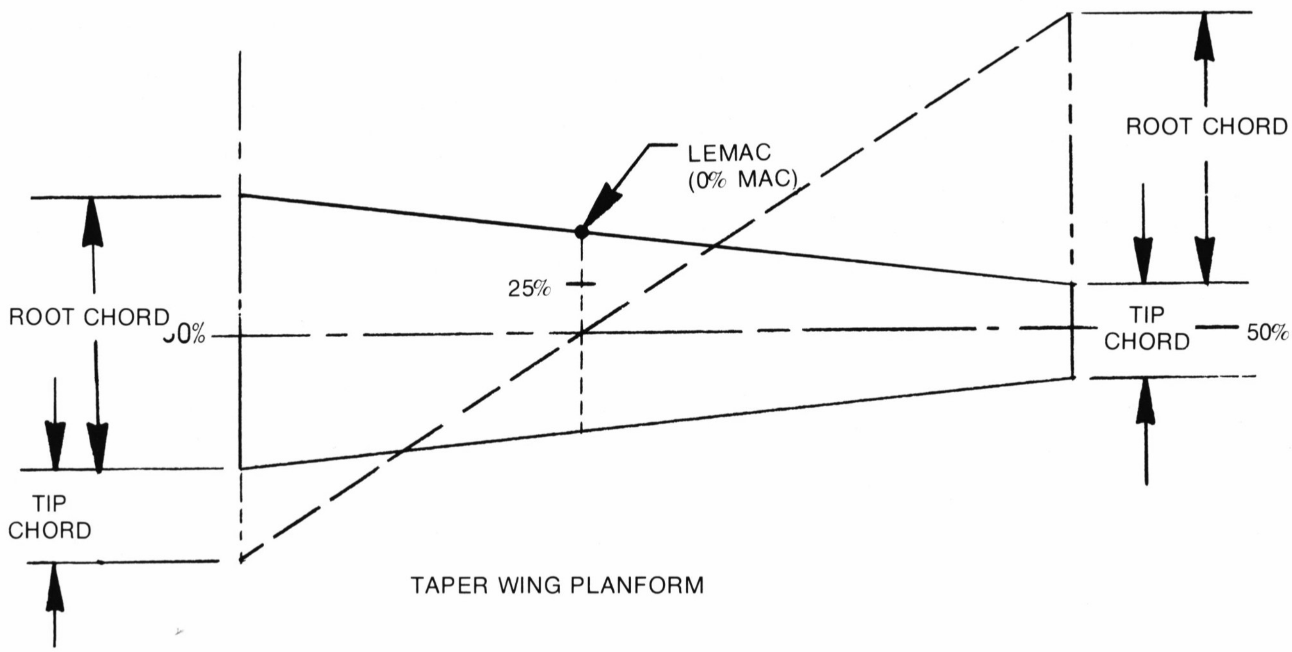
FIGURE 2



STRAIGHT WING PLANFORM



SWEPT WING PLANFORM



TAPER WING PLANFORM

FIGURE 3

COOL IT

The following Technical Safety field report submitted by an IAC member concerns a possible commonly overlooked problem.

BAFFLE STRIPS

"With the high rpm's and temperatures experienced by engines on aerobatic aircraft it is essential that the designed cooling process be kept in operating condition at all times. A hammerhead turn at full throttle and zero airspeed is not conducive to good engine cooling.

"The top rear baffle strip on some flat engines, which takes the full force of the ram air blast, will sometimes fold back and cause the air to spill over the accessory section instead of circulating around the cylinders.

"The strip is folded forward when the top cowl is closed to trap the air, however, with time and if the strip has been cut too short it will eventually fold back causing the engine to sustain heat otherwise dissipated by the cooling air flow.

"The fold back can be avoided by insuring that there is enough underlap of the baffle strip when the top cowl is closed or a stiffer material can be used. A quick fix can be realized by installation of a bracket in back of the strip and bent forward to insure that the curve is maintained.

"Conversely, when your practice session has finished the tightly cowled engine will trap the air and maintain heat for a prolonged period. It is good practice to open the side cowls immediately after deplaning to allow the engine heat to escape.

"The condition of your engine baffles is every bit as important to the life of your engine as maintaining normal oil pressure.

"So, next time you raise the top cowl to check the oil take a look at the position of the baffle strips to insure that you are not cooking on the front burner."

As a complement to the above report, the following engine cooling information from the August 1978 issue of the EAA Designee Newsletter (reprinted from **The London Flyer**, London Flying Club of Canada, London, Ontario) should be of interest to IAC members.

ENGINE COOLING

"The early engines were velocity cooled. These engines had little if any baffling and cooling was entirely dependent on the velocity of air flowing over the cylinders. Cooling on the ground was accomplished by the propeller and in flight, forward motion provided the necessary air flow.

"Velocity cooling left something to be desired in that it did not provide uniform air flow around the entire cylinder assembly. By this we mean that as the air flow passed over the first 2/3's of the cylinder, the air would remain in contact with the cylinder and dissipate the heat properly, but the last 1/3 of the cylinder lacked the air flow contact on the rear side of the cylinder. Therefore, the heat was not removed properly and the area developed a 'Hot Spot'.

"However, this type of cooling was satisfactory for these early engines. The compression ratios went up and rpm's increased, so did the amount of dissipated heat that had to be removed from the engine; therefore, the velocity method was no longer adequate enough to cool the engine. Cowlings were then placed around the engine and baffles installed between the cylinders and cowlings.

"The baffling installed on the engine guided the cooling air completely around the cylinder heads and barrels. Other baffles channel cooling air into oil radiators and cooling ducts for various accessories. Rubber seals were provided along the cowling edges of the baffling. These seals were very important since they provide the necessary airtight seal between the baffling and the cowling, therefore developing a new type of cooling called Pressure Cooling.

"The way that this cooling system works is that the air is forced through the cowling's air inlet by the prop during ground operation, or by ram air from forward movement or flight. The cooling air 'piles up' inside the top portion of the cowling creating a pressure and it is this pressure that forces air around the cylinders and through the desired routes provided by the baffling.

"Once again we must stress that every baffle and its seal must be in its proper position in order to obtain that 'Pressure' and cool the engine properly. If the engine is not cooled properly damage to the engine will occur in the form of broken piston rings, scored pistons or cylinders or perhaps lead to a premature overhaul.

"Here are a few rules to remember while operating the airplane on the ground to ensure proper cooling and care for the engine.

"1. Always face the plane into the wind when running up — it helps.

"2. Avoid prolonged or unnecessary run-up.

"3. Avoid high power run-ups except when absolutely necessary for maintenance checks and then only as long as necessary.

"4. When high power run-ups are necessary be certain you idle the engine for a few minutes prior to shutdown. This will remove the excess heat developed during the high power running.

"5. Always open all cowl flaps and cooling devices during run-up.

"6. Don't ever run an engine up under high power with the cowling removed.

"7. During a walk-around or if you have the cowl off and you are about to put it back on, check to see if the baffle tapes or seals are facing the proper direction; they should be facing 'in' towards the center of the engine."

Many thanks to the IAC'er who submitted the "Baffle Strip" report. It is only through input such as this that the IAC Technical Safety Program operates. Thanks again.

BELLANCA SERVICE LETTER C-139A

SUBJECT: Inspection Wing Rib/Spar Attachment and Leading Edge Support Block Nails

AIRCRAFT AFFECTED: Part I deals with the inspection of wing rib/spar attachment nails and applies to Bellanca (including Champion) Model 7 and Bellanca Model 8 aircraft as indicated below.

Model 7GC, 7GCA, 7GCB, 7GCBA, 7HC, 7KC, 7KCAB: All Serial Numbers.

Model 7ECA: Serial Number 1 thru 1350-80
7GCAA: Serial Number 1 thru 396-80
7GCBC: Serial Number 1 thru 1213-80
8KCAB: Serial Number 3-70 thru 638-80
8GCBC: Serial Number 1-74 thru 355-80

Part II deals with the inspection of leading edge support block nails and applies to Bellanca Model 8KCAB, Serial Number 3-70 thru 638-80.

COMPLIANCE: Bellanca recommends that the inspection presented herein be accomplished (1) within the next 60 days or 20 hours of flight time for aircraft with more than 100 hours total flight time and (2) at the next and subsequent 100 hour/annual inspections for all aircraft regardless of flight time as serialized above. If the inspection conducted per the procedures presented in Part I of this Service Letter determines that repair is required, the repair must accomplished (1) prior to further flight if the inspection determines that there is spar damage; or (2) within the next 30 days or 10 hours of flight time if the inspection determines that there is no spar damage, with aerobatic flight (acrobatic model aircraft) prohibited during this time.

INTRODUCTION

Bellanca has received a few reports of the rib/spar attachment and leading edge support block nails loosening and backing out of the spar. Tests indicate that this problem may occur when the aircraft are subjected to very high loads combined with high ambient temperatures and/or prolonged low moisture conditions.

The rib/spar nails transmit the wing normal loads from the ribs to the spars. If the rib/spar nails become loose, these loads will be transmitted by other means in such a way that prolonged use may cause spar damage. If the leading edge support block nails become loose, the leading edge may buckle during high loading conditions; repeated buckling will eventually cause the leading edge to crack at the buckle.

The inspection presented herein is not a substitute for a complete 100 hour/annual inspection of the entire wing including rib/spar attachment nails at other locations of the wing.

PART I: RIB/SPAR NAIL INSPECTION

Remove the wing inspection covers at the wing station in the vicinity of the strut attachment just aft of the front spar and slightly ahead of rear spar. If the covers are not installed, cut out the fabric inside of the inspection rings.

Inspect the rib/spar attachment nails on the three ribs nearest the strut attachment (i.e., rib nearest the strut and ribs on both sides of same). The nails are located on the aft face of the front spar and the forward face of the rear spar and can be viewed with an inspection mirror through the above inspection holes. The nails should be tight against the rib flange.

If one or two nails in a single rib are more than 1/32 inch out but less than 1/8 inch out, tap the nails back into the spar.

If three or more nails in a single rib are more than 1/32 inch out or any nails are out more than 1/8 inch or are missing, remove the nails in that rib and inspect the spar as described below; replace the nails in that rib with 14 gauge ringed nails as described in Service Kit No. 273: Rib/Spar Nail Repair.

If all the nails in the three ribs nearest the strut attachments are secure (both spars, both wings), the Part I inspection is complete. If any nails in the three ribs nearest the strut attachment are loose, the inspection must be continued inboard and outboard until two consecutive ribs do not have any loose or missing nails. Additional inspection holes will be required; cut the inspection holes so they may also be used to accomplish the repair.

If the nails in any rib must be replaced per the above criteria, inspect the spar for damage after the nails are removed per the following procedures.

1) Inspect the top and bottom of the spar in the plane of the rib for damage resulting from abrasion by the rib web. The spar must be repaired or replaced if the abrasion has broken the wood grains in the spar completely across the spar and more than 1/16 inch into the spar.
2) Inspect the spar for nail hole elongation damage by pushing a standard 16 gauge nail in each existing hole (starting with all nails in that rib removed) one hole at a time and moving the rib up and down relative to the spar. If the nail can be inserted at least 1/2 inch into the spar with hand pressure and if it is possible to move the rib up and down ± 1/16 inch with moderate hand pressure, the spar must be inspected further by moving the rib and looking at the nail hole directly. Nail holes which have elongated such that wood grains are broken more than ± 1/16 inch at the surface require that the spar be repaired or replaced.

Note that the above spar inspection criteria require that the wood grain be broken as indicated. Minor chafing and small indentations are not cause for rejection.

Spar repair and associated rib modifications shall be accomplished in accordance with AC 43-13: Acceptable Methods, Techniques and Practices, or other Federal Aviation Administration approved data. Please contact the Bellanca Service Department if spar repair is required.

PART II: LEADING EDGE SUPPORT BLOCK NAILS INSPECTION

Inspect the upper outside surface of the wing approximately 1/2 inch forward of the aft edge of the leading edge skin approximately halfway between ribs for indication of loose or missing nails. A nail is considered to be loose if it is pushing up the fabric more than 1/16 inch or if it has broken the fabric and the nail head is exposed. A missing nail may be identified by inspecting the above area very closely for a small break in the fabric.

If the nails are loose, replace them with nails as specified in Service Kit No. 274: Leading Edge Support Block Nail Repair. If any nails are missing, install Service Kit No. 275: Leading Edge Support Angle, and inspect the entire interior of the wing to locate any missing leading edge support blocks which could cause interference with aileron travel.

CONCLUDING REMARKS

Install the inspection covers and make appropriate log book entries to indicate that this inspection has been accomplished and the necessary repairs complete.

If the inspection conducted per the procedures presented in Part I of this Service Letter determines that repair is required and there is no spar damage, the airplane may be flown provided that all rib/spar nails have been tapped back into place tight against the rib flange and an "ACROBATICS PROHIBITED" placard in 3/16 inch high red-on-white or white-on-red letters is installed in full view of the pilot (aerobatic model aircraft). Remove the placard at the time the aircraft is repaired.

This Service Letter describes procedures which apply to standard production aircraft. It may not apply directly to aircraft which have been field modified. Contact the Bellanca Service Department if you have any questions concerning this Service Letter.

BELLANCA SERVICE KIT 273A

TITLE: Rib/Spar Nail Repair

APPLICABLE MODELS: Bellanca (including Champion) Model 7 and Bellanca Model 8 aircraft as indicated below:

Model 7GC, 7GCA, 7GCB, 7GCBA, 7HC, 7KC, 7KCAB: All Serial Numbers.

Model 7ECA: Serial Number 1 thru 1350-80
7GCAA: Serial Number 1 thru 396-80
7GCBC: Serial Number 1 thru 1213-80
8KCAB: Serial Number 3-70 thru 638-80
8GCBC: Serial Number 1-74 thru 355-80

MATERIALS:

Item	Part Number	Description	Number Required
1	¾" 14 Gauge	Flat Head Steel Annular Threaded Nickel Plated Nail	60
2		Epon 815 with Instructions	Small Quantity
3		Curing Agent U	Small Quantity
4		#18 Needle Syringe	1
5	1-268-1	6" Diameter Patch	10
6	C-139A	Service Letter	1

INSTRUCTIONS:

1) Cut neat round 3½-4" access hole on side of rib opposite inspection access hole for all ribs effected.
2) Remove all nails in effected ribs.
3) Conduct spar inspection as indicated in Service Letter No. C-139A.
4) Mix Epon 815 and curing agent per instructions and fill syringe.
5) Insert syringe into nail hole and inject contents of syringe until epon is visible outside of nail hole.
6) Tap 14 gauge x ¾" flathead steel annular threaded nails into hole.
7) Install 6" patch and finish as required.

BELLANCA SERVICE KIT 274A

TITLE: Leading Edge Support Block Nail Repair

Use to replace leading edge support block nails which are loose but in place including support block.

APPLICABLE MODELS: Bellanca Model 8 KCAB, Serial Number 3-70 thru 638-80

MATERIALS:

Item	Part Number	Description	Number Required
1	1" 18 Gauge	Flat Head Unfinished Steel Nail	20
2		Epon 815 with Instructions	Small Quantity
3		Curing Agent U	Small Quantity
4		#18 Needle Syringe	1
5	1-268-5	1" Diameter Patch	20
6	C-139A	Service Letter	1

INSTRUCTIONS:

1) Remove loose nails, taking care not to disturb wood spacer blocks.
2) Conduct spar inspection as indicated in Service Letter No. C-139A.
3) Mix Epon 815 and curing agent per instructions and fill syringe. Insert syringe into nail hole and inject contents until epon is visible outside nail hole; take care not to disturb wood spacer blocks.
4) Roughen surface of 1" 18 gauge nail with sandpaper and tap into hole.
5) Cover nail with patch and finish as required.

BELLANCA SERVICE KIT 275A

TITLE: Installation Wing Leading Edge Support Angle

Use to replace missing support block and nail combination.

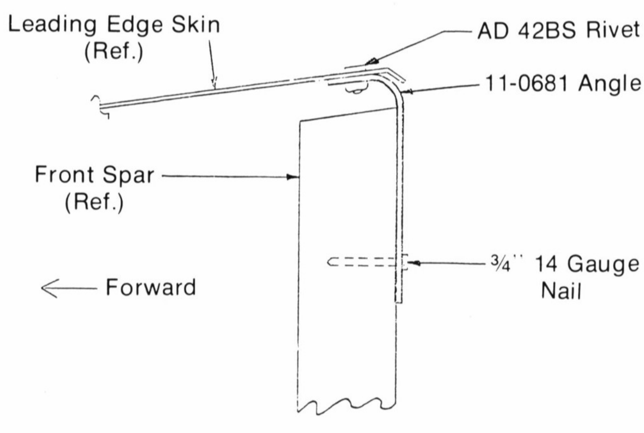
APPLICABLE MODELS: Bellanca Model 8 KCAB, Serial Number 3-70 thru 638-80

MATERIALS:

Item	Part Number	Description	Number Required
1	¾" 14 Gauge	Flat Head Steel Annual Threaded Nickel Plated Nail	20
2	11-0681	Angle-Leading Edge Skin to Spar Attach	20
3	AD42BS	Rivet	20
4	1-268-1	6" Diameter Patch	20
5	1-268-5	1" Diameter Patch	20
6	C-139A	Service Letter	1

INSTRUCTIONS:

1) Cut access hole on lower surface just aft of spar and centered between ribs in those locations where support block and/or nails are missing.
2) Recover all missing leading edge support blocks as indicated in Service Letter No. C-139A.
3) Position 11-0681 angle vertical and flat against spar and centered in line with old nail hole in leading edge skin. Position angle vertical against leading edge skin so as leading edge skin is flat horizontally between ribs. Nail 11-0681 angle to spar with 14 gauge x ¾" nail noted above.
4) Drill #30 (.1285) diameter hole through old nail hole in leading edge skin and through 11-0681 angle. Use care to avoid drilling into spar.
5) Rivet leading edge skin to angle flange with AD42BS rivets.
6) The below sketch shows correct installations of 11-0681 angle.
7) After installing all 11-0681 angles necessary, cover access holes with 1-268-1 6" diameter patch and AD42BS rivet with 1-268-5 1" diameter patch, and finish fabric as required.



CORRECT INSTALLATION OF 11-0681 ANGLE

THE HISTORY OF A PITTS 714 HOTEL

By Bob Davis

I am writing this article to show the continuous maintenance history of one of the highest-time Pitts' in existence and probably **the** highest time Pitts to fly Unlimited.

Pitts 714 Hotel was built in 1967 by Curtiss Pitts for Hale Andrews of Berkeley Springs, W. Virginia. This was the first symmetrical-wing Pitts ever built. Manny Peck, Verne Jobst and I purchased it in 1970 and named it "Tres Hombres". It had accumulated only 120 hours in 3 years but required complete disassembly due to cracked and broken ribs in all three wings. These ribs were the original ¼' cap strip type and, evidently, the sun caused tightening of the doped fabric which resulted in 20 broken ribs. 714 Hotel flew the next three years in Intermediate, Advanced and Unlimited. In 1974 an engine failure resulted, fortunately, in a landing on an airport. This, plus problems other Pitts owners had experienced, led to the decision to completely tear down the airplane for inspection and repair.

One of the first problems was inflight failure of the elevator torque tube due to cracking. The airplane was built with .028 steel while later aircraft were built with .035-4130 steel. This is still an area that should be inspected regularly because it sustains high torque loads when it contacts the aileron stops. Some years back an Unlimited pilot actually **bent** the control stick due to the force exerted when contacting the stops.

In 1974 the leading edges were removed and almost all nose ribs were found cracked or completely broken. Repair for this was detailed in an earlier issue of *Sport Aerobatics*. (See February, 1977 issue, "Technical Safety" article, Page 12. ED.) The lower wing-fuselage attach fittings were badly worn and egg shaped. This was repaired by drilling and reaming a hole from ¼" to 5/16". The lower wing spar fittings were also elongated, so I installed steel bushings. The top wing fittings on both the Cabane and top wing showed no wear.

Moving along, I found the bushing-type elevator and rudder hinges badly worn. I cut them off and replaced them with new hinges with bronze bushings which are still in good shape.

The airplane, at this time, had the standard shock cord landing gear and I found the fuselage attach fittings badly worn.

All parts of the airplane were stripped of paint and inspected, especially in high load-bearing areas. Everything else was alright.

I had a terrifying experience in 714 Hotel in the spring of '75 when the forward horizontal stabilizer spar, which the horizontal stabilizer is attached to, broke in flight. The stub spar has bushings for ¼" bolts which allow adding or subtracting washers to adjust the angle of incidence of the tail. Well, in the case, the weld had been ground away during manufacture to the point that there was no weld metal holding the bushing, and this allowed a crack to develop.

The only work done then until 1979 was the addition of a spring aluminum gear, purchased from Monnett Aircraft. This required extensive modification and strengthening of the first fuselage bay. The airports in Russia are the roughest I have ever seen, so when I returned home I removed the landing gear and inspected the first bay area. I was sure happy to see there was no damage!

714 Hotel has accumulated 1200 hours, 80% of which is aerobatic practice, air shows or competition. It was due to be revamped! I tore it down last winter and shipped the wings to Gil Bodeen in south Florida for his expert modification and inspection. I was concerned about the top wing's center section and fittings, which are not accessible for inspection. Openings were made and both front and back fittings removed. The rear fitting was fine. Paint was removed from the front fitting and it was **cracked and the bolt broken with the head missing!** There was no wood damage and other wing repairs were minor.

On the fuselage, the removable streamlined tube that allows access to the fuel tank was broken at its bottom hole on the back side. This would be difficult to find unless the streamlined tubing was removed.

It appeared the damage to the top wing front fitting and the removable Cabane streamline tubing were related. I made a call to Curtiss about this. A piece of ½' x .049 tubing has been welded between the front and rear fittings to strengthen the Cabane.

Lower fuselage-wing fittings were again found worn and had to be repaired. This is a continuing problem and perhaps removable bushings would allow easy replacement.

There have been a number of reports of airplanes with the spring gear modification with cracked and broken lower longerons. Mine were not.

The last area I found was the forward tube of the left horizontal stabilizer. It was cracked at its attachment point on the fuselage. This apparently was caused by a prop resonance mode acting on the leading edge of the horizontal stabilizer. It can be corrected by installing an additional strut, like the S-2A, or an additional set of tail wires.

714 Hotel is going back together and will be flying soon. I hope this account helps with your inspections and gives some insight into the problems encountered with the S-1 over the years.

Old number 1 has had its share of problems, yet I believe the Pitts is the strongest aerobatic airplane ever built and a credit to its designer, Curtiss Pitts.

INTERNATIONAL AEROBATIC CLUB

Experimental Aircraft Association

I. A. C.

EGRESS

Last year an EAA/Warbird member was checking out in a WW II type fighter and crashed just after completing the take-off roll. A couple of people were immediately on the scene but did not know how to open the aircraft's canopy to assist the unconscious pilot. A fire broke out and the trapped pilot died.

Several months ago an IAC member encountered an inflight structural failure while his a/c was in an inverted position. He decided to exit the a/c but when he attempted to open the canopy in this position he discovered that it would not open. He did get the a/c to an upright position so the canopy would operate and successfully left the plane and parachuted to the ground.

How many IAC'ers are flying a/c that have a potential canopy/egress problem? Over the past couple of months several IAC'ers have expressed concern to the IAC Technical Safety Committee regarding potential canopy/canopy release problems. The following ideas should be given careful consideration by all IAC members with regard to the a/c they are now flying.

External Markings — Here we should take a lesson from the military. We have all seen the external emergency markings such as "Canopy Release," "Emergency" — with an arrow, "Pull Here," "Emergency Release," etc. painted on the fuselages of military aircraft but have you ever seen such markings on the outside of an aerobatic aircraft? The tragic incident mentioned at the beginning of this article definitely illustrates the **need** for such markings.

Take-Offs & Landings — We know, from reviewing accident reports, that take-offs and landings have a high accident rate. IAC members may want to consider making T.O.s and Landings with their canopies in the open position. If an emergency situation should arise, a canopy that is already open would possibly be one less problem to overcome if a quick exit from the a/c should become necessary. Using the WW II Supermarine Spitfire as an example, it should be noted that the cockpit door had **two** locking positions — one fully closed and one with the door approximately ⅜" ajar. Since the upper edge of door made up part of the canopy track, when the canopy was slid to the extreme aft position, locking the door in the "door ajar" position prevented the canopy from moving forward — in effect locked the canopy in the open position. The canopy could be locked in the open position for landings and take-offs — a feature IAC members may want to incorporate into their a/c.

Jettison — When thinking about egress from an a/c, one of the first things one considers is how to jettison the canopy. One possible consideration for a hinged-type canopy would be removable hinge pins. The May 1979 EAA Designee Newsletter had a note on this subject.

> "An acceptable answer was found when using MS20257 type hinge; the hinge pin is replaced with ⅛" stainless music wire that has a one inch finger loop at the front end. A ⅛" hole is then drilled into the base side of the hinge and the wire loop end snaps into this hole and locks the pin in place until pulled to release the canopy in an emergency. To finish the job, use ⅜" red 'stick on' letters along the hinge **'Pull Emergency.'** " (See FIGURE 1) (Note this system could be used either on the inside or the outside of the cockpit/canopy.)

Still another consideration for a hinged-type canopy might be to mount one side of the canopy hinge through the canopy "Plexiglas" as opposed to through the canopy frame. If mounted in this manner, if the canopy were opened in flight, it would break away at the Plexiglas-hinge attach point. This type of canopy jettison design was incorporated into the Lockheed P-38 Lightning which had a canopy which locked at the front and was hinged (through the Plexiglas) at the rear. Opening the front of this canopy in flight and pushing it slightly upward would result in the entire canopy being torn away from the a/c.

An idea concerning a canopy-release system for a sliding-type canopy was forwarded by an IAC member and is as follows:

> "All the parts except the rod guides (which I made) were purchased with one trip to the hardware store.
>
> "Basically, I used a 3/16" steel rod, held by two guides I fabricated, in the center two holes.
>
> "The rail is attached to the airplane with clevis pins at the outer two holes instead of the usual bolts.
>
> "Compression springs are inserted between the rails and the airplane on the clevis pins for rigidity and to force the rails outward when actuating the release.
>
> "A lock key which is attached to the steel rod is inserted through the clevis pin hole inside the cockpit. I also used a washer and I secured the key to the rod with a simple eye.
>
> "The rods were bent at the forward end and handles made of dowels attached. To release, the handles are pushed forward, pulling the lock keys out of the clevis pins." (See FIGURE 2 and Photo 1)

While not being able to be considered exactly canopy-release mechanisms, two IAC members had the following ideas.

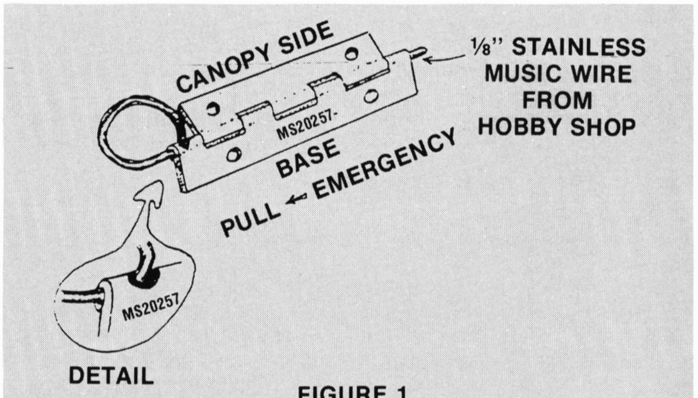


FIGURE 1

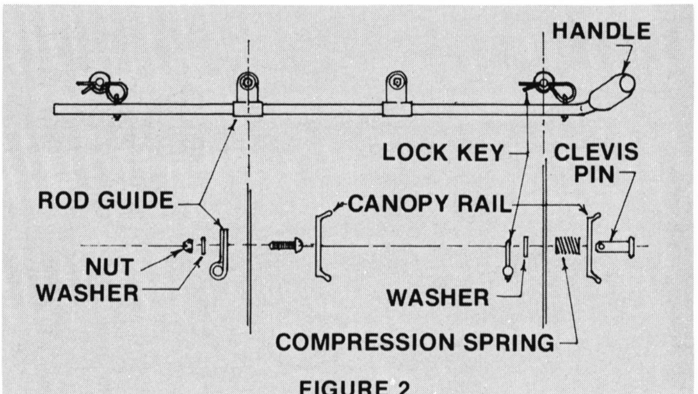


FIGURE 2

One member noted that on canopies that slide fore and aft on rails, at the front edge of the canopy, where the canopy mates to the edge of the windscreen, sometimes the metal interlocking lip is attached to the canopy and sometimes the metal lip is attached to the windscreen. This member feels it would be preferable to have the metal interlocking lip attached to the windscreen so if it was necessary to break the canopy, it would be much easier to do so without the metal lip giving strength and support to the canopy's leading edge.

Another IAC member advised that the canopy on his aircraft was very flimsy. However, he considered this to be an asset for he felt if he had to leave the a/c in an emergency, he would be able to support his feet on the a/c floor or seat and ram his body right through the canopy.

Tools — A right tool at the right time and in the right place might be a handy item to have. Again, using the Supermarine Spitfire as an example, note that clipped to the inside of the cockpit door there was an "egress bar." This was to be used in case of "jamming of the Malcom hood." (A translation for IAC members who live outside the U.K. is that a crowbar was clipped inside the cockpit door for use in case the canopy stuck.)

We believe we recall seeing one time a short thick-bladed knife with a large weighted handle that was U.S. Air Force issue for breaking through canopies. Perhaps some IAC'er could come up with some specifics on such an egress tool.

The EAA Designee Newsletter also contained a "tool tip" that all IAC members should keep in mind. It was noted that many canopies are impossible to break with bare hands in an emergency and suggested using a CO_2 fire extinguisher to "freeze" the canopy so it could be broken. IAC contest chairmen and contest technical monitors should take special note of this tip.

Every IAC'er who is flying an aircraft with a closed or bubble-type canopy should have a good, well-marked, canopy emergency release system. IAC thanks to all the individual IAC members who contributed to the above article.

BEECH
Airworthiness Directive
Volume I

80-07-05 **BEECH:** Amendment 39-3728. Applies to the following airplanes regardless of the category or categories of airworthiness certification:

BEECH MODEL	SERIAL NUMBERS
99	U-40, U-55, U-67, U-73 U-87, U-90
99A	U-96, U-126
B99	U-152, U-153
A100-1 (Military RU-21J)	BB-3 through BB-5
200 (Military RU-21J)	BB-2, BB-6 through BB-599
	BB-601 through BB-606
	BB-608 through BB-613
	BB-620
A200 (Military C-12A, C-12C)	BC-1 through BC-75
	BD-1 through BD-30
A200C (Military UC-12B)	BJ-1 through BJ-8
200C	BL-1 through BL-5
200T	BT-1 through BT-10
F90	LA-2 through LA-15, LA-22 LA-23, LA-25, LA-26, LA-28
H90 (Military T-44A)	LL-1 through LL-61
T-34C	GL-2
	GL-4 through GL-163
T-34C-1	GM-1 through GM-13
	GM-15 through GM-71
	GM-78
34C	GP-1 through GP-6

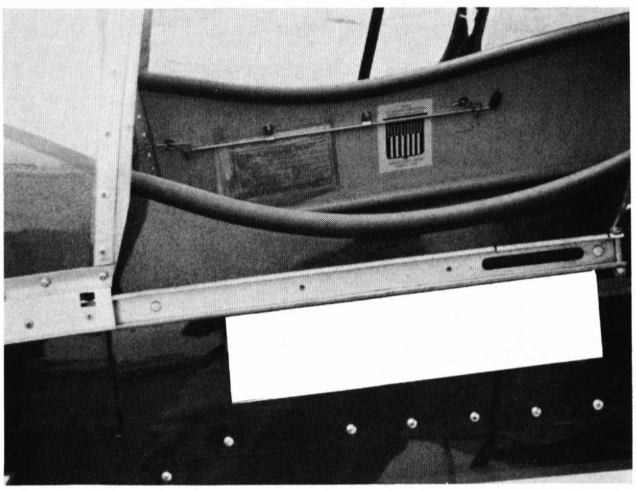


Photo 1

COMPLIANCE: Required as indicated.

In order to assure integrity of attachments of the outer wing panels to the wing center section, accomplish the following for the left and for the right sides of each affected airplane:

A) Prior to the next flight **unless already accomplished** for compliance with the corresponding emergency AD transmitted by letter dated February 11, 1980 (for Models 99 and 200 Series) or a communique or service instruction specified by Table 1, below, accomplish the following at the lower forward wing attachment:

NOTE: Hereafter in this AD, the words, "barrel nut assembly," "washer assembly," and "bolt" mean the parts and part numbers for an airplane as specified by Table 1, below:

TABLE 1

Airplane Model (Read downward)			
99, 99A, B99	200, A200, A200C, 200C, 200T, A100-1	F90, H90	T-34C-1 34C, T-34C
Barrel Nut Assembly			
RMLH7940T-144 or 113LH7940T-144	RMLH7940T-162 or 113LH7940T-162	RMLH7940T-144 or 113LH7940T-144	RMLH7940T-162 or 113LH7940T-162
Washer Assembly			
90-380019-1	73757-16-58.6	73757-14-43.5 or 90-380019-1	73757-16-58.6
Bolt			
LWB22-14-46	LWB22-16-44 or VEP220121-16V44	LWB22-14-46 or VEP220121-14V46	NAS636-40 or NAS636-H40
Torque, Foot Pounds, per Paragraph A)11, below			
280	300	280	50-100 on jacks then 375 on wheels
Beechcraft Safety Communique or Service Instructions			
200-51A or 200-52	200-51A, 200-52 or C-12-0053	200-52 or T-44A-0038	200-51A, or T-34C-0140, or T-34C-1-0074
Part Number of applicable Beech Maintenance Manual or Drawing			
Drawing 99-4023	101-590010-19, 92-37443-1, or 92-37443-2	(90-590012-13 + Suppl. 92-37056) or 109-590010-19	104-590025-5, 92-37867, or 98-37986

1. Remove the bolt, washer assembly and barrel nut assembly from the lower forward wing attachment. After turning the bolt out of the barrel nut assembly, remove the bolt by hand without using any tool. Reposition the wing as necessary for such removal.

Grade 2 compound or clean General Electric G322L Versilube. (General Electric Company, Silicone Products Department, Waterford, New York 12188, can help locate a source of G322L Versilube.)

11. Install the nut assembly along with the bolt and washer assembly. For this, except as noted below, use procedures in the Beech Maintenance Manual, or the Beech Drawing that is specified for an airplane by Table 1, above.

a. Reuse of the washer assembly is authorized for compliance with this AD.

b. Position the wing as necessary to allow the bolt to be inserted into the fittings by hand without the use of any tool.

c. Use the standard procedure for tightening the bolt whenever a new washer assembly has been used.

d. If a used washer assembly is being installed, tighten with measured torque as specified by Table 1, above, while the necessary correction for any adapter is made and while the socket does not bear against the fitting of the wing center section. Then, test the outer center ring of the washer assembly with a pin inserted in the test hole, and contact Beech Aircraft Service Department (See Paragraph A)8., above) if the ring rotates.

e. Coat the entire portion of the bolt that projects beyond the nut assembly with material (MIL-C-16173 or Versilube) used for compliance with Paragraph A)10., above.

B) Prior to approving the airplane for return to service, devise a procedure to assure that the MIL-C-16173 or Versilube used per Paragraph A), above, is not removed or destroyed while the airplane is in service or being washed. If necessary to accomplish this, fabricate and install appropriate markings and placarding.

C) Between 90 and 110 hours time-in-service after accomplishment of action specified by Paragraph A) of this AD, check bolt tightness, using the same procedure that was used for accomplishment Paragraph A)11.c or A)11.d, above.

D) Within 3 days after replacing a part in accordance with Paragraph A)7., above, submit a written report to the Federal Aviation Administration via an FAA M or D Report (FAA Form 8330-2) or a letter to the office specified in Paragraph F), below, and send the replaced part(s) to Beech Aircraft Corporation.

(E) A special flight permit in accordance with Federal Aviation Regulation 21.197 for a flight not exceeding a total of ten hours duration is permitted in order to accomplish this AD. The nearest FAA Flight Standards District Office may be contacted to obtain a telegraphic special flight permit.

(F) Any equivalent method of compliance with this AD must be approved by the Chief, Wichita Engineering and Manufacturing District Office, Federal Aviation Administration, Room 238, Terminal Building, Mid-Continent Airport, Wichita, Kansas 67209, telephone (316) 942-4285.

This amendment becomes effective on April 3, 1980, to all persons except those to whom it has already been made effective by an airmail letter from the FAA dated February 11, 1980.

a. Throughout all action required by this AD, keep parts of each washer assembly together so that parts of one assembly are not intermingled with parts of another assembly.

b. Thoroughly clean all removed parts with naptha or methyl ethyl ketone (MEK), using a bristle brush as necessary. Prior to each subsequently specified action (until lubricant is applied) ascertain that the parts are clean, repeating the cleaning process whenever this is necessary.

2. Disassemble the barrel nut assembly sufficiently to separate the cradle from the threaded body of the nut.

NOTE: Hereafter in this AD, the word "nut" means the threaded body in the barrel nut assembly.

3. Visually inspect the bolt, nut and cradle for reddish rust. Do not classify copper residue over cadmium plating as rust.

4. Using a 10X magnifying glass, visually inspect each bolt and nut for a pit or a crack in steel (not plating) material. For the bolt, pay particular attention to the fillet and shank, including threads. For the nut, pay particular attention to the chamfer (that faces the bolt head when installed) and perceptible threads adjacent to this chamfer.

NOTE: Refer to Paragraph A)7., below.

5. Bake the bolt and nut continuously for 23 hours at 350 degrees to 400 degrees Fahrenheit and cool in still air.

6. After accomplishment of Paragraph A)5., above, use a magnetic particle method of Advisory Circular AC43.13-1A to inspect the bolt and nut for a crack, paying particular attention to locations specified in Paragraph A)4., above. For the bolt, use a fluorescent particle method with approximately 6000 ampere-turns in a coil to produce longitudinal magnetization in the bolt. For the nut, use any magnetic particle method with 500 to 700 amperes through a central conductor of at least 0.6-inch diameter through two nuts to produce circular magnetization. Demagnetize the bolt and nut after the above inspection.

7. Replace each rusted, pitted and/or cracked nut and bolt and each rusted cradle with a new part of a P/N shown by Table 1. Obtain the new part(s) from Beech Aircraft Corporation. Reassemble the barrel nut assembly. (Baking and field inspection of these new parts are not necessary.) (Caution: Do not recadmium plate any of the wing attachment components.)

8. Clean the bore and recessed washer/cradle seat area of the outboard and inboard wing fittings with naptha or methyl ethyl ketone ("MEK"). Visually inspect these areas for burrs, gouges and coining. If any defect is found, contact Beech Aircraft Service Department, 9709 East Central, Wichita, Kansas 67201, telephone (316) 681-7261, 7278, 8365, or 7656, for work disposition.

9. Treat the bore and recessed washer/cradle seat areas of the inboard and outboard wing fittings with Alodine 1200 or 1201. Allow the alodine coating to dry for 5 minutes. Wash the coating with water and blow dry with air without wiping.

10. Coat the Alodined areas of the wing fittings, the fillet, shank, and threaded portion of the bolt, the cradle, and all portions of the nut with either clean MIL-C-16173,

COMPARING AIRFOIL SHAPES OF AEROBATIC AIRCRAFT

By Jim Johnson
Corvallis, Oregon

When discussing airfoil shapes of aerobatic airplanes we find there are basically two categories; symmetrical and semi symmetrical. Briefly, in the case of the symmetrical airfoil the contours of the top of the wing are identical in every respect to those of the bottom. Looking at the cross section of a semi symmetrical airfoil the bottom is found to be noticeably different than the top yet still having some roundness to it.

Currently the world champion aerobatic airplane is the Czechoslovakian Zlin Z 50L. It has a symmetrical airfoil wing. The root is the NACA 0018 and the tip is NACA 0012. Believe it or not, the NACA 0018 goes all the way back to the Boeing B17. As airplanes got bigger and heavier they needed thicker wings to accommodate the enormous spars and still be able to penetrate the air quickly. NACA has a whole series of 00 airfoils, the 0018 being one of the thickest at 20% thickness ratio, and the 0012 having a more typical 12% thickness ratio.

Next lets talk about the NACA 23012. For those of you not familiar with this airfoil (shame on you) it is commonly referred to as the Taylorcraft wing. This airfoil is on more planes than you can imagine, and is really a testament to it's versatility. Following is a list of just a few of the aircraft using the NACA 23012: Taylorcraft, Cessna 120 and 140, Lockheed Lodestar, Beech 18, Douglas DC 4, tip for the Cessna Citation 500, Mooney Mark 21, Rockwell Shrike Commander, Stits Playboy, EAA Biplane, Jurca Siracco, Taylor Titich, Cap 10 and Cap 20, and Stevens Acro. The 23012 is a semi symmetrical airfoil. It was a welcome newcomer to the world of flat bottom Clark Y's and USA 35B (Piper Cub) wings.

The 23012 is a fast wing and seems to work at just about any air speed, and once discovered by the aerobatic world got immediate acceptance. Duane Cole probably made the 23012 more famous than anyone. With only a 90 horsepower engine in his clipped wing Taylorcraft, he managed to capture two U.S. championships and literally showed the world the outside capabilities of that semi symmetrical airfoil. Bob Hoover year after year puts on an incredible "dead stick" routine with his Shrike Commander — it has a 23012 wing. Leo Loudenslager in his Laser 200 made National Champion four years in a row also using the 23012. So how can one after looking at the track record of this wing say it isn't suited for unlimited competition? With the most sincere respect for the previously mentioned masters of aerobatics, it appears that the 23012 is outdated for the current "state of the arts" in aerobatics.

The fine French aerobatic airplane the Cap 10 and Cap 20 finally gave up on the old 23012 wing. Now there is a brand new Cap 21. I haven't been able to find out the series number of the wing but it is said to have a "more symmetrical" one. Superstar, Laser 200, or just plain Stephens Acro, they are all derivatives of the Stephens and all use the 23012. No matter how clean you make them through canopy redesign or how agile you make them through control surface redesign you will never get the inverted or the vertical performance that is readily available with a symmetrical airfoil. It has just been found out that a Stephens has been designed by Pikes Peak Avia using at the wing root a NACA 0015, and at the tip a 0012 modified. Called the Z200. The Stephens is a beautiful airplane, it seems to be a real hope for the future, but consider the following: The Zlin Z 50L is 30% heavier then the Stephens and has a .251b/hp heavier power loading, and yet without the aid of flaps lands at a respectable 62 mph and has a rate of climb of over 2500 fpm.

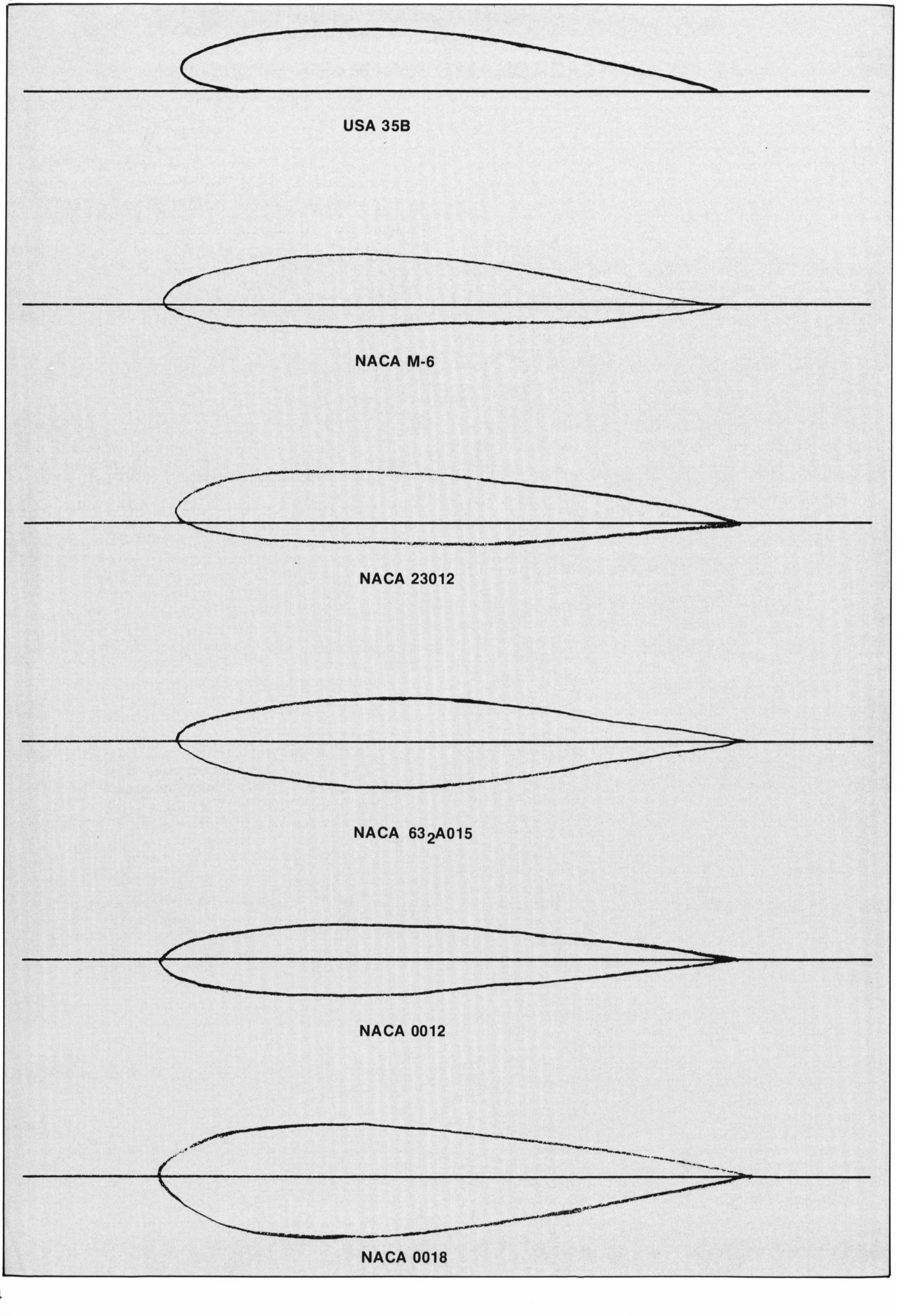
It is no secret that the big points are in the vertical line. It is no longer good enough just to go outside. Now it's how many vertical rolls you can do. All this straight up demand, leads to more aerodynamic ships, hence the monoplane popularity. It's sad to see the Great Lakes and the Bucker Jungmeister fall by the wayside — but only the strong survive in unlimited competition. Take the Pitts for instance, it went through a metamorphosis of wings finally to end up with a totally symmetrical wing on the Pitts S-2. The lower wing is the NACA 0012 (remember from the tip of the Z 50L) and the upper is the NACA 63_2A015, also a symmetrical wing (The Skybolt share the identical airfoils respectively). The Pitts S-1 on the other hand employs the NACA M-6 both top and bottom wing as does the EAA Acrosport and the Starduster Too in a modified version. The M-6 is a rather odd looking shape, almost resembling an inverted super critical airfoil.

Kermit Weeks has taken his S-1 all the way to the number 2 position in the 9th World Aerobatic Championship, but his plane is so modified he doesn't call it a Pitts anymore (Week's Special). The bottom wing is swept back to match the top, the cockpit moved back, dihedral removed, ailerons modified, and so on trying to squeeze out every last bit of performance. My point is this; there are much better airfoils than the M-6, and if it wasn't for the fact that the S-1 is now certified by the FAA in it's present configuration I think the Pitts Company would be considering changes.

There seems to be a new challenge to the Pitts monarchy, the Christen Eagle. It uses symmetrical airfoils. In reality the wings are similar to the Pitts S-2, the upper being a NACA 63_2-015 and the lower a NACA 0012 both modified for performance but kept totally symmetrical. The Eagle seems to be a real contender, causing hardened Pitts advocates like Charlie Hillard (only American to capture 1st place in world competition), Gene Soucy and Tom Poberenzy (of the famous Red Devils) to defect over to the Eagles camp and reform as the Eagles Aerobatic flight team.

To all you men and women with stars in your eyes and gold medals on your minds, please at least investigate some of these totally symmetrical airfoils. It is simple math, the thicker the wing the lighter it can be built, and the only possible way to achieve mirror image performance is with a symmetrical airfoil. It is rather disheartening to see a foreign built airplane that uses an American airfoil and an American engine beat the Americans. I rest my case.

Sincerely,
Jim Johnson
IAC 4631


USA 35B
NACA M-6
NACA 23012
NACA 63_2A015
NACA 0012
NACA 0018

THE MYSTERY OF ENGINE OIL

By Mark Danielson
IAC #4190

After talking with several pilots about the type of aircraft engine oil they use in their airplanes and how often they change the oil, I realized that no one was standardized and began to question my own maintenance practices. I decided to write to Shell Oil Company for some answers since Shell is widely used in aircraft engines. The following is a summary of my findings.

Without intending to insult the intelligence of mechanics, I feel it is helpful to provide a basic understanding of oil as described by Shell. Engine oil lubricates, cleans, rust proofs and cools our engines. Oil grades determine the viscosity of an oil — that is, how thick the oil is, thus how well it protects the engine. The higher the number grade, the thicker the oil. A multi-weight oil, ie 10W40, means this oil is thin for easier starting in cold weather, yet lubricates the hot engine as well as a single grade 40 weight oil. (This isn't always true, however.)

It is also necessary to discuss mineral oil vs. detergent oil. Mineral or "non-detergent" oil is used for engine break-in. The mineral oil permits the necessary metal to metal contact which wears the piston rings properly for extended engine life. After initial break-in (the first 25-50 hours), a detergent oil may be used. This detergent oil, as the name implies, keeps the engine clean by carrying dirt, carbon and sludge in the oil to the filter where it is deposited until the next oil change. A detergent oil is composed of "dispersants" which prevent contaminants such as carbon particles, lead compounds and dirt from gathering into clumps and forming deposits in the engine. A multi-grade detergent oil contains further additives called "viscosity improvers" which prevent the oil from thinning out at high temperature. As the oil ages, whether it be from engine operation or sitting idle in a cold engine, the dispersants lose their ability to suspend the contaminants, thus the oil is refered to as "breaking down". Further, a multi-grade oil will lose its ability to retain a high viscosity level as the improvers break apart. As a result of this oil breakdown, the oil must be changed.

With this understanding of engine oil, we can now turn our attention to how often the oil should be changed. Lycoming recommends the oil should be changed every 25 hours on engines using an oil screen and 50 hours on engines with an oil filter. On aircraft which are used constantly, as in rental aircraft or training aircraft, oil changes may be extended without affecting engine performance. In fact, the Florida Institute of Technology (F.I.T.) has, with the approval of Lycoming, extended the time between overhauls from 2000 hours to 2600 hours on the 0-320-E2A engines with the following maintenance practice: they change oil every 50 hours, oil filter every 100 hours and also inspect every 100 hours the air filter, replacing it as necessary. One must realize that these aircraft fly between 50 and 100 hours a **week**, which means that the oil will not break down as readily. Aerobatic aircraft are subjected to severe abuse and don't fly as often as the F.I.T. trainers, therefore their maintenance must be tapered to the individual engine installation as well as the individual flying characteristics. For example, many homebuilt aircraft may incorporate an oil screen and may not provide space for a filter modification. Further, some installations do not use air filters at all. Finally, not all of us are lucky enough to fly through "clean" air as F.I.T. is evidently able to do. (Try rubbing a clean cloth over your leading edges after your next flight on a "clear" day.)

It would be foolish for me to set down specific recommendations for what oil to use and how often you should change it; that is not the intent of this article nor do I feel qualified to state such recommendations. I will point out that the more often you fly your aircraft, the less you may need to change your oil since there will be less time for oil to breakdown and less condensation build up in your engine through the process of rapid heating and cooling. One can expect to see a darker color oil when you change it regardless of how often it is changed due to the carrying properties of the oil to rid the engine of contaminants as well as a slight amount of oil left in the oil lines from previous changes. A clean air filter will not only eliminate dirt from your engine, it will prevent horsepower loss through a clogged filter.

Engine oil is the life-blood of an engine. It must be kept clean to prevent engine damage. Oil filters should be inspected for excessive metal particles which could reveal impending engine difficulty. Oil samples may be taken and analyzed through special firms which will indicate any problems related to engine wear. It might be noted that all military aircraft have oil samples taken every 5 to 10 hours in special cases or every 25 hours in normal cases to provide this valuable analysis of engine wear. No information I have received indicates that I should change the oil more often than every 25 hours unless I encounter severe conditions which were mentioned previously. This does not mean that changing the oil more often is harmful; it may simply not be necessary and cost extra money needlessly. You now have as much knowledge as I do on this subject, thus I leave the mystery to you. Take your maintenance seriously — your life, as well as the lives of others, may depend on it. Fly safe!

SECURITY PARACHUTE UPDATE

Several past IAC Technical Safety reports have dealt with parachutes and parachute usage. A T.S. article in the July/August 1976 issue of *Sport Aerobatics* entitled ". . . Most Neglected . . ." concerned Security 150 parachutes and made note of checking the position of the knots on the pack closing loops. An IAC member recently had an inquiry about a German A.D. notice related to the pack closing loops on Security chutes and a check with Pete Peterson, Vice President of Security, brought forth the following information. In October of 1978 Security Parachute issued a newsletter which listed product improvements including a reference to the pack closing loops. The Security letter stated:

"The pack closing loop on our Safety-Chutes Models 150 and 250 has been recently changed due to the width of the nylon locking loops (Mil W 9047) — some friction on the grommets had been noticed. Our new pack closing loop has been incorporated into our revised packing manual. Many successful emergency uses of our Safety-Chutes have been recorded using the old loop. To insure smoother operation, Paragraph 6.2.2 of the Safety-Chute Manual (Revised November, 1977) is hereby changed to incorporate the use of pack closing loop (78A1679) — copies and loops enclosed. The new packing loop is good for repeated repacks and additional sets are available at a nominal cost. (Optional) M C 5040 Type III Nylon cord sleeving may be used by tying an overhand knot forming 1¼" loop. NOTE: When using the gutted 550 cord, the **knot goes to the "S" Hook and Spring and the ripcord pin goes through the formed loop**."

Paragraph 6.2.2 in the later operation, service, and maintenance instruction manuals noted above reads as follows:

"6.2.2 Pack Closing Loops Installation. Part No. 78A1679, Type 3 MIC-C-5040 coreless manufactured loop, with a loop at each end, 1¼" long or MIL-C-5040 Type 1, 100 T.S. may be used. When using Type 1, form a 1¼" loop by holding both running ends together and securing with an overhand knot leaving enough material to secure both running ends with an additional overhand knot. Then sear-cut remaining cord to within ¼" of ends. Install locking loops on the ripcord pins. Pass loop end through the grommet or end with overhand knot if using Type 1. 2 required. Place pull up cord through the locking loops. NOTE: Loop end of Type 1, not knotted end will have pin inserted.

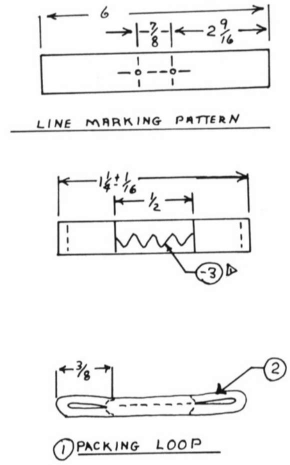
TEMPORARILY tape the Ripcord pins in place using ¾" wide masking tape (see FIG. 1). Turn pack over and pull cords through. Lay cords in Pilot-Chute compartment."

To further help IAC members identify the 78A1679 packing loop, Security Parachute Co. forwarded a copy of the proper loop drawing (see Fig. 1).

It is recommended that all IAC members with Security 150 or 250 parachutes check the pack closing loop on their equipment and, if necessary, update to the latest style loops.

IAC thanks to the member who brought his subject to the fore and to Pete Peterson of G. Q. Security Parachutes Inc. for his time and concern.

ALL DIMENSIONS ARE IN INCHES
ALL ZIGZAG STITCHING TO BE PER FEDERAL STANDARDS NO 751, TYPE 308



-3		THREAD	V-T-295, E	NYLON	AR
-2		LOOP	MILC5090 TYPE III	CORELESS NYLON	6"
-1	78A1679	PACKING LOOP			AR
	PART NUMBER	NOMENCLATURE	SPECIFICATION	MATERIAL	REQD

PACK CLOSING LOOP
SAFTEY CHUTE MODEL NO 150,250

DETERMINING FLYING AND LANDING WIRE TENSIONS

By Ben Owen
EAA Information Services

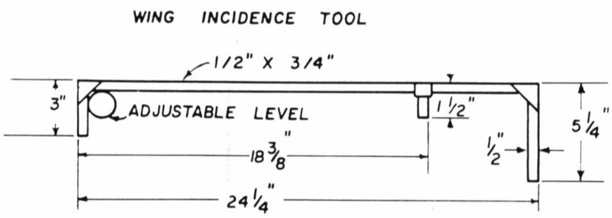
This following idea comes from the Pitts Aviation Enterprises, Inc. S-1 Assembly manual. There instructions state: "Hold a rule or yardstick perpendicular to a wire at its midpoint which you have marked with tape. Hook the spring scale through a rope loop at the middle of the wire. A pull of 50 lbs. perpendicular to the flat side of the wire at its midpoint should deflect the wire 1¼" when the wire is tensioned correctly. Check all 8 wires." Following these instructions (we used a thick piece of rope to pull on, tied around the wires so they would not be damaged or sharply bent), we checked a Pitts in the EAA Aviation Museum. Lo and behold, 6 of the 8 wires measured exactly 1¼" deflection at 50 lbs. pull and the other two measured 1⅜". This was pretty remarkable! The Pitts tail "tie rods" are supposed to deflect 1⅛ to 1¼" using the same test. Here we found this particular Pitts measured very close to these also. It might be mentioned that this Pitts has been very well maintained and flown actively in competition by a highly competent pilot.

We then ran the same tests on the ACRO SPORT N1AC. It has slightly different geometry, longer wires, etc. This is what we came up with for the Acro Sport and the Super Acro Sport recommendations. (Use a 50 lb. pull at the wire midpoint; use a rope loop. Do not use wire or sharp objects around the tie rods.) What we used were two 27 lb. fish scales in parallel. We pull them to 25 lbs. each to give a total pull of 50 lbs. These fishing fisherman's "De-liar" are available in many fishing supply houses.

Tie Rod Location	**DEFLECTION at 50 lbs.**
Front Flying Wires	1¾"
Rear Flying Wires	1⅜"
Landing Wires	1¼"
Tail Wires - Upper	1¾"
Tail Wires - Lower	1 ¼"
Roll Wires	⅜"

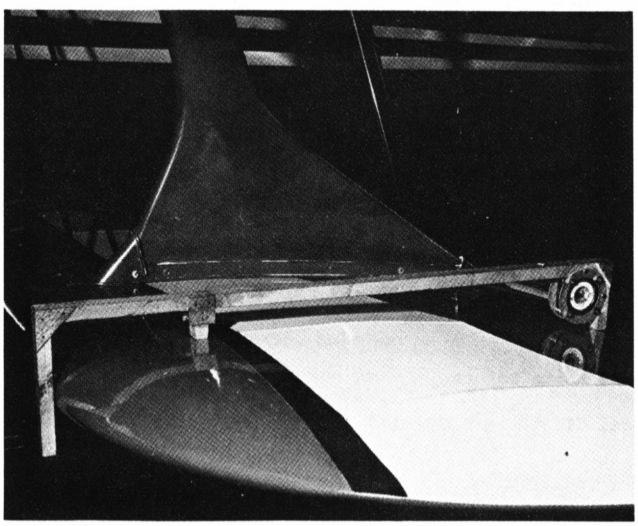
For the engineering minded, we have a friend who has an old World War II flying wire tensiometer. The flying and landing wires measured a 750 lb. tension at the above deflection. This corresponds to a "dull thud". It is felt that the deflection method is a very good method in getting the correct tension on Acro Sport, Pitts and other aircraft. You may have to work out the geometry for tensions on your own individual aircraft. It might be mentioned that obtaining a tensiometer of the proper tension for flying wires is very difficult in this day and age. It is unnecessary if one does use the above method of deflection.

(Copied from February 1980 EAA Designee Newsletter)



With this tool, the incidence along the wing (or wash-in and wash-out along the wing) can be checked to eliminate any twist. The dimensions shown are for either Pitts or Acro Sport I. The tool is useful for any aircraft, but dimensions may need to be changed. The better the level used the more accurate the tool.

— ED. —



RIGGING TOOL FOR SWEPT WING BIPLANE

(Courtesy of Pitts Aviation)

John Livingston devised this tool to make it easier for his friends to rig their swept wing biplanes. Pitts Aviation Enterprises, Inc. worked out the details to make it useable on both the Pitts S-1S and S-2A.

Refer to the upper right hand portion of drawing no. 41574. When block -4 is the positoin shown on the rib profile the tools are used to rig the S-2A.

When movable block -4 is turned to the down position so that it contacts the leading edge of the wing the tool is used to rig the S-1S. When properly used on either the S-1S or S-2A the top edge of the tool is parallel to the wing chord line.

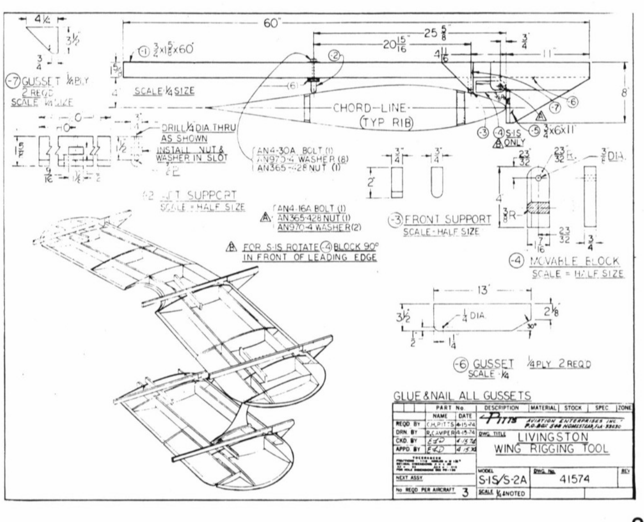
To check the rig of the upper wing proceed as follows. (We assume the wing to be level across the fuselage.) This being the case it is not necessary to level the airplane.

1. Place three rigging tools on the upper wing as shown on drawing 41574.
2. Make sure the tool is parallel to the ribs.
3. Make sure the -2 member is parallel to the rear spar and rests on at least two ribs.
4. Make sure the tool is in proper contact with the wing leading edge.
5. Sight spanwise across the top of the three tools with your eye approximately aligned with the center point of the two outboard tools.
6. If the top of all three tools are in spanwide alignment there is no dihedral in the wing.
7. If the top edge of all three tools are parallel there is no twist in the wing. For this check, all three tools top edge must be exactly parallel. Be very accurate with the adjustment of the wing tip wash in or wash out to accomplish this. Here is where accuracy pays off.

To check the rig of the lower wings place two tools on each lower wing as shown. Follow steps one through five and step seven as outlined above.

Dihedral is fixed by the strut length, therefore, if the upper wing has zero dihedral the lower wing dihedral will be correct.

We will not answer individual correspondence on this subject.



CESSNA
Airworthiness Directive
Volume I

80-06-03 **CESSNA:** Amendment 39-3713. Applies to the following models and serial number airplanes certificated in all categories:

MODELS	SERIAL NUMBERS
150M	15078506 through 15079405
A150M	A1500685 through A1500734
152	15279406 through 15283354
A152	A1500433, A1520735 through A1520867
172N	17261445, 17267585 through 17272447
R172K	R1722000 through R1723127

COMPLIANCE: Required as indicated unless already accomplished.

To assure continued structural integrity of the wing flap direct cable, thereby preventing possible sudden unexpected retraction of the left wing flap accomplish the following:

A) Prior to or upon accumulation of 1000 hours time-in-service for airplanes with less than 900 hours time-in-service on the effective date of this AD or within the next 100 hours time-in-service after the effective date of this AD for airplanes having 900 hours or more time-in-service on the effective date of this AD:

Install a new Cessna Part Number 0560037-1 flap follow-up cable clamp and associated hardware in accordance with instructions in Cessna Single Engine Customer Care Service Information Letters SE79-16 and SE79-16 (Supplement #1) and Cessna Service Kit SK172-60A dated May 3, 1979.

B) A special flight permit, in accordance with FAR 21.197, is permitted for the purpose of moving affected airplanes to a location where the modification required by this AD can be accomplished.

C) Any equivalent means of compliance with this AD must be approved by the Chief, Engineering and Manufacturing District Office #43, Wichita, Kansas, Telephone (316) 942-4219.

This amendment becomes effective April 21, 1980.

SLICK ELECTRO
Airworthiness Directive
Volume I

80-06-05 **SLICK ELECTRO, INC.:** Amendment 39-3718. Applies to the following Slick magneto models and associated serial and impulse coupling numbers.

MAGNETO MODEL NO. (1)	SERIAL NO. (1) (2)	IMPULSE COUPLING NO. (1)
447 & 447R	9040001 thru 9040049	M2374
662 & 662R	9020462 thru 9070000	M2362
664 & 664R	9040001 thru 9040086	M2370
680 & 680R	9020462 thru 9070000	M2369
4151 & 4151R	9020017 thru 9070000	M1709
4152 & 4152R	9020017 thru 9070000	M1709
4181 & 4181R	9020017 thru 9070000	M1709
4201 & 4201R	9020210 thru 9070000	M3007
4251 & 4251R	9030001 thru 9070000	M3163
4281 & 4281R	9030001 thru 9070000	M3007
4230 & 4230R	9040001 thru 9040197	M3068
6210	8090073 thru 9070000	M3050
6214	8050001 thru 9070000	M3089
		(3) M2371, M3100, & M3165

NOTES: (1) Any of the units listed were manufactured subsequent to January 1979.

(2) Any magneto serial numbers between and including the lower and upper limits as shown are affected by this AD.

(3) These coupling numbers are for parts used as spares and also must be tested.

The magneto models as listed above are installed on, but not limited to, the following engines:

Lycoming	AEIO-360
	AEIO-320
	IO-320
	O-235
	O-320
	O-360
Continental	A-65-8
	A-75-8
	C-85-8
	C-90-8
	O-200-A
	O-300-A, -B, -C, -D
	O-470-U
	IO-360-KB
	IO-470
	IO-520-A, -B, -F
	TSIO-470
	TSIO-520-T

Compliance is required as indicated unless already accomplished. To prevent a possible magneto failure and subsequent engine or accessory malfunction, accomplish the following:

Prior to the next ten (10) hours of aircraft time in service, or within the next thirty (30) calendar days from the date of this AD, whichever occurs first, complete the following comparative hardness test procedures:

1. Remove the impulse coupling magneto(s) from the engine per engine manufacturer's instructions.
2. Remove the impulse coupling assembly from the magneto frame per Slick's maintenance and overhaul instructions.
3. Establish a reference level of acceptable metal hardness by sliding a fine cut mill file over the flat surface of either pawl. The file will slide freely and will only burnish the hard surface of the pawl.
4. By a smiliar filing action, test for the hardness of each of the two rivet heads.
5. If there is resistance to sliding and material is removed from the rivet head, the rivet has not been heat treated and the coupling assembly must be replaced. Return the defective coupling assembly to a Slick Electro, Inc. distributor.
6. If hardness of the rivet heads and pawls are equivalent, reassemble and identify AD compliance by metal stamping a letter "C" on the Slick insignia located on the side of the magneto identification plate.
7. If the results of the comparative hardness test on the rivet(s) are questionable, the coupling assembly must be replaced.

This amendment becomes effective March 28, 1980, as to all persons except those to whom it was made immediately effective by the airmail letter dated February 4, 1980, which contained this amendment.

YAK-50

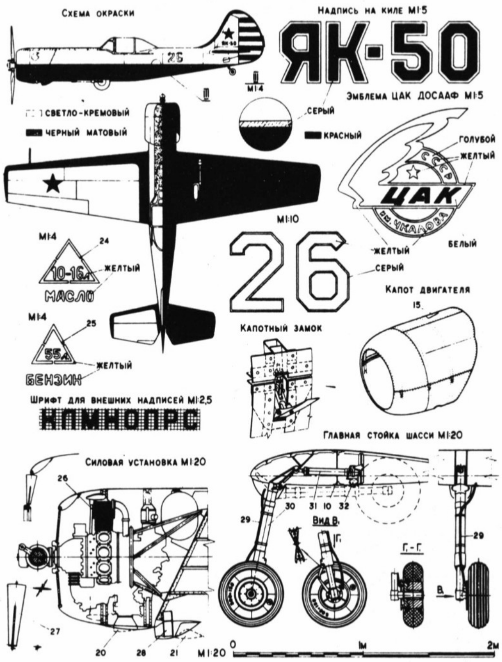
By Don Berliner
Aviation/Science Writer

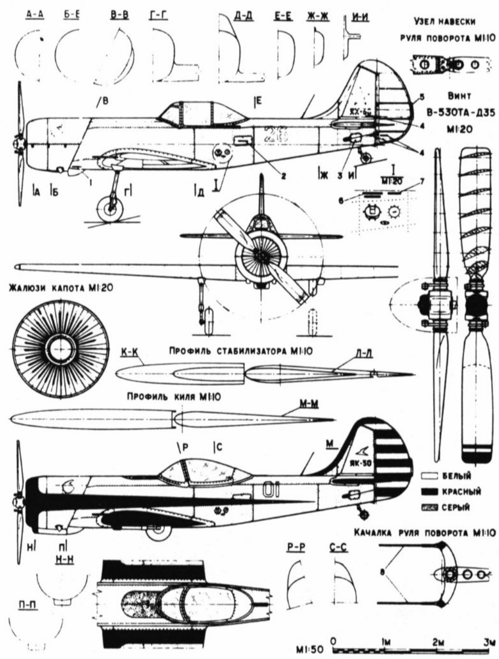
Since, unfortunately, the Yak-50 was not present at the 1980 World Contest, members may find the following information of particular interest. This was xeroxed from (get this!) the Russian Aviation Research Group, of Air Britain (which is an international society of aviation historians).

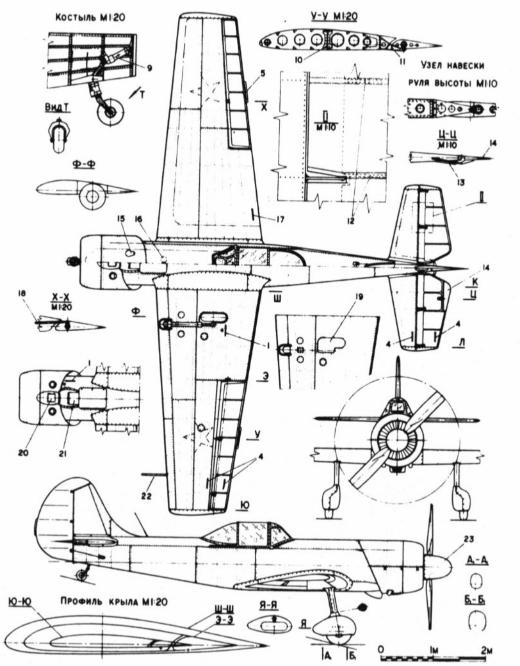
It shows the Yak-50 like I've never seen it before, with about enough detail to build one. Note the version with the bubble canopy, and the one with fixed landing gear; neither item has been seen, even in photos, to the best of my knowledge.

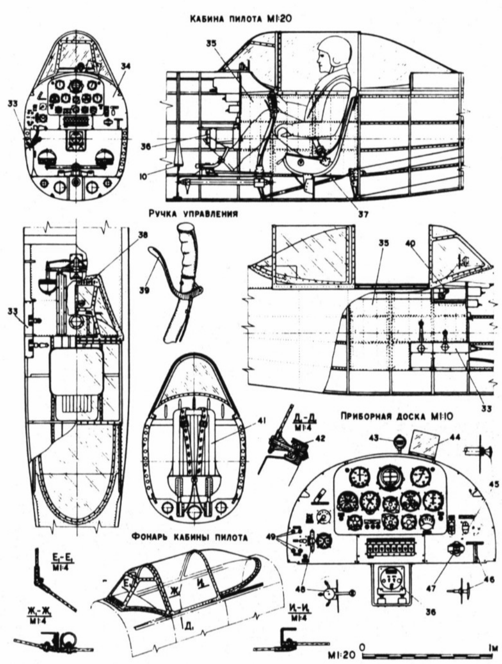
Wish I could tell you what all the Russian writing means, but I have enough trouble trying to read English!

In re-reading some of it, however, I see that a lot of the words refer to the paint scheme, as detailed to the right of the tail of the side-view of the Yak with the bubble canopy. The top one is sort of an off-white, the second is a fairly dark red, and the third is flat black. I think " ЖЕЛТЫЙ " means yellow.









TEXAS T-CRAFT

By Mike Sharp

About the airplane . . . N46WW was located in March 1976 in Dallas, Texas as a BC 12-D Taylorcraft (N43305) of 1946 vintage. My partner in the project, John Keyes (now president of Citizens National Bank of Brownwood, Texas), and I initially intended to conduct a restoration project of the T-Craft but were referred to Jim and Mike Swick (Swick Aircraft Corp. — Lewisville, Texas), regarding their new STC for modifying the BC 12-D Taylorcraft. After another trip to Dallas to visit with the Swick's, we decided to utilize all kits in the STC and build a Sportsman/Intermediate class airplane with full inverted capabilities. At that point in time, neither of us had any aerobatic instruction whatsoever.

We enlisted the help of our local A/I, Lee Boehm of Mid-Aero Service, and 16 months 21 days (and approximately 3,000 man-hours) later our good friend Gene Beggs made the maiden flight on August 13, 1977. Shortly after all the finishing touches were completed, John moved to Brownwood, Texas and I bought his equity.

For the first two years I just flew the plane to air shows and fly-ins. Then Gene Beggs finally got me inspired toward competition flying and 1980 became my first year of IAC competition. I won first place in the Sportsman category at my very first IAC contest in Longmont, Colorado. Then I won second place at the Lone Star in Dallas, first place at Kansas City, and first at the Fond du Lac IAC Championships.

For those interested in the airplane specifics . . . it is powered by an IO-320 B1A fuel injected Lycoming (160 hp).

Empty Weight	950 pounds
Cruise, TAS	130 mph
Climb Rate	2,000+ fpm
Sink Rate	700 fpm
Stall Speed	40 mph
Roll Rate	180+ deg./sec.
Propeller	Sensenich 74DM6-0-52

Mike Sharp with the Texas T-Craft.

The Texas T-Craft looks right at home on a turf airport.

The Texas T-Craft in action along the Colorado Rockies.

PITTS HAPPENINGS

The IAC Technical Safety Committee has received input from several sources relating to problems encountered with Pitts aircraft. The following is a compilation of these reports.

One member sent the following detailed list of discrepancies found on his S-1 when he recovered it last spring:

"1. Elongated hole in left lower, forward spar fitting in wing. This is a repeat of the same problem when it was discovered six years ago. The fix then was to replace the .062 strips with .090 straps and redrill the hole to 5/16" from ¼". Although the elongation was not as severe as the previous time, it was serious enough to make it worth the effort to tear into an aerobatic aircraft more often than other aircraft.

"A bushing was installed and this should result in a permanent fix.

"The cause of the elongated hole at this position is probably due to double and triple snap rolls. As the left wing arcs around at a high angle of attach (snaps are usually performed to the right as it increases the rotation rate) it is evident that the fitting in question would come under a torsion stress and tend to move to the rear.

"The holes in the "I" strut attach plates in the spar (lower forward and top rear) were also elongated on the previous recover job. At this time the drag wires were found to be quite loose. On this more recent inspection the drag wires were tight.

"2. Elongated holes in the seat. All of the 3/16" holes at the rear attach position were elongated almost the diameter of the hole. At least half of the front attach holes were elongated. This cause is naturally from high "G" loads that an aerobatic aircraft is exposed to.

"This one item could be serious as directly below the seat is the aileron push rod attach fitting. These seats have been known to sag enough to make contact with this fitting.

"3. Elongated holes at aileron push rod idler bracket and bellcrank bracket. This resulted in considerable play in the ailerons. Although not a dangerous condition it should be corrected as any play in the controls is not conductive to responsive flying.

"4. Broken nose ribs. At least half of the nose ribs were either cracked or broken with three laying inside the leading edge. On the previous recover job the l.e. was not removed. A 1974 Service Bulletin (No. 8) from Pitts Aviation Enterprises deals with inspection of the UPPER wing leading edge for cracked ribs listing as the cause 'repeatedly flown to or beyond the limits of the design speed-acceleration envelope.' There is cause to doubt that this is the real reason for these rib failures. It is more probable that this failure is caused the day the l.e. is installed. All ribs on my aircraft appeared to have failed by nails being pounded into the nose ribs to hold the l.e. in place. Some of these ribs had as many as three 1" nails driven into the wood. With ONLY a cap strip over the spar to offer support it is not surprising that these ribs failed. The nails were driven in just forward of the front spar causing a shear load on the cap strip that it was not designed to take. It is doubtful if this operation is necessary as after the fabric is shrunk in place ALL nails are redundant. This condition was found in both upper and lower wings.

"5. Half the l.e. nails were popped up and could easily be removed with a pair of dykes.

"6. The nails retaining the ribs to the spar face were either loose or ready to pop out allowing the ribs to 'float.' This was particularly evident in the upper wing ribs between the center section and aileron well.

"This was corrected by installing 'chinking blocks' in the corners where the ribs cross the spar. This method is found in many antique designs such as the Bücker Jungmeister, Waco, S.E. 5, etc.

"In this case when the rib 'floated' it actually cut all the rib stitching between the spars on four ribs.

"7. Hand-hold in upper wing cracked. The round, laminated hand-hold was split in two layers and the bracket attaching it to the spar was split from its corner block on the right side. Not considered dangerous, however, this hand-hold should be used in bail out and should be in top condition.

"8. Lack of large area washers at aileron support bracket in aileron well on lower wing. Large area washers had been used at this position in the upper wing with no indentation in evidence; however, on the bottom wing only regular washers were used and they had sunk into the mahogany plywood one washer thickness. Now, the bottom wing should incorporate these large area washers more so than the top wing as these support brackets must also carry the load of the top aileron when activated. The area in question is on the plywood plate on the inside of the rear spar.

"A fix was made by removing the varnish and gluing a 2" x ⅛" birch plywood plate over the indented area and leaving the indented washer in place to fill the gap and add some support to the area. Large area washers were installed at the position in question.

"This aircraft was one of the several built at the Pitts factory in Homestead, Florida but built by a private individual on the premises and I'm certain that not installing large area washers was an oversight.

"9. Both wooden formers at the rear belly were broken. These are fixed to the top of the rear tube that holds the front leaf spring for the tail wheel and seemed to have broken from too tight a slot on the first plywood former forward of this position.

"In summary the following is recommended:

"1. That nails NOT be driven into the l.e. nose ribs to retain the l.e.

"2. The lower left wing drag wires should be checked for looseness at least every 50 hrs. of flight.

"3. An aerobatic aircraft should be recovered every five years especially Pitts S-1's engaged in Unlimited aerobatics."

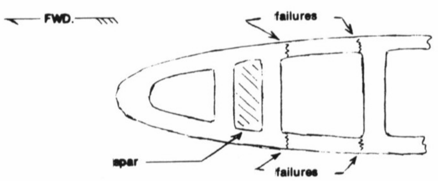
With regard to above Item #6 relating to loose ribs and "chinking blocks," IAC members may want to review the IAC T.S. article "Severing of Rib Stitching on Pitts S-1 Upper Wing" in the August 1977 issue of *Sport Aerobatics*.

The Experimental Aircraft Association of Canada Technical Committee has issued the following safety bulletin:

"SUBJECT: Wing Rib Failures

AIRCRAFT AFFECTED: All Ultra-Light (Amateur-Built) Pitts S-1

THE PROBLEM: We have received 3 reports of wing rib failures in ultra-light (amateur-built) Pitts biplanes. All 3 cases are aircraft which have been constructed using Spar Craft wing kits. The ribs in question are in the upper wing and are ribs number 5, 6, and 7 numbering from the wing root outboard. (For additional referencing the interplane struts are between ribs number 6 and 7.) The number of ribs which failed and the number of failures per rib varied in the 3 cases, however all but one of the failures occurred at the first lightening hole aft of the main spar. The one remaining failure was through the first lightening hole forward of the rear spar.



"We have not received any reports of the original Pitts style (built-up) ribs failing in this upper wing location, nor are there any reports of any ribs failing in the lower wings.

"A sample of this Spar Craft rib was tested by the EAA Canada Tech. Committee prior to approving this wing for acrobatic flight and the following 2 paragraphs are taken from the test report.

'For the Pitts the critical loading for the upper wing was a rib load of 611 pounds at a positive ultimate load factor of 12. The critical lower wing rib load was 430 pounds for a negative ultimate load factor of 12.

'The ribs all survived the maximum loading without failing although the Pitts ribs showed considerable snaking between the spar mountings. However they did not buckle. In all cases the 1.25 times ultimate load was left on the test rib for thirty seconds.'

"These rib tests and the limited data available on the failures indicate that the failures may be due to torsional loading of the wing from aileron inputs. Until the **extent** of the problem, the **cause** of the failures, and a **solution** are found we recommend the following action by the owners and operators of all ultra-light (amateur-built) Pitts S-1.

"PROVISIONAL RECOMMENDATIONS:

"To The Owners of All Ultra-Light Pitts S-1:

(1) Install inspection panels on both upper wings aft of the main spar so that ribs number 5, 6, and 7 may be visually inspected.

"To The Operators (Pilots) of All Ultra-Light Pitts S-1:

(1) Before each flight visually inspect upper wing ribs number 5, 6, and 7.

(2) Before each flight check all other upper and lower wing ribs between the front and rear spars as follows: — Press vertically down every few inches along the length of each rib checking for a spongy feeling and for movement of the fabric on **both** the top and bottom wing surfaces. Repeat the check for the bottom of the ribs by pressing vertically up and noting any sponginess or movement of either the top or bottom wing fabric. — Any indication of a soft spot or fabric movement is justification to ground the aircraft until an inspection panel is installed and a visual inspection carried out.

(3) Ground any aircraft with rib failures until repairs have been completed.

"To The Operators of All Ultra-Light Pitts With Sparcraft Type (Plywood Web) Wing Ribs:

(1) Do not engage in full aileron rolls, snap rolls, or any other maneuver which requires large and/or sudden aileron loads."

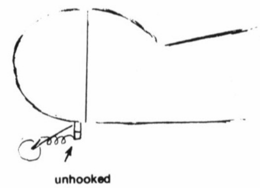
If any IAC members flying Pitts' aircraft with plywood web wing ribs encounters any rib problems, please advise the IAC Technical Safety Committee or the EAAC Technical Committee immediately. Any and all input will be helpful in resolving this safety problem.

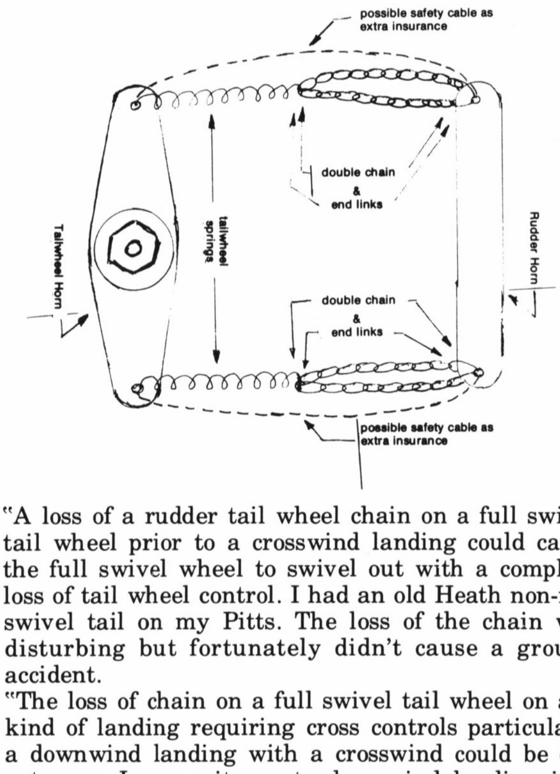
Another IAC member related the following information on tailwheel interconnect springs/links on his S-1.

"I should like to bring to your attention a possible accident-causing problem on the Pitts S-1.

"I had made a number of take offs and landings during a day with a strong crosswind. On one landing I felt a loss of steering after the plane slowed below about 30-35 knots. I decided to stop, get out and inspect. A look at the tailwheel showed a dropped chain from the tail wheel to the rudder arm. One chain on, one off. This happened once on a Cessna 140 I was flying with a similar loss of ground steering.

"The solution on the Pitts is to double up on all tail wheel steering chains and links. This gives a much lower probability of such a failure. An additional safety cable could be added as extra insurance.





"A loss of a rudder tail wheel chain on a full swivel tail wheel prior to a crosswind landing could cause the full swivel wheel to swivel out with a complete loss of tail wheel control. I had an old Heath non-full swivel tail on my Pitts. The loss of the chain was disturbing but fortunately didn't cause a ground accident.

"The loss of chain on a full swivel tail wheel on any kind of landing requiring cross controls particularly a downwind landing with a crosswind could be disasterous. I was witness to downwind landing in a 170B with a crosswind when the tail wheel full swivelled during the rollout with a resultant ground loop and very major damage to the aircraft.

"I hope this warning keeps someone from a ground accident."

Tailwheels have been and continue to be service problems. In this regard IAC members may want to review the Technial Safety article, "Shimmy, Breakage, and Other Tailwheel Woes" that appeared in the August 1978 issue of *Sport Aerobatics*.

Another IAC member sent in a short article on exhaust stack repair on his S-1 which could obviously be used on just about any type of aircraft.

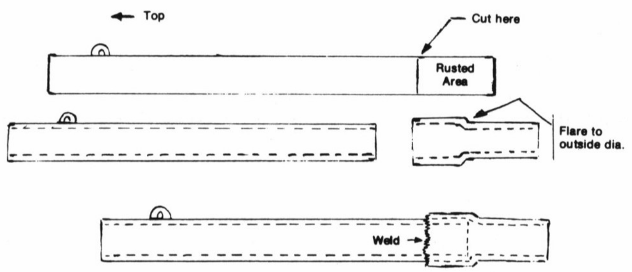
"MIDASIZE YOUR EXHAUST STACKS

"Aerobatic aircraft located in humid climates or near the ocean have experienced exhaust pipe rusting in the exposed area at the end of the stack.

"This can become a serious fire hazard as the metal will flake away and actually shorten the length of the pipe causing the exhaust to be directed at a metal or fabric area.

"Instead of replacing the entire exhaust pipe it can be easily repaired with a quick fix. (See drawing)

"Any reputable exhaust repair shop can flare the new replacement part and sleeve it to the old pipe with long lasting results. A butt weld is not recommended. The new pipe is usually made of a thicker gauge metal; however, this will tend to further solve the problem of exhaust stack end rusting."



One other IAC Pitts owner reported that on his recently completed homebuilt S-1 he had a tailwheel spring U-bolt attach fitting break on landing with the resultant loss of directional control, slightly damaged wing tip, etc. The aircraft did **not** have the additional gusset plate between the tailpost and the U-bolt attach fitting (see *Sport Aerobatics*, August 1979, Technical Safety article, "Pitts Parade" and the aforementioned August 1978 issue of *Sport Aerobatics*). IAC members should note that late factory build aircraft incorporate the above mentioned gusset and should strongly consider upgrading any Pitts aircraft not so equipped.

Another IAC member sent in a detailed report on **three** S-1 Pitts aircraft that he had recently worked on. His report is as follows:

"I recently completed some modification work on an S-1S which has 500 hours, Sportsman through Advanced. The aircraft has had annual inspections by an FBO which is not a Pitts specialist. Listed below are the problems found.

"Arm broken on alternate air box, stuck in hot position. Padded clamp which holds forward end of alt. air cable slips — replaced with metal clamp similar to throttle cable clamp.

"Mixture cable rubbing on engine sump — installed plastic hose around cable.

"Tailwheel — steering arm loose, steering spring clips worn, locks in one direction only — replaced tailwheel.

"Right lower engine mount to fuselage bolt loose two turns; elastic nuts used do not appear to have adequate locking power — replaced with high temperature all-metal nuts.

"Engine mount to engine bolts all loose two turns; numerous cracks in baffles.

"Oil cooler hoses too close to exhaust.

"Cracked left exhaust tailpipe.

"Tailpipe clamps improperly installed.

"Right rudder pedal hits fuel drain tube at full travel.

"Fuel pressure and oil pressure lines rubbing in fuel tank area.

"One rocker cover gasket leaking.

"Rocker box drain tubes — all hose clamps loose and improperly positioned.

"Hand hold — trailing edge bow broken away from ribs on both sides.

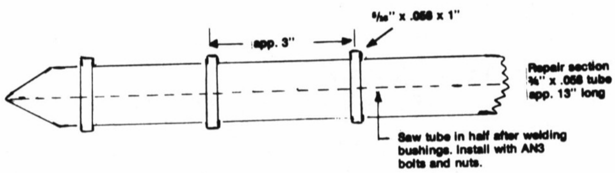
"Aileron hinges at rear spar — all hinges were slightly loose on spar. There is no access to tighten these bolts without cutting fabric.

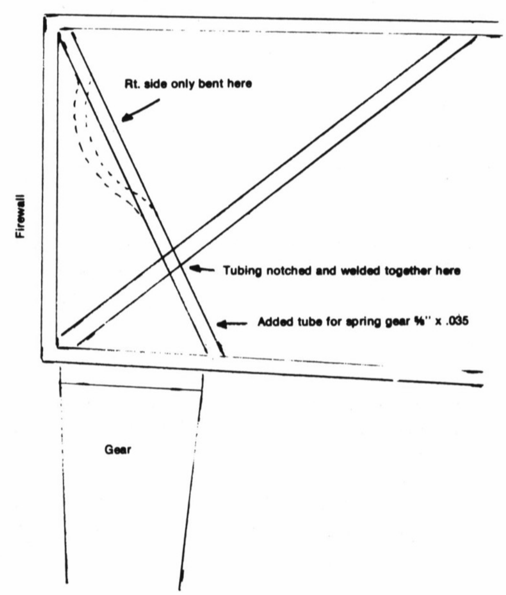
"Engine baffles tend to blow back at high speed and rub against the engine mount at the top Lord mounts. I have added two extra braces to the rear baffles in this area.

"In March I completed a very extensive inspection of my homebuilt S-1S which included removal of the wings and engine. No fabric was removed. Stabilizers were removed and inspected, and a heavy H tube installed. There was no wear in the lower wing fittings, which I feel is due to a perfect fit and alignment on these fittings. When I built the aircraft I installed bushings on the main attach hole only, and installed .090 doublers on the lower fuselage wing fittings. At 475 TT the removable cabane fit perfectly. At 550 TT it was necessary to remove the gas tank due to a leak. The removable cabane bolt holes are misaligned approximately $^{1}/_{16}$ inch. Loosening the upper wing bolts did not change this. Also, the upper front wing attach fittings (flange type) are bent slightly. Apparently the cabanes have been slightly bent, however there is no visible damage. It is obvious that snap maneuvers are causing loads on the cabane and upper wing fittings in excess of design considerations.

"On a third S-1S which is a factory kit airplane with factory installed spring gear, there has been a failure of the fuselage side diagonal tube which supports the aft edge of the gear. The tube is ⅝ by .035 and failed in compression. A temporary fix was made by straightening the tube and installing a split outside sleeve which is bolted in place.

"Total time on this aircraft is approximately 125 hours and the failure occurred in approximately the last 40 hours. No hard landings have been made and most landings have been on paved runways."





Some past IAC Technical Safety articles that relate to the above report that IAC members may want to review are:

"Cool It", *Sport Aerobatics*, May 1980.

"Hardware", *Sport Aerobatics*, December 1979.

"Pitts Horizontal Stabilizer Support Tube", *Sport Aerobatics*, July 1979.

"Pitts Parade", *Sport Aerobatics*, August 1979.

"Pitts Fuel Lines", *Sport Aerobatics*, December 1977.

The last portion of this Pitts related Technical Safety article is an FAA Service Difficulty Report on an S-2A.

"Pilot reported that prop and spinner departed aircraft while doing aerobatics. Pilot glided to landing on airport with no further damage. Crankshaft flange broke through lightening holes. Rust on cracked surface indicates approximately 50% of failed section was cracked previously."

Over the years there have been reports of several crankshaft/propeller flange failures on acro aircraft. IAC members should review two articles appearing in the July 1973 issue of *Sport Aerobatics*: "Pitts Special Propeller Attachment Flange Failure", and "Solid Crankshafts."

To the members who took the time and made the effort to submit the above noted reports goes a very large IAC "Thank You." These people with their concern for fellow IAC members reflect the true purpose and meaning of IAC.

(NOTE: The above Technical Safety article makes mention of some earlier *Sport Aerobatics* magazines as reference. For those IAC members who do not have all the back issues of *Sport Aerobatics*, or would like to have all the past IAC Technical Safety informtion consolidated into one book, the IAC will soon offer a "Technical Safety Tips Manual" which is, in fact, a compilation of all the Technical Safety related articles that have appeared in *Sport Aerobatics* during the last 10 years.)

AEROBATIC SAFETY CHECKLIST

By Mike Leveillard
Route 1
Brooks, GA

Editor's Note: In light of the numerous accidents occurring among our members during practice last Spring, this Editor felt the need for re-emphasizing **safety** first and foremost. Therefore, this article, which first appeared in the March, 1974 issue of *Sport Aerobatics*, is reprinted here for your thoughtful and sober consideration. **Please**, keep it safe so we'll all continue to see you around an airport.

— Steve

Now that many people are flying solo aerobatics, after those initial dual rides, I would like to suggest the following aerobatic checklist:

1. Review government regulations regarding aerobatic flying and parachutes.
2. Remember that the 1500 feet and 3 miles visibility as specified by regulations are only legal minimums for VFR flight. Watch out for hazy days and the absence of the natural horizon. For training and practice purposes, never fly with less than 5 miles visibility. Plan your entry so that the maneuvers will never be completed at less than 3000 feet above the surface during those first several solo flights.
3. Keep plenty of distance between you and clouds. You never know when somebody might pop out of one and you are especially blind when concentrating on your maneuvers.
4. Make sure you are in top physical condition. A small head cold can turn into real misery during rapid altitude changes.
5. If you are not current or haven't flown aerobatics for a while, ask an instructor to go along with you. Do not attempt any new maneuvers on your own. (Unless, of course, you have a single-place airplane. Then, some instruction in a similar two-place is desirable beforehand.)
6. Check your parachute carefully. Make sure it is adjusted properly and check its currency. Most chutes are good for 90 days. Security chutes are good for 120 days. Do not leave the chute in the airplane.
7. Practice how you would abandon the airplane should the occasion arise. Sit in the airplane with the chute, safety belt, and shoulder harness buckled, then try it. You would be surprised how many of us have unbuckled the parachute by mistake during this practice dry run. Be familiar with the door quick-release handle, if your aircraft has one.
8. Preflight the airplane very carefully. Watch out for loose objects in the cockpit. Always set the altimeter on zero. Reset the G meter before flight but do not reset in flight. Wait until after landing for this. Have the airplane gone over thoroughly if you have exceeded the maximum G loads. Perform a postflight inspection as well.
9. Plan your maneuvers and practice session before take-off. Stick to it once airborne.
10. On the way to altitude, use every minute of your time to perfect your basic flying techniques. Concentrate on smoothness, coordination, airspeed control, and watch for traffic.
11. Do not perform any maneuvers in sequence until you have achieved a high level of proficiency in each maneuver. Then start putting two or three maneuvers together. The Basic Achievement Award sequence is a good start. One-turn spin, loop and aileron roll. Watch your framing and remember the lines. Pretend that each practice session is a contest.
12. Finally, don't show off and stay plenty high. Always watch for other aircraft.

During those first solo aerobatic flights it is especially important to be careful. You will find, however, that solo aerobatics cannot be excelled in satisfaction, enjoyment, feeling the true freedom of flight.

STRUTS

An IAC member recently forwarded the following report and photographs concerning a wing lift strut/ corrosion problem he encountered.

"The enclosed photos show corrosion effect to the bottom side of the left wing lift strut on my 1947 Aeronca 7AC "Champ", at the fuselage end. I found this spot by tapping the struts with a small ball peen hammer, using the ball end, on both top and bottom sides of the struts. Visual inspection before tapping with the hammer disclosed no corrosion deterioration, but recent publicity on corrosion and other problems in various struts and airplanes prompted the 'hammer test'. I used the hammer because I don't have a fabric punch.

"Tapping up and down the length of the strut, lightly enough to preclude paint damage, produced a ringing bell-like sound, except in the corroded area. There it produced a dull thud and a dent in the strut. When I located this spot I drove a screwdriver blade into the metal, pried it up, and using pliers bent the metal back and forth to make the hole shown. The metal was paper thin at this area, dry, and rusty.

"Later I cut the strut end off about two feet up from this end and found the metal there like new, with an oil coating still on the inner surface. Apparently, over the years, moisture had condensed in the strut and settled in the lower end. There is no drain hole there, or in the other strut, but I plan to drill drain holes when rebuilding the airplane this winter.

"While the "Champ" is in no way an aerobatic airplane, I hope this information will be of interest to IAC members."

We fully concur that this report should be of interest to many IAC members — especially those who own a pre-August 1964 Aeronca or Champion Model 7 series aircraft or those who own a pre-1978 Citabria who have not replaced front strut P/N 5-144 with P/N 5-392 lift strut.

On February 8, 1967 Champion Aircraft Corporation issued S.L. #72 which advised that some Model 7 aircraft (most Model 7AC's) were not provided with a front strut drain hole during manufacture. It advised that an ⅛-in. drain hole be drilled 3¼ in. up from the strut fuselage pin in approximately the center of the strut through the lower strut wall only. It also advised a close check be made for internal corrosion and that the strut be rejected if any corrosion other than light surface corrosion was found.

On October 14, 1977 Bellanca Aircraft Corp. issued S.L. C-127 which advised that Citabria front struts (P/N 5-144) be replaced with struts (P/N 5-392) or the a/c redline be reduced from 162 mph CAS to 153 mph CAS. The difference between the two struts is that the old strut had a .035" wall thickness while the newer strut has an .049" wall thickness. The struts can be easily identified: the ".035" strut has a round tube fitting at the wing end while the ".049" strut has a square tube fitting at the wing end. Bellanca S.L. C-127 also included a wing strut inspection procedure that can be applied to any a/c with wing lift struts. The Bellanca Service Letter states:

"Wing lift struts are highly loaded structural members and therefore must be maintained in good condition. Do not use the lift struts to tie-down or move the aircraft.

"Bellanca Aircraft Corporation recommends that Wing Lift Struts be inspected as follows in addition to normal inspection procedures.

"1. During preflight inspection performed by pilot.
   1.1 Inspect the front and rear lift struts for straightness, dents and other damage.
   1.2 Check strut drain holes to insure that they are not plugged and the struts do not contain water.
   1.3 If either of the above conditions is found, contact an authorized aircraft mechanic to determine aircraft airworthiness.

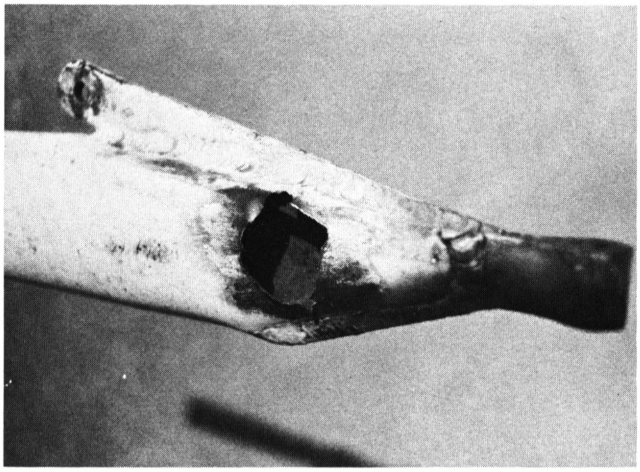
"2. During Annual/100 Hour Inspections.
   2.1 Inspect the front and rear lift struts for straightness, dents and other damage.
   2.2 Check strut drain holes to insure that they are not plugged, and there is no visible evidence of corrosion.
   2.3 Check strut end fittings for condition and security."

A large IAC "thanks" is definitely due the member who sent in the first-noted report. We should all remember that each of us is a member of the IAC Technical Safety Committee and it is really part of our own obligation to report safety items that may benefit our brother members — as exemplified by the above report.

HORIZONTAL STABILIZER SUPPORTS

There have been several Technical Safety articles in *Sport Aerobatics* regarding broken Pitts horizontal stabilizer support tubes — one of the last being in the July 1979 issue of *Sport Aerobatics*. A new, heavier support tube member (P/N 1-210-166) is available from the factory as per Pitts Aerobatics Service Bulletin #14.

However, the Pitts is not the only aircraft to have encountered problems in the stabilizer attach point area. Note that EAA service difficulty records show several Stits Playboy stabilizer leading edge attach tubing failures. Although these failures are pretty old, the last one being 6/10/73, and it should also be noted that Stits published a design modification drawing covering this area on 2/17/68, these failures indicate the stabilizer L.E. attach point is a highly stressed area.



To continue, the EAA Acro Sport I and the Acro Sport II have had changes made to their horizontal stabilizer L.E. attach methods. Last year Ben Owen, EAA Executive Director, Aviation Safety, advised that some tubing sizes had been changed from .035 x ¾ to .058 x ¾ and went on to say.

"In addition, we raised the height of the rear horizontal stabilizer attach so that builders would not be tempted to file those vertical tubes down. We had the vertical bushings projecting ⅜" both top and bottom of the ¾" tube and this bushing could be cut or filed down to ¼" but no more, and in addition, the weld should not be filed on the Acro Sports. That change went out to all plan holders.

"On the Acro Sport II, we went to a brace from the longeron up to the horizontal stabilizer leading edge and the drawing is attached. In fact, we have decided to change the Acro Sport I and have mailed the attached correction to all the Acro Sport I plans holders. We used the brace wire attach point and nested the tube in with the brace wire attach there and ran that tube up to the leading edge as the following diagrams will show."

To emphasize the point even further, IAC members may note the Wag-Aero Wag-A-Bond, a non-aerobatic airplane, had a tubing size change on the front stabilizer carry-through tube from ⅞ x .035 to ⅞ x .058.

All this must tell us that the horizontal stabilizer L.E. attach point is a critical area on many aircraft and it would behoove all of us to pay particular attention to this area during all inspections (including each pre-flight inspection). The modifications noted above obviously could be applied, if not directly, at least in the same general form, to aircraft other than those mentioned in this article.

In this article EAA Executive Director Ben Owen is mentioned by name and his input to the IAC Technical Safety Program on this particular problem is given. IAC members should be aware that Ben and many others at EAA Headquarters are continually supporting and sending information to the IAC Technical Safety Committee. Their help is one of the factors that makes this IAC program possible and an IAC thank you is definitely due them. Thanks.

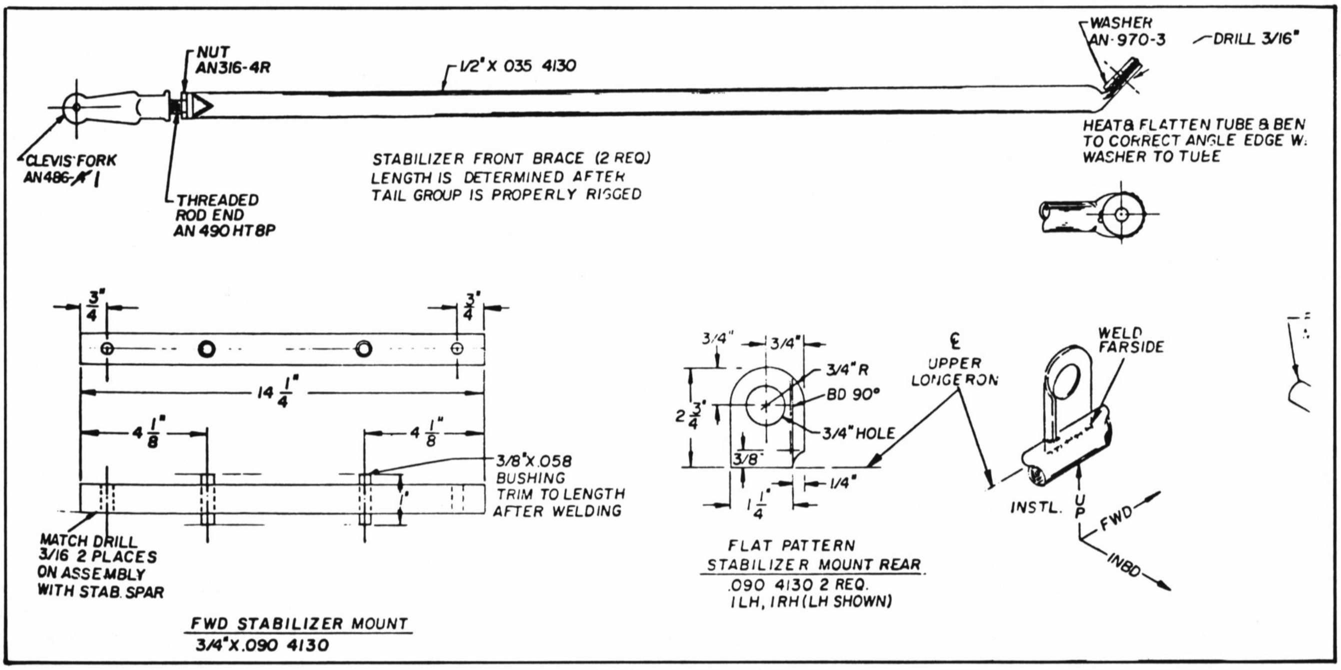


DIAGRAM 13

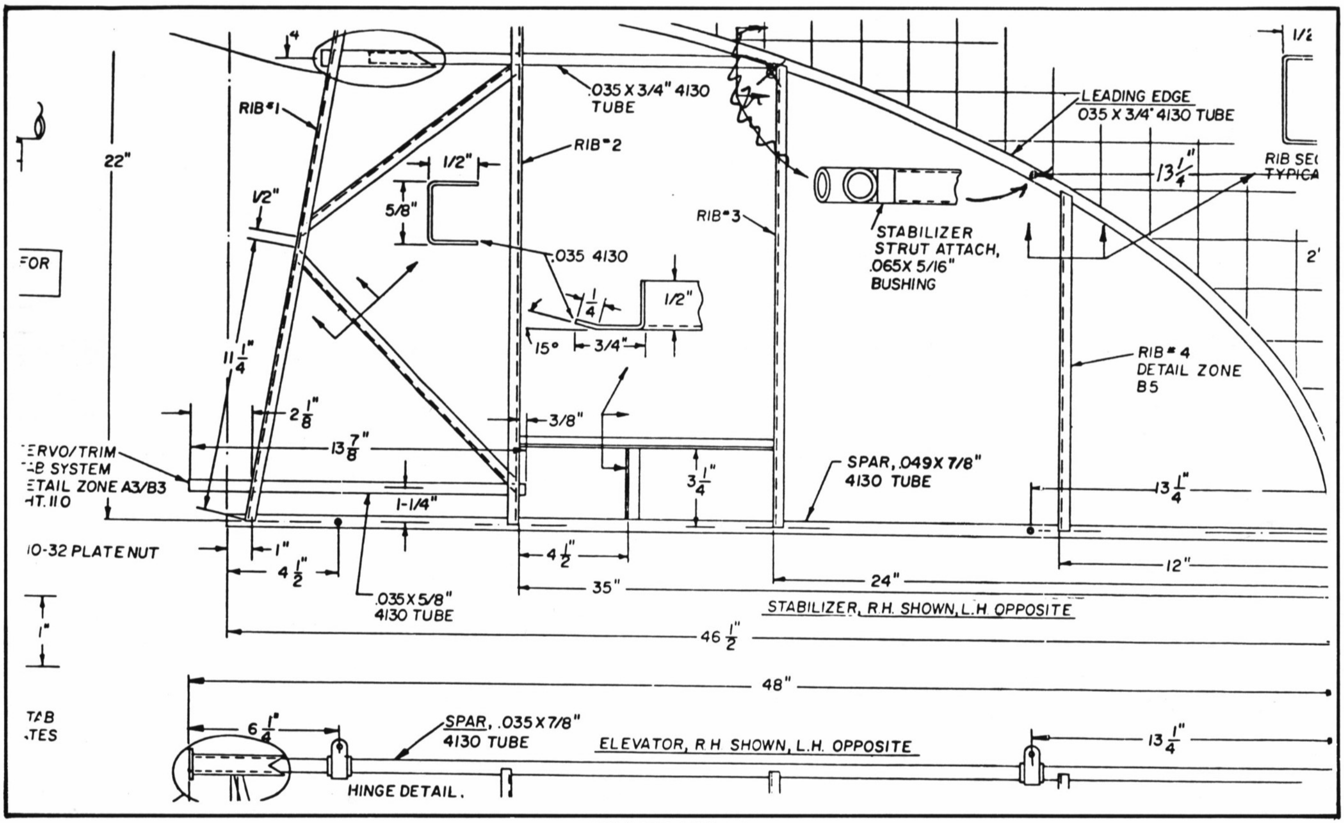


DIAGRAM 14

Henry Haigh Used His Super Star to Clinch the Unlimited Trophy at the Fond du lac International Aerobatic Competition.

EMERGENCY PLANNING

"One of the books in my library is **The Lonely Sky** by William Bridgeman and is the story of test pilot William "Bill" Bridgeman and the Douglas Skyrocket. The book covers events at the time man was just attempting and learning about supersonic flight. One of the things mentioned in this book that impressed me was Bill Bridgeman's approach to emergency flight problems — no doubt one of the prime concerns of a test pilot. Bridgeman used to dream up emergency flight problems and would then formulate the best course of action to cope with a particular problem — and then an alternate course of action or two. His plan was to have fast 'answers' to a possible problem prepared ahead of time. He did not want to be 'taken by surprise' so he tried to prepare a plan and an alternate plan or two to cover any possible emergency.

"Bridgeman's idea of explicit and detailed planned and practiced action to cover emergency situations had an appeal to me and I felt that it could be applied, at least on a small scale, to my sport/aerobatic flying. I have preplanned my own personal course of action for several possible in-flight emergencies but the one possibly 'ultimate' emergency concerns itself with what to do if you find yourself in a situation where your airplane has become uncontrollable because of a structural failure, control blockage, etc. Below some 'critical altitude' there is not much you can do except keep fighting to regain control of the plane and then prepare for a crash by shutting off the fuel and the mags. Above this 'critical altitude' it seems the most prudent course of action is to leave the airplane and try your second flying machine — your parachute.

"With this kind of background thinking I decided I had better determine what should be my 'critical altitude'. First, I've worked out an eight-step drill for getting out of my airplane — which, by the way, is a Citabria. My drill is as follows:

"1. Open top door latch
2. Open main door lock
3. Pull pin on emergency release handle
4. Push emergency release handle (this pulls the hinge pins from the cabin door)
5. Hit the door with my right elbow to knock it off the airplane
6. Release the top (back-up) seat belt
7. Release the bottom (main) seat belt
8. Exit a/c out the doorway.

"Each time I go flying I sit in the plane on the ground and go through the above drill using the military 'by the numbers' routine to try to get this a/c departure procedure down to almost a conditioned reflex. Naturally, I don't actually knock the cabin off the airplane each time but I do simulate knocking the door off. This 8-count a/c exit drill takes me approximately ten seconds. Again, that is ten seconds with **the a/c sitting on the ground**. Who knows how long it would take with the a/c flopping through the air.

"I have a Security 150 parachute. In the December 1974 issue of *Sport Aerobatics* an evaluation report of the Security 150 parachute was published and in it several test jumps were reported. The chute deployment times given ranged from 1.1 to 1.8 seconds. For my emergency preplanning program I rounded this off to 2 seconds.

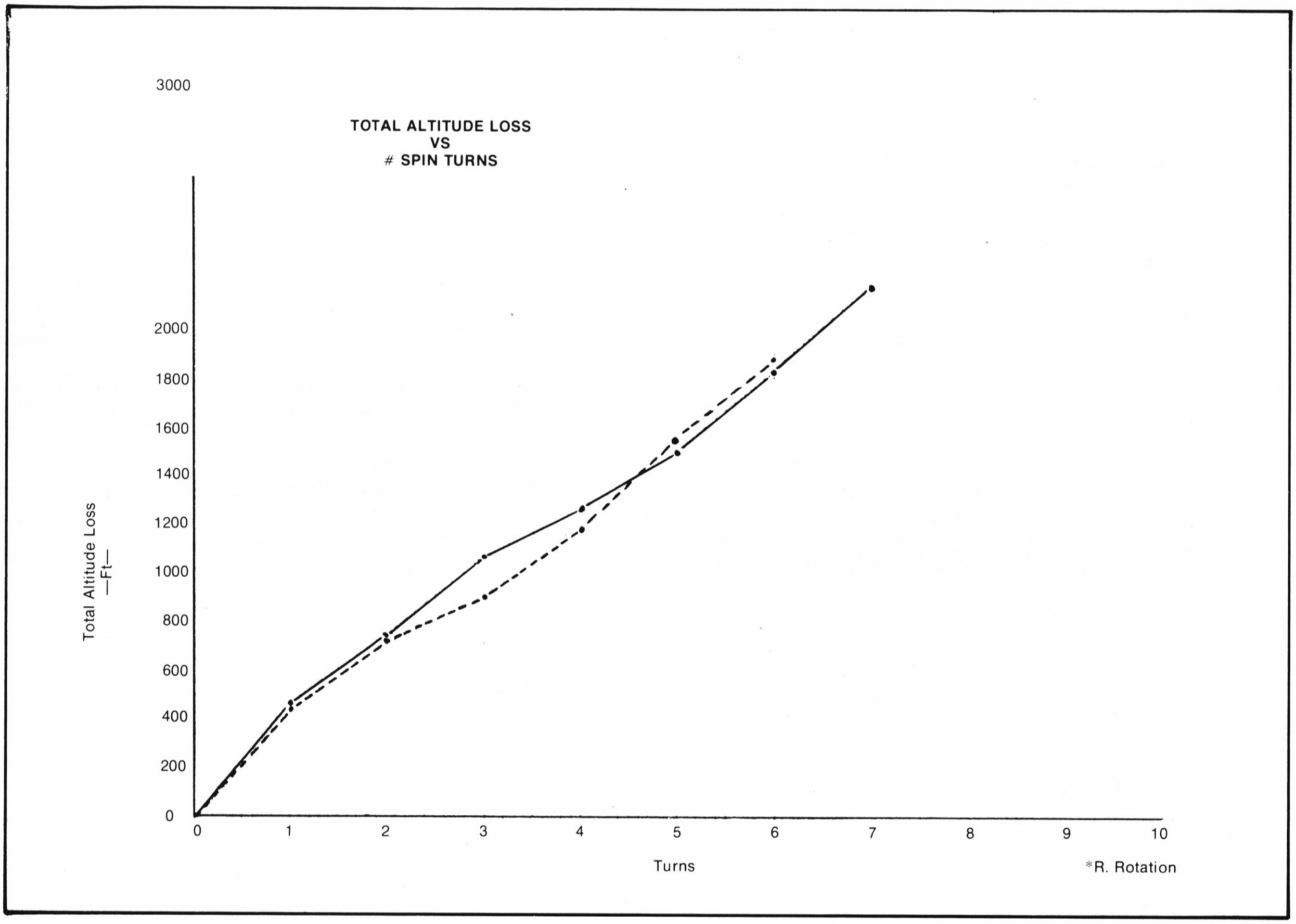
"From accident reports it seems that often when an aircraft experiences a structural failure or control blockage it ends up in a spin. With this in mind, last summer I conducted some spin tests in my Citabria. These were normal upright spins entered from a straight-and-level power-off stall. Spins were begun at altitudes of 4000 and 4500 feet AGL, O.A.T. at ground level (approximately 750 feet) ranged from approximately 75 to 80°F., gross weight ranged from approximately 1315 to 1410 lbs., C.G. ranged from approximately 14.5 to 17 inches aft of the wing L.E. (which is datum line for this a/c), i.e., 24.2 to 28.3% of the M.A.C. This placed a/c C.G. within the flight envelope and toward the forward edge of the envelope. The results of these spin tests were 'graphed up.' (See FIGS. 1 and 2)

"To establish my 'critical altitude' I reasoned as follows:

"(1) It takes me 10 seconds to get out of the airplane.
(2) It will probably take me at least 3 seconds to find and pull the rip cord handle after I leave the airplane.
(3) Security 150 parachute deployment time is approximately 2 seconds.
(4) After I exit the airplane my downward R.O.D. will probably be equal to or greater than the R.O.D. of the airplane.
(5) Therefore, I need **at least** 15 seconds to get out of my aircraft and to get my parachute deployed.
(6) Looking at the 'time vs. turns' graph, it seems like once a spin is established it takes about 2 seconds per turn.
(7) Therefore, I need 7.5 (15 ÷ 2) turns worth of altitude.
(8) Checking the 'altitude vs. turns' graph which is pretty linear, 7.5 turns equals about 2300 ft. (if you extrapolate the data).

"I realize the above 'reasoning' has many holes in it, but I feel my guesstimate of a 2300 ft. critical altitude for me makes more sense than someone telling me to be sure I have 'plenty of altitude' in case I have to bail out. I hope that the IAC Technical Safety Committee would publish my letter and ask if other IAC members have any thoughts on 'critical altitudes' or ideas on how to handle specific emergency in-flight situations."

O.K., IAC members, what thoughts do you have on minimum altitude/time required for a safe bail-out or other emergency procedures? An IAC "thanks" to the member who submitted the above letter. Here is another opportunity for all of us to pool our ideas and experiences for the good of our fellow members and the good of the sport. Let's hear from you.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TOTAL ALTITUDE LOSS
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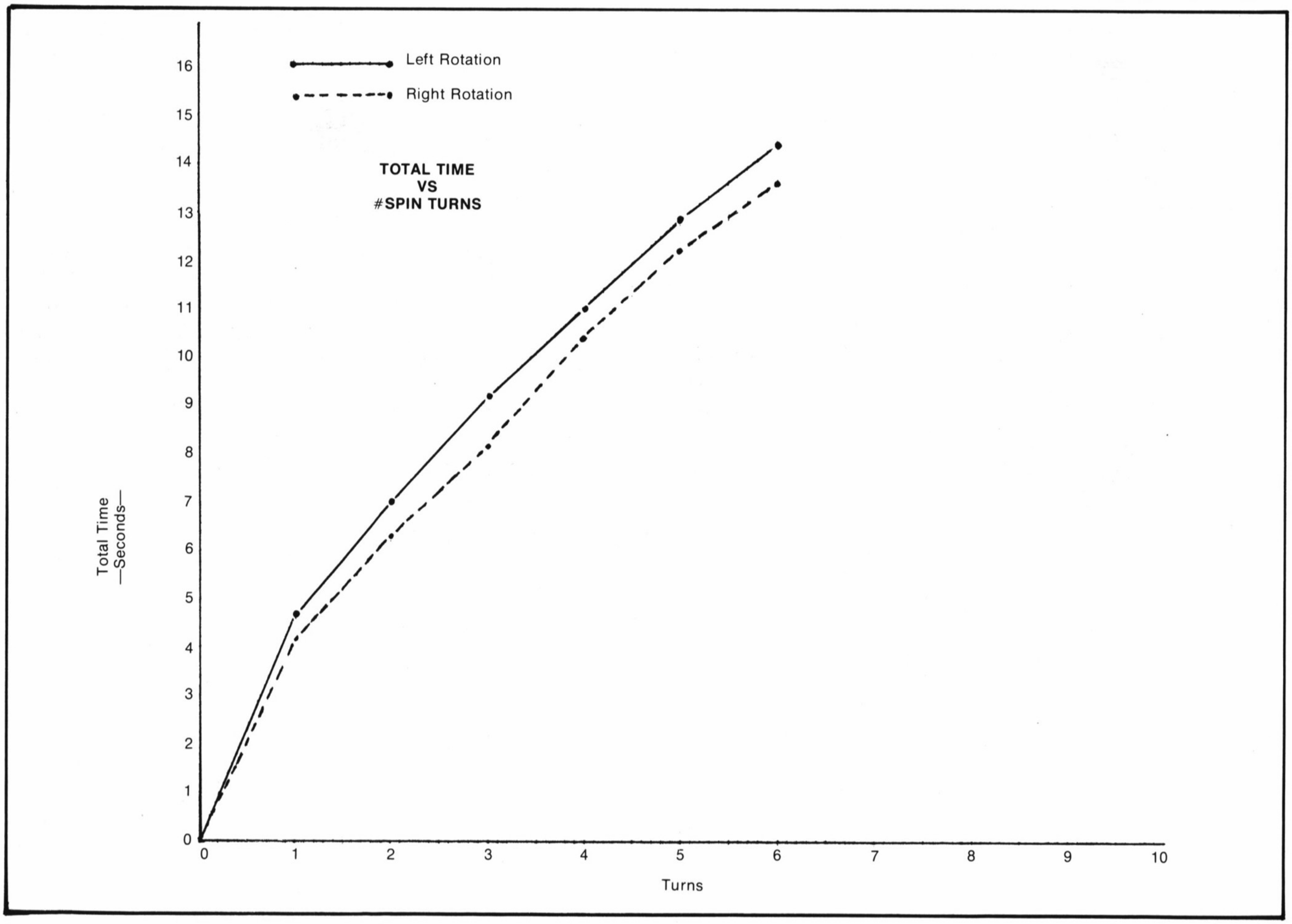
Turns
*R. Rotation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VS
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BELLY STRINGER SUPPORTS

In the October/November 1979 issue of *Sport Aerobatics* there was an IAC Technical Safety article entitled "Formers, Nails, & Stacks" which alerted IAC members to the problem of possible breakage of the belly stringer formers/supports on Bellanca Decathlons and Citabrias. As was noted in that article, if the belly stringer support becomes completely separated from the stringers there is a possibility of the broken support working its way back to the tail section of the aircraft and causing control blockage.

Since that time the IAC Technical Safety Committee has received several more reports on the same subject. Shortly after the October/November 1979 *Sport Aerobatics* article appeared, the following report was submitted by an IAC member:

"I am the owner of a Bellanca 8KCAB (180 HP C/S). The annual inspection on this airplane had just been completed when I received the latest issue of *Sport Aerobatics*, containing details about the problems with the Aluminum Fuselage former underneath the cabin area. The repair station had not found any problem during the annual inspection. Upon further checking, the rear former was found to be broken where it changes from a U shape to a flat piece. The rivets were still attached but the former itself had broken.

"The repair that was made (approved repair station) was to manufacture another former out of 2 inch by .040, 2020T3 aluminum.

"Again, the interesting thing here is that this problem will probably not be detected during the normal course of an annual inspection."

Another IAC member sent in a report covering an IAC contest where he was Technical Monitor. His report in part was as follows:

"Another recurring problem again this year in the Decathlons was the failure of the aluminum cross braces between the stringers on the belly. These braces will crack loose and slide into the back of the fuselage. We found one of them lying just behind the battery box on one airplane. Two others were found cracked loose on one end, however, still in their original location. The complete loss of these braces could result in control interference in the tail of the airplane."

Also, the FAA has put out a Service Difficulty Report on the same subject. The text of this report is:

"During preflight inspection of an 8KCAB the pilot was unable to obtain any downward movement from elevators. Investigation disclosed that a stringer support, P/N 2-1965-1, had broken and was jamming the elevator controls. Inspection of another aircraft model 7KCAB found the same problem existing. Aircraft TT 2096 hours."

Several months ago the IAC T.S. Committee was advised by a Bellanca engineer that the belly area on Decathlons and Citabrias is an area that is subjected to much turbulence and that is what they believed was causing the stringer support problem. Recently Bellanca released S.L. C-140, "Belly Fabric/Stringer Support Inspection" which spells out inspection procedures and also lists a Bellanca Service Kit which is applicable to this problem. The Bellanca S.L. is as follows:

"SUBJECT: Belly Fabric/Stringer Support Inspection.

"AIRCRAFT AFFECTED: Models 7ECA, 7GCAA, 7GCBC, 7KCAB aircraft, 1968 model year equipped with belly fabric/stringer supports through the following serial numbers: 7ECA S/N 1355-80; 7GCAA S/N 400-80; 7GCBC S/N 1220-80; 7 KCAB S/N 617-77.
Model 8KCAB S/N 3-70 thru 647-80.

"COMPLIANCE: Bellanca recommends that the inspection presented herein be accomplished during the preflight inspection prior to each flight and continued until the modification described in Bellanca Service Kit No. 277 is installed. If the inspection determines that a Belly Fabric/Stringer Support is damaged, it must be repaired prior to flight.

"INTRODUCTION

The Belly Fabric/Stringer Supports are located on the lower skin below the cabin entry door. Bellanca has received a few reports of damage to and/or failure of these supports. Undetected failed supports are a foreign object and can be a source for a jammed control system. The inspection/rework presented herein will detect such a condition and provide a means to strengthen the Belly Fabric/Stringer Support.

This Service Letter describes procedures which apply to standard production aircraft. It may not apply directly to aircraft which have been field modified or a few production aircraft which incorporated alternate designs. Contact the Bellanca Service Department if you have any questions concerning this Service Letter.

"INSPECTION

Locate the Belly Skin/Stringer Support members approximately 1½ inches forward and 26 inches aft of the wing strut fuselage attach point running across the belly between the two lower fuselage stringers. Push up with moderate hand pressure on each support member approximately two inches inboard of the fuselage stringer to which it attaches (both sides) and on centerline, and observe the support member deflection. A small amount of deflection is acceptable. If the support member moves more than ⅛ inch, it is probably damaged or failed. Remove the inspection covers just aft of the rear support member and check the support members visually. If the support members are damaged, replace them per the procedures describes in Service Kit No. 277.

"SERVICE KIT NO. 277

The Bellanca Service Kit No. 277 is available to replace and/or strengthen the Belly Skin/Stringer Support members."

Thanks much to all the IAC members who contributed to this T.S. report and to the Bellanca engineers for their help and support.

BELLANCA SERVICE LETTER

Bellanca Aircraft Corporation
Municipal Airport
P.O. Box 69
Alexandria, Minnesota 56308
Phone: (612)762-1501

Service Letter No. C-141
FAA APPROVED
Date: July 11, 1980
Revision:
Page 1 of 2

SUBJECT: Fuel Manifold Leak Inspection.
AIRCRAFT AFFECTED:
Model 7ECA, S/N 1224-78 thru 1352-80
7GCAA, S/N 349-78 thru 396-80
7GCBC, S/N 1006-78 thru 1214-80
8KCAB, S/N 358-78 thru 642-80
8GCBC, S/N 261-78 thru 360-80

COMPLIANCE: Bellanca recommends that the inspection presented herein be performed within the next 30 days or 10 hours of flight, whichever occurs first. If the inspection determines that the fuel manifold is leaking, it must be repaired prior to further flight. If the inspection determines that the fuel manifold has an unacceptable fitting lubricant/sealer, the fitting must be repaired within the next 30 days or 10 hours of flight.

INTRODUCTION

The fuel manifold is located in the aft fuselage compartment directly above the battery and master switch solenoid. Bellanca has received a few reports indicating that the manifold may develop a small leak and allow fuel and/or a high concentration of fuel vapors near the battery and starter solenoid. The inspection and repair presented herein will serve to eliminate this potential ground or in-flight fire hazard.

This Service Letter describes procedures which apply to standard production aircraft. It may not apply directly to aircraft which have been field modified or a few production aircraft which incorporated alternate designs. Contact the Bellanca Service Department if you have any questions concerning this Service Letter.

INSTALLATION INSPECTION

Remove the battery access panel on the aft side of the baggage compartment. Inspect all six faces of the fuel manifold using a flashlight and mirror as required to determine if there is any evidence of fuel leakage (i.e. fuel stain, discoloration); inspect the area below the manifold for evidence of fuel leakage. If evidence of present or previous leakage is found, drain the aircraft fuel system, remove the fuel manifold and determine the cause for leakage as described under MANIFOLD/ FITTING INSPECTION.

If no evidence, of leakage is found, examine the AN nipples which are threaded into the fuel manifold to determine the type of thread lubricant/sealer. If the lubricant/sealer is oily and slippery to the touch or powdery, it is unacceptable. An acceptable lubricant/ sealer will adhere to the manifold and will appear to be sticky to the touch. If you are unable to make an acceptable or unacceptable determination, remove the manifold and reassembly as indicated below.

If the thread lubricant/sealer is acceptable, replace the aft baggage panel and the inspection is complete. If the thread lubricant/sealer is undetermined or unacceptable, remove the manifold and reassembly and install as described under MANIFOLD/FITTING REASSEMBLY AND INSTALLATION.

MANIFOLD/FITTING INSPECTION

Carefully remove the four nipple fittings from the manifold and examine them for acceptable lubricant/ sealer as described in INSTALLATION INSPECTION. Remove the lubricant/sealer and inspect the manifold block for minute cracks in the threaded areas using a magnifying glass and/or dye penetrant. The crack will be perpendicular to the threads and may extend into the face of the manifold. Do not mistake tap marks for a crack. If a crack is found, replace the manifold. Reassemble the manifold and install as follows.

MANIFOLD/FITTING REASSEMBLY AND INSTALLATION

Thoroughly clean old lubricant/sealer from manifold and fittings. Apply an acceptable thread lubricant/seal to the nipple pipe thread (leave first two threads clean) per the list below.

Acceptable Lubricant Sealers
Tight Seal, Radiator Specialty Co.
Permatex No. 3, Permatex Co., Inc.

Install the fittings in the manifold. Install manifold assembly in aircraft. Wipe dry and clean. Fill fuel tanks. Check fitting to insure that there is no leakage. Install aft baggage panel.

PITTS AEROBATICS

Service Bulletin

DATE: 5-15-80 **Service Bulletin No. 14**
SUBJECT: Front Horizontal Stabilizer Support Tube
MODELS AFFECTED: S-1S 1-001 thru 1-0060
TIME OF COMPLIANCE: Immediate

There have been several instances where failure of the front horizontal support tube has occurred where the attach bushings weld to the support tube.

All of the failures to date have occurred on homebuilt aircraft.

However, we now have a reported instance of cracks being found during inspection on a factory completed aircraft.

We are, therefore, requesting that the Front Horizontal Stabilizer Support Tube, P/N 1-210-126, be replaced with a new, heavier member, P/N 1-210-166, on all factory built aircraft at the owners earliest convenience. The new member, P/N 1-210-166, is available from the factory. The price of the new member is $26.36.

It should be possible to replace the member by working through the existing inspection rings on the fuselage. The turtledeck skin is notched on the left side so that the member can be removed by rotating it 90° and sliding it out the left side of the fuselage after the attaching bolts have been removed.

Replacement of the 1-210-126 carry thru tube with the 1-210-166 carry thru tube is FAA approved.

Please fill out and return the compliance card sent with the new member after it has been installed.

CLUES

An IAC contest Tech Monitor submitted a T.S. report covering problem areas encountered during the contest. Part of his report concerned itself with a broken Decathlon engine mount.

"It helps to have a bit of past experience regarding the recurring problems of a particular airplane. I have operated a Decathlon as an aerobatic trainer since 1973. The first one was a 1973 model with the old-style mount. That airplane required changing engine mount bushings every 200 hours due to wear caused by aerobatic operation. The first sign of wear and excess engine sag was a cracked landing light which occurs when the starter ring contacts the landing light. My present airplane is a 1978 model with the new style mount and improved mount bushings. I have operated this airplane 950 hours to date. The mount bushings were checked at 500 hours and found serviceable, however a new set was installed at that time. The engine sag is not a problem on this airplane.

"The Decathlon with the engine mount we found cracked was about a 1976 model which still had the old-style mount without the additional vertical bracing; however, the newer mount bushings had been mated to this mount. This procedure is something which was O.K.'d by the manufacturer. As I had talked to a factory rep some time back on this type of change I decide against this procedure on my first Decathlon, however, because I felt the newer bushing which is much more rigid would put loads on the old mount that would be excessive. I think this changeover may have contributed to the cracked mount on the airplane involved.

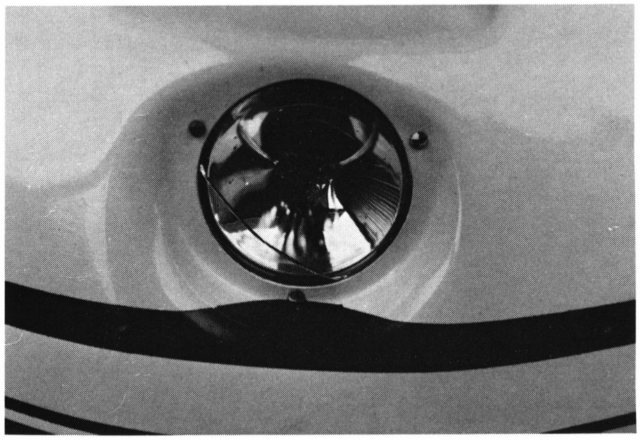
"The actual cracked tubing was at the cluster and mounting point on the upper right corner of the firewall. That tube was cracked completely through and had separated from the cluster. It appeared that the tube had been cracked about two-thirds through for some time prior to the complete separation. The engine had broken the landing light as well as allowing the exhaust stacks to burn through the cowling on the right front corner."

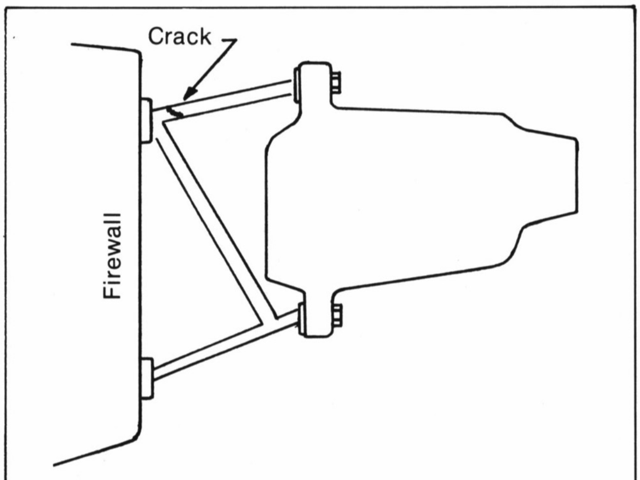
Another IAC member reported that he noticed the landing light on his 1969 7ECA Citabria was broken and knew that meant excessive engine movement had taken place and allowed the engine to come in contact with the landing light/cowling. He went on to advise that although the engine mount bushings appeared O.K. from an external inspection, and, in fact, had been replaced only 40 hours earlier, the engine was removed and the bushings were discovered to be "pounded out" and cracked on the inside. These were the early style bushings and the later style lord bushings were then installed. When this member made his report he had accumulated only 10 hours on the lord engine mount bushings and had encountered no further problems.

(IAC members are advised that the engine mount and engine bushing replacement for Bellanca Citabrias and Decathlons that is mentioned in the above two reports is covered in Bellanca Service Letter C-126.)

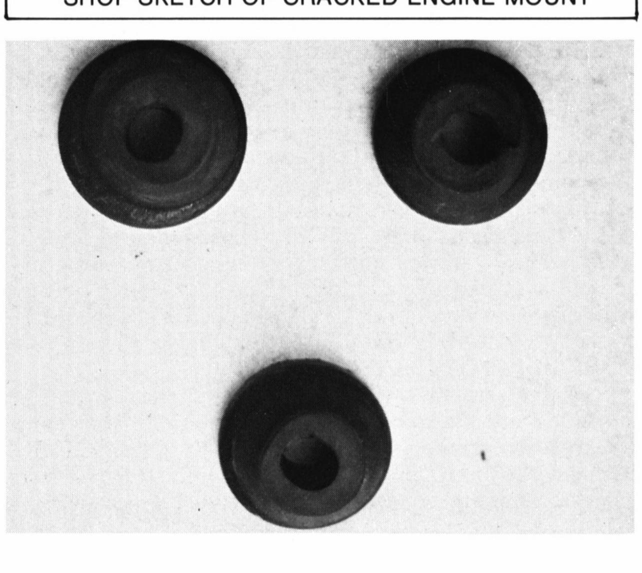
One of the significant things about both of the above reports is that some damaged item removed from the actual failed part was the initial clue that something was wrong. For example, items like broken landing lights, wrinkled fabric, "strange" noises, etc., cannot be ignored — the basic "causes" must be found.

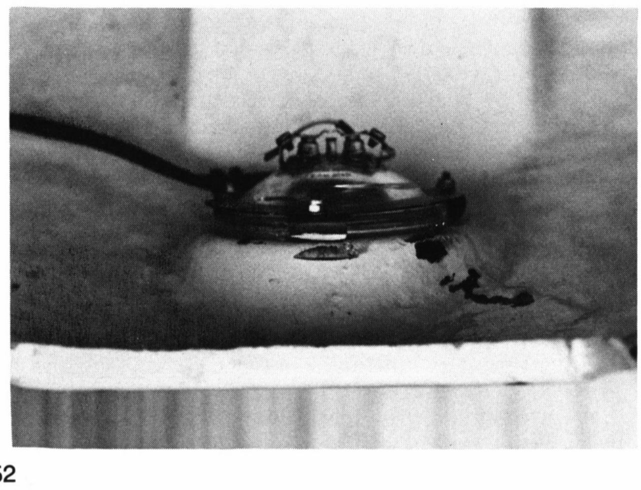
IAC "thanks" to the two IAC members who submitted the above reports.





SHOP SKETCH OF CRACKED ENGINE MOUNT





CLEVELAND BRAKES

The following report is excerpted from the November 1980 and December 1980 EAA Designee Newsletter and may be of interest to some IAC members.

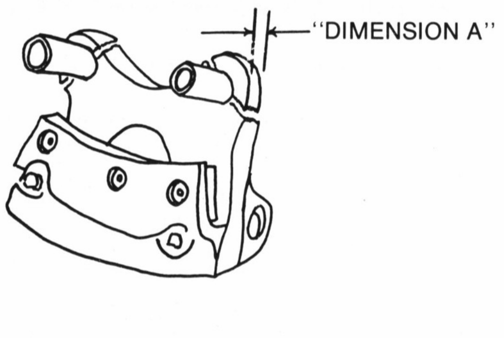
In the November EAA Designee Newsletter an EAA/IAC member made the following report:

"The sketch shows the Cleveland Brake that **was** installed on my Pitts.

The story goes as follows:

"After landing and during the latter part of my roll-out, I applied light braking in order to make a turnoff that was still several hundred feet ahead of me. The right brake pedal went to the floor; however, since the left brake was working, the Pitts swerved to the left and put me in the grass. Even though the left wing raised quite a bit, I was lucky that I did not drag the right wing tip, and once I was in the grass I regained directional control and prevented a ground-loop.

MODEL 30-9
MFG. 12-73
CLEVELAND



"Examination disclosed that **both** ears on the right brake had severed as shown on the sketch, and the brake assembly rotated with the disk, which shattered my wheel pant, ruined the disk, and punctured the tire, and broke the brake line.

"Since I had another set of wheels and brakes in the shop, I decided to replace both wheels, and both brakes. Comparing the broken brake with the new one, I was surprised to find that "Dimension A" had been doubled in thickness on the newer mfg. dated brake. "Dimension A" on the broken assembly is approximately ⅜"; however, on the newer assembly, it is ¾". Both brakes are still the same Model 30-9 . . . just different mfg. dates."

The December Designee Newsletter published the response from Cleveland concerning this problem:

"Our designs are constantly reviewed for field performance, ways to standardize and improve performance to the customer. Product improvement and standardization are ongoing processes at Cleveland. Inputs such as yours are helpful and appreciated.

"The particular change you note in your letter was the result of a standardization program in 1975. The old style anchor pin used on the early 30-9 brake was replaced with a more common anchor pin used in the majority of our brake assemblies. The standard anchor pin necessitated the increased thickness at the lugs to function properly.

"The FAA MDR history for the last six years was reviewed to obtain an indication of the 30-9 performance. There have been four reports of incidences with this brake, one of which was yours. There was one other difficulty similar to yours, the other two were unrelated. The brake location on the Pitts, six o'clock position on the strut, puts the brake in a very susceptible position. As you know, the brake is an external design in which the brake extends beyond the wheel O.D. Being in this position, many occurrences could cause damage to the brake; flat tire or hard landing (the tire would hit the brake), collision with a rock or other item on the runway, etc. We recommend that the brake be mounted in the three or nine o'clock position."

There is very much technical information put out in the EAA Designee Newsletter which is edited by Chuck Larsen. This monthly Newsletter is available to EAA/IAC members at a $10.00 per year subscription rate and may be a very worthwhile addition to one's technical information library. Interested IAC members should write:

Designee Newsletter
P.O. Box 229
Hales Corners, Wisconsin 53130

FAA SAFETY RECOMMENDATIONS

Two FAA safety reports relating to structural problems with aerobatic aircraft have been sent to Ben Owen at EAA Headquarters and are as follows:

I. "We have reviewed two pages of an NTSB incident report, dated October 2, 1980, which involved a De Havilland DHC-1B-253 airplane licensed in the experimental category.

"It was reported that during a tail slide, rudder control was lost, although the pilot returned to the airport without further incident.

"Apparently the upper rudder hinge separated from the vertical stabilizer main spar. The spar skin failed.

"During a disassembly inspection, cracks were noted in the vicinity of the four attachments for the horizontal stabilizer also.

"Reported repairs included a steel stiffner for the vertical stabilizer spar-web and larger steel attach bolts for the aluminum horizontal stabilizer. Also, rivets in the elevator torque tube are replaced by bolts."

II. "This Safety Recommendation is made as a result of a fatal aircraft accident involving an amateur-built aircraft.

Make: Mong Biplane, Model M.S.I.

"Mr. . . . was performing several aerobatic maneuvers at an air show . . . The flight maneuvers prior to the accident consisted of hammerhead stalls and spins. During his second maneuver (spins) the right wings separated from the aircraft at the 200' level during the pullout. Mr. . . . was fatally injured.

"Subsequent accident investigation revealed that the right flying strut appeared to have separated where attached to the top, right, forward part of the interplane strut.

"My observation of the construction of this aircraft is as follows:

"1. The flying strut appears to be made of very thin material. The streamline strut measures 69" long with a 2" chord and appears to be adequate in thickness — however, the tube that is welded inside strut to form an attach point for the wing interplane the strut appears to be too thin in thickness. Further, this thin tube, when welded to the strut, is further weakened by heat absorption if improper gas pressures are used for the thickness of the metal during the welding process. A cursory inspection of the failed strut end shows some signs of carburizing from torch heat.

"2. In addition, the attached parts that remained on the right interplane strut appeared to have separated as a secondary failure. However, I feel that these parts should be machined instead of assembled by sweating the stud to the basic block assembly.

"3. This aircraft should be restricted against any maneuver unless the aircraft incorporate both landing and flying struts or wires.

"This statement is based on an interview with a friend of Mr. . . . He stated that on three occasions Mr. . . . landed the aircraft hard enough to shake up Mr. . . . 'both mentally and physically.' In studying his statement, it appears that the current construction of this aircraft's wing structure is vulnerable to other than flying loads. Since there are no landing struts or wires, the entire load transfer is subjected to the one flying strut each time the aircraft is operated.

"It is therefore my recommendation that this aircraft be restricted against aerobatic flight until the wing structure can be improved by either redesigning the flying strut and its attach points, or by adding a landing strut or wire to box-in the wing structure.

"Exhibits of the failed strut and its attach fittings are being retained at the General Aviation District Office, South Bend, IN, and will be forwarded to Engineering upon request.

Mr. Alfio A. Sapienza
Principal Maintenance Inspector
South Bend, Indiana GADO"

AIRWORTHINESS DIRECTIVE

80-21-06 **BELLANCA (CHAMPION):** Amendment 39-3939. Applies to Bellanca (Champion) Models 7GC, 7GCB, 7HC, 7KC, 7GCA, 7GCBA, 7ECA (Serial Numbers prior to 985-74), 7GCAA (Serial Numbers prior to 280-74), 7GCBC (Serial Numbers prior to 604-74), 7KCAB (Serial Numbers prior to 405-74), and 8KCAB (Serial Numbers prior to 120-74).

Compliance is required within the next 25 hours time in service, or 60 days after the effective date of this AD, whichever occurs first, and thereafter at intervals not to exceed 100 hours time in service, or 12 months from the last inspection, whichever occurs first. To prevent a degradation of the induction system icing protection or partial engine power loss, accomplish the following:

(1) Visually inspect the baffle installation within the muffler core and body assemblies, Bellanca (Champion) P/Ns 3-1079 or 3-1493, for cracking or deterioration, with the mufflers removed from the aircraft. Replace any muffler where baffle cracking or deterioration is evident, with an airworthy muffler core and body assembly of the same or other FAA approved part number.

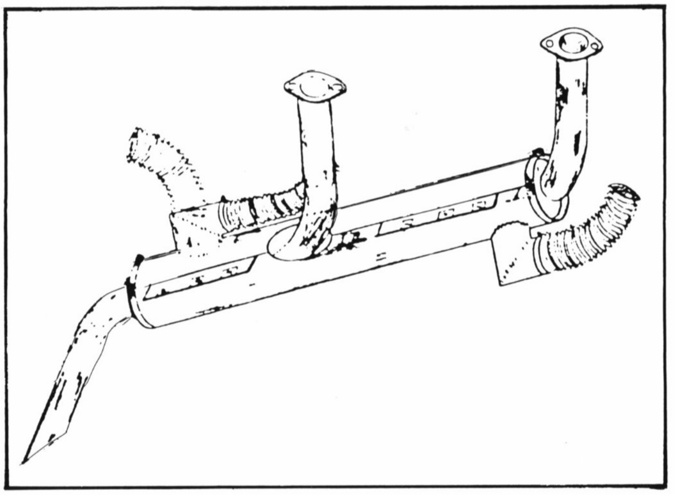
(2) If an airplane is at an unsuitable base when compliance with this AD is required, the airplane may be issued a special flight permit in accordance with FAR 21.197 and 21.199 for the purpose of flying to a base where the required inspection may be performed.

(3) Equivalent methods of complying with this AD, including the installation of different exhaust systems, must be approved by the Chief, Engineering and Manufacturing Branch, FAA, Great Lakes Region.

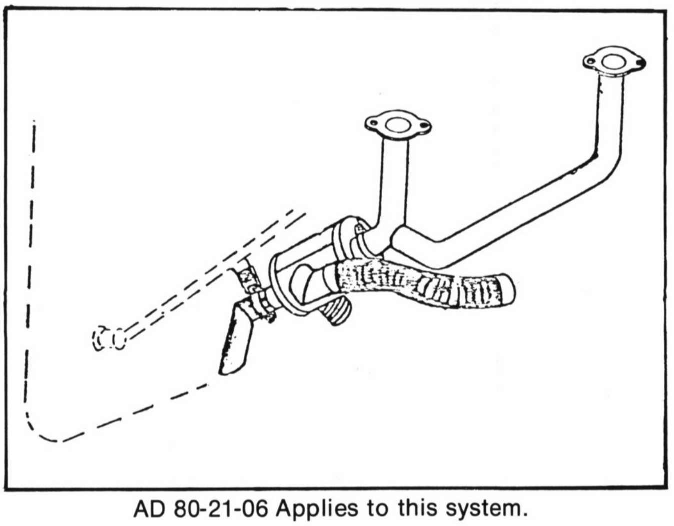
This amendment becomes effective October 16, 1980.

FOR FURTHER INFORMATION CONTACT:

Kevin Mullin, Engineering and Manufacturing Branch, AGL-214, Flight Standards Division, FAA, 2300 East Devon Avenue, Des Plaines, Illinois 60018, telephone number (312) 694-4500, extension 308.



AD 80-21-06 **NOT** Applicable.



AD 80-21-06 Applies to this system.

MODIFICATIONS ON PITTS SPECIALS

By Richard N. Goode

Reprinted from the BAeA Newsletter

Courtesy Tony Lloyd

In so far as aerobatic pilots in the U.K. at an unlimited level use Pitts Specials almost entirely, and equally at the 1980 World Aerobatic Championships they were by far the most prolific aircraft present, I felt it of interest to examine the modifications that people are doing to their aircraft in the U.S.A. Before going any further it should be pointed out that many of the modifications are done totally on a 'hit and miss' basis, with one 'expert' doing one particular modification, which then has everyone else following suit without any real idea of what the effectiveness of the modification might be. In consequence I am sure that a lot of the areas along which people have been proceeding have been of the nature of blind alleys, which is aggravated by the Americans keenness to experiment and change. Having said that there were comparatively few Pitts' at Oshkosh that could be called standard S1S's, and the message was certainly that, to get to the top, one needed fairly major modifications which can be divided up into various principal areas, but the most important of which are:

1. Aerodynamic Modifications for greater streamlining.
2. Engine Modifications for greater power.
3. Control Surface Modifications for more powerful and quicker control response.

In so far as these are often combined with each other, I felt it easier to examine the various parts of the aeroplane and tackle each separately:

1. **The Air Frame:**

Virtually everyone still has standard air frames, although certain people, e.g. Kermit Weeks, has modified his fairly radically, which has included moving the seat some 18 inches to the rear. At the same time there is considerable emphasis on lightness with people aiming at cutting out every excess ounce, and there is quite a lot of weight that can be saved even on a standard factory fuselage.

2. **Wings:**

The standard fitment is Pitts Symmetrical Wings, although a number of people have Sparcraft Wings, which do have the disadvantage of a lower roll rate and higher induced drag. Some people have experimented with reducing the dihedral of the bottom wings to zero, with the emphasis of making inverted and direct flight more similar, but the effect does not seem very pronounced. At the same time other people have set both top and bottom wings with zero-incidence, but again there is no unanimity of thought on this matter.

3. **Ailerons:**

Ailerons were very much the talking point of Oshkosh, and there were all sorts of different theories with only one principal point being agreed upon — which is that one should seal the gap between the aileron and the wing. On most Pitts' however full up-aileron results in this seal being made naturally, and thus one is only really concerned about the effect on down-aileron.

With the advent of the S2S the factory has done quite a lot of work on ailerons, and has brought out 'symmetrical' ailerons, which are supposed to give about 20% increase in rate of roll, although coupled with a substantial increase in control forces. This has been counteracted by the fitting of aerodynamic spades coupled to the ailerons (as on some Zlins), and although this has not really progressed down to S1's because of the already light control forces, I did fly one S1 that had been thus modified and the control forces were extraordinarily light. Certainly a standard Pitts does not roll very fast — by today's standards — and there is undoubtedly a great deal that can be done with proper research and knowledge to improve this.

4. **Tailplane:**

With various reports of failures of the leading-edge support tube, many individuals have added a tube from the bottom of the fuselage up to the leading edge of the stabilizer, to supplement the four flying wires. The factory themselves say that this is unnecessary, but it would seem to be a useful precaution. Many people have gone in for bigger rudders, which would seem a useful move particularly from the point of view of the aircrafts enhanced knife-edge ability. Several S1's had their trimmers chopped in half, and one half made into an elevator servo-tab which might be a useful idea.

5. **Under Carriage:**

None of the front ranking Pitts' had 'bungee' under carriages, and these were replaced with spring aluminum gear. Contrary to popular theory these are in fact rather heavier (about 4-lbs), than the original Pitts gear, but not only are they somewhat more aerodynamic in themselves, but they have the advantage of enabling the floorline of the aeroplane to be raised, which in itself permits much tighter cowling and hence better streamlining. There is of course the additional advantage of lack of maintenance and an aeroplane that is slightly easier to land.

Many people had also converted to Henry Haig tail wheels, which are very small castors at the end of a long (18 inches) spring steel tube. These have the advantage of being more streamlined, and again making the aeroplane rather easier to land, but do not actually confer any real weight advantage.

6. **Fuel System:**

Here the absolutely universal modification was that of a header tank, which provides between one and two gallons of fuel in a separate tank, and this enables aircraft to compete with between 3 and 4 gallons less fuel than they might otherwise do, and still ensure completely clean fuel delivery.

7. **Engines:**

The Americans are comparatively unadventurous in terms of engine modifications, which seems unusual in the light of their involvement in car racing, etc. Most individuals use the Lycoming Helicopter cam shaft, and couple this with an increased compression ratio and careful assembly to give (say) 210 h.p. from a standard 180 h.p. engine.

There was some dispute over the relative advantages of the 180 and 200 h.p. engines, particularly in terms of the reliability of the latter under arduous aerobatic conditions. There is no doubt that the 200 h.p. engine with hemispherical cylinder heads, gives better breathing and can be developed to give considerably more power, and Lycoming themselves say that with its stronger crank case and heavier components it is a more reliable unit. It also has the advantage, for a Pitts installation, of being able to be fitted with a forward facing fuel injector which can result in much more streamlined engine cowls.

On the debit side the 200 h.p. engine is some 32 lbs.

heavier than the 180 h.p. engine and this poses major problems on an S1S, which is already towards the forward limit of its center of gravity. For this reason a number of such aircraft were carrying leadweight either externally on their tail springs or internally in the rear of the fuselage.

8. **Propellers:**

Here the big development was the use of Hoffmann Variable-Pitch Propellers. However, with a diameter approaching that of the 76 inch metal Zensenich, to my mind these do not really confer as much of an advantage as some people would think, for the principal reason that, by virtue of its length, engine revs cannot really go much beyond 2,800, before the propeller tips go supersonic and there is thus much less ability to rev the engine for more power. Nevertheless it gives the ability to rev the engine at (say 400 rpm more at static than with a fixed pitch Sensenich, and thus one does have considerably more power when it is really needed, i.e. at zero or very low air speeds).

I personally feel that the best avenue would lie with a 3 blade Hoffmann V.P. Propeller, which with shorter blades, can be revved harder before losing efficiency with the propeller tips encountering compressibility. However, these propellers apparently suffer even more than the 2 blade propeller from overspeeding, which can only be alleviated to a limited extent with hydraulic accumulators in the system.

Apart from anything else the variable pitch propellers have further disadvantages, not only of complexity, but also of weight in so far as they are some 20-lbs. heavier than the metal Sensenich, and this weight is right at the very front of the aircraft. There is obviously not much point in having a great deal of power for a vertical climb if you need to fly in a very large arc to go from horizontal to vertical flight!

I personally feel that the best compromise is probably a propeller of some (say) 70 inches in diameter (as opposed to the 76 of the Sensenich), but with a rather coarser pitch than Sensenich, which would allow the propeller to turn faster, and thus for the engine to deliver more power. Overall this is a key area where much greater efficiences are certain to be found, and we may see a return to wooden propellers.

9. **Aerodynamics:**

Considerable attention is given to streamlining of the aircraft, which ranges from the very tight cowls which are made possible with one-piece under carriages to careful fairing of cabane struts and other parts of the aircraft. Certainly the Pitts is intrinsically a very unstreamlined machine, and it would appear that, purely with aerodynamic modifications, increases in top speed of over 25 m.p.h. can be obtained fairly simply.

10. **Exhausts:**

The standard Pitts exhaust is pretty inefficient, and most of the Americans were using a 'cross-over' system coupling number one with number four and number two with number three. This is certainly more efficient, but is not as effective as a proper 'four into one' system, but this has the major disadvantage of complexity and pipe length — which theoretically needs to be a total of some 18 feet long!

Certainly there is no doubt that the Pitts is an amazing aeroplane even in standard form, but that nevertheless there is a great deal that can be done to enhance its performance, particularly with the increasing trend of international judges to look for very long vertical lines and, for example, the ability to do multiple rolls in both vertical and horizontal lines. People have been saying for years that the day of the Pitts is over, but I personally feel that it can continue to provide a level of performance the equal of any other competition aircraft, with is only real disadvantage being its comparative smallness of size and the intrinsic difficulties of judging, which tend to mean that given an identical maneuver, a monoplane will be awarded fractionally more points — which of course has the converse that mistakes in a monoplane are always that much more visible.

December 5, 1980

80-25-07 **STEWART-WARNER CORPORATION:** Letter issued December 5, 1980.

Pursuant to the authority of the Federal Aviation Act of 1958, delegated to me by the Administrator, the following Airworthiness Directive (AD) is issued and applicable to all owners and operators of aircraft with Stewart-Warner Corporation oil coolers of the following model and serial numbers that do not have a date ink stamped next to the oil cooler nameplate.

Stewart-Warner Model Nos.	Beginning Serial Nos.	Ending Serial Nos.
8406J	12558	16212
8406L	1496	1763
8432K	514	541
8432L	631	964
10568C	1105	1141
10578B	2212	2316
10599A	7369	9013
10610A	815	1956
10614A	732	947
10662A	334	394
10634D	105	907
8446C	575	629
8437C	422	472
10641B	143	162
8493B	1269	1603

NOTE: Oil coolers of the above model and serial numbers that do have a date ink stamped next to the nameplate have been inspected and found satisfactory for continued use.

These oil coolers may be installed on, **but not limited to,** the following aircraft:

Bellanca Models: 7GCAA, 7GCBC, 7KCAB, 8GCBC, and 8KCAB.

Cessna Models (including Reims Aviation): 152, A152, F152, FA152, 172I, 172K, 172L, 172M, 172N, 172P, 172RG, F172L, F172M, F172P, 177, 177A, 177B, 177RG, F177RG, R182, FR182, TR182, T182, A188B, T188C, 210N, T210N, and P210N.

Piper Model: PA-38-112 and PA-44.

Mooney Models: M20C, M20E, M20F, M20G, and M20J.

Great Lakes Models: 2T-1A-1 and 2T-1A-2.

Beech Models: 76, 77, and C-23.

This directive is effective immediately upon receipt of this letter.

There have been reports of oil cooler ruptures on several different makes and models of aircraft caused by inadequate salt bath removal following assembly of the oil coolers.

To prevent loss of engine oil, accomplish the following:

1. If the oil cooler has accumulated 10 hours or less total time in service since new, prior to further flight, replace with an airworthy oil cooler not of the above serial numbers or with an airworthy cooler of the above serial numbers that have a date ink stamped next to the oil cooler name plate.

2. If the oil cooler has accumulated more than 10 hours time in service since new, visually inspect the coooler for oil leakage prior to further flight.

NOTE: Removal of the engine cowling is not required if it can be positively determined from inspection of areas adjacent to the oil cooler that the oil cooler is not leaking.

A. If oil leakage is evident, prior to further flight, replace with an airworthy oil cooler not of the above serial numbers or with an airworthy oil cooler of the above serial numbers that have a date ink stamped next to the oil cooler name plate.

B. If oil leakage is not detected:

i. Fabricate and install the following placard on the aircraft instrument panel in plain view of the crew, using letters ⅛-inch high minimum:

"Visually check oil cooler for leakage prior to each flight. If leakage is detected, see Emergency AD Number 80-25-07."

NOTE: Pilot or owner may make and install this placard.

ii. If the oil cooler is replaced with an airworthy oil cooler not of the above serial numbers or with an airworthy oil cooler of the above serial numbers that have a date ink stamped next to the oil cooler name plate, the placard can be removed.

3. Any equivalent method of compliance with this AD must be approved by the Chief, Engineering and Manufacturing Branch, 2300 East Devon Avenue, Des Plaines, Illinois 60018, telephone (312) 694-4500.

FOR FURTHER INFORMATION CONTACT:

Kevin Mullin, Propulsion Engineer, Engineering and Manufacturing Branch, AGL-214, Flight Standards Division, FAA, 2300 East Devon Avenue, Des Plaines, Illinois 60018, telephone number (312) 694-4500, extension 308.

CORRECTION

December 3, 1980

Emergency Airworthiness Directive dated November 24, 1980, distributed by air mail letter to all owners of Avco Lycoming Model O-235 series engines installed in, but not limited to Piper PA-38-112, Cessna 152, Gulfstream American AA1C, Beech 77, and Bellanca 7ECA aircraft.

Pursuant to the authority of the Federal Aviation Act of 1958, Sec. 313 and 601, delegated by the Administrator, (14 CFR 11.89:31 F.R. 13697), the following alleviating changes to Emergency Airworthiness Directive dated November 24, 1980, are effective immediately upon receipt of this airmail letter. Some of these changes are also described in Lycoming Service Bulletin No. 453 dated November 26, 1980.

80-25-02 R1 **AVCO LYCOMING:** Letter issued on November 24, 1980 as amended by letter issued November 28, 1980.

1. The Emergency AD applies to O-235 series engines with Serial Nos. L-12500-15 thru L-20676-15 inclusive, all remanufactured O-235 series engines, regardless of serial number, shipped between December 10, 1976, and November 8, 1979, and all O-235 series engines regardless of serial number, that had pushrods replaced between December 10, 1976, and November 24, 1980.

2. The Emergency AD does not apply to those engine serial numbers specifically listed in Lycoming Service Bulletin No. 453 and engines incorporating eight pushrods identified by revision letter K or subsequent revision letter, or by Code T-T, -85, or the symbol # as described in Service Bulletin No. 453.

Compliance required as indicated:

1. Prior to further flight, remove all eight pushrods and inspect for loose ball ends and evidence of bulging and splitting of the pushrod tubing. Measure the length of the pushrod assembly. The overall length shall not be less than $11^{17}/_{32}$ inches. If all these conditions are satisfactory, set valve clearances in accordance with Paragraph 8 of Lycoming Service Instructions Nos. 1388A dated January 25, 1980, and 1068A dated September 1, 1978. If any pushrod is found damaged or is less than the specified dimension noted above, replace with a serviceable part prior to further flight.

2. Within 25 hours in service after the effective date of this AD and every 25 hours thereafter, measure and record valve tappet clearances in accordance with Lycoming Service Instructions 1388A and 1068A. If any valve clearance increases more than .015 inch since the last 25 hour inspection, remove the pushrod and inspect for damage and shortening in accordance with Item 1 above.

3. A special flight permit may be issued in accordance with FAR 21.197 to fly the aircraft to a base where the aboe inspections may be accomplished.

This Airworthiness Directive becomes effective upon receipt.

FOR FURTHER INFORMATION CONTACT:

Pat Perrotta, Propulsion Section, AEA-214, Engineering and Manufacturing Branch, Federal Building, J.F.K. International Airport, Jamaica, New York 11430; telephone (212) 995-2894.

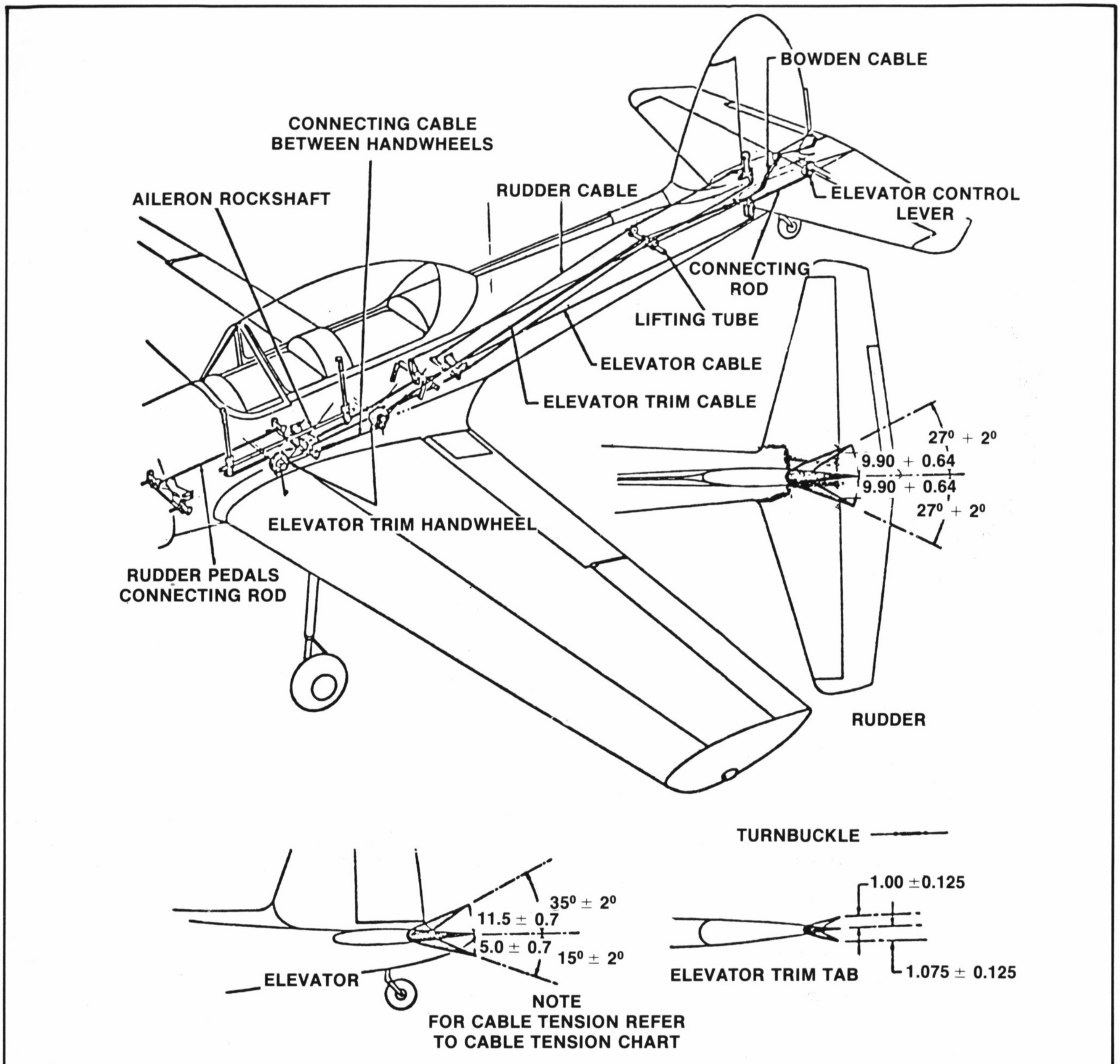


Figure 2-10 Rudder and Elevator Rigging Diagram

CHIPMUNK EMPENNAGE

Through EAA Headquarters, the IAC Technical Safety Committee received an NTSB Report concerning an in-flight rudder hinge failure on a DeHavilland Chipmunk. The essence of this Report is as follows:

"History of the Flight

The pilot was performing acrobatics in an air show. During a tail slide the pilot stated that he lost rudder control. A visual check revealed the rudder was tilted to the side at a 15 degree angle. The pilot was able to return to the airport and land without incident.

"Wreckage

Examination of the aircraft revealed that the upper attach point for the rudder hinge had separated from the main spar of the vertical stabilizer. The nut plate was still attached to the hinge and only the skin on the main spar had failed.

The empennage was removed from the aircraft and the vertical stabilizer and rudder were separated from the horizontal stabilizer to facilitate repair. Inspection of the horizontal stabilizer four attach points nut plates revealed that all four had cracked near the nuts and at the 90 degree bend.

"Corrective Action

A steel stiffener was placed between the upper and lower rudder hinge nut plates and the vertical stabilizer web.

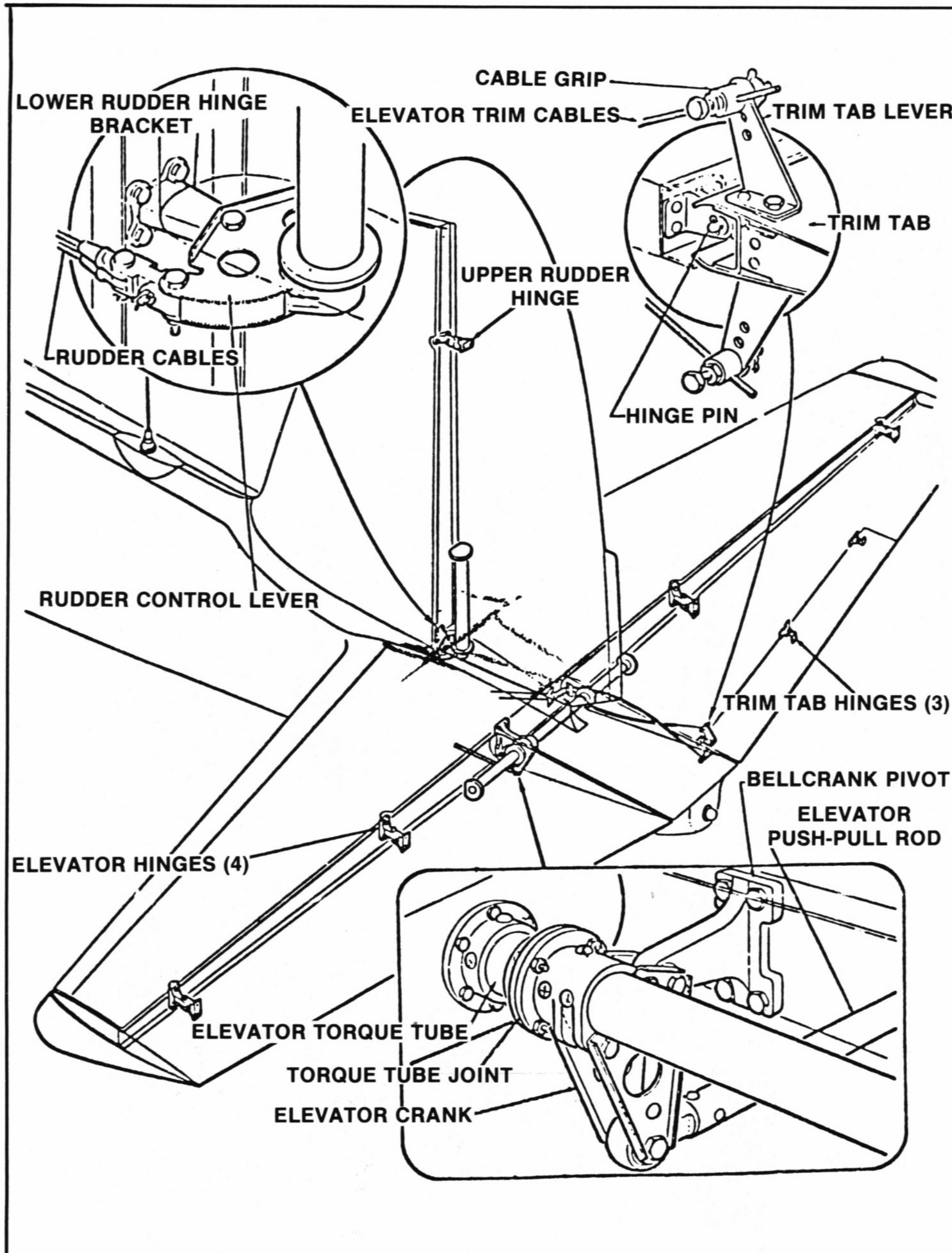
The horizontal stabilizer forward attach points nut plates were redesigned. The size was increased and the nut plates were made from 1063 mild steel. The stiffeners were made from ⅛ inch 2024-T3 aluminum.

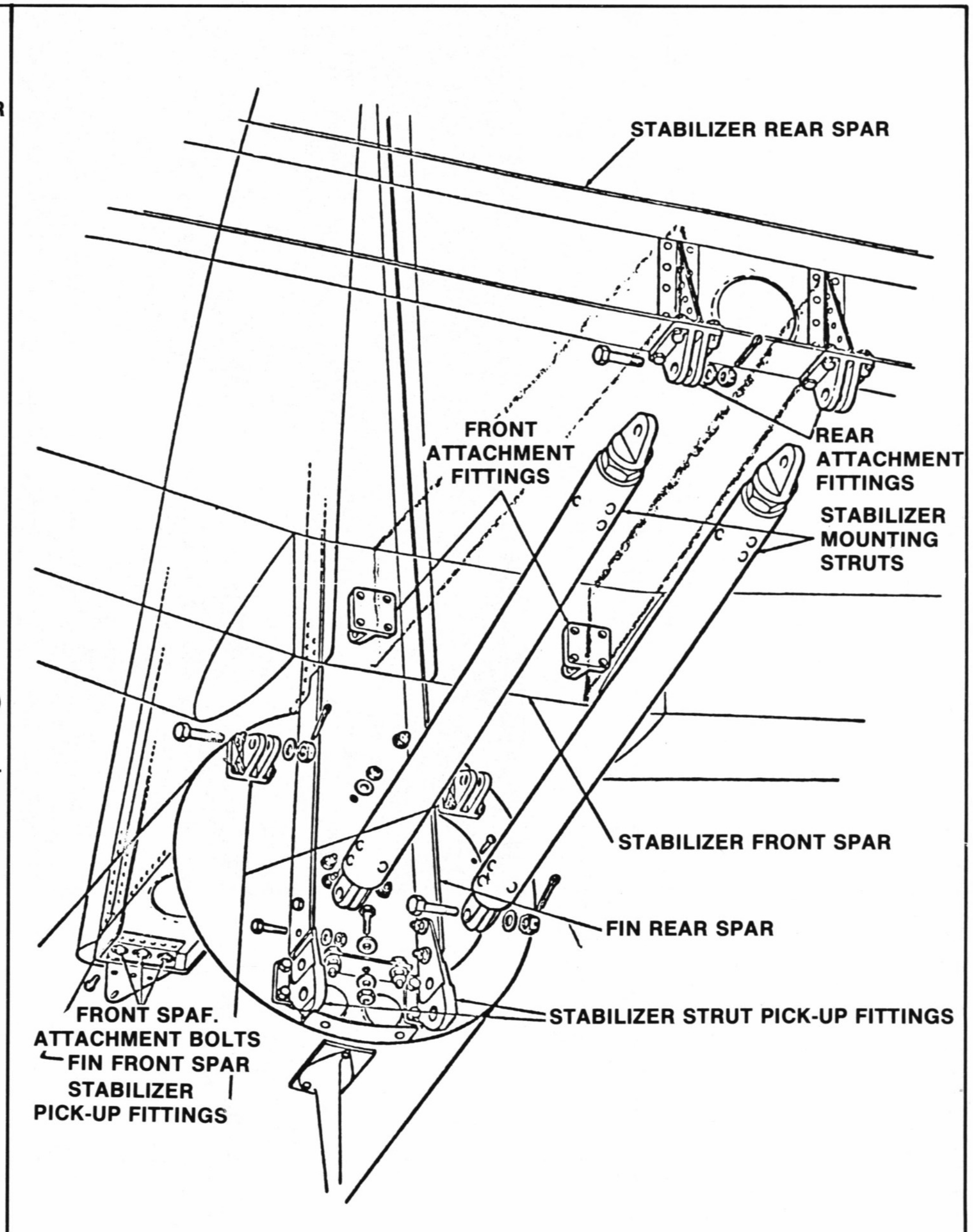
The elevator torque tube is riveted to collars at both ends and at the joint. It has been noted that these rivets tend to shear. This aircraft has the rivets removed and replaced with 1/16 inch diameter bolts."

A check of the IAC M&D files revealed another Chipmunk with approximately 2000 hrs. TT also had rudder problems. This report stated:

"The rudder spar cracked under lots of snaps. The hinge bracket tore the spar."

Corrective action was reported as "Fixed with stress plates and additional hinge."





Rudder and Elevator Controls

MODIFICATION TO A "HAIGH" TAILWHEEL

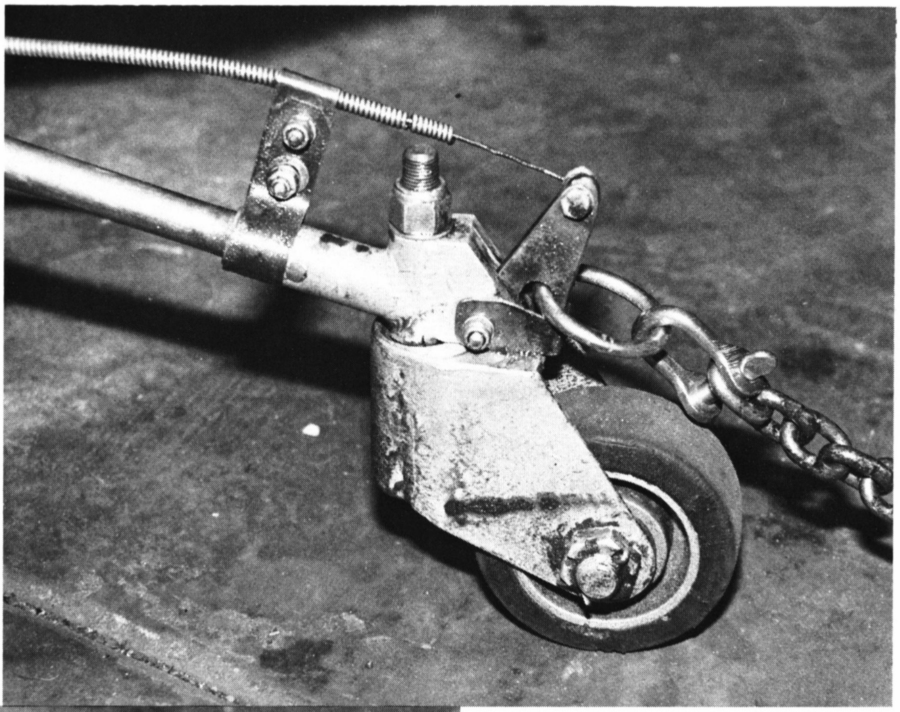
By G. Zuccoli
IAC #3333

This concerns a modification carried out to a "Haigh" tailwheel fitted to my Pitts S1S, enabling the retaining chain to be released from **inside** the cockpit.

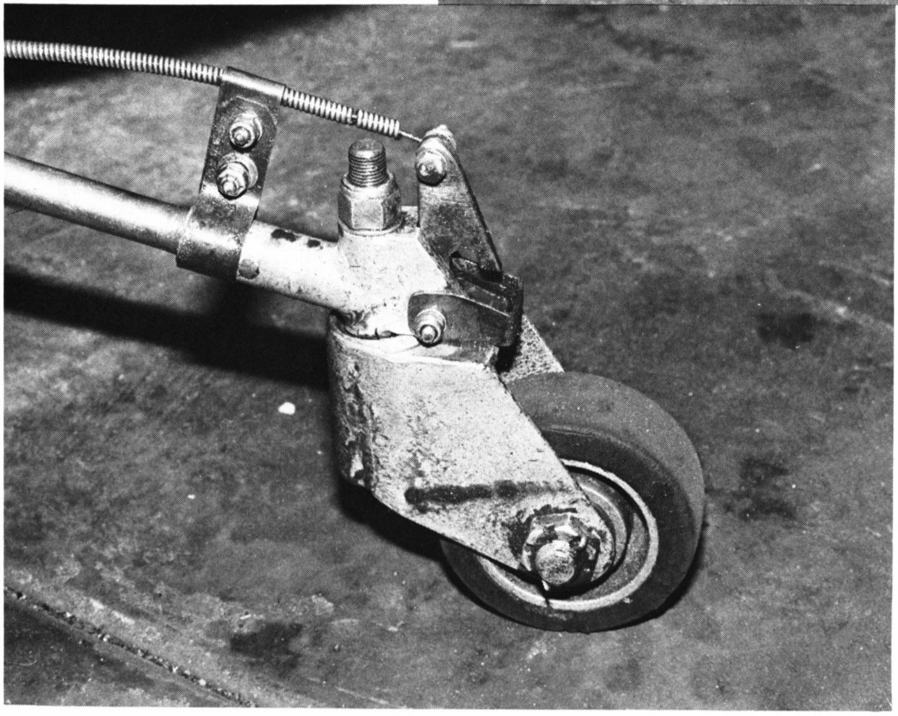
Briefly, the original locking "VEE" tongue has been replaced by an enlarged triangular piece with a cut out ring-holding slot. A supporting bracket made out of .035" 4130 is required for the proper releasing of the anchoring ring.

The geometry of the system insures a positive locking force, increasing in proportion to the applied thrust, to be kept of course within reasonable limits, in order not to exceed the shear stressed on the 3/16" pivot bolt. Some final shaping of the retainer had to be carried out by filing the slot on the field to obtain a smooth release, but always with an eye towards maintaining the original interaction between thrust and increased hold.

The "Haigh" tailwheel performs, in my opinion, considerably better than the standard Maule, the only problem being confined to a proper attachment detail of the spring arm to the airframe, which requires an extended sleeve fitting.



Retaining Chain in position prior to release from inside cockpit.



Tailwheel free after chain is released.

THE CAP21 — A NEW AEROBATIC STAR

by Eric Müller
Reprinted from the BAeA Newsletter

On 23rd June 1980 the CAP21 made its maiden flight with Louis Pena, Avions Mudry's test pilot, at the controls: just eight weeks before the commencement of the next World Aerobatic Championships in the USA on 16th August, at Oshkosh, Mecca of the homebuilder. It was to be with this CAP21, all being well, that I would compete in the World Championships. With time so pressing, I went along on 26th June during the test flights to Bernay, home of Avions Mudry, where the aircraft was undergoing stringent tests.

The love of flying has been the keynote of aircraft-builder Mudry's life. After beginning as a military pilot, in 1953 he started up an aircraft maintenance business; yet he still wanted to build aeroplanes himself, and eventually the CP100, his first aeroplane, made its first flight in 1966. From this design there followed in 1968 the CAP10, today's most successful two-seat aerobatic aircraft for both training and touring, having an elliptical wing modelled on the British Spitfire.

The energetic M. Mudry, pursuing ever higher ideals, then wanted a high-performance single seater aerobat, and from the CAP10 developed the CAP20 which saw its debut in 1970 on the occasion of the World Championships at Hullavington. The flying characteristics of the CAP20 were good, but they were bettered by the modified Pitts, Acrostar, etc. So manufacturer Mudry had to build something better, and the result was the CAP20L (L for leger = light), retaining the elliptical wing and the old aerofoil section. Believing that this could still be improved upon, however, he started research into a completely new wing.

Calculations for aerofoil sections these days are worked out by computer — one need "only" feed in the requirements that must be fulfilled. For aerobatics, the aim is to provide considerable increase in lift coefficient with small increase in angle of attack, which produces only small variations in the longitudinal axis; successfully solved in the case of the Acrostar by the use of integrated ailerons/flaps, but these are both expensive and weighty. Exceeding the critical angle of attack should then abruptly reduce the lift coefficient, thereby achieving good auto-rotation characteristics (for spins, flick rolls, outside flick rolls). The computer from the French aircraft company Aero-spatiale, which was responsible for the Caravelle, Concorde, Airbus and Ariane amongst others, devised an aerofoil — known as V16F — which would be ideal for the CAP21. The prognostications were confirmed by windtunnel tests; and from personal experience of flying the aeroplane I can safely say that the best possible results have emerged from both computer and wind-tunnel.

Of equally crucial importance is the wing design; and Avions Mudry's engineer Jean Marie Klinka clearly came up with the right answer here, too. The wing is trapeziform and the aileron spans 86% of its length. By unstinting effort the Mudry team reduced the CAP21's empty weight to 487 kg. Using fiberglass, they managed to make the undercarriage a few kg lighter still than that of the CAP20L.

(Continued on Bottom of Page 21)

DATA

Length	6.46 m
Wingspan	8.08 m
Empty Weight	487 kg
Competition Weight	600 kg
Wing area	9.2 m
Wing loading	65 kg/m
Maximum speed	300 km/hr
Minimum speed	82 km/hr
Cruise speed	240 hm/hr
Permitted load factor	+8g-6g

And now for the first flight. As soon as we climb in, it is obvious that this will handle like a sophisticated aeroplane. The seat is comfortable, the visibility excellent, and the harness set up correctly for negative stresses. The floor panels allow a directly vertical view downwards in level flight.

The 200 hp Lycoming fuel-injection engine with constant speed propeller and Christen oil system is a reliable aerobatic engine, with a weight/power ratio of 3kg/hp which augurs well. Full power — we are airborne after barely 100m, climbing away at 160km/hr and the rate of climb is a lively 12m/sec. At 1500m we begin aerobatics. Rate of roll to left and to right 1.8 sec for 360^{0}.

(cf: CAP20L 2.3 sec, Acrostar 2.5 sec. Bücker Jungmann approx 6 sec).

At 250 km/hr two vertical rolls and push out into level flight — no sign of wing drop and the usual juggling of controls. Positive and negative flick rolls are very fast and easy to stop. Spins, flat spins, inverted spins, a real joy! For a stationary flat spin I give inside aileron, elevator up and opposite rudder: after three-quarters of a revolution the aircraft is immobile. The recovery manoeuvre takes something over half-a-second.

The high rate of roll is also amazingly good at slow speed — guaranteed by the area of aileron that lies within the slipstream of the propeller. The relatively high fuselage generates good lift in knife flight, something distinctly noticeable in rolling circles. Finally, landing is easy thanks to the excellent handling characteristics at low speed and the good forward view, provided that one is familiar with the niceties of highly sensitive taildraggers.

In the next couple of flights, going through the complete spectrum of aerobatic manoeuvres in my repertoire, I am absolutely thrilled with the aeroplane. On average one can fly individual figures with about 80 km/hr less initial speed than with the Cap20L and 50 km/hr less than with the Acrostar. This means more available engine power and more in reserve, as well as more safety margin, lower acceleration, less fatigue, good care of component parts; shorter distances being covered, the flying of the programme within the box becomes effortless.

For this gem the price is approximately 100,000 Swiss Francs, from the Bernay factory. But the term of delivery could be subject to long delay.

CAP21 vs ACROSTAR — A COMPARISON

by Eric Müller
Reprinted from the BAeA Newsletter

There is first of all a fundamental difference between the Acrostar and the CAP21. The former was a revolutionary design, based on ideas that were very sophisticated but entirely undeveloped and not even completed. The latter is an evolution from a conventional aircraft derived from extensive research and a great deal of care. The result being that the Acrostar is a difficult, even arduous aeroplane to fly, requiring great understanding and effort of will from the pilot. The development of the CAP21 has been very successful but also a lengthy and painstaking process, to such an extent that I can safely say now it is by far the best aeroplane that can be bought today for competitive aerobatics. All this goes to show yet again that evolution is a more valid and productive process than revolution.

Cabin arrangements, equipment and pilot comfort are equivalent in both aircraft, the Acrostar being a little larger which provides rather more comfort but at the same time diminishes performance. This point is most important in an aerobatic aircraft (after flying and debriefing, then comes the time to think of armchair comfort!).

The controls are fine in both aeroplanes, except that the brakes of the CAP21 are easier to operate; this point is not insignificant, especially as the Acrostar has a tendency to perform ground loops. (Anecdote: not long ago, a taxi-driver with a brand-new PPL bought an Acrostar from Hoessl. Eight landings and eight ground loops later, the unhappy man was determined to bring a lawsuit against Hoessl!).

The visibility from the CAP21 is better with the floor panel as it permits a view downwards in horizontal flight a view downwards in horizontal flight that is strictly vertical; in the Acrostar one sees only 30 degrees ahead of the vertical. The rate of climb is equal for both aeroplanes in erect flight with zero acceleration. Inverted, the Acrostar does 8m/sec more and the CAP21 12m/sec.

The controls of the two aircraft are very different. The CAP21 maintains its stability with any given position of the controls, whereas the Acrostar requires constant correction. At the same time the CAP 21 controls are much more effective at low speeds (between 60 and 200 km/hr) which means that with the CAP21 one can achieve considerable change in attitude with small control surface adjustments. Its effectiveness in comparison with the Acrostar is particularly striking with the ailerons, notably better with the rudder, and less so with the elevators. The uniformity of response of all three controls is good at all speeds with the Acrostar; with the CAP21 it is good at low speeds but the ailerons have a tendency to become heavier at higher speeds. I wouldn't say that this is a particularly important point, but it is perhaps of some concern to anyone with a weak constitution (easily rectified, however, with plenty of Ovaltine and a little regular exercise). In any case, pushing the controls to their fullest extent beyond manoeuverable speed is structurally dangerous; and this could be an additional safeguard for badly-trained pilots. Since my last flight, Avions Mudry have put servo-assisted tabs on the ailerons, and it could well be that these comments of mine are no longer entirely valid.

The flick rolls of both aeroplanes are quite well controlled: the CAP21 turns faster, and in particular the speed of exit is superior to that of the Acrostar (at the same rate of entry, of course). Stopping any negative autorotation with the CAP21 is more difficult and more tricky than stopping the positive, or stopping negative autorotation with the Acrostar. But I don't rule out the possiblity that with more experience I shall be able to find a simpler method (this refers to well developed negative autorotations, that is to say after two or more turns). There is also a certain philosophical point here: a pilot may say that an aircraft will not do this or that, but such opinions are nearly always proved wrong; for what he ought to consider is that the aircraft won't do this or that according to the methods he is employing. Using the latter approach, I have very often found in my aerobatic career that it is surprising how often one can get an aeroplane to perform all those things that it appeared not to want to do. This is probably one of the reasons why I am the only pilot left who has success with the Acrostar. To master an aeroplane one must understand the aeroplane as it is, and not attribute faults to the manufacturer or ask him to make changes in the machine. This is also probably the reason why the CAP20L was unsuccessful, for there were no pilots willing to accept it as it was, and everybody said the aeroplane "would not do" whatever they wanted. The aeroplane does not do anything itself — it's the pilot who makes it perform.

You must forgive this digression, but this is an essential part of my thinking where comparisons between aeroplanes are concerned.

I can best explain aerodynamic points with two tests that I make with all aeroplanes. Maximum speed in level flight, full power (at medium height), medium temperature, about 500 m a.m.s.l. and 15 C — no need for scientific test conditions) the CAP21 does 280 km/hr and the Acrostar does 270 km/hr (indicated). Inverted, the CAP21 does 270 km/hr and the Acrostar 220. For a vertical roll with erect horizontal exit the minimum initial speed with the CAP21 is, starting erect or inverted, 200 km/hr. With the Acrostar I need from erect entry at least 240 hm/hr and from inverted at least 280. Second test: a tight, erect turn, full power, level flight — what maximum and constant g can I hold, and at what speed? CAP 21, 4 g at 180 km/hr. Acrostar, 1.8 g at 160 km/hr. What does this mean? With the CAP 21 I have much more engine power available to use for aerobatics, and no need to change potential energy into kinetic energy to compensate for loss of disposable power. With many of the figures required in competition I do not lose altitude, indeed I can gain altitude with the CAP 21 where I lose it in the Acrostar. This need not give too much cause for rejoicing, however, to my prospective opponents when I fly the Acrostar in competition: there is a lot that can still be done with the aeroplane, albeit one must cheat a little and it is very hard work — but I've had to learn to handle this so that the judges scarcely notice, or don't notice at all.

That was something that had to be said, too!

In general I must say that aerobatics with the CAP 21 are much easier and less hard work than with the Acrostar. Many figures require a lower speed of entry — much lower, even — with the CAP 21, and above all there is thrust more often still in hand. This means that with the CAP 21 one has a lot more in reserve than with the Acrostar. Agreed there is also a difference of ten years in age.

The Acrostar has integrated ailerons/flaps. This has the effect that for a change in lift coefficient one has only a small change in attitude because the angle of attack is principally altered with changes in the flap configuration. This is brilliant from a technical point of view (and equally it is costly, and involves maintenance of a critical and expensive nature); and also it is heavy.

The CAP 21 arrived by a different route. With the aid of a modern computer (from Aerospatiale, I believe) an aerobatic aerofoil has been sought that will provide, with a small change in the angle of attack, a large change in lift coefficient and a small change in drag coeffcient. (I hope that my explanations in a foreign language are adequate — in German it would be much easier for me because I know the technical and aerodynamic terminology.) In the main, this should give the same effect as the Acrostar but with a much more modest technical effort (less complication, less cost and less maintenance). And there I can safely say that the computer did a good job. The CAP 21's aerofoil section is sensational.

In addition, with the Acrostar we see when operating the ailerons that the outside section moves twice, while the inside section moves once. That is logical and creates less drag. Whereas with with CAP 21 the ailerons along the entire length of the wing (I believe 86%) have the same extent of movement. But at low speed, when drag doesn't play an important part because one has sufficient engine power, this is when the effectiveness of the aileron section within the slipstream becomes important, and is greater with the system of the CAP 21 than with that of the Acrostar. This is one of the reasons why its rate of roll at low speeds is so superior.

What strikes me when I look at the CAP 21 is its simplicity. Simple means inexpensive and less problem with maintenance, therefore less time consumed by the workshop, more time for pleasure, more time for aerobatics. This is the opposite of the Acrostar, but also the opposite of the Zlin 50.

One can always improve. The CAP 21 also could be and will be improved. But, as it is now, it's an excellent aeroplane with a performance that I, being the owner of an Acrostar, can only dream of. In other words, as of this moment I wouldn't change the CAP 21, I would fly it.

TAIL WHEEL STEERING CHAIN LINKS

An IAC member made the following report:

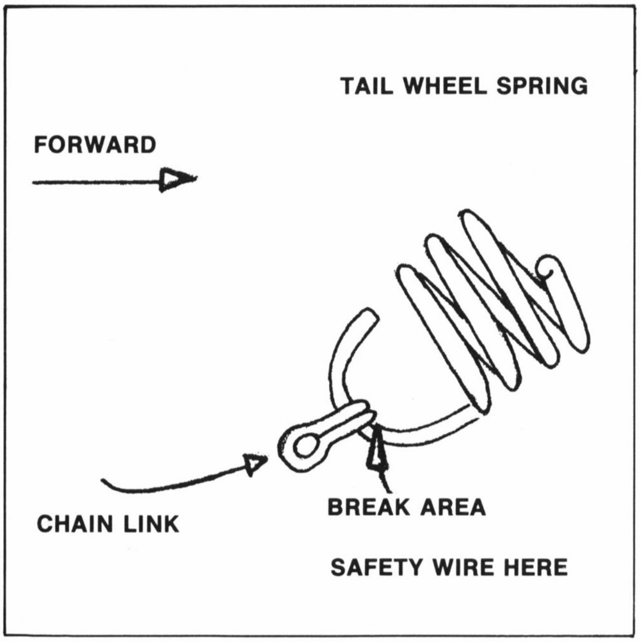
"If you have never ground looped your Pitts right in front of God, Poberezny, and everyone at Oshkosh you have an experience coming.

"The tail wheel steering chain link broke on roll out and it went around three times, luckily with no damage other than to the pilot's ego. However, the crowd liked it as they all applauded as I was walked in to park.

"These links are suspect as they are not really AIRCRAFT QUALITY. You buy them in a hardware store and they are nothing more than a dog chain. Yet they come in most tail wheel kits you buy.

"To preclude link breakage, the link that attaches to the spring (this is the one that seems to break first) is wrapped with safety wire. This is the area of more wear. The other end attaching to the teardrop clip at the tail wheel steering arm shows no sign of wear. On a Pitts this is usually a difficult area to inspect as the tail wheel assembly is usually covered with oil from the breather tube.

"While inspecting the chain links it is smart to run your finger over the sheet metal screws (three on a Maule) under the kickout pin as these have been known to drop out allowing the pin retainer plate to separate thereby rendering the steering mechanism inoperative. This has been corrected in later models with bolts."



IAC members may want to review two previous *Sport Aerobatics* Technical Safety articles dealing with tail wheel problems: August 1978 "Shimmy, Breakage & Other Tail Wheel Woes," and August 1979 "Pitts Parade".

Many thanks to the IAC member who sent in the above report. Remember, operation of the IAC Technical Safety Program depends on input from IAC members — PLEASE HELP.

UNDERSTANDING METAL FATIGUE

was written by Bill Freeman, EAA #148597. Bill is an engineer and a member of Chapter 200 of Overland, Kansas. Reprinted from the EAA Designee Newsletter

In the aircraft community the term "metal fatigue" is often used without any explanation, usually in reference to some part which has failed an inspection or perhaps a part which has failed in service. Some self-styled authorities will say that the metal "crystallized," which caused it to crack. You may envision the metal somehow getting "tired" and failing, and in some older aircraft it might seem that there was good reason to become tired, but these are far from the reality of metal fatigue.

Metal will not fail when the only load applied is a static or steady one, unless the tensile strength is exceeded. However, a rotating shaft with a side load on it or a part (bolt for example) with a fluctuating load may fail when the load applied is far below the tensile strength of the material. The fluctuating nature of the load is the key to metal fatigue.

Although there are details of metal fatigue that are not fully understood, the actual failure occurs something like this. A crack begins on the surface of the part, under conditions that we will discuss later. This crack is very tiny and very shallow at first, nearly undetectable. With each successive load fluctuation or cycle, the crack increases in depth and length a very small amount. As the crack increases in size, it eventually has separated enough of the load bearing portion of the part that the remaining metal can no longer sustain the load and fails suddenly and completely. If the part was a wing fitting, a connecting rod bolt or control bracket, the results could be spectacular. The purpose of magnetic particle ("Magnaflux") and dye penetrant ("Zyglow") inspection is to detect parts with fatigue cracks before they ultimately progress to failure.

Iron based alloys have a stress level below which the part can be loaded for an infinite number of cycles without fatigue occurring. Obviously this is desirable, and any critical components must be designed so that the stress level is below this endurance limit. For most steels the endurance limit is between 40 and 60 percent of the tensile strength for tensile strengths up to 200,000 psi. Above 200,000 psi tensile strength the endurance limit is approximately 100,000 psi. For non-ferrous alloys there is no true endurance limit, in the sense of a stress level below which infinite cycles are attainable. Endurance limits for these alloys usually refer to a stress level that ensures 10^8 (10 million) cycles before failure.

When a part fails from fatigue, the crack begins at a **stress concentration**. A stress concentration is self-explanatory, and may take many forms. On a shaft, a keyway, snap ring groove, a bearing shoulder, or abrupt change in section can be a stress concentration. Nicks, gorges, or holes can also be stress concentrations (also called stress risers).

On any part the surface finish is important if you want to avoid any stress concentrations. A highly polished surface finish has the best fatigue resistance. See the table below.

FRACTION OF ENDURANCE LIMIT ALLOWABLE

Surface Finish	Steel with Tensile Strength of 100,000 psi	Steel with Tensile Strength of 200,000 psi
Polished	1.0	1.0
ground	0.9	0.9
machined	0.75	0.65
hot rolled	0.55	0.35
as forged	0.4	0.25

The 100,000 psi column approximates the effect of surface finish on the fatigue life of an annealed alloy steel such as 4130. The figures are only presented to reinforce the understanding of the effects of surface finish on fatigue life, and are only approximate. It is readily apparent that there is a strong relationship between surface finish and the endurance limit (hence fatigue life). A part that will be perfectly satisfactory with a fully machined surface may fatigue and fail if left with an "as forged" surface. A part that fatigue cracks may be replaced with an identical part with a carefully polished surface and then may serve very well.

Any notch or hole in a structural component, however small, causes a stress concentration. In a very ductile material the first heavy load imposed may yield the material at the stress concentration, and thereby relieve the stress concentration. For a more brittle material, the notch or hole can cause an immediate failure when loaded heavily or may initiate a fatigue crack. The more brittle material is said to be more "notch sensitive" than the ductile material. Most steel aircraft structural parts are made of 4130 chrome molybdenum alloy steel, which is failry ductile in the annealed condition, and therefore are not as notch sensitive as if they were heat treated to a higher strength.

STAR WASHERS

from Dick Von Ber, Designee #1113,
of 4403 Alvin Street, Saginaw, Michigan 48603

If a notch is present in a part, the degree of stress concentration is dependent on the radius of the notch or hole. The smaller the notch radius, the greater the stress concentration. A crack may have a "radius" at the leading edge of something like .00001" or even less, which concentrates the stress tremendously. By drilling through the leading edge of the crack, the notch radius may be increased to .0625" (1/16") an increase of over 6,000 times, and a huge reduction in the stress concentration. This "stop drilling" is common practice in non-critical aircraft parts such as cowlings, fairing and windscreens, but, of course, is not recommended for critical structural components.

In the same way that surface finish can affect the fatigue life of structural components, various surface treatments can also have a large impact on the fatigue resistance of a part. Shot peening, hammering or cold rolling can cause locked in compressive stresses on the surface of the part, and significantly increase the fatigue resistance of a component. Connecting rods and crankshafts (except the journals) are frequently shot peened for use in automotive racing engines.

"Minor" surface pitting on parts, especially heat treated, high strength parts can cause very real reductions in fatigue life, and should be polished out or the part replaced if failure would cause a structural failure or loss of control. Even if quite significant amounts of material are removed to grind and then polish out notches on highly stressed components, the component is likely to be more fatigue resistant and therefore safer than leaving a pit or notch with extra material still around it.

Plating can significantly reduce the endurance limit of a structural component. By "dressing up" that key part in your airplane with chrome or nickel plating, you may be reducing the endurance limit by as much as 35%. Also, (not necessarily related to fatigue, but on the subject of plating) avoid having any parts plated at an automotive plating shop. Plating causes hydrogen to enter the metal, causing it to become brittle, (quite apart from its reduction of endurance limit) which is very undesirable. The hydrogen can be removed by baking the parts, and aircraft plating shops do this, but we haven't space for a discussion of plating and post-plating heat treating. Generally, it is best to avoid plating any critical structural parts.

Understanding fatigue brings up another subject often confused in the aircraft community: threaded fasteners and why torquing them is important. The reason is usually to help prevent fatigue failure of the bolt. Of course on certain assemblies the application of uniform clamping loads to prevent distortion of a part (as on crankcase assemblies) can be more important than preventing fatigue. Generally the purpose behind torquing is to prevent the bolt from failing from fatigue.

A bolt can be thought of as a very, very stiff spring, which can be stretched by tightening the nut. Tightening the nut to a specific torque value stretches the "spring" a predictable (very small) amount. If the preload left in the bolt by stretching it is greater than the fluctuating axial loads applied in service, the bolt doesn't "see" these loads, and it will never fatigue.

An analogy can show this more clearly. Imagine an old-fashioned spring type hanging fish scale with a 20 pound weight hung on it. The pointer pulls down to the 20 pound mark and the spring compresses the distance from the zero to the 20 mark on the scale. If you were to carefully cut a small block of wood and prop it between the scale frame and the hook, then remove the 20 pounds, the spring stays compressed, and the scale still reads 20 pounds. The scale is now **preloaded**, like a torqued bolt. If you now hang a 15 pound load on the scale, nothing happens, and the pointer still reads 20 pounds; the scale doesn't "see" the load. As long as the applied load is less than the preload (20 pounds in this example), the scale is unaffected.

For a bolt, as long as the fluctuating axial loads applied to it in service are less than the preload applied when the bolt was torqued, it never "sees" the load and will not fail due to fatique. Any improperly torqued threaded fastener can fail due to fluctuating loads. Engine components such as cylinder base studs, connecting rod bolts and main bearing through bolts or studs are examples of fasteners that must be carefully torqued to prevent fatigue. If a proper torque value is not available, **and the clamped part will not be damaged**, over torquing is better than under torquing from a safety standpoint. The importance of preloading bolts cannot be overemphasized, since a high preload improves fatigue resistance and the locking effect. Please don't take this as a license to wring off every bolt in your airframe with a 36" Crescent wrinch, crush the valve cover gaskets by over tightening and warp the crankcase by exceeding recommended torque values — all to beat fatique. Use proper torgue values for the fastener size used if at all possible.

Hopefully I have shed some light on the subject of metal fatigue and provided some useful insight for the homebuilder. Don't go out and polish your fuselage tubes on your project to protect against fatigue, but do be aware that highly stressed parts must be treated sensibly and carefully to avoid fatigue problems.

AEROBATICS IN A CUBy?

Reprinted from Aerobatics Canada Newsletter

By Stan Kereliuk

Are you tired of that A to B routine and you want to get on your back and use that third dimension mother nature gave us for a bit more than ground clearance? You mean you need one of those sleek high-powered, flush-rivetted jobs? Just hold it right there buddy, I may have some news for you. What about an "oldie but goodie"?

Recently the EAAC Technical Committee turned back the clock and accepted an offer to look at a new "oldie" and determine its acceptability as an aerobatic trainer. The aircraft was a newly-built CUBy (clipped-wing CUB), "hand built" by Gordon Price of Aerobatics Canada fame. The aircraft, at first glance, looks like what it is, a Cub with some wing real estate expropriated. However, it had none of the rugged, agricultural complexion which the elderly chaps with quivering voice would expect; this one was immaculate. The sporty finish job made one regret that this fine machine may soon be subjected to operations characterized by venting oil and splattering pasture refuse.

Once one successfully got the engine purring, the next exercise was to strap this baby to your butt, a procedure not recommended for chaste lasses in skirts or large farm boys wearing other than Jackie Stewart racing shoes. Rules, experience and common sense dictate that you must wear a parachute, be tightly strapped in (lap and shoulders) and yet be able to reach all essential controls. These criteria were overlooked in the olden days, and this "oldie" reflects it by not meeting the last criterion when in the rear seat, and severely cramping large farm boys when in the front seat. Furthermore, location of the frequently used controls and their model direction of operation should be determined by the general rules of:

a) No switching of hands

b) Forward - GO, Rearward - WHOA.

This aircraft does not hide any secrets, and when you open up the tap with wheel brakes on you find that you can raise and wiggle the tail with only partial engine power. This means good news and bad news. The good news is that if you run out of steam during your aerobatic routine and you end up at zero speed with the nose way up there, you can open up the tap and have readily available pitch and yaw control power either to impress you buddies with a hammerhead or to prevent frightening your instructor in an inadvertent tail slide. The bad news is that you better take it easy when using brakes on landing, and when you stomp on the binders, make sure the stick is in your gut.

The CUBy, by its inherent design, is a very stable bird, which is also good news and bad news. Longitudinal static stability (i.e. how much you must push the stick forward to increase speed and vice versa with elevator trim fixed) is strong. This means that when subjected to speed excursions at fixed engine power, the aircraft will tend to return to the trim speed. However, the magnitude of this stability is such that when trimmed at low speed you will require up to 30 pounds push at the top speed. Hence the requirement for a good, convenient elevator trim system. In aerobatics, where speed excursions from below the stall to maximum occur very quickly, one must be prepared to handle the high stick forces or trim them out. However, if the stick is released in the CUBy in a severely mistrimmed situation, a maximum of only 1 G increment may be expected, certainly not enough to worry about exceeding limits.

Aircraft manoeuvre stability is exhibited in an aircraft by the amount of stick force is required to increase wing loading by a 1 G increment. Primarily it is a measure of the difficulty in overstressing an aircraft on the pro side, and a measure of physical pilot workload requirement on the con side. The pitch control forces are high, in the order of 25 to 40 pounds per G, tending towards the high value at slow speed and the low value at high speed. Assuming the aircraft is trimmed out at high speed, this means a force requirement of 125 pounds pull or 50 pounds push to exceed the +6, −3 G Envelope. This also means that when applying G, the stick force increase for a further G increment does not decrease, another safety factor inherent in the old bird.

A method of investigating the lateral/directional stability is to perform steady sideslips by increasing rudder deflection but to maintain direction of flight with aileron deflections (cross-control). The amount of the control deflections, control forces, and their rate of change with increased sideslip are important in determining the stability characteristics of the machine. The CUBy passed these tests with flying colours, and showed no tendency for the rudder to over balance or stall, a feature most important in hammerheads, spin recoveries and even simply to raise a dropped wing in the stall. Because of the location of the pitot tube on the port wing strut, airspeed indications were unusable in starboard sideslips exceeding 15°, a point one must remember when high and hot in a right-hand base turn.

An aerobatic aircraft, even more than the straight and level birds, must tell you it is about to stall, and when it does, it must not be nasty. The stall tests in the CUBy were performed at 1 G power off, 1 G power full, extreme nose attitudes up to the vertical, and turning stall. The stall warning in this aircraft is weak, and occurs only about 3 mph before the actual stall. It is characterized by a mild wing rock and in some cases a slight pitch attitude porpoise. However the stall is extremely docile, a mild wing drop (easily corrected with rudder or aileron) but a pronounced nose down pitching moment. At typical aircraft loads, it would stall at 40 mph with power at idle and down to 30 mph with full engine power.

The extreme nose up attitude stalls showed how docile the CUBy is. The nose down pitching moment apparent in 1 G stalls was still extremely prevalent nose high

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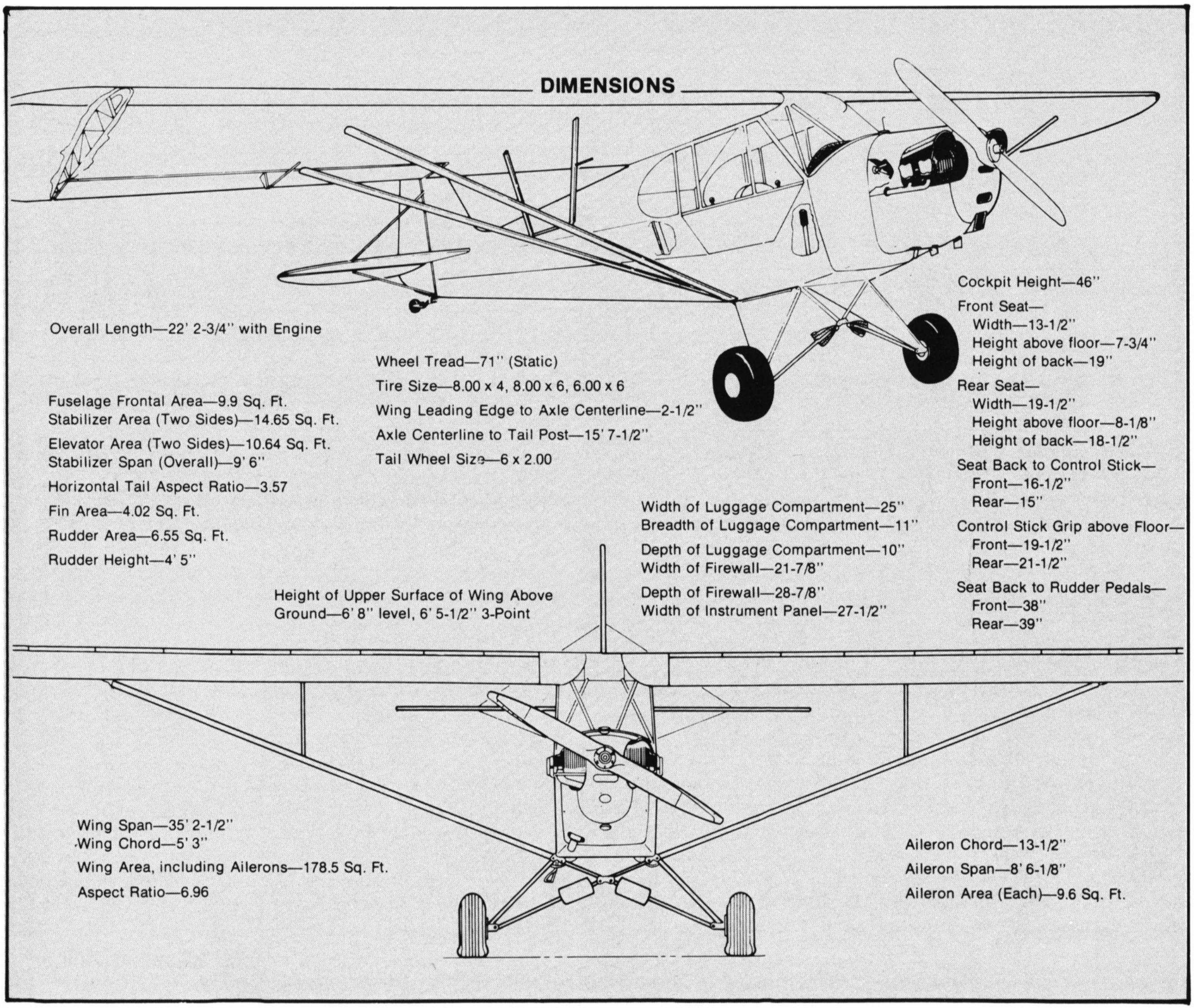
attitudes well below the stall speed. At speeds near zero and nose attitudes close to the vertical with power at idle, even full back stick was insufficient to prevent a tail slide, and use of the rudder or elevator with full engine power is recommended for recovery.

Turning stalls were characterized by basically the same symptoms as normal stalls. This aircraft is obviously in its element in close display work, with 2.2 G available at 60 mph at average loadings, allowing a turn in a 250 foot circle. Use of full engine power would even increase this performance. Stick forces are high, and this same turn when trimmed for straight and level flight would require approximately 35 to 40 pounds pull.

The CUBy also appears to be in its element as a spin demonstration machine. Spin entry is accomplished using the conventional technique of aft-stick and full pro-spin rudder at approximately 45 mph. After one turn of rotation a slightly oscillatory entry to allow the inertia and aerodynamic moments to balance, the aircraft settles into an extremely smooth, 45 degree nose down spin. The rate of rotation is rather high, one turn being completed in less than 2 seconds with a height loss of approximately 100 feet. For recovery, full antispin rudder to stop the rotation and slight forward stick to unstall the aircraft results in a recovery within one turn of the spin. Spin entries at up to the vertical nose attitude with up to full in-spin or out-spin aileron were performed with no adverse effects. In all cases, the rudder appears to be the dominant control to start, maintain and stop the autorotation.

When demonstrating aerobatics in ultra-light aircraft, the EAAC Technical Committee selects, the appropriate IAC aerobatics Classification for the aircraft, on the advice of Aerobatics Canada and reflected in results of the stress report. It then attempts to demonstrate most manoeuvres which the aircraft will be expected to do. This CUBy did not have a complete inverted fuel system, and in any event the stress report and handling tests indicated that the Sportsman Class was probably appropriate though with improvements, the Intermediate Class is certainly not out of reach. The CUBy performed all Sportsman Class manoeuvres quite admirably. The inherent handling qualities of this machine would keep most people out of trouble, and would certainly be most beneficial when introducing novices to aerobatic flight. It is also likely that, because of its manoeuverability, this aircraft could probably make a very respectable name for itself in close-in aerobatic demonstrations.

At this date, aerobatic flight tests have not been completed, the only outstanding tests being the demonstration of maximum loads and G on the aircraft. When this is complete, the EAAC Technical Committee is hopeful that it can recommend to Transport Canada that the CUBy be permitted to do aerobatics, a flight regime which this aircraft certainly simplifies.



SAFETY RECOMMENDATIONS Issued By The National Transportation Safety Board

Washington, DC
James B. King, Chairman
A-81-41 and 45

The National Transportation Safety Board's investigation of the crash of a Bellanca 8 KCAB Decathlon aircraft in Queenstown, Maryland, on March 7, 1979, has revealed a hazardous condition which could affect the safety of flight of similarly equipped aircraft when performing aerobatic maneuvers. The pilot of the accident aircraft was practicing for his flight demonstration to obtain an "unlimited letter of competence" permitting aerobatics at and above ground level (AGL) when the aircraft crashed. He already held a "letter of competence" permitting him to perform aerobatics at and above an altitude of 200 feet AGL.

The investigation failed to disclose an aircraft mechanical malfunction, and postmortem examination of the pilot revealed no pre-existing diseases. However, the aircraft's previous owner stated that during full forward stick aerobatic maneuvers the rear control stick had become entangled on occasion in the front-seat acrobatic shoulder harness where it was routed up the back of the front seat. He said that freeing the control stick was accomplished by releasing the front-seat narrow webbing lapbelt, thus releasing the shoulder harness. Additionally, a student of the fatally injured pilot said that earlier in the week the front-seat narrow webbing lapbelt had been slipping and had to be retightened between maneuvers.

The front seat of the accident aircraft, which was manufactured in 1972, was equipped with a dual-restraint system designed to provide restraint for normal and aerobatic flight. The front-seat restraint system consisted of a lapbelt of narrow webbing with a fabric-to-metal friction buckle. The lapbelt was attached to the seatframe at the seatback-to-seatpan intersection. The seat also was equipped with a narrow webbing, dual-strap shoulder harness which slipped over the lapbelt webbing. Each shoulder harness strap was modified from the original installation to attach to the seatframe at the same points as the lapbelt. The shoulder harness was routed up the back of the seat and through fabric shoulder harness guides at the top of the seatback. An additional lapbelt of wider webbing, equipped with a metal-to-metal buckle, was attacked to the floor. Bellanca has indicated that the restraint systems described above were standard equipment for that model year. However, the shoulder harness straps were designed to attach at a single point to the overhead wing carry-through structure rather than to the seat where they must be routed up the back of the seat. Later models of the Decathlon employ a lapbelt and single diagonal shoulder harness as the primary restraint system and a five-point acrobatic restraint system with the shoulder harness installed in front of the seatback and the inertia reel attached to the seatpan frame.

Thus, a potentially dangerous situation is created when the attach points of the acrobatic shoulder harness are altered on aircraft manufactured prior to 1973, such as was done in the accident aircraft, and/or when the shoulder harness straps are routed behind the front seatback. In fact, the propensity for owners to reroute the shoulder straps creating this hazard to aerobatic flight apparently was recognized by the Bellanca Aircraft Company. In May 1977, the company changed the FAA-approved Decathlon flight manual by adding a new section, "Occupant Restraint Systems", which contains the following caution: "DO NOT ALLOW SHOULDER HARNESS TO RUN UP BEHIND THE FRONT SEAT BACK WHERE IT MAY POSSIBLY INTERFERE WITH REAR STICK MOVEMENT." This section also notes that the acrobatic restraint system does not provide crash protection and therefore should always be used with the primary lapbelt and shoulder harness. This information should be particularly useful to owners of Decathlon aircraft built between 1973 and 1977 who presently may be unaware of the potential hazard.

The Safety Board believes that a modified acrobatic restraint system which permits the acrobatic shoulder harness straps to run up the back of the front seat as described above presents a potential hazard in aerobatic flight since this modification apparently can result in entanglement of the rear control stick with the front-seat shoulder harness.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Immediately issue a General Aviation Airworthiness Alert warning Decathlon owners of the potential hazards to aerobatic flight when they modify Decathlon acrobatic restraint systems by attaching the shoulder harness to the seatpan frame and/or route the shoulder straps behind the seatback. (Class I, Urgent Action) (A-81-44)
>
> Issue an Airworthiness Directive revising the Bellanca Decathlon FAA-approved flight manual for aircraft manufactured prior to 1977 to include the relevant cautionary information of section 2.1.9, "Occupant Restraint Systems", which is contained in subsequent approved flight manuals. An accurate description of the proper installation of the restraint systems should be included. (Class II, Priority Action) (A-81-45)

A-81-48

On May 7, 1980, during a practice aerobatic flight, an Aerotek Pitts Special S2S crashed near Olathe, Kansas. Even though this investigation is still in process, the National Transportation Safety Board has reason to believe that the pilot may have experienced physiological incapacitation as a result of G forces encountered while performing aerobatic maneuvers.

The pilot had completed his "known" sequence of 18 maneuvers. At the suggestion of an observer, a regional aerobatic judge who was critiquing his maneuvers, the pilot decided to fly his "free" sequence, a series of 25 maneuvers. After a short rest, the pilot began these maneuvers which he had flown many times. He had completed maneuver number 19, two and one-half rolls from inverted to upright, which was preceded by an outside three-quarter loop. After completing the roll maneuver, the aircraft flew straight and level for a short time. The aircraft then started a short climb, then the nose dropped below the horizon and the aircraft departed the practice box in a 45⁰ nosedown attitude. The aircraft impacted in a heavily wooded area and burned. The pilot did not survive.

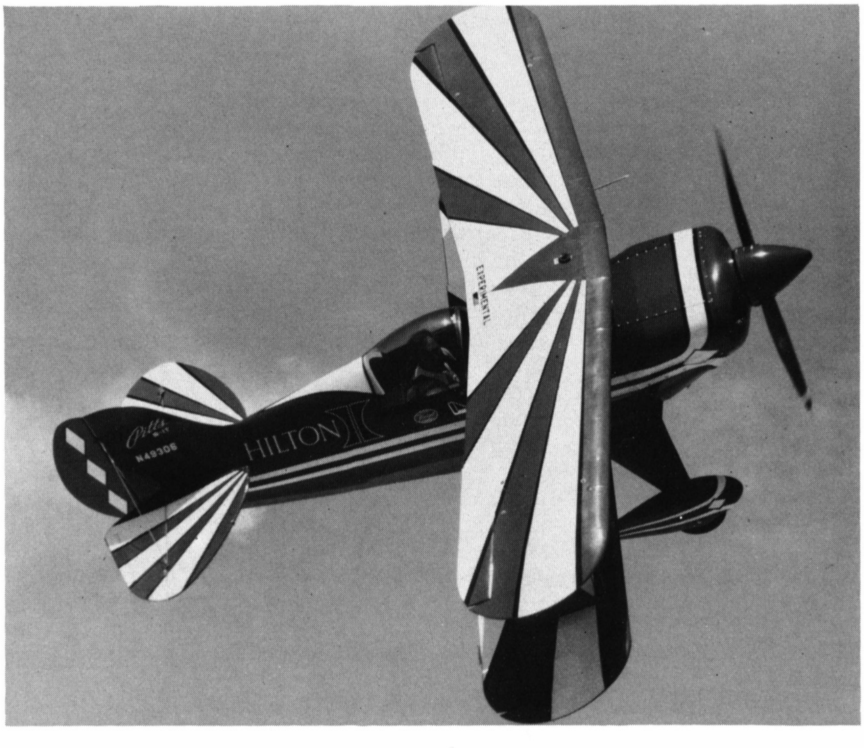
During the entire practice flight, the pilot had been in radio contact with the observer on the ground. When the pilot appeared to break off his series of maneuvers and depart the practice box, he was asked his reasons for this but he did not reply. The investigation has not revealed any preimpact aircraft malfunctions; postmortem examination of the pilot disclosed no diseases.

The effect of aerobatic G forces, i.e., Gz or vertical axis forces, on human physiology is well stated in a Federal Aviation Administration (FAA) publication entitled "G Effects on the Pilot During Aerobatics", FAA-AM-72-28, July 1972, by Stanley R. Mohler, M.D. This report provides information relative to the nature of aerobatic G forces; human physiology in relation to G forces; human tolerances and exposure limits to G forces; and methods to increase tolerance to aerobatic G forces. Data in the report indicates that aerobatic pilots can expect to experience a variety of symptoms resulting from different levels of positive and negative G's over a wide range of exposure times. Symptoms from grayout to unconsciousness can occur during a positive G maneuver (referred to as an "inside" maneuver). A negative G maneuver (referred to as an "outside" maneuver) can result in discomfort, headaches, or unconsciousness. For the aerobatic pilot, the most significant finding in the report is the fact that loss of consciousness most likely will occur when high negative G maneuvers are followed by high positive G maneuvers such as a vertical "8" (i.e., an outside upper loop followed by an inside lower loop). Unconsciousness occurs due to the rapid swing from negative to positive G forces resulting in decreased blood circulation to the brain at G force levels of −3.5 to −4, and +4 to +4.5.

G forces sustained in aerobatic demonstrations and competitions today are more likely to be near −6.5 and +8 G's for some aerobatic aircraft. The pilot's last two maneuvers, mentioned previously, took him from a high negative G in the pullout from an outside loop into a sustained high positive G environment of two and one-half rolls. It is the Safety Board's opinion that, in the light of the evidence presented, physiological incapacitation of the pilot cannot be ruled out.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Include in a future revision of the Airman Information Manual (AIM), Basic Flight Information and ATC Procedures, Chapter 7, Medical Facts for Pilots, a brief discussion of the physiology of aerobatic G forces as explained in FAA-AM-72-28. (Class II, Priority Action) (A-81-48)



HARD STARTING

An IAC member recently wrote stating that he had observed serveral pilots encountering engine hot starting problems at an IAC contest. Before getting to this member's report, below are listed the "causes" of **hard** starting as taken from a Lycoming reciprocating engine troubleshooting guide.

Possible causes of hard starting:

1. Technique
2. Flooded
3. Throttle valve open too far
4. Insufficient prime
5. Mag impulse coupling not operating properly
6. Defective spark plugs or ignition wire
7. Low voltage to vibrator input
8. Inoperative or defective vibrator
9. Retard contact assembly in magneto not operating electrically
10. Vibrator-magneto combination not putting out electrically
11. Magneto improperly timed to engine
12. Magneto internal timing not adjusted properly or "E" gap drifting because of point or follower wear.

O.K., now to the first-mentioned field report — it is as follows:

"At a recent contest I noticed that several pilots were experiencing problems in getting a hot engine started. This was especially apparent when an airplane was used by more than one pilot, and therefore afforded little cooling time between flights. The following suggestions are offered in the hope that they may be of some help to fellow pilots.

"Most hot start problems occur in engines with fuel injection of pressure carburetion. Practically speaking, the only difference between the two is the location where fuel enters the intake system; in the intake pipe just ahead of the intake valve in the fuel injected engine, and in the intake manifold just downstream of the carburetor in the pressure carbureted engine. In both systems, fuel is constantly entering the intake system whenever fuel pressure is applied by the engine fuel pump or the auxiliary fuel pump whether the engine is running or not (except when the mixture control is in idle cut-off). Consequently, you may prime these engines by placing the mixture control in full rich, cracking the throttle, and activating the boost pump. And if you follow that sequence you **will** prime the engine, whether you want to or not.

"When an engine with an injected or pressure system is stopped by putting the mixture control in idle cut-off, this does not mean that the flow of fuel is totally stopped. Some fuel still flows, even after the prop stops rotating, and leaves the engine partially 'flooded', creating the hot start problem. Thirty minutes or more is usually required to evaporate the fuel and eliminate the problem.

"So here we are, with a 'flooded' engine, which means a fuel mixture too rich to burn, and no time to wait for the fuel to evaporate. How do we start the engine, hopefully before the battery goes dead?

"For one thing, on a hot start we must expect a 'flooded' engine, and treat it accordingly. First, open the throttle. Don't just crack it, open it at least half way. Let the engine breathe — it's got too much fuel and needs air. Opening the throttle is the key to a successful hot start, but be prepared to close it when the engine starts. Second, leave the boost pump off. Third, leave the mixture in idle cut off. Now crank the engine, and after 10 or 12 blades it should start, the mixture can be put in full rich, and you can be on your way.

"But what if it doesn't start? Well, then it's time to fall back on an 'old pro' trick that always works. If an engine won't start, the 'old pro' usually figures that is for one of two reasons — too much fuel or too little. He selects one or the other, adjusts the controls accordingly, and tries the start. If he thinks the engine has too much fuel (mixture over-rich, engine 'flooded'), he will open the throttle, but the mixture control in idle cut-off, leave the boost pump off, and crank the engine. If it starts, he made the right choice. If it doesn't start, then he made the wrong choice, but now he knows that it won't start because of too little fuel. So, he cracks the throttle, puts the mixture into full-rich (on carbureted engines) or in idle cut-off (injected engines), turns the boost pump on, and cranks the engine.

"Remembering that the usual reason for a difficult start hot is a flooded engine, if you don't get a start after 10 or 12 blades, stop cranking for about 30 seconds (it helps the starter), then crank another 10 or 12 blades. If it still doesn't start, then it is not flooded and you can now go to a normal start.

"Try it — you'll like it. And, after a few trials of this method you can fine tune it to suit your engine. (Now is a good time to re-read your engine operator's manual.) Just remember that the key ingredient is to get the throttle open. And, the hotter the engine, the further the throttle should be opened. Let the engine breathe, and it will reward you with good start."

IAC members encountering hot/hard starting problems may also want to refer back to the February 1975 issue of *Sport Aerobatics* or to the IAC Technical Tips Manual for an article entitled "Hot Starts on Lycomings."

IAC "thanks" to the member who submitted the above input. Please remember it is only through such input that the IAC Technical Safety Program can function. We are **all** members of the Technical Safety Committee.

REMINDERS

A few months ago an IAC member submitted a report about possible aileron blockage on Decathlons. That report is as follows:

"I would like to tell all of you Decathlon owners and operators about a condition that could occur which might restrict the aileron travel on the Decathlon. There are four access covers on the bottom of each aileron. When an aileron is at its upward limit of travel, a portion of these access covers are designed to be hidden by the aluminum aileron gap seal. This is fine, but if the access covers do not fit perfectly and if they should vibrate to their rear-most posssible position, the portion of the cover that Bellanca intended to stay beneath the gap seal will come out from under that seal. This in itself is not a problem but when the aileron is returned to its neutral position, it is **possible** for the gap seal to become sandwiched between the aileron and the access cover and restrict any further downward travel! I have seen this occur! Fortunately, it did not occur in flight. All you have to do to safely recreate this glitch is to find an access cover that has been removed a few times. It will probably not fit as well as Bellanca intended it to. Take the cover and slide it towards the trailing edge of the aileron until it won't go any further. Move the aileron all the way up using the trailing edge of the aileron, not the stick. This will load the aileron similar to the way an accidental tail slide would and it will put the aileron to its **absolute** upward limit. Be gentle — there's no need to force it. If your Decathlon is like ours, the access cover will come out from under the gap seal. Gently return the aileron towards neutral and gently hold the gap seal against the aileron. The gap seal will insert itself between the aileron and access cover!

"Now, you might think that this is a long shot and you might think that I went a long way to create this condition, but we all should remember Murphy's Law. Maybe the odds of this occurring in flight are 1 to a million but can we take that chance? I know you're not supposed to tail slide the Decathlon but I bet we all have or will do it once without meaning to. I also know that if the access covers and gap seals fit correctly, this cannot occur. But what if they don't! My feeling is that if a serious condition **might** occur we should take steps to prevent it. Isn't that what safety is all about?

"There are a few things that could be done to make this condition impossible. We could install a screw in the access cover to prevent it from moving or maybe even make larger access covers that would never come out from under the gap seal. Of course, there's the obvious; be sure the access covers fit perfectly. It might also be wise to check for this condition on each preflight — I do!

"By the way — our Decathlon is a well-maintained 1977 Super Decathlon. It has flown 400 hours and much of those hours were Sportsman and Intermediate aerobatics."

***** ***** *****

A couple of weeks ago we were advised by Ben Owen at EAA Headquarters that the FAA was planning on publishing an airworthiness directive concerning the routing of the low mount shoulder harness on Bellancas. Shortly thereafter we noted the following article in the June issue of AVIATION magazine.

"Bellanca Seat Harness Can Entangle Rear Stick"

"A potentially dangerous condition may exist in Bellanca Decathlon dual restraint systems, the National Transportation Safety Board (NTSB) has warned.

"The restraint systems, which are designed to protect the occupant of the front seat in both normal and aerobatic flights, may catch the rear seat control stick during full-forward stick aerobatic maneuvers.

"The situation can occur if the system has been altered so that the shoulder harness straps are routed up the back of the seat from attach points on the seatpan frame, rather than attached at a single point to the overhead wing carry-through structure as was originally installed.

"The board released its warning as a result of an investigation into the fatal crash of a Decathlon 8KCAB with one such modified system in March of 1979. The pilot was practicing for his flight demonstration to obtain an unlimited letter of competence when the crash occurred.

"According to the previous owner of the aircraft, the rear stick had become entangled on occasion in the shoulder harness straps, which were routed up the seat back from attach points at the seatframe. The attach points also held the front seat lapbelt.

"The former owner said the stick was untangled by releasing the narrow-webbed lapbelt, which released the shoulder harness as well.

"Additionally, a student of the fatally-injured pilot said that several days before the crash the front seat lapbelt had been slipping and had to be retightened during maneuvers.

"The condition exists most frequently in Bellancas manufactured before 1973, the board said. The practice of rerouting the shoulder harness was so popular among pilots, the board said, that Bellanca was forced to add a caution to its Decathlon flight manual in 1977.

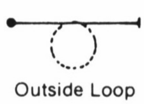
"The caution warns that the rear stick may become entangled if the harness is run up the seat back.

"The board has recommended to the FAA that it issue an Airworthiness Alert to Decathlon owners, stating the hazards of attaching the harness to the seatpan frame."

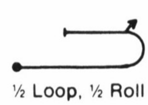
***** ***** *****

Both of the aforementioned problems have been reported in previous *Sport Aerobatics* Technical Safety articles. The possibility of restricted aileron travel on Decathlons was covered in the January 1978 and April 1979 issues of *Sport Aerobatics* and the possibility of the rear stick becoming entangled in misrouted Bellanca shoulder harnesses was noted in a Technical Safety article in the November 1977 issue of *Sport Aerobatics*. The two first-mentioned recent reports serve as reminders to all of us that these potential problems are still around and still demand our attention. The two recent reports may also indicate that some IAC members may have missed the former Technical Safety articles on the subjects in question or perhaps they did not have access to these articles. As a matter of fact, very few IAC members have access to **all** the former IAC Technical Safety articles. And, possibly many members may be missing some valuable information that relates to potentially dangerous problems. Therefore, this Technical Safety article also serves to remind us that IAC now has available a Technical Tips Manual which is a compilation of all the Technical Safety related articles that were published in *Sport Aerobatics* from 1970 through January of 1980. It definitely would behoove all IAC members to have a copy of this manual for review and as a ready source of Technical Safety info.

IAC thanks to Ben Owen at EAA Headquarters who always contributes strongly to the IAC Technical Safety Program and also a large thanks to the IAC member (who, because of IAC policy, will remain anonymous) that took the time and made the effort to submit the restricted aileron report.



Outside Loop



½ Loop, ½ Roll

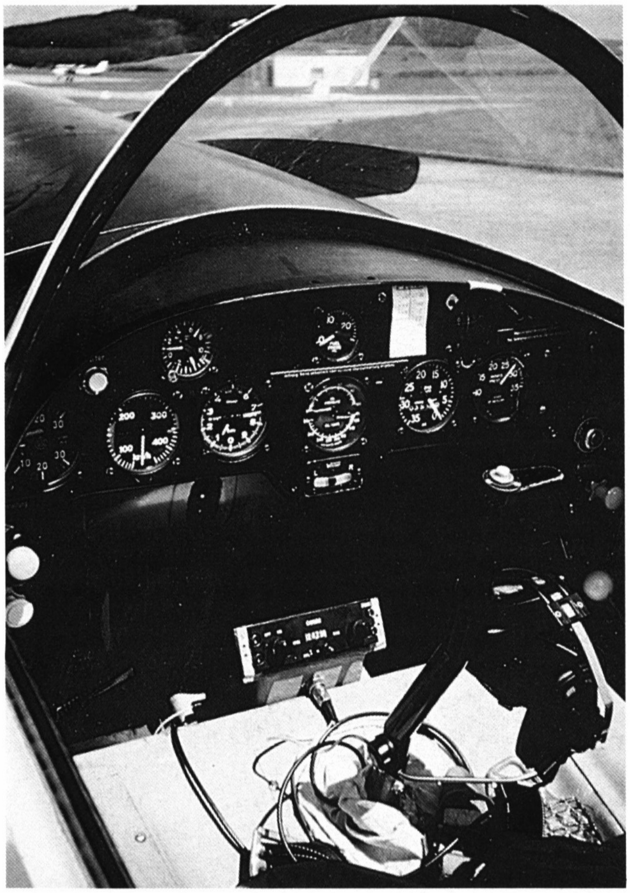
pilot report

THE ACROSTAR

By Dr. Urs Meyer

The comparison of the Eagle, the Pitts and the Acrostar that was published in a recent issue of *Sport Aerobatics* has led me to give some more information on the Acrostar, which may be of interest to the reader who in most cases may never have seen this airplane.

Nine Acrostars have been built during the years 1969 to 1973 — mine carries Nr. 4009 and is the last ever produced. The Company Wolf Hirth Gmbh, Nabern/Teck, Germany, still has all tools and a complete set of materials for at least one more airplane, but there is no chance that it will ever be completed due to the high price this latecomer would cost, probably about $90,000. Of the nine planes, two were exported to Switzerland and are still in frequent use. These two have been modified and reportedly behave very well — although being a Swiss myself, I have never seen one of them because they are operating in the French speaking part of this country. Two planes are still in Germany, one of them is mine. One is still operating in Spain, where a second one has been wrecked on the ground while taxiing. One plane was exported to the United States, but its present location is unknown to me. Two planes have crashed due to mistakes on the side of the pilot.



The Acrostar panel: in the center fuel and oil pressure gauges. On the right side manifold pressure and rpm indicator, on the left airspeed and altimeter, climb/descend and G-meter. Most indicators are metric. Throttle and rpm levers are left, mixer and manual fuel pump right.

The unique feature introduced by the Acrostar is certainly the integrated control system. By a very ingenious mechanical linkage, the movements of the elevator, the ailerons and the flaps are interconnected. First of all, let's look at the ailerons and flaps: stick to the left gives a full movement of the left wing aileron to the upside, while the right wing aileron goes completely down. The flaps follow, but with half way travel only. On the other hand, if the stick is moved back from central position, the elevator goes up on the rear end, while both flaps move completely down and the ailerons follow halfway. All movements are completely symmetric, so that the plane has virtually identical behavior in normal and inverted flying attitude. The controls are all totally balanced and connected by pushrods and spherical bearings, so that there is no recognizable play, and the stick is holding in any position on ground.

Due to this interlinked controls, the plane has some unique characteristics that make unconventional handling necessary for take-off and landing. In principle, it is probably easier to control than the Pitts. For take-off, the plane must be held straight by the brakes for the first feet of rolling, while power must be applied very slowly. The slipstream effect is very strong, and may be enhanced by the prop that will go to high pitch with a certain delay when the throttle has been suddenly opened. This effect has displaced me several times about 40 feet to the left side when I started to learn flying this plane — until I recognized the reason by careful analysis of what had happened.

Another special feature on take-off is that the stick is firmly held in a near-fully pulled position. The airplane will accelerate in the tail-to-ground attitude until liftoff, which calls only for a 300 feet ground run. Whenever the stick is given way forward, the plane just tends to jump, because this at the same time lifts the flaps and consequently reduces wing lift.

As to landing, I was told quite controversial things by the experts before trying to fly the plane. One person told me to keep to grass runways of ample width by all means, so that a turn-around would do not much damage. Another just cautioned me against using grass strips, due to a certain weakness in the fixture of the tailwheel, and advised me to land only on smooth concrete runways. Well, after all, I didn't have any choice: the airodrome where my Acrostar found a convenient home has a concrete runway of 2500 feet by 50 feet.

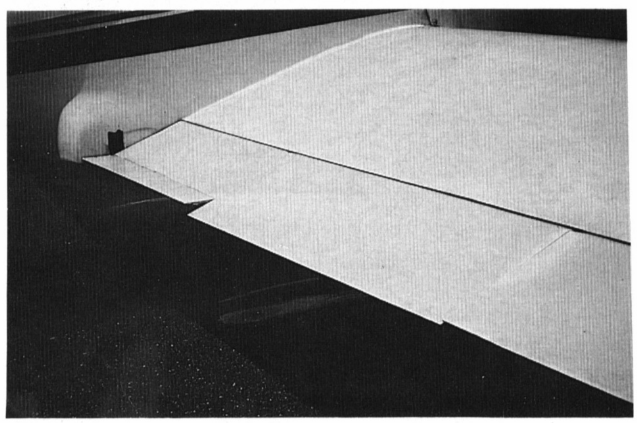
For landing, a long lineup on final is preferred, because the rate of descent is controlled only by stick and by throttle, and the speed has to be watched carefully because the plane has only a marginal speed difference between a warning shake of the stick and the final drop into the spin while stalling. In fact, power-off stall takes place exactly at 55 KIAS, so that the approach speed is about 80 KIAS, reduced to 65 KIAS over the threshold. Just after touchdown, which I prefer to do slightly tailwheel-first, the brakes are applied fully to decelerate until a normal taxiing speed is reached. Actually, I found out that the safest landings are done with both heels fully on the brakes already on touchdown. Maybe this will cost some more use of tires and brake pads, but it gives reliable control of direction regardless of the sidewind component. By the way: the manual says that brakes may be fully applied anytime, because the main wheels are mounted so much in front that there is no danger of overturning.

The Acrostar is designed to fulfill all requirements of FAR 23. Therefore, means had to be provided to make control possible even if a failure of the ailerons or the elevator would occur. This might be an academic assumption, but the requirement was met by the arrangement of two trim tabs on the flaps. This will make this plane

The integrated control system of the Acrostar. Upper picture: stick pushed completely, lower picture: fully pulled. Ailerons follow flaps half way. Oil can on tail helps to collect oil from crankcase vent tube, keeps ground clean. Of course, it is removed before take-off!

probably the only one with flap trimming! In fact, while the flaps are directly connected to the elevator, trim tabs on the flaps give a shorter length for the controlling pushrods while serving the same purpose. Because the plane has no dihedral at all, its stability regarding the roll movement is virtually non-existent. In case of the failure of aileron control, it would be possible to control bank by a different setting of the trim tabs on both sides. The overall range of the trim tab effect is quite large: it is possible to trim for landing attitude on the full "tail down" side, over to a full power climb in inverted flight on the full "tail up" side.

Now to some positive properties and some problems of the plane. Of course, you must be aware that I have only about 20 hours of training on it, so my knowledge is quite limited. The Acrostar is easy to maintain, because there is hardly any weak point in the structure, except perhaps the tailwheel mounting. All surfaces are covered by plywood or fiberglass, so there is no fabric



The right side flettner trim tab on the flap: upside deflection means downward force on flap and consequently nose up tendency of the airplane. Right and left side trim tabs are independently operated by two levers on the left hand side of the pilot.

to take care of. No problem with the undercarriage, that has been borrowed from the Boeklow MONSUN. However, the engine may become a headache for the owner, because the production of the Franklin engines has been shifted to Poland, and there seems to be no way to get parts else than going behind the iron curtain and bribing the persons involved. There is no alternative to this engine, because of its excellent power/weight ratio. One major problem, at least on my plane, is the oil supply. The engine is equipped with two oil pumps, operating both together, one on the standard bottom oil sump and one on the engine top. The changeover from positive to negative G's leads to several seconds of zero oil pressure. The same applies of course in knife flight. So, in order to keep the engine alive as long as possible, I refrain from hesitation rolls and knife flight attitude almost completely.

On the other hand, the plane is very easy to handle on inverted spins and flicks. A stable normal spin takes exactly 180° to recover, while the inverted variant takes 90°. Snap rolls are admitted up the manoeuvering speed of 150 KTS, and may be terminated at almost zero speed due to the excellent effectivity of the controls. On the other hand, the roll rate is considerably slower than with the Pitts. The manual states that 3 vertical rolls are possible if started with the maximum speed of almost 200 KTS and with 2800 RPM, which is full power. The speed is probably generally higher than with the Pitts, and the aerobatic manoeuvers are likely to put more and longer G's on the pilot. But if I see the owner of the Pitts in my neighborhood crawling in his seat — I would certainly need some sort of shoehorn — I prefer the ample room in the cockpit I get for my 190 pounds. Moreover, in European weather conditions, the excellent visibility of the single wing airplane is an asset for training aerobatics in reduced VMC.

PROPER PROPPING PROCEDURE

An IAC member recently submitted the following pertinent article:

"Even though this item is more along the Flying Safety lines, it still has a technical safety background.

"The subject is hand propping an engine for starting. This does not relate to the many stupid accidents we have with no one in the cockpit as I believe our IACers are beyond this, but covers the proper challenge and response calls between the person in the cockpit and the man on the business end.

"I see so many blatant disregards for a proper procedure that we all need to brush up on this, the first step of a flight.

"As most of our aerobatic aircraft with any power do not have a starter installed, we need to review the safe hand propping procedures.

"Back before WW II we had a standard procedure that was universal and as just about **all** the light aircraft then did not have starters, everyone was an expert at hand starting.

"Here are the basic rules to be followed.

"1. Loudly inform all the tire kickers and punsters that there will be complete SILENCE while the starting operation is in progress.

"2. The propper in front of the aircraft is the one in charge. He calls the shots.

"3. The pilot should brief his propper as to the procedures he will use for priming, how many blades with the switch off, etc., as every aircraft is different.

"4. The propper will initiate the call for the switch position by calling either SWITCH OFF or CONTACT. Any other names like 'make it hot', 'O.K.', 'ready', 'switch on', etc., is just asking for confusion in the signals.

"5. When the pilot responds to SWITCH OFF he turns the switch off then calls SWITCH OFF. When he responds to the call CONTACT he calls CONTACT, **then** turns the switch on. This will provide an overlap with the obvious built-in safety factor. There is no need for any other conversation at this crucial time until the engine starts.

"The propper should, of course, treat all propellers at any time as though the switch is on contact. How many of us are guilty of not making it a habit to check the 'OFF' position while our engines are at idle to insure that when you do call SWITCH OFF you are not telling a fib. Every fifth flight is a good sequence just before shut down.

"In addition to all this, you should check the "P" leads at least once every fifth flight as you taxi in by turning the switch off while the engine is at idle. This will insure that when your propper swings that blade on the next flight he doesn't have a hot one."

"Call it nostalgia or WW II grandfathers antiquated engine start rules, but it worked. Remember, it is either SWITCH OFF or CONTACT.

"I also have no empathy for the pilot who calls 'CLEAR' and then immediately hits the starter."

The above are some very worthwhile suggestions. At this time IACers may also want to review some other IAC Technical Safety articles that relate to engine starting:

"Gentlemen, Oil Your Engines", 4-73
"Hot Starts For Lycomings", 2-75
"Hand Starting" 8-81

AVCO LYCOMING — ENGINES FOR AEROBATICS

By Richard Goode
Reprinted From BAeA Newsletter - July 1981

Introduction

Most of us take the engines of aerobatic aircraft totally for granted, which is surprising since so much both in terms of performance and safety (not to say cost) depends on one's engine. It can be fairly said that Lycoming dominates the world market for aerobatic aircraft engines, and I believe I am correct in saying that every single aircraft at the 1980 World Championships was equipped with Lycoming engines. There is absolutely no doubt that Lycoming builds a quite excellent engine, but at the same time as a company they inevitably have to adopt an official line on not accepting any modifications, or use of their engines beyond design specifications, all of which is largely as a result of product liability legislation in America. To an extent because of this and to an extent because many aerobatic pilots take their engines for granted, there are quite substantial areas of confusion relating to Lycoming engines and a number of people have asked me if I could write a short article to clear up various points. Obviously the whole field is an enormous one, and the following is only scratching the surface. Nevertheless, it should sort out a few of the more fundamental points, and I hope will prove useful to some of you.

It is possibly most constructive to look at the engines under various headings and to deal with the important points in each.

i) Overall Types and Nomenclature

There are over 500 different Lycoming engines listed, many of which are only minute variations of others, but unless one knows what one is looking for the whole scheme can be very confusing. In essence all Lycoming engines are "O" engines — meaning that they are opposed cylinders. At the same time in each engine number there is a figure — in our case usually 360 meaning the displacement in cubic inches (about 6 litres for the 360). In addition to this many of the engines begin with "I" meaning injected, while the letters after the cubic capacity of the engine refer to the horsepower and the type of installation details — positioning of fuel injector, etc.

At the same time more complex engines have "G" and "S" in their letters referring to geared and supercharged engines respectively.

For common aerobatic use the most popular engines are the IO360 — producing either 180 or 200 horsepower or the IO540 engine usually producing 260 horsepower. In terms of these power outputs it cannot be stressed too strongly how conservative Lycomings are, and how artificially governed down these engines are in the interests of longevity and safety. As an extreme it is worth pointing out that if the IO360 could hypothetically be developed to produce the same specific output as the Formula 1 turbo-charged Ferrari engine, its output would be 2,200 horsepower and not 200! At the same time the more highly developed 540 series engines with turbo-charging produce 450 horsepower at a continuous 3,200 rpm, which is equivalent to the IO360 — which shares most of the mechanical components including bearings, pistons, etc., producing 300 horsepower at the same rpm. From this it can be seen that there is very considerable scope for producing more power than the standard engines, although inevitably this must be at the expense of the engine's traditional reliability and long life.

Two other points in terms of the nomenclature should be cleared up. The first refers to the "AIO" engines, which are very rare dry sump engines, which since the advent of the fully-inverted wet sump engines seem to have lost favor. Conversely the "AEIO" engines are merely the same as the "IO" version but with a Christen inverted oil system fitted.

In terms of the two engines most applicable to aerobatics — the IO360 and the IO540, these engines are essentially identical, with the 540 being "1½" 360s, i.e., simply a 6 cylinder version.

ii) Cylinder Heads

Essentially there are two types of cylinder head — one with parallel valves and one with inclined valves.

This is the fundamental difference between the 180 and 200 horsepower IO360's, and in terms of identifying the engines the 200 engines are either "A" or "C" engines after the 360, while the 180 are "B" engines. There is a lot of dispute about the most reliable of the two types under very arduous conditions, but there is no doubt that the 200 type breathes much better, and potentially can give a great deal more power. The 200 type engine also utilises what is called "tuned-induction", which is a system of identical length induction tubes into a common plenum chamber cast integrally with the sump. (One particular important point is that the IO540 engines with the tuned-induction system are not compatible with the inverted oil system which is why the 6-cylinder engines such as in the ZLIN-50 and the Pitts S2S use the 260 horsepower rather than the 300 horsepower version.)

iii) Crankcases

The crankcases of the engines are fundamentally similar, although on those engines equipped for variable pitch propellers, some drive the CSU off the backplate, while others have a CSU mounting at the front of the crankcase. In addition the high performance (i.e., inclined valve) engines tend to have oil-cooled pistons, a distinct advantage.

iv) Crankshafts

Many people will be familiar with the "solid crankshaft" of the aerobatic "B" series engine. By solid this of course only means that the nose section of the crankshaft is solid — from the main bearing forward. This is obviously an advantage, but what should be pointed out is that there are 2 different crankshafts for use with CSUs, one of which has a thick wall and the other a thin wall; the former is very strong and is used in the S2A Pitts. Conversely the thin wall crank should be avoided, and a number of aircraft have lost propellers doing aerobatics with this.

v) Fuel Systems

Although a few people use pressure carburetors, the vast majority use Bendix fuel injection systems, which are simple and usually very reliable, although they do dislike any dirt in fuel systems. It is worth pointing out that they can be mounted in any attitude whatsoever, and this does not affect, for example, their ability to start.

The normal injector is the RSA-5, which is good for up to 300 horsepower, although more powerful installations than this should apparently use the RSA-10. The great advantage of Bendix fuel injectors is that they automatically adjust the mixture for the right amounts of air and fuel (apart from idle settings), and thus, within limits, need not be adjusted to fit an engine giving more power than standard.

vi) Camshafts

This is a somewhat dark subject, and although there are several different part numbers for Lycoming camshafts, and the factory themselves imply certain substantial differences between cams, all Lycoming camshafts that I have see identical profiles and timing, and I suspect that different engine outputs within "families" of engines are due to a combination of compression ratio and engine revs.

vii) Oil Systems

The Christen inverted systems that are universally used on Lycoming engines are extremely efficient and reliable, and once set up properly — that is according to the Christen manual — are not only very effective, maintaining oil pressure in almost any attitude, but also greatly minimize any oil loss.

At the same time there are various "extended-sump" modifications which are strongly recommended for aircraft use for serious aerobatics, and many a case of bearing problems has been du;e to people flying aeroplanes hard when only equipped with the standard sump modification. (All these points are covered in the Christen manual.)

To my mind a fundamental problem on many Lycoming engines is the use of an old-fashioned metal gauze oil filter, and while the factory does supply an excellent cartridge type system, there is not sufficient room to install this in a Pitts Special without modifications to the bulkhead. However, if it can be done such an installation is very strongly recommended.

On the subject of oil, although the official manuals say that oil temperatures of up to 240° F are acceptable, I personally feel that these are far too high, and certainly any of the oil companies say that their oil will begin breaking down at temperatures below this, and whereas inlet oil temperature might be (say) 230° F, the actual oil in critical parts of the engine can be substantially higher. On a hot day an IO360 will usually run well over 200°, and for this reason I feel that coupling a second oil cooler in series is a good idea, particularly if used in conjunction with the thermobypass valve, which only brings the oil coolers into play at high oil temperatures.

viii) Turbo Charging

Although all the more powerful Lycoming engines utilize turbo charging to achieve these power outputs, turbo charging is not as applicable to aerobatic engines for the following reasons:

- Turbo chargers run at up to 80,000 revs a minute, and need a constant supply of oil, and even a couple of seconds without oil pressure — as can often happen — can allow the rotor bearings in the turbo charger to seize solid.
- Throttle response on turbo chargers is often poor, and rapid throttle response is usually necessary for aerobatic aircraft.
- The violent use of the throttle can lead to very problematical "over-boosting", which is something that one cannot monitor while concentrating on aerobatics.

Nevertheless, these are all problems that can be overcome with sufficient money and application!

ix) Engine Reliability

The basic Lycoming engine is extremely rugged and reliable, and certainly in mechanical terms is perfectly safe to rev to well over 4,000 revs, before any dramatic mechanical problems. At the same time any over-revving obviously increases (dramatically) loads on the engine, and I suppose the following are the three areas of potential failure of the engines under arduous conditions:

- **Camshafts —** With two of the cam lobes each serving two valves the loads on these lobes are very high, and the surface hardening has been known to break down — as the pile of IO360 engines taken out of Air Force Bulldogs demonstrates.
- **"Big-Ends" —** These are relatively small for the size of the engine, and although reasonably reliable with a constant supply of oil will very quickly fail if the oil supply stops for any reason (for this reason extended periods on "knife-edge" are to be avoided). However, metal will always be seen in the filters before any significant damage is done to the crankshaft.
- **Exhaust Valves —** which are a weak point, particularly with the inclined valve engine which has sodium cooled valves, which do drop their heads into the combustion chambers on occasion.

x) Tuning The Engine

From the relative power outputs of the engines it can be seen that there is an immense amount that can be done to give more power, but this is an area that would probably require a complete article in itself.

MICROLON ENGINE TREATMENT

Readers of *Sport Aerobatics* will have read Newt Phillips article in the March issue describing the improved engine performance he obtained after giving his engine the Microlon treatment.

Geoff Masterton has had a supply of Microlon imported; and can arrange treatment of BAeA members' engines. Whilst the treatment is not cheap it is certainly worthwhile.

Microlon provides an extra margin of safety for extreme operating environments, and significantly reduces friction by forming a permanent TFE resin film on bearing surfaces. It is the only Teflon formulation accepted by the FAA for use in aircraft engines.

Microlon treated engines exhibit higher compression, more useable horsepower, greater fuel efficiency, lower oil consumption, lower operating temperatures, longer component life, and lower maintenance costs.

TITLE 14 — Aeronautics and Space
CHAPTER I — FEDERAL AVIATION ADMINISTRATION DEPARTMENT OF TRANSPORTATION

(Docket No. 81-GL-6-AD; Amdt. 39-4172)
PART 39 — AIRWORTHINESS DIRECTIVE
Bellanca Aircraft Corporation Model 8KCAB FAA Approved Airplane Flight Manuals and Model 7ECA, 7GCAA, 7GCBC, and 7KCAB Operations Limitations Instructions

AGENCY: Federal Aviation Administration (FAA), DOT.
ACTION: Final rule.
SUMMARY: This amendment adopts a new Airworthiness Directive (AD), which requires information to be added to:

1. Bellanca Model 8KCAB, FAA Approved Airplane Flight Manuals and;
2. Bellanca Models 7ECA, 7GCAA, 7GCBC and 7KCAB Operations Limitations Instructions.

This AD is being issued as a result of NTSB Safety Recommendation No. A-81-45, which addressed improper field installations of occupant safety belts. This AD is being enacted to prevent a potentially dangerous situation. Due to improperly installed front seat occupant "competition harness" safety belts, the rear seat stick becomes entangled in the front seat safety belt.
DATES: Effective — July 28, 1981.
ADDRESSES: Written comments are not requested.

AIRWORTHINESS DIRECTIVE

The following Airworthiness Directive issued by the Federal Aviation Administration in accordance with the provisions of Federal Aviation Regulations. Part 39, applies to an aircraft model of which our records indicate you may be the registered owner. Airworthiness Directives affect aviation safety. They are regulations which require immediate attention. You are cautioned that no person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of the Airworthiness Directive (FAR 39.3).
81-16-04 **BELLANCA AIRCRAFT CORPORATION:** Amendment 39-4172. Applies to Models 8KCAB, 7ECA, 7GCAA, 7GCBC and 7KCAB airplanes certificated in Acrobatic category.

To insure that the competition harness (also referred to as the ACRO harness) is installed properly, accomplish the following before further flight:

1. Unless previously accomplished, insert figure I of this AD into all applicable aircraft having approved flight manuals.
2. Attach figure I of this AD to all "Operating Limitation Instructions" (yellow card) for those applicable aircraft where a flight manual is not required (Model 7 Series airplanes).
3. Inspect all competition harness installations to insure that the shoulder straps are installed in accordance with figure I of this AD. Insure that the shoulder straps of the added harness pass on the forward side of the seat back.

This amendment becomes effective July 28, 1981.
FOR FURTHER INFORMATION CONTACT:
Mr. Kenneth W. Payauys, Engineering and Manufacturing Branch, AGL-210, Flight Standards Division, Federal Aviation Administration, 2300 East Devon Avenue, Des Plaines, Illinois 60018; telephone (312) 694-7138.

Figure I
AD 8-16-04

NOTE: Acro harness does not provide for forward restraint crash protection and therefore should always be used with primary lap belt and shoulder strap.

WEARING FRONT SEAT ACRO HARNESS
ACRO HARNESS ASSEMBLY INCLUDES:
—Double Shoulder Harness with retractor reel.
—Lap belt (L & R portions).
—Groin strap.
—Five point buckle.
Installation:
—Extend shoulder harness from reel.
—Adjust over shoulders and couple to buckle.
—Allow shoulder harness reel to retract and adjust harness placing the buckle above the waist but below the chest.
—Attach both lap belt portions to buckle and tighten.

CAUTION

DO NOT ALLOW SHOULDER HARNESS TO RUN UP BEHIND THE FRONT SEAT BACK WHERE IT MAY POSSIBLY INTERFERE WITH REAR STICK MOVEMENT.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

FLIGHT STANDARDS NATIONAL FIELD OFFICE
P. O. BOX 25082
OKLAHOMA CITY, OKLAHOMA 73125

July 28, 1981

Airworthiness Directive

The following Airworthiness Directive issued by the Federal Aviation Administration in accordance with the provisions of Federal Aviation Regulations Part 39, applies to an aircraft model of which our records indicate you may be the registered owner. Airworthiness Directives affect aviation safety. They are regulations which require immediate attention. You are cautioned that no person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of the Airworthiness Directive (FAR 39.3)

81-16-05 SLICK ELECTRO, INC.: Amendment 39-4173. Applies to the following Slick Magneto models and serial numbers:

Magneto Model Numbers*

4250, 4250R	4251, 4251R	4216, 4216R
4230, 4230R	4252, 4252R	6210, 6210R
4201, 4201R	4281, 4281R	6214, 6214R

*All 4200 series magnetos use Slick Coil part number M-3114
All 6200 series magnetos use Slick Coil part number M-3009

Serial Numbers**

8100000-8109999	9050000-9059999	9110000-9119999
8110000-8119999	9060000-9069999	9120000-9129999
8120000-8129999	9070000-9079999	0010000-0019999
9010000-9019999	9080000-9089999	0020000-0029999
9020000-9029999	9090000-9099999	0030000-0039999
9030000-9039999	9100000-9109999	0040000-0049999
9040000-9049999		

**Year and month of manufacture is given by first three numbers of serial number; for example 9032576 was manufactured March 1979.

The above magneto models are installed on, but not limited to, the following engines:

Teledyne-Continental

A-65	C-90	O-470
A-75	O-200	IO-470
C-75	IO-360	IO-520
C-85	TSIO-360	TSIO-520

Lycoming

O-235-C2C	O-320-D3G	O-360-A4M
O-235-H2C	O-320-E1J	O-360-C1E
O-235-K2C	O-320-E2D	O-360-C1F
O-235-L2C	O-320-E2G	O-360-C2E
O-320-A2D	O-320-E3D	O-360-F1A6
O-320-D1D	AEIO-320-E1B	AEIO-360-B1G6
O-320-D2G	AEIO-320-E2B	AEIO-360-H1A
O-320-D2J	O-360-A4K	

PROPELLERS & AEROBATICS

Over the years there have been several articles in *Sport Aerobatics* relating to propellers used in aerobatics. On the same subject, an IAC member wrote to Mr. George Collinge, who has recently authored a series of articles on aerodynamics in *SPORT AVIATION*, asking about the stresses induced in propellers during aerobatic flight. Copies of the exchange of letters between this member and Mr. Collinge were forwarded to the IAC Technical Safety Committee and are shown below for your information.

"15 June 1981

"Dear George:

"I have read with much interest your recent articles on 'Lift and Thrust' and more particularly the one in the June, 1981 issue of EAA's *SPORT AVIATION* on propellers.

"This is a subject we in the International Aerobatic Club need some enlightenment on as related to the strange forces encountered on a propeller during a Lomcevak. This is an aerobatic maneuver developed by the Czechoslovakians which in a literal translation means 'real crazy' or 'drunken bum'. It is used mostly in air show routines and is quite simple to perform. A climb angle of over 45 degrees is established and when the air speed shows 110 (Pitts S-1) you perform an outside snap with right rudder and forward stick, then hang on as the ride is completely out of control. As the aircraft tumbles through the air, swapping ends and cartwheeling the aircraft component that seems to bear the most stress is the propeller as it slices the air at other than normal angles. Several air show pilots have experienced propeller flange cracks attributable to this gyrating maneuver. As a result, it is seldom practiced to preclude undue stresses on the propeller.

"I'm sure you have seen a Lomcevak performed, and the purpose of my letter to you is to ask you to write an article on the unusual stresses imposed by these abnormal forces in layman's aerodynamics and submit it to the IAC."

"June 23, 1981

"Dear __________ :

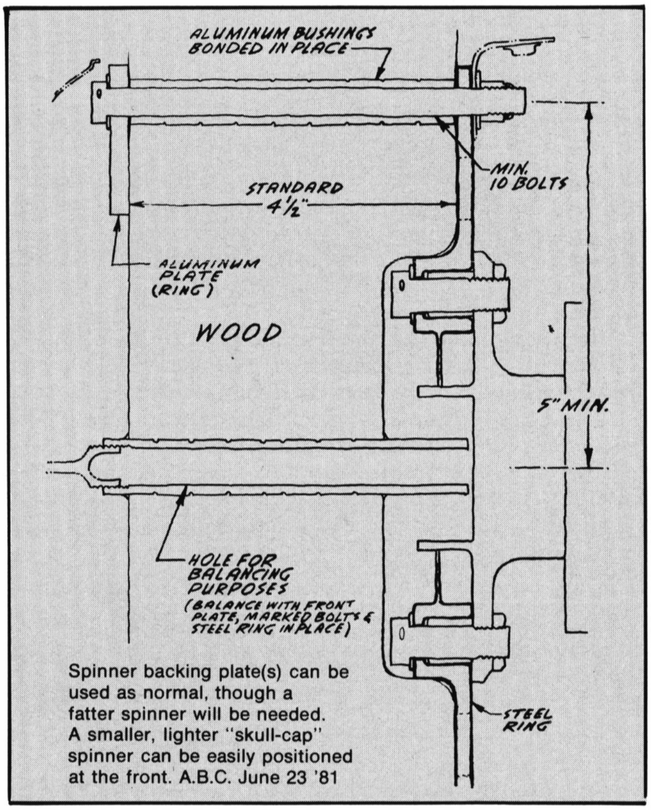
"You mean I'm writing to the famous __________? That's enough reason why I would like to write something for you but all the more difficult for me to tell you that there is little on which I can comment in regard to propeller flow during aerobatics.

"So, I thought it proper initially to delineate in letter form what I perceive as the real problem, that which is causing the cracks in the propeller.

"From an aerodynamic point of view, my thoughts are that at high r.p.m. there is always air flowing through the propeller in the correct direction, though obviously not in a uniform manner. Even coming down backwards, your smoke goes downward, **then** wafts off to the side or wherever. So, I believe there is nothing really bizzare taking place up there aerodynamically and, anyway, the air loads are of minimal consequence.

"The big problem is gyroscopic loading. Lots of quick snaps with high r.p.m. will do-in the average commercial aluminum propeller, given time.

"From an engineering point of view, aluminum is not the best material to resist cracking while under a rapidly reversing stress pattern. How the standard alum-



Spinner backing plate(s) can be used as normal, though a fatter spinner will be needed. A smaller, lighter "skull-cap" spinner can be easily positioned at the front. A.B.C. June 23 '81 inum propeller holds up to aerobatics as well as it does, operating way beyond its designed strength, is a miracle in itself.

"The two villains are precession and the property of being rigid in space. At high r.p.m. the metal propeller is essentially a powerful gyro and wants to remain fixed in whatever position it happens to be. It strongly resists any attempt to change its axis angle, which change, of course, comes from the crank flange via the hub bolts. It is resisted by the spinning, vibrating aluminum in a perhaps strange manner, but one strictly in accordance with natural law.

"Instead of the bolts transmitting their normal load mostly in shear to the hub, they go into a strong tension mode twice every revolution as long as the change force is being applied. At high r.p.m. and with fast shifts in axis angularity, you will appreciate the rapidly alternating type of load being imposed.

"As you know, metal (generally) can take a stress just so many times. Old DC-3 airplanes accumulated such high times, the calculated life (stress occasions) was used up and many had to be scrapped even though they looked O.K. Jet airframes are supposed to last longer because of less vibration or stress.

"So, this is why metal propellers may be satisfactory in aerobatics for a while, but as they approach their individual fatigue life, the molecules begin to let go, as in a progressive crack, although occasionally the failure is large enough to be catastrophic.

"Now, wood accepts a load differently than aluminum. It does not remember stress (assuming there is no actual break). There is no molecular realignment; consequently, there is no buildup of fatigue.

"Engine flange diameters have been reduced, over the years, adequately for aluminum propellers doing A to B type flying. However, for your purposes, a much larger diameter propeller (hub) flange is again required, which will allow a wider grouping of the propeller bolts (and more of them). And this in all probability means a wooden propeller, as aluminum would be too heavy, of high cost (for small runs) and too prone to vibrate.

"Wood is lighter, damps well, will have lower gyroscopic loading, and your airplane should snap easier, faster, and be safer.

"In lieu of a factory new, wide diameter engine-crankshaft flange, I would propose a concept for adapting to existing flanges. Included is a rough sketch of what I think should be the trend to 'standard' for airplanes that are capable of very rapid changes in yaw and pitch.

"My best regards,
George Collinge

"P.S. And 'almost-constant-speed' swept blades should reduce fiddling with the throttle during routines."

Many IAC thanks to the member who initiated the above and who forwarded this material to the IAC Technical Safety Committee. And, also a large thank you to Mr. George Collinge for his permission to publish the above.

When talking about propellers and aerobatics, the question of fatigue/service life always is brought forth. Some time ago the IAC T.S. Committee attempted a survey of IAC members to try to establish some kind of service life numbers for fixed-pitch aluminum props used in aerobatics. Membership response was very poor with only slightly more than 1% of the membership participating. We can again attempt a prop-life survey if there is enough interest at this time. If you want to participate in a prop-life survey, drop a note to the IAC T.S. Committee and if a sufficient number of members are interested, we will make up and publish or distribute some questionnaires/forms.

FLYING ON BORROWED TIME?

Reprinted from Aerobatics Canada Newsletter

Aircraft parts do wear out — engines in particular. Unfortunately there's no sure way to predict precisely when any component will fail in **your** aircraft; however, there are several ways you can minimize the odds of a failure. Let's look at the engine first.

Aircraft engine manufacturers produce lists showing the maximum recommended time in hours of engine operation between overhauls (TBO) for each model of engine they produce. These maximum recommended TBOs are a requirement for a C of A but can be exceeded in ultralight aircraft.

It is acceptable to exceed the manufacturer's TBO. The manufacturer's TBO is just a figure chosen at random. It's based on extensive operational experience. To understand why a company endeavours to be realistic with his recommended TBO, think of his point of view. If he chooses to be ultraconservative and recommend a very low TBO, potential customers will obviously go elsewhere to find an engine which has a longer life between overhauls. If the manufacturer chooses a very high TBO which the engine can't realistically reach, then the reputation of the manufacturer would suffer when customers became disenchanted with this engine.

The TBOs recommended by both Lycoming and Continental are the number of hours that it is reasonable to expect to operate without major internal problems provided that the engine is operated under certain conditions. Some of the main criteria:

- the oil is changed at the specified times and oil screens or filters properly serviced.
- the air intake filter is maintained in a clean and serviceable condition.
- **the engine is run a minimum of 20 hours per month.**

Without an inhibiter in the oil, an engine will corrode when sitting around not being used. This results in abnormally high wear rates. A rule of thumb (which is admittedly based on general observations rather than hard facts) is that if an engine has not reached its normal TBO in ten years it should be given an overhaul anyway.

THE SPIN — MYTH AND REALITY

By Eric Müller
(Translated from German by Annette Carson)
Reprinted From BAeA Newsletter

This subject could really fill a library. In contrast to all the more or less scientifically written texts, I want to try to assemble here one or two simple but important facts, with the object in mind of giving the aerobatic pilot — or indeed any pilot who finds himself getting desperate in an unintentional spin — an easy method of getting out. I know my theories are correct because, in addition to studying every existing text on the subject, I have practiced spins intensively myself, taking in the widest possible variety of aeroplanes that come into the class of "conventional" design (i.e., excluding canards, T-tails, etc.). If you were to put all these spins end-to-end, they would cover roughly the distance from London to Rome . . . in other words, that means twelve hours of spinning. But, more importantly, that means I have successfully stopped the spin 4000 times, exactly as required and without its getting out of hand.

Now, to begin. But without some basic theory we will not get very far:

The Angle of Attack

To keep an airplane in the air you need lift. In horizontal flight the lift must be the same as the weight, and the formula is:

$$L = C_L \frac{P}{2} Sv^2$$

This means that the lift (L) is dependent upon air density (P), wing surface (S), and speed squared (v^2), and all this is multiplied by the lift coefficient (C_L) which is the really important thing for the subject in hand. The lift coefficient increases to a certain extent with the increasing angle of attack of the wing (Fig. 1).

At a certain angle of attack the lift coefficient no longer increases and the critical angle is reached. Beyond the critical angle of attack the lift coefficient decreases — an "overcritical" angle of attack — and that is the vital point for the spin. We see in Fig. 1 that the lift decreases with the increasing angle of attack. If we now look at Fig. 2, the front view of an airplane which is turning around its longitudinal axis, we see that the downgoing wing has a greater angle of attack than the upgoing wing. If the wings have an overcritical angle of attack, the downgoing wing will have less lift and the upgoing wing will have more lift. These differences in lift create a self-perpetuating rotation which is called autorotation. Now we must briefly discuss drag. From our swotting for the PPL we will recall vague memories of the graph for the airplane (Fig. 3) in which it is evident that after reaching the critical angle of attack the lift coefficient decreases but the drag coefficient cheerfully goes on increasing. This means that with an overcritical angle of attack the downgoing wing has more drag, and for this reason is pushed backwards. Obviously, the reverse applies to the upgoing wing — less drag and more lift. So it is typical that we also have a twisting movement around the vertical axis of the airplane which, added to the twisting movement around the longitudinal axis, gives the typical movement of the airplane in the spin. Now we know why our airplane is merrily twisting and rotating, but what we want to know is how to decrease this twisting and then stop it altogether and resume normal flight. For that we need power, and as long as we are in the air we can produce it aerodynamically — but since we have a low speed it will be only a gentle power. If we return to the ground we will have power at our disposal to stop the spin which is very effective, but also very unhealthy. So we must stop the autorotation in the air, and do so as quickly as possible.

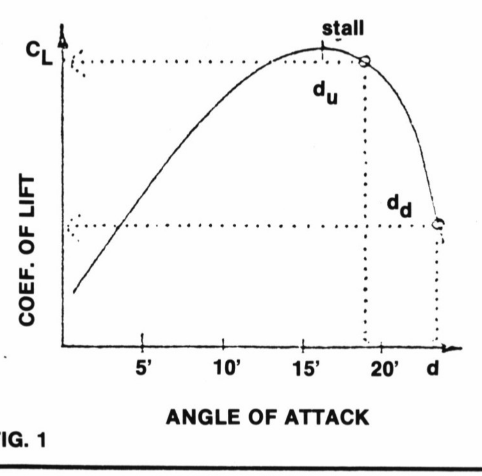


FIG. 1

Stopping The Autorotation

In the air we have at our disposal three controls and a motor. The motor will not help us in getting out of a spin because, by reason of precession, it produces an increased angle of attack when the spin is against the engine, and an increased rate of rotation when the spin is with the engine. So we must close the throttle. If we then release all three controls, they go of their own accord into a certain position. If we put them into another position, we will produce an aerodynamic force. Whether this force will be for or against the autorotation we must find out, and these are the observations I have made for you during my hours of spin tests. I have seen that the stick goes back, and the ailerons and rudder go in-spin. First I try to move just the ailerons against the spin rotation, and — how alarming! — the aircraft spins faster. That cannot be a good move, especially if I want to live to enjoy my pension. So I leave the ailerons where they want to go (in-spin) and try the elevator. I push it slowly forward as far as it will go, and I notice that the rate of rotation increases. Wrong again: so we must leave the stick where it was, almost fully back, and turn our attention to the rudder. I try kicking the rudder hard to the opposite side (anti-spin), and that needs strength, especially when you kick full rudder (and you **must** kick full rudder) but — how interesting — the rotation starts to decrease. The rate of decrease may appear at first to be slow, but the spin will stop. At the moment when the rotation stops, I observe my stick, and, as if by magic (but of course it isn't magic) it moves to neutral. The aircraft is now in a nearly vertical dive, so I centralize rudder at once and resume my hold on the stick, pulling gently back. If I pull too much I will again go into an overcritical angle of attack: if I do not pull enough I will exceed the Vne (maximum permitted speed). So my conclusion is that the easiest method of getting out of a spin is to close the throttle, take my hands off the stick, and kick full opposite rudder.

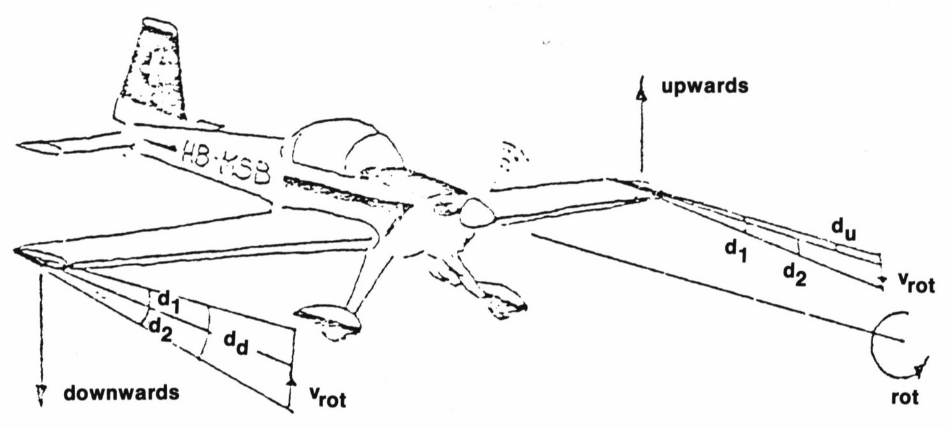


FIG. 2

But why, you will ask, has the spin always been such an awesome thing? Why has it cost so many human lives and given rise to so many written texts and articles, and now somebody comes along and says it's all really quite easy? I think I have an explanation: fear. Fear alters your state of consciousness, it interferes with perception, it upsets all sense of time and faculty of recall. So let us try to find the source of this fear. When you are told in the club bar, and you read also in the specialist literature on the subject, that in a spin you never know exactly what is happening, this is not likely to make you feel either very happy or very confident about spinning: and the spin smacks of Russian roulette. Then you encounter a real spin, and invisible forces come along to take hold of your airplane and rotate it like a toy, that same airplane which immediately before was flying so nicely, just as you learned in school. The effect is very discomforting and the result is fear. Even the oldest experienced pilot will react, in his first 100 or so hours of spinning practice, just like a fish when it finds itself thrown up on shore. That produces fear. The best-learned flying instincts, when wrong theories are applied, will be worthless — and all the time you are being tossed about like a mouse in a washing machine. Every pilot in-the-street knows that each change in controls will result in a change of attitude, but in the spin that just isn't so. I can push the stick forward with all my strength, and give ailerons to try to stop this nasty twisting, but nothing happens. The washing machine continues to turn. That can really produce fear. And the earth is coming nearer and nearer. And fear in an airplane is not a good counselor, but it is a very good myth-maker.

There are of course explanations why the spin can be so easily stopped with my method — close the throttle, release the stick, kick full opposite rudder until the rotation stops, then pull gently and centralize rudder — but such detailed explanations would be too long and complicated for this article and are best set out in a book about aerobatics (this I am presently preparing and will publish in 1982). Many pilots will ask why a different method appears in their aircraft manual. The methods given in the various manuals are not necessarily wrong if you use them exactly as prescribed, but they do often give rise to misunderstanding or mishandling, and they ask too much of a pilot unused to spinning: the accident statistics give proof of this. So my method is just simpler and easier. And it has one more advantage: it is absolutely the same whether you are in a negative spin or a positive spin or a flat spin. By the way, there is basically no difference between a normal spin and a flat spin, and essentially no difference in the method of getting out. The ailerons and elevator know best for themselves, and the rudder must be kicked on the side that gives the most resistance — but please, **full** rudder.

Now for a few additional recommendations. Only spin with an airplane that is certificated for spinning. With this aircraft, start by going high enough (minimum 5000 ft. above ground) until such time as you are really certain that you have full control of your actions: the first spins you practice will, in any case, be with an instructor accustomed to spinning, because he will not be liable to panic.

And now I wish you much fun with your spinning.

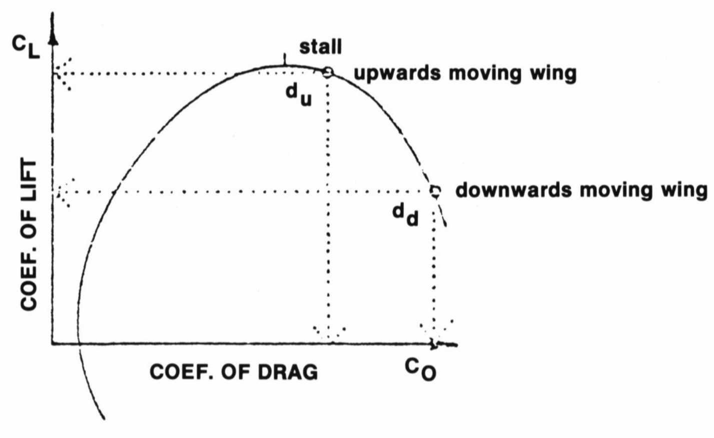


FIG 3

FDL '81 - TECHNICALLY SPEAKING

By F. H. "Moon" Wheeler

When Jim Batterman volunteered IAC Chapter 8 for Technical Committee duty at FDL '81 I felt it was a fine idea. Last May I competed at the Rebel Regional at Arlington, TN (my first contest), realized how much work was necessary to make a contest happen, and figured I had better find a way to do my share. The only job I could possibly qualify for was tech inspection, and it would also afford me a great opportunity to look closely at a lot of other people's airplanes and ideas.

So I was on the field before noon on Saturday, August 8, ready to do my thing. Jim and other Chapter 8 members, not so naive, didn't show up until later in the afternoon. Even then we had to hunt for customers. As Jim told us several times, most contestants expect to get their tech inspection at 2:00 P.M. on Sunday, so the early birds wait until then and the late arrivals get there about the same time and it's a mess. But we got through it, if just barely.

Working with Jim Batterman is a pleasant and educational experience. He has a quiet but forceful way of getting his point across, and he can inspect an airplane as fast and as well as anyone I know. His detailed and extensive knowledge of Citabrias and Decathlons impressed and educated many of us who saw him in action. The other hard working Chapter 8 members who made up the committee were;

Beverly Rucks	Rod Anderson
Jim Lange	Bob Schlamer
Jack Vandehei	Jack McCombs

And if I left anyone out you get one free shot at me at the next Chapter 8 meeting — with a marshmallow.

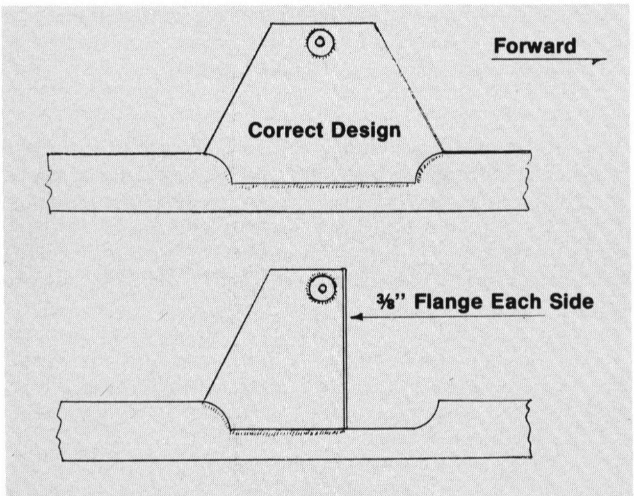


FIG. 1

According to our new Prexy, Mike Heuer, 98 contestants attended. At 4:00 P.M. Sunday we thought each had brought two airplanes, but that was an illusion caused by their ganging up on us. How about you Sporting Types giving us a break on this next year? Give us a chance to spread it out a bit — sure would be appreciated.

Now for some of the nitty details (there were no gritty ones; thank you, Lord).

1. On one aircraft we found that the inverted oil system transfer valve was fitted with water pipe nipples and common hose clamps holding oil pressure lines to the nipples. The same a/c used plastic hose in the engine compartment for the oil breather tube.
2. A Pitts had a control stick torque tube assembly that was incorrectly built in that half the torque tube tower was missing (see FIG. 1). The same aircraft had the aileron push rod stop nuts backed off so that the rod rotated freely. It also had aileron gap seals that interfered with aileron movement in the full travel position. There were also no control stick stops, and on full aileron deflection the torque tube could be seen bending. This airplane did not pass inspection and was not allowed to fly.
3. Another Pitts had the old style Lycoming engine mount bushings, and the lower right bushing was pounded out and had to be changed prior to contest flight. The new TECHNICAL TIPS MANUAL has a good picture of this condition on page 108.
4. Several Pitts aircraft had loose wheel fairings. Two required repairs prior to contest flight.
5. A Decathlon had a broken belly former which was found loose just behind the battery. See page 135 of the TECHNICAL TIPS MANUAL for the word on this one. It should be a pre-flight item. Incidentally, this was the only loose or foreign object found in any of the aircraft, and that's GOOD!
6. We found one shoulder harness in a Citabria incorrectly routed up the back of the front seat and advised the owner of the AD on that item.
7. An older Citabria had no nails holding the ribs to the spars on any of the ribs that we were able to see. Also the aileron attach brackets to the rear spar seemed unusually loose (up and down movement). We could not see the mounting plate and bolts but suspect that the mounting bolts were not tight. This a/c was not allowed to fly.
8. Pitts S-2 aircraft have the certificate holder mounted to the back of the front seat, and on one a/c the top of the rear control stick would strike the holder when the stick was full forward. On a couple of others, the top of the stick would get within ¼" of the holder. Looked like sure knuckle-busters, but the pilots said they never noticed it being a problem. Later Fred Cailey asked Herb Andersen of Pitts Aerobatics about this and he said that there should be approximately 1" clearance between the top of the stick and

the holder, and that he suspected that the a/c in question had been re-rigged and full forward stick clearance not checked.

9. During the contest a Pitts experienced a slight engine problem because of a partially plugged fuel filter element (Christen manual fuel pump filter). A good bit of the gunk in the filter element was aluminum flakes which were beaten off the inside of the fuel tank by the flop tube weight. Fred Cailey tells me that no final fix to this problem has been discovered, and that it seems to be worse in aircraft fitted with header tanks (with flip tubes in the header tanks). I changed my filter element at 100 hours, and it looked like it could have gone 1000 hours (Sportsman type maneuvers), but I suspect it was clean because of a fuel drain that I installed at the very bottom rear of my fuel tank. When I check this drain at pre-flight I always get a lot of aluminum and usually drain several ounces which seems to get most of it out. It might be a good idea to change this filter element often enough so that you can get a feel for how many hours you can safely go between changes. The next question is, how long will the tank last? Anyone got the word on that?

The remaining items were fairly minor in nature, such as missing sheet metal screws, fairings that needed adjustment, and control hinge pins that showed some wear and should be replaced on the next trip into the shop.

One Pitts had quite a few problems even though the logbook showed a fresh annual by an FBO. The logbook also had an entry that stated "Aircraft completely recovered" dated 7/31/81, and it was very obvious that this was not true. We suspect that the A & P who made this entry did not intend it to read as it did, but meant that certain parts were completely recovered. This points up the need for the a/c owner to check all work and logbook entries on his or her airplane for, contrary to popular belief, the FAR's place responsibility for proper maintenance on the aircraft owner, and **not** on the A & P or FBO who performs such maintenance. And this includes the responsibility to see that proper logbook entries are made.

On this note I advance the opinion that too many pilots, not all of them Acronuts (or is it Acronauts?) do not have adequate knowledge of the machines they fly, especially if the a/c is homebuilt by someone other than themselves. Homebuilding is sometimes more art than science; more an expression of the builder's thoughts than those of the designer's. If you're gonna buy a homebuilt it might be a good idea to find out for yourself how well the builder followed the plans. And understand that your A & P, no matter how carefully chosen, may not know enough about the design of your bird to recognize digressions from design, even dangerous digressions. A & P's are not trained in design, but rather in maintenance, and they have no practical way of knowing that what they are maintaining was improperly built or incorrectly designed. The new IAC TECHNICAL TIPS MANUAL should be considered mandatory for aerobatic pilots. It holds solutions (some of them arrived at the hard way) for most of the technical problems that we face.

The opportunity to look closely at a lot of Pitts provided an unexpected bonus for me. While building my Pitts S-1C I tried to be particularly careful with the alignment of the landing gear. The result was 1/32" toe-out on each main wheel, which is supposed to be good, but later taxi tests required rudder reaction times faster than I could remember possessing. After consultations with those more experienced than I, I tightened the tail wheel steering chains and springs tighter than I thought they should be, and that helped quite a bit. I was still a tad nervous on roll-out, however, and I thought it could be improved, but didn't know how.

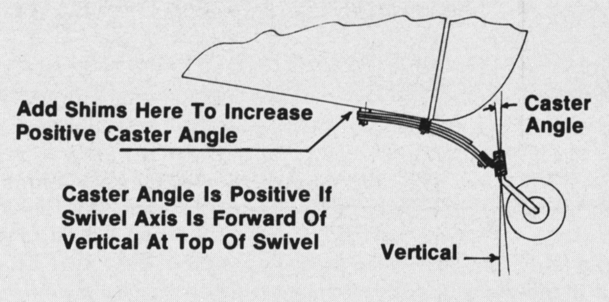


FIG. 2

So imagine my surprise when I saw a Pitts S-1 and an S-2 (both factory built) with tail wheel chains hanging slack. Both pilots said they had no problems, just like your ordinary everyday superpilot, you know? But later I was able to question Lloyd Otey, the S-1 driver, at some length. Lloyd told me that he made a cross-country flight with this airplane that required nine landings, with the left brake inoperative all the while. Said it was a pussycat. Now, maybe I wouldn't trust Lloyd to tell me how the wind was blowing in the box, but his charming wife Gladys backed him up on this, so I had to believe him. And that meant that something was different about those tail wheels with the slack chains.

After that conversation I eyeballed every steerable tail wheel I could find on the field, and found only one noticeable difference in them. That was the angle (from the vertical) of the tail wheel swivel axis (see FIG. 2). I found that this angle ranged from approximately 5 degrees negative to 30 degrees positive. Most were zero degrees or within a couple of degrees of zero, and the ones with slack chains were definitely positive. This precision eyeball measurement was taken when all three were solidly on the ground.

After getting home from the contest I decided to apply empirical design techniques to the problem (that's fancy talk for "try it and see if it works"). At first I shimmed my tail wheel swivel to a 5 degree negative caster angle and made a taxi test. It was definitely worse. Then I shimmed it to an approximately 5 degree positive caster angle (again see FIG. 2) and it was much better. I then reduced the spring tension by half, and it was better yet. So I made the chains slack, and it was great. I've made 6 or 8 landings since, a couple in crosswinds, and the airplane is a pussycat, almost like a Decathlon. Now a brake failure would be no problem, whereas before it would have unleashed a hungry tiger. It was worth all the work of the contest just to find this out.

One last general observation about the tech inspection. We found no new technical problems at FDL '81. Every problem that we found has been written up in *Sport Aerobatics* and/or AD's. That's good, because that means that we at least know where to look. But it also means that pilots are not checking their aircraft as well as they should. Get an IAC TECHNICAL TIPS MANUAL and read the articles that pertain to your airplane. You'll be glad you did.

I enjoyed meeting so many fine people at the contest, and at other contests during the year. I'm hooked, really looking forward to next year, hope to see ya'll again soon.

SLINGSBY T.67A

Reprinted From BAeA Newsletter

Statically displayed at Le Bourget and demonstrated in the air at Sleap, the T.67A is the British built, by Slingsby Engineering Ltd., derivative of Rene Fournier's FR6B produced in the 1970's in small numbers until financial difficulties curtailed production. The remaining Continental powered aircraft have subsequently served the French aero clubs well.

The British version has a 118 hp Lycoming 0-235-L2A and also differs from the original by having an enlarged rudder and 3 inches greater wing span. The prototype first flew at Teesside on 15th May.

This two-seater trainer tower and sporting aircraft is endowed with excellent visibility, superb handling and classic good looks; stressed to +6/–3 G the aircraft is ideal for standard to intermediate level aerobatics. The demonstration at Sleap showed conclusively that aerobatics by the T.67A look good.

The aircraft is of advanced wood and composite structure with a 30-year service life with no problem of corrosion.

The high aspect ratio, high efficiency wing gives a rate of climb of 810 fpm significantly better than other aircraft in this class. Similarly the overall aerodynamic efficiency of the aircraft demonstrated by the engine-off glide angle of 1 in 13.

The aileron and elevator controls are push rod operated, and sealed-for-life bearings are widely used. Ample luggage space is provided for touring, and avionics and instrumentation options of varying degrees of sophistication are provided.

There is an inverted oil breather system to allow short term inverted flight and five piece acrobatic straps are a standard fit.

Price for the standard aircraft is £16,750. The Popular Option Package which includes Narco 720 Channel comm transceiver and 200 channel nav receiver and VOR/LOC is a further £2,745, while the more sophisticated full airways Luxury Option Package is £4,520. Presumably the dratted V.A.T. has to be added.

Performance figures provided by the manufacturers are:

Max Speed (Sea Level) .... 113 kts.
Cruise Speed (75% power at 8000 ft.) .... 108 kts.
Range (allowing for unusable fuel, take-off
and initial climb) .... 342 nm
Take-Off 656 ft. ground roll, and 1115 ft.
total to clear a 50 ft. obstacle
Landing 918 ft. ground roll and 1476 ft.
over 50 ft. obstacle
Max Weight 1653 lbs. (Utility cat)

The T.67 is the first two seat light aircraft produced in this country since the demise of the Beagle Pup (if one discounts the military Bulldog derivative which is horrendously expensive) and the closure of Rollason's Condor production line. We hope that it will gain the success in the marketplace that it so eminently deserves, and displace some at least of the American spam-can trainers.

Further details can be obtained from Rober Bull at Slingsby Engineering Ltd., Kirkbymoorside, York, Y06 6EZ. Telephone 0751 31751: Telex 57911.

SPINNING

By Chris Kelleher
Reprinted from BAeA Newsletter

Note: Eric Müller's articles in Newsletter 28 on spinning prompted Chris Kelleher to undertake some tests to see how the Chipmunk aircraft would react to the Müller method. His report follows and highlights the need to be fully conversant with the aeroplane and its idiosyncracies.

Tony Lloyd Ed.

Having read Eric Müller's article, I was concerned to read his method of spin recovery for all conventional aircraft: "Close the throttle, release the stick, kick pull opposite rudder until the rotation stops than pull gently and centralise rudder.

The method will not necessarily work because, although the rudder is opposing the spin, the elevator may not find itself sufficiently down to reduce the angle of attack enough to break the stalled condition of the wings whilst spinning.

Curiously, the method is more likely to work on some dedicated aerobatic aircraft because of their enormous rudders being able to reduce the yaw until the wings are symmetrically stalled and then the aircraft nose will drop and unstall. This is why the yaw is slow at first to stop as in Eric's article.

My wife Suzy (a Flight Test Observer!) and I have just spun a Chipmunk from 5000-ft. to try out Eric's method. The Chipmunk is certainly a conventional type but, like the Bulldog, the manual says "may require full forward stick for recovery".

On the first spin it recovered. On the second spin it recovered. On the third, after three turns, I again applied Eric's method exactly. The stick went to a half-back position but with **FULL** opposite rudder it continued to spin (with low airspeed). After nine turns there was no sign of recovery so I eased the stick forward. The aircraft recovered within 1/3 turn at 2800-ft. I conclude that Eric's method is not a guaranteed method of getting out of a spin as any spin recovery must be. I will happily demonstrate it anytime.

To recover by letting go of the stick is a bad idea. All we can say is that it will go somewhere and not necessarily to a recovery position, let alone to the optimum recovery position.

Most aeroplane manuals will have the standard spin recovery of.

- Close the throttle
- Apply full opposite rudder
- Pause
- Move the stick progressively forwards until the rotation stops (with ailerons central). If necessary keep the stick fully forwards until it stops.
- Centralise the controls and recover from the ensuing dive.

The purpose of the down elevator is to reduce the angle of attack. Because the aircraft is spinning, the elevator will cause the yawing angular momentum to be transferred into roll as the nose drops — hence the increasing roll rate is a sign of recovery.

Some aeroplanes have the rudder blanketed by the tailplane at the high angle of attack achieved in a spin. On these aircraft the manual may recommend something less than full down elevator to give the rudder more effect. This is the **only** reason for not using full down elevator on any aircraft in a spin.

Several recent accidents have highlighted the consequence of not applying the correct recovery. It is crucially important to get it right.

PITTS SI WING RIBS

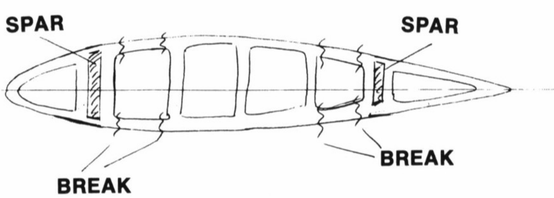
We have long been familiar with the incidence of broken ribs in aerobatic aircraft. Breakage can occur because of many reasons:

— faulty design
— poor quality materials
— poor construction
— overstressing
— deterioration through long use
— accident damage etc. . . .

A combination of two or more of these factors simply increases the rate of failure. Example: use poor materials, strain to bang those I strut bolts into place because the wing was warped in building (this already loads the wing with several g's before leaving the ground), fly 250 hours of unlimited aerobatics on your plywood ribs and there is every chance of a failure. All are susceptible, whether red lines are respected or not.

My particular concern is with a kind of rib which is frequently used as a substitute for the normal truss cap-strip rib. It is usually made of ¼ inch thick 5 ply Douglas fir or mahogany and has four lightening holes in the area between the two spars to which it is attached with chinking blocks. When this type of rib breaks, in either upper or lower wing ribs, the failure seems mostly to occur in the area immediately aft of the front spar or ahead of the rear spar. Failures have been noted throughout the span of wings though usually starting in the I strut area.

DIAGRAM 1

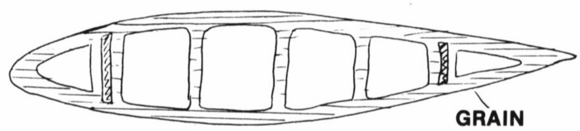


You can check for broken ribs by pushing down or up on the fabric on the ribs in the area in question.

Now, it may be that failure is caused by twisting either of the spars or of the entire wing or wings. The addition of an extra flying wire to the rear spar of the upper wing has been offered as a possible solution. However, if the alternating positive and negative pressure (say 80 lbs. at 6 gs) — particularly as the center of pressure moves rapidly back and forth — is also an important factor, then the added wire is somewhat ineffective in correcting the problem. **The square lightening hole tends to adopt trapezium shapes no matter what**. Sideways strain on the rib also occurs tending to deteriorate the wood rib fibres, which leads to another consideration.

Plywood has face grain and interior cores, the inner cores being usually of softer wood. The plywood rib ¼ inch thick has usually only 3 veneers with the grain running lengthwise (the useful direction); two other filler cores have grain running vertically in the rib. The lengthwise grain also runs off the rib edge sooner or later because of the airfoil shape:

DIAGRAM 2



In contrast, cap-strip ¼ inch thick has all its fibres running in the useful direction — lengthwise. The different strength characteristics appear obvious, but we are not through yet.

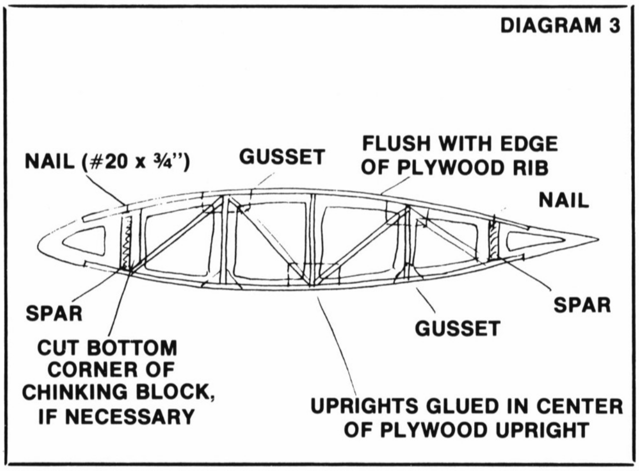
I tested the strength of plywood versus cap-strip by making up about two dozen samples of each. Pieces were cut 6 inches long and approx. 12 inches long of Douglas fir, mahogany, and Finnish birch plywood. All 5 ply, all ½ inch wide, in order to simulate the dimensions of actual rib material. I also cut pieces of ¼ inch square cap-strip sitka spruce (with varying grains to the inch) in similar lengths. Holding one end of a strip in a vice, I systematically broke the pieces and noted:

cap-strip	6 inches long — break between 4 and 6 lbs.
	12 inches long — break between 4 to 5 lbs.
mahogany	6 inches long (edgewise) break 18 to 20 lbs.
	12 inches long (edgewise) break 8 to 10 lbs.
	6 inches long (sideways) break 10 to 12 lbs.
	12 inches long (sideways) break 4 to 6 lbs.

Douglas fir proved to be considerably stronger than either cap-strip or mahogany, and **Finnish birch the champion — twice as strong as any of the others,** in any direction. Just for the record I glued one layer of 1/32 thick carbon fiber to a piece of mahogany and pulled 50 lbs. before breaking a 6 inch long piece! I noted the brittle nature of the mahogany (which I find least suitable for rib material of any of the stuff I tested), bearing in mind that only the face veneers are of mahogany, the inner cores being of some softer white wood, and the resistant quality of the fir and birch which tend to break in long splinters. But most striking in this test was that cap-strip would seem to be the **weakest**. Why then its success in rib construction?

Answer: **Design — strength in triangulation**

Uncovered, plywood rib wings can be strengthened by adding the diagonals, the uprights, and the cap strips of conventional cap-strip ribs using ¼ inch square sitka spruce of good quality. Simply glue the necessary pieces to one side of the existing clean (remove varnish) plywood ribs. I do it by gluing first the upright pieces, each one ¼ inch shy of the edge of the plywood rib. These serve as formers to bend the upper and lower cap strips into place. Nail each end to spar and extend two inches beyond spars front and rear. This is the only use of nails. Then add diagonals. The plywood rib actually serves as a large gusset but gussets can be added on the other side as well. Two hundred clothes pegs work well as clamps to hold the cap-strip pieces in position whilst the glue (I suggest a good white epoxy or equivalent) sets, the complete set of wings being done in three days.



Those ribs with compression members can be strengthened by gluing either sitka spruce (¼ inch thick and approx. 2 inches deep) or ⅛ inch birch ply to one side of the existing rib, full length between the front and rear spars. This simulates the strength of the box rib construction seen in the compression ribs of factory Pitts wings. The finished ribs are now ½ inch wide and very strong. I have converted four sets of wings in this manner and there are others that have been done by other people. To those who say: "What about the extra weight?" I simply note that the **Total** added weight on the whole set of wings is 4 to 4½ lbs. Not even a gallon of gas!

No failures have been reported in this type of rib so far despite ongoing unlimited testing of up to two hundred hours on each converted set. I rest my case.

John W. Batchelor

Anyone wishing to contact me should feel free to do so at:

Stuntair Aviation,
66, Woolwich St., N.
Breslau, Ontario, phone: 519-648-2070
Canada. N0B 1M0

"Ed. Note: IAC members want to refer to the November 1980 issue of *Sport Aerobatics* for the EAAC's SB-1 on Pitts S-1 plywood ribs. Note, as John mentioned, Pitts factory-built a/c use a truss-type rib construction but many homebuilt Pitts a/c do utilize the plywood ribs as discussed and in EAAC's SB-1."

EXHAUST STACKS

The following Tech Safety input was received from an IAC member: "Some time ago 1-607-2 (R.H.S. upper exhaust stack) failed at the junction weld and the entire lower section was close to falling off.

"As you know, I had little or no experience building aeroplanes and even though my entire aircraft was 'assembled' from Pitts Aerobatic kits, I generally put my Pitts together entirely by following 'the book' and telephoning Herb Andersen.

"Well, in the case of the exhaust system, I went astray, as I did not understand the purpose of the straps, nor did I follow the book. I had tightened the nuts so that there was **no** movement at all at the bottom! Kit 8, P38 - #136 (enclosed) instruction is quite clear."

Pitts Instructions, Kit #8, page 38, #136:

"136. Tighten bottom nut so there is approximately ½" movement at stack bottom when firmly gripped by hand and rocked back and forth. Do not overtighten in an attempt to make stack one 'solid' unit or it will crack. Safety nut with AN380-2-2 cotter pin."

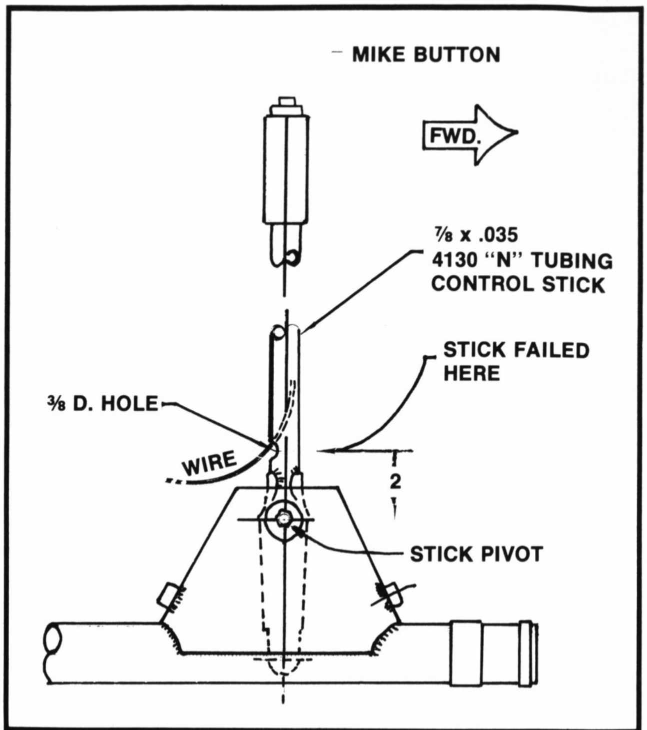
Over the years there have been reported exhaust stack/system failures on various aerobatic aircraft. A quick visual check of your aircraft's exhaust system should be part of your pre-flight inspection. Where do you look? Check for blown gaskets at the cylinder to pipe attach flange, check for cracks near any weld — pipe to flange, junction of two pipes, around "smoke fittings", etc., check to make sure slip joints slip, check external condition of muffler(s), and check any exhaust system hangers.

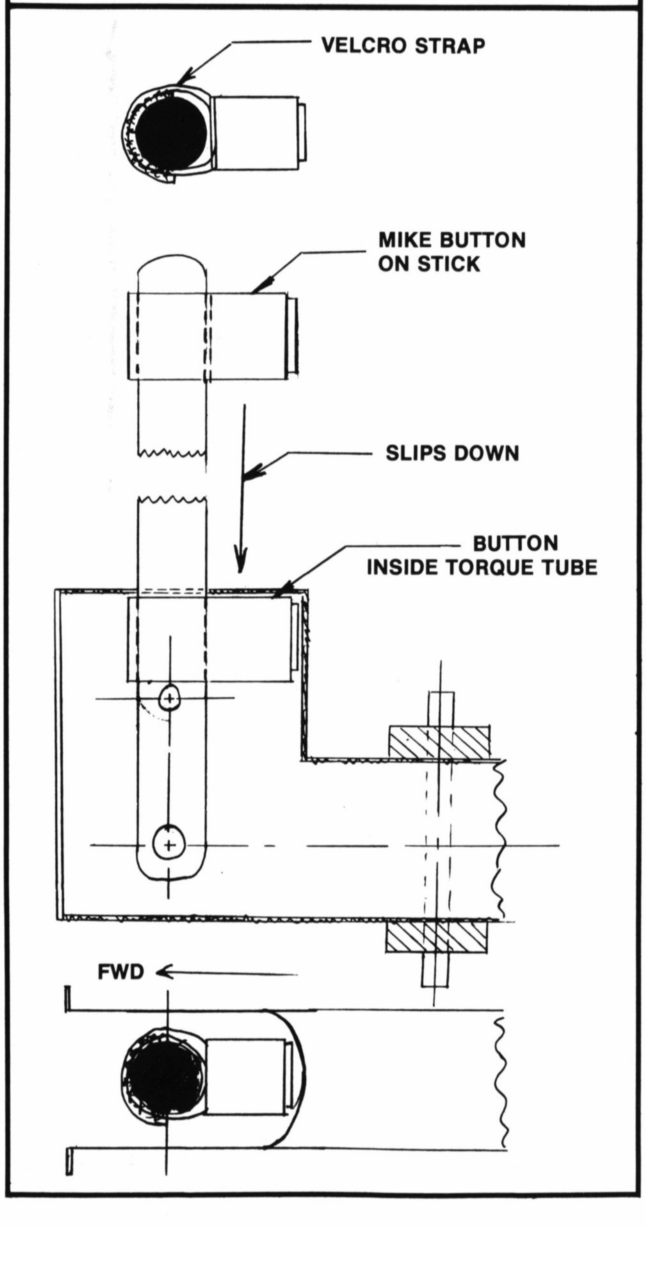
An IAC thanks to the IAC'er who supplied the initial input on this subject.

AEROBATIC BONANZA UPDATE

You are all probably aware of the running battle between Beech E33 and F33 owners and the FAA regarding the proposed rescision of the Aerobatic Category for these aircraft. This has been in limbo for over a year. FAA claims they have evidence which will cause them to revise the type certification status of the aircraft because it cannot meet the requirement for **power-on spins**. An Airworthiness Directive was developed but held in abeyance while the case was restudied. Upon returning from Oshkosh and Fond du Lac last August, Charlie Schuck was advised that the AD was truly coming out. It had been to FAA Headquarters in Washington and was passed back to Kansas City for issuance as they are the lead region for small aircraft. Charlie immediately called Jim Robinson in KC FAA Regional Office, and he confirmed that it was, indeed, ready to go. The basis for the note, however, was worse than before as FAA now had test data that showed the aircraft could not meet the recovery requirement for **power-off spins**. FAA was at this time obligated to rescind the aerobatic category for the aircraft rather than entertaining the possibility of placarding the aircraft to accomplish the desired end. Something had to be done immediately to try to stop the AD, or at least to slow it down, so Charlie called Scott Crossfield, who was active in getting the initial hold placed on the AD last year. Scott did some checking while Charlie called Beech. Chet Rembleski, VP of Engineering, was astounded that the AD was iminent and assured Charlie he would talk to FAA and call him back which he did, advising Charlie that he was successful in getting agreement from FAA to reflight test the aircraft rather than use the data that was on hand. The airplane was to be instrumented for tests which were to have been run in early November. We are still awaiting word on the outcome of those tests.

Certainly, had Charlie not acted immediately, the AD would have been published, and then it would have been difficult to get it reversed. Although there are not many E33 and F33 aircraft involved, each case is of extreme importance to its owner. IAC thanks to our good friend Charlie Schuck on behalf of those owners.





MIKE BUTTONS & CONTROL STICKS

An IAC member recently sent the IAC Technical Safety Committee the following report:

"I recently experienced an elevator control blockage. The blockage, occurred where the control stick enters the torque tube, and prevented the stick from traveling full aft by approximately 4" of travel (as measured at the top of the stick). The aircraft was a Pitts S2A.

"A full control check was made, stop to stop, prior to take-off. During the flight all controls were normal and several positive G aerobatic maneuvers were accomplished. Returning to land, a shallow approach was made to flare and just before touch down it could be felt that the stick would not come full aft. Landing rollout was completed but with the expected porpoising and tail banging which occurs when tail wheel type aircraft are landed with the stick not held fully aft.

"First suspicion was that the front stick had contacted the safety belt buckle worn by pax in the front seat. But I didn't feel any give nor did I get a puff from the pax when I pulled back harder on the stick. Upon deplaning the controls were inspected and the culprit found!

"My a/c is equipped with an intercom. The mike button for the front cockpit is a Telex brand with **velcro** strap being used to wrap around the control stick grip, for the button, to be activated by the index finger. The button had been dislodged from around the grip and had slipped down the stick to within the torque tube. It was a perfect fit. The 1" cube button fitted nicely inside, rode along and became an unbreakable object when the stick was moved aft.

"This situation could occur to many type of aircraft. But Pitts have an open floor and exposed torque tube assemblies. Those that do have floors often lack a boot around the stick and attached to the floor. And, as this style mike button and method of attachment to the stick enjoy considerable popularity, many other aircraft could have this potential problem."

The above report brought to mind another mike button/control stick problem that appeared in the June 1970 issue of *SPORT AVIATION*. This article is reprinted on the following page:

"ATTENTION: PITTS OWNERS AND BUILDERS

"We have recently learned of a serious in-flight incident which, if the pilot had not used exceptional skill and coolness, could have resulted in loss of the aircraft as well as the pilot's life.

"The owner of this aircraft had installed a mike button on the stick grip, run the wire down inside the stick, and out through a ⅜ diameter hole in the aft face of the stick, two inches above the stick pivot. (See sketch.) The stick had been chrome-plated after this modification.

"Some time later, another pilot was flying aerobatics in this airplane, and upon application of forward stick was surprised and chagrined to find that the stick literally came off in his hand. For the next few minutes he was very busy and, after trying several alternatives, he finally succeeded in curling up an aluminum sheet metal holder, (which had held his aerobatic routine), jamming it down into the stick stump, and jamming the failed stick over the aluminum "splint." The landing, which followed rather promptly, was uneventful.

"The stick failed thru the ⅜-in. dia. hole (see sketch). It is most probable that the stick failed because of the loss of net section bending material through the hole, augmented by the stress-riser the hole added, and possibly aggravated by hydrogen embrittlement from the plating operation.

"As a result of this incident, we would like to emphasize to all Pitts owners and builders the following points.

"1. Do not drill any holes in the control stick, or in any other members of the airframe primary structure.

"2. If you want to chrome-plate certain structural elements of the airframe, make certain that the plater follows the plating operation with the baking operation to aircraft-quality standards, to preclude the possibility of hydrogen embrittlement.

"3. As a general rule, it is an excellent policy to stick religiously to the configuration offered in the plans by the designer.

Signed Pitts Aviation Enterprises"

The above two control stick problems certainly must remind us that we have to always be on the alert, for even the most seemingly inconsequential items can lead to grave results. Many thanks to the IAC'er who wrote the first mentioned report and alerted us all to the potential safety problem.

FIRST POINT OF FAILURE

An IAC member recently called the IAC Technical Safety Committee with the following report concerning an incident in which he was not directly involved but to which he did have a chance to observe the results.

This IACer reported that a low-time aerobatic pilot (approximately 8-9 hrs. acro time) was flying solo in a Super Decathlon and initiated a rolling maneuver and got the aircraft in an inverted position. At this point the pilot commenced to Split-S. Noting that the airspeed was rapidly building, approximately 185 knots, the pilot pulled harder — while still having some rolling motion in his maneuver. The reporting IAC member stated that the pilot told him he heard a "bang" — the trim tab failed. The aircraft was pulled to +8.4 G. (Note: Limit load on a Decathlon is +6 G, with an ultimate load of +9.0 G.) The pilot declared an emergency, brought the aircraft back to the field, and landed uneventfully — although he had to use slight forward stick.

The IACer making this report stated he closely looked over the failed trim tab and it appeared to him that the small turnbuckles at the ends of the trim tab cables had failed first — both at their aft portions. One was completely separated and the other partially separated — being kind of held by a piece of safety wire. The trim tab was torn along the piano hinge and was just barely attached at the outboard end.

At the time of this report, a thorough inspection of the entire a/c had not yet been accomplished.

So much for the incident. Fortunately, no one was hurt. Now, what can we learn — from a structural viewpoint? Test flying to destruction is not a recommended procedure, but since this is obviously what happened, Decathlon pilots (and possibly Citabria and other similar a/c pilots) should note that one of the first items to fail when the limits of this a/c were exceeded, was the trim tab. Therefore, close and thorough inspections of trim tabs/trim tab linkage should be conducted regularly.

Note also that the ultimate G-limits (+9.0) were closely approached (+8.4) in a rolling maneuver. Remember the G-limits on aircraft are assigned in one plane (the vertical plane, if you will) with symmetrical loading on the aircraft. When you roll and pull at the same time, the G-limits are usually reduced. The rule of thumb is, when rolling and pulling at the same time, the G-factor is approximately 2/3 of the placarded G-factors.

IAC thanks to the member making this report. It is by the action of such responsible members that we can learn, take care of each other, and promote **safe** sport aerobatics.

More S-2

By J. Michael Wigen
IAC #6252

Close-up showing oil door, eyebrow and cheek cooling vents; note alternator bulge.

Everybody wants more, and Aerobatic Pilots are no exception to the rule. "Boy, if I could only get just one more vertical roll . . ." Slight pause, followed by a wistful skyward glance. Well I'm just the same, folks, so I decided that my ol' S-2 had more in it than I was finding.

First I checked into stuffing a 260 H.P. Lycoming in, but still keeping the front seat a'la the Canadian Reds (really a nifty installation and very versatile) but the cost stuck in my throat. Next came the obvious answer for my draggy Bi-plane - Aerodynamic cleanup. A stock Pitts is just bristling with drag, and mine was no exception. The cowling looked like the worst offender, so this seemed like the best place to start. The Canadian Reds had been doing experiments with low pressure cooling vents in a super-clean cowling before they had changed to 260's, so I used their head-start and bought a rough fiberglass plug from them.

S & S Aircraft of Athol, Idaho did all the fit, finish, baffle work, etc. with excellent results.

The installation involved the removal of one oil cooler, and the relocation of the other behind a Naca duct. Air exited the cowling at 5 locations - two eyebrow vents on top above the mags, 2 side cheeks, and at the bottom with the exhaust. Other changes involved the addition of a crossover exhaust system and a Q-tip propellor.

As expected, we received a nice performance jump for our efforts, as both cruise and top speeds went up by about 14 m.p.h. Mid-range acceleration and vertical performance were both noticeably improved. Visibility with the tighter, lower cowl was also much better. Noise levels went way down due to the Q-tip and crossover.

Life in the low speed regime was a lot easier with the Q-tip. It seemed to pull a lot better (e.g.) over the top of a loop with a lower than normal entry speed. Take-off and climb rates were also much better than stock.

As far as cooling goes - it was almost too cool! The next cowl we build will have both smaller inlets and outlets. One reason it cooled so well was that it had 30% more exit area than intake area with all the exit area in low pressure zones. Cylinder heads would never get over 325 F with the fronts generally 15 F hotter than the rears. In cruise CHT would run just under 295 F.

The only drawback we've experienced so far is in the maintenance department. There are no less than 53 screws holding this baby on, and it takes endurance and patience to remove and install her. Our new edition, which is in the works, will have a one piece fiberglass nose bowl, and three main aluminum panels with Dzus closures at 12 o'clock, 4 o'clock, and 8 o'clock to provide easier engine access. All in all we're quite pleased with the change. It's fully Stc'd - the FAA couldn't have been more helpful (no kidding) and the whole operation from start to finish took less than six weeks.

Obviously there's a lot more that can be done in the Aerodynamics department. For example, S&S Aircraft finished their Super Pitts this past May. It utilized somewhat the same cowl, rod gear, clipped wings, and flush everything. At 25 & 25 it trued out at 194 with a stock 180 Lycoming and a Hartzell Q-tip. Flat out it would run neck and neck with my 150 HP RV-3 at just a little better than 205 true. From 220 it would do 5½ vertical rolls. It's a real mover!

Our next project is a 250 HP monoplane which, at this writing, is in the silver, so we'll keep you posted. It promises around 215 MPH at 11 GPH so we'll see if we meet our target.

Steve Wolf holding up old S-2 nose bowl for comparison.

¼ front view. Note intake tube clearance bulge at lower forward star point.

The Piel Beryl

By Mike Russell
IAC 5851

This article was written to bring attention to a homebuilt Aerobatic design that I feel has been overlooked by the aerobatic community, the Piel Beryl.

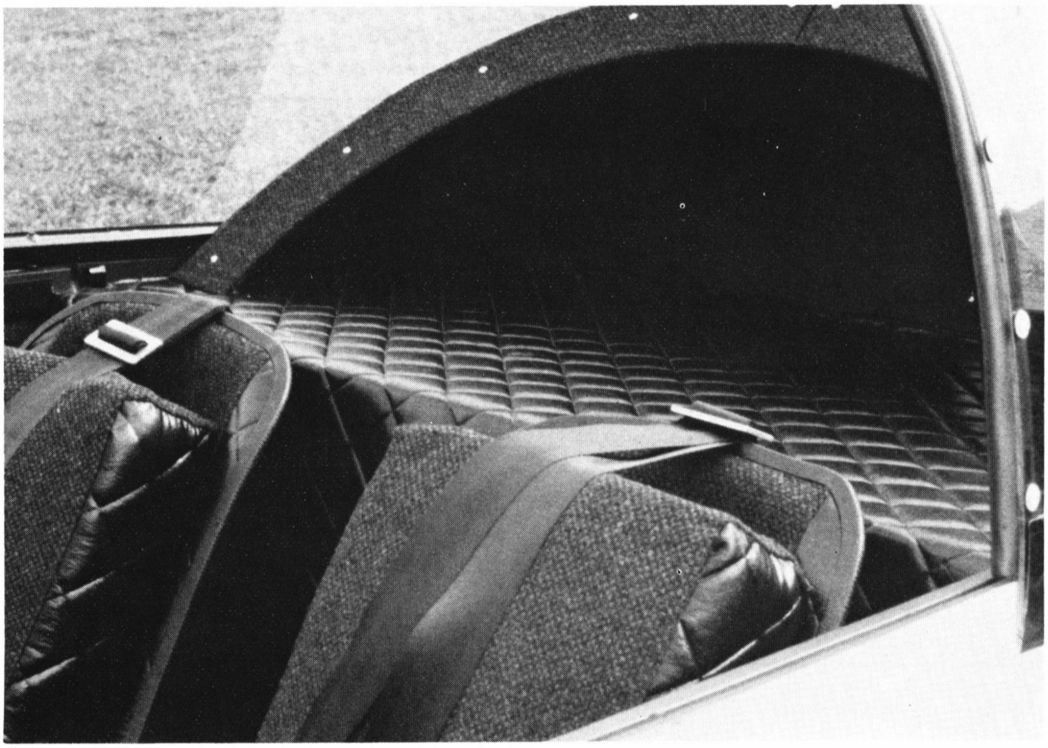
While I would never argue that a Pitts isn't a tremendous Acro mount (I built and flew an SIS several years ago), it is a more specialized airplane than I can justify owning . . . although, **if** I could afford two aircraft, one would certainly be a Pitts. I enjoy aerobatics, in a good Acro plane, but also like to go cross country occasionally with a passenger. The Beryl is an aircraft with which you can perform both of these tasks with a great deal of satisfaction and efficiency, for a reasonable cash outlay.

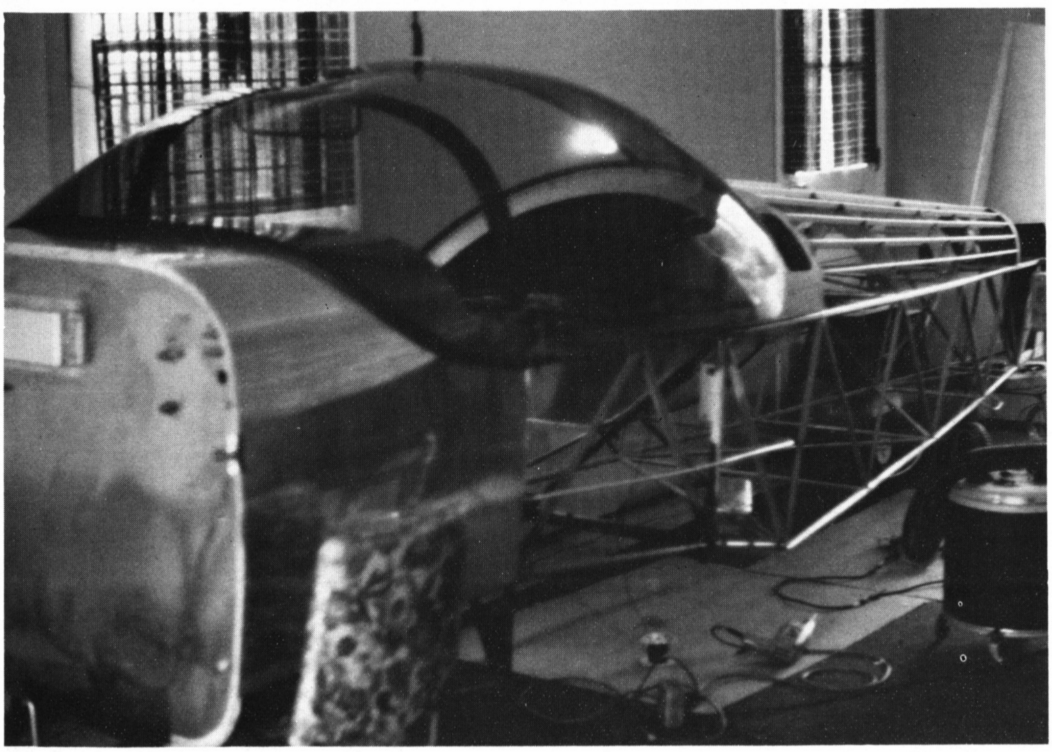
I have built two of these aircraft, modified in various ways, and I'm surprised that there aren't more copies flying. During the 50's Calude Piel of France designed the highly successful Emeraude. He later created variations of this design including the three place Diamant and the two place aerobatic Beryl. In addition, Mr. Piel worked with Mudry Aviation of France when they developed the CAP-10 from the Emeraude concept.

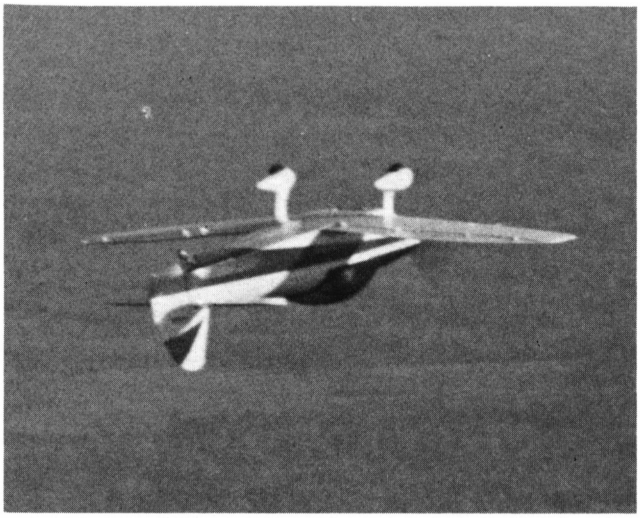
I have been interested in the Beryl since before the drawings were completed but did not build one until 1974-75 because I didn't have the space available to fabricate the one piece 26' wood wing. My first Beryl (N3MR) was modified with a straight tapered wing with no dihedral, and steel tube tail section (the Beryl drawings call for a 4130 tube fuselage which I utilized). With two seats, full electric system and a radio the empty weight (with very careful attention to adding lightness) was 920 lbs. With a 160 HP Lycoming and a pressure carb setup it was a capable Acro ship and a pleasure to fly. My wife didn't care for tandem seating on cross countries and I had a few additional ideas I wanted to try. I had an opportunity to fly the CAP-10 with Mudry Aviation in Poughkeepsie, New York, and was very impressed with the airplane. I have always disliked flying in side by side seating aircraft, but the dual throttles and sticks made me feel right at home. I sold N3MR and built N40MR using the Beryl drawings combined with several of the features of the CAP-10 (including the windshield and canopy which I purchased from Mudry). In spite of a full time job, a family, and a J-3 restoration I was able to have N40MR flying 19 months after the materials were ordered (N3MR had taken 18 months and I think these statistics are note-worthy because they show it doesn't have to take five years to build a wood aircraft). N40MR is all wood except for the fuselage. Again, inspite of major creature comfort concessions due to old age, a real effort was made to keep weight to a minimum (one Beryl flying reportedly has an empty weight in excess of 1300 lbs.) and with the heavier wood tail, full electric system, lights, upholstery, sound proofing, radio, carpets, 160 HP inverted injected Lycoming, etc., the empty weight came out at 1062 lbs. including oil.

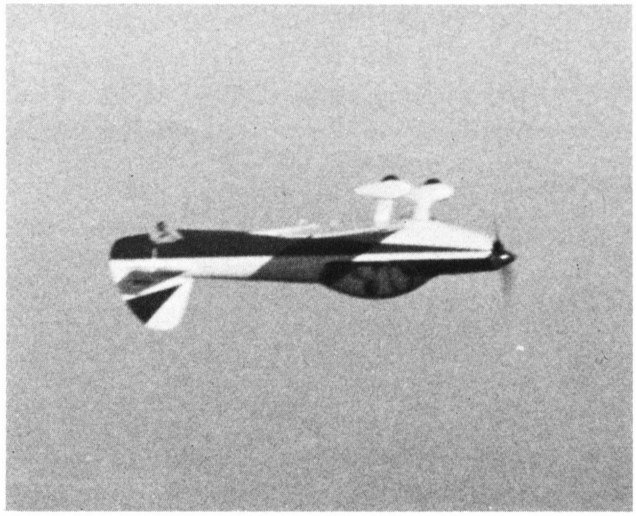
The Beryl is stressed for +6 and -3 g's at 1400 lbs. These numbers are based upon a maximum fiber stress in the wing spar of 4700 PSI. Actually, all the spruce I used tested in excess of 6300 PSI so I feel very comfortable with the +6 and -3.

I have over 100 hours on N40MR (about half of that time is Acro) and I am very happy with it. To date I have flown it through Sportsman and Intermediate category maneuvers. All controls are light and responsive. Entry speeds for most maneuvers can be whatever seems convenient loops 135 ias and up, rolls 115 ias and up, etc. Maneuvering speed is 146 ias, power off positive 1G stall is 50 ias and negative 1G stall is 70 ias. Redline is 220 ias. Stalls upright and inverted are straight forward and docile yet snaps are good anywhere from 95 ias to 105 ias. One of the things that I find interesting is that even with no washout and no stall strips the wing is very docile in the stall yet will snap and spin with no difficulty. I have stalled the airplane at speeds up to 130 ias and although there is some wing drop tendancy, it is very easy to handle. Spins are somewhat oscillatory with the nose pitching up and down at the ½ turn points. Normal spins in excess of 1 turn take ⅜ turn to recover to the left and ¼ turn to the right. Inverted flight is well mannered and with the wing incidence reduced to 0° the pitch attitude is quite flat. Trim changes from upright









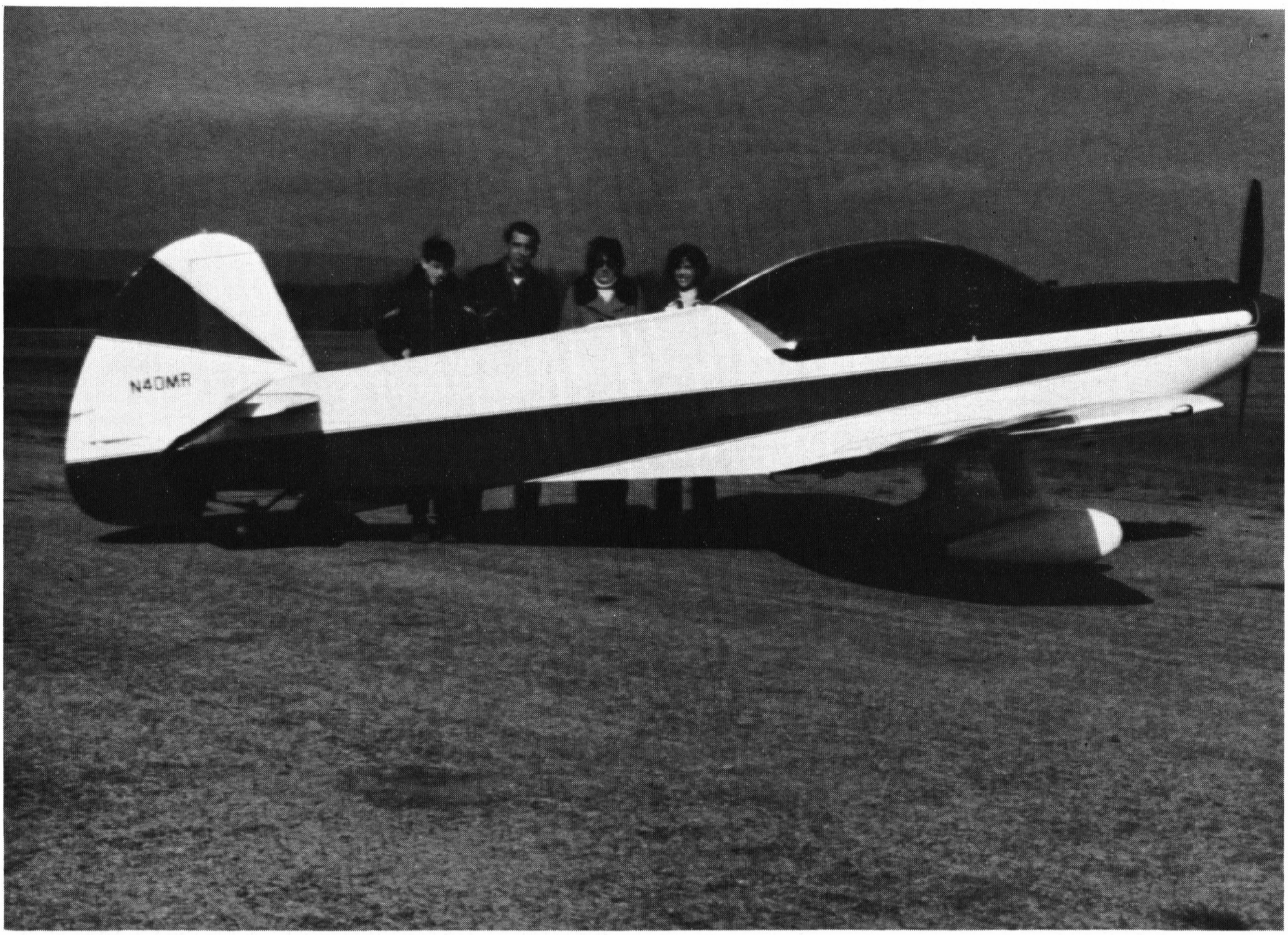
to inverted are quite modest even though I have a somewhat forward GG location (23% solo Acro).

Cross country performance is very satisfying and with two 20 gallon tanks range is considerable. The two seats, full tanks and 42" and 26" x 14" baggage compartment can't come close to hitting the 1760 lb. normal category maximum gross weight.

With the 72" diameter x 66" pitch prop installed the maximum rate of climb solo is 1860 fpm from sea level. Full throttle produces 2750 RPM and 174 tas at 1500 msl. Most of my cruising is at 2350 RPM, 7.8 gal/hr and 141 tas.

I've been very happy with my versions of the Beryl and the blend of compromises which they entail. A short time ago I used N40MR to haul four big boxes of tools and supplies to perform some out-of-town aircraft maintenance. The two 40 minute flights took the place of 6 hrs. of driving. When I got back home I emptied the cockpit, put on my chute, and got in some Acro flying. That kind of versatility is hard to beat. I would encourage anyone interested in a "Sporting Aircraft" and competition in less than Unlimited category to investigate this fine aircraft.

Drawings for the Beryl are available through Mr. E. Littner of Montreal Canada who advertises in *SPORT AVIATION*.



ENGINE SAFETY CABLES

The IAC Technical Safety Committee just received the following letter from an IAC member concerned about the possibility of propeller blade failures and the possible consequential separation of the engine from the airframe. After reading the letter below, IAC members may want to check some back issues of *Sport Aerobatics* which contained Tech Safety articles concerning the subjects in question. These back issues/articles are:

1-79 "Propeller Service Life"
3-79 "Engine Retention Cables"
(The above two articles are also included in the IAC Technical Tips Manual.)
3-80 "Propeller Service Life — Part II"
10-81 "Propellers & Aerobatics"
(This article noted in letter.)

"Subject is safety cables on engine mounts for aerobatic aircraft.

"Propeller mounting flange cracks and modern wooden propellers seem to be cause for the IAC Technical Safety Committee to feature this subject in *Sport Aerobatics* with the purpose of getting our members more interested in this potential problem.

"A recent article in *Sport Aviation* citing a blade failure on a three-bladed wooden propeller on an aerobatic aircraft should concern us all. These recent designs of wooden props have also been documented to fail at the hub when not properly torqued.

"Safety cables are not anything new. Art Davis had one on his Taperwing Waco around 1937. It was used to retain the J-6-J and was wrapped around the top three cylinders.

"The Bucker Jungmeister with the Siemens installation features a steel cable replete with leather wrappings.

"Just losing the propeller will place most aircraft C/G in the extreme rear of the envelope (not to mention the possible damage to the aircraft when it departs), but when you lose the mass of the engine, the aircraft will be uncontrollable.

"It is not unusual for the engine to vibrate loose after a prop blade failure as the throttle cannot be retarded in time. This is when a safety cable would serve its purpose. Although the engine may break loose from the engine mounts, the idea is to retain the mass to maintain control of the aircraft and be able to land it with some degree of safety.

"These cables are usually attached to the REAR of the two top engine mounts where the aircraft frame will support the engine. There are several methods of routing the cable around the cylinders of a flat engine.

"The article on page 49 of the October 1981 issue of *Sport Aerobatics* sends a sage warning about metal propellers. Quote, 'From an engineering point of view, aluminum is not the best material to resist cracking while under a rapidly reversing stress pattern. How the standard aluminum prop holds up to aerobatics as well as it does, operating way beyond its designed strength, is a miracle in itself.' Unquote. Also, check out the article in the November 1981 issue of *SPORT AVIATION*, page 6, "Hot Line" WARNING — PROP BLADE FAILURE.

"Each individual aerobatic aircraft configuration would necessarily have to be engineered for its particular cable installation; however, care should be taken to connect the cable in a manner independent of the engine mount which would probably fail under any severe vibration.

"Any more reported incidents of prop failures and the safety cable may be required at aerobatic contests as are the two seat belts."

The IAC Tech Safety Program strongly solicits membership input on this subject — service difficulty reports, drawings/sketches of engine retention cables, and general opinions. We thank the member who submitted the above letter and remind all IACers that your input is necessary for this program to function. And, more importantly, your input is necessary for the good and safety to the sport.

ADDENDUM

The following input has just been received from one IAC member that relates directly to the above T.S. article.

"After reading the article in the IAC Technical Tips Manual on engine retention cables (page 110) I was impressed with the number of Formula One racers experiencing engine mount failures when they lose a propeller. (14 incidents with 3 fatalities) A recently reported incident of a 180 hp Pitts S-1 throwing a prop tip and breaking the engine mount in several places also impressed me. Radial engines are also exposed to these problems as reported by a competition pilot when he lost eight inches from the tip of his Aeromatic propeller. So, I installed a set of cables.

"I might pass on an alternate method I used in fastening the cable to the frame as shown on page 111-112. I used 3/16 inch 'U' clamps (two each side) instead of the nicro press as shown on the drawings. (It does say 'or equiv.') This will facilitate easier removal for any major engine repair work that may be necessary. (See Figure 1)

"The nicro press seemed like too permanent an installation and removal would be difficult and could damage the cable at that time. In addition, the working room available for the nicro press tool is very restricted. The 'U' clamps went on nicely using a socket extension."

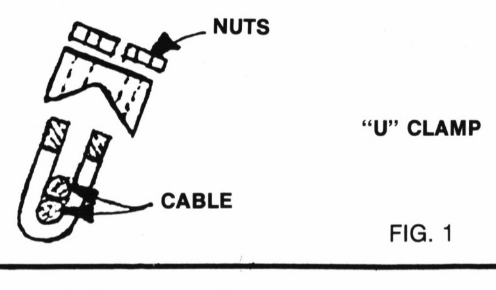


FIG. 1

A REMINDER

The following input by an IAC member should serve to remind **all** of us that one of the best ways we can take care of ourselves and promote safety in the sport of aerobatics is simply to pool our knowledge/experience. What "aerobatically" happens to one of us, very likely will happen to some other IACer and it is really our duty/obligation to try and help our brother and sister members. The aerobatic community is a relatively small group that must try to take care of its own. IAC, and in particular the IAC Technical Safety Program, provides a forum where this exchange of safety-related information can take place — all we have to do is to take advantage of this Program.

* * * * *

"I recently bought a copy of the Technical Tips Manual and read with interest the article on 'Fuel Starvation', page 47. Except for the probable cause, I might have written the story myself. The outcome for me, however, was happier since my recovery, also at 800 feet, was directly over a runway and landing was made without incident.

"I suspected the same problem as your man in the article since I knew I only had about 3½ to 4 gallons of fuel in the tank. I, too, had just rolled from inverted. There was no problem history prior to this.

"The problem as it turned out was in the A.C. fuel pump part #41272. I have never experienced any difficulties with vapor lock and all of my fuel system components are behind the firewall except, of course, the fuel pump.

"The real shock came when I turned to page 48 and read about myself again in the article 'No Chute - No Acro.'

"Now, you may ask yourself how this relates. Well, I think there is a strong possibility the connection is psychological. First of all, it happened the day after I replaced the fuel pump.

"I stayed over the field for about 20 minutes to make sure the engine was going to run. After all, it could have been sucking air although I checked all the lines. I left the airport and went to a practice area with some reassuring fields. Pulling to vertical at 3500 feet AGL, I capped off at 4500 and reduced power for a 1½ turn inside spin to the left. When my point came around I stabbed opposite rudder and the airplane immediately snapped around and started spinning right. I was bewildered. I checked the throttle to be sure the power was off and looked at the ailerons to see that they were neutral. Now I was scared. I reversed that damned spin two more times before I checked the altimeter. It showed 2500 feet but with lag I knew I had less. Since I was reaching the end of my string and an airplane is no yo-yo, I made the decision to vacate. I looked at my first seat belt buckle and with my left hand I opened it and simultaneously reached for the canopy handle with my right. Well, you have probably guessed what happened by now.

"As soon as I let go of the stick the stall broke and the airplane started flying. I couldn't believe I hadn't broken that stupid stall.

"My first reaction after I got things sorted out was to take the bird back to the airport and park it, and I did start back. But I began thinking, this is really a dumb thing to do, so, like Ed Dennis, I went back to the practice area, climbed to 6000 feet and did several one turn spins both ways.

"When you really pop that stick forward it's simply amazing how quickly an S1-S recovers.

"Fred, I'm at a loss to explain my actions on that day. Certainly I had my head where the sun doesn't shine, but why?

"Could it be that the previous week's experience with the fuel pump was still in the back (or front) of my mind? How many other guys have augered in because they were looking through plexiglas belly buttons?

"I went through jump school and actually jumped to prepare for such a crisis, but often wondered what I would do if I was faced with leaving the airplane. There was no hesitation on my part so now I know.

"I have **never** left the ground in an aerobatic airplane without a chute even on my low level waiver. I never will.

"The circumstances surrounding the incidents in the Tech Tips Manual and my experiences are so parallel that I thought it might be worth letting you know."

INTERNATIONAL AEROBATIC CLUB

Experimental Aircraft Association

I.A.C.®

"Steinfeldt Solution"
aerobatic aircraft design

Submitted by Bill McIntyre
IAC Chapter 69

Design notes: As you can see from the photographs, Jack has moved the ailerons, which are symmetrical and about 60" long, out to the wing tips, and the roll rate is faster than the pilot can keep up with. They all roll fast at 180 IAS, but this design rolls fast at **110 to 120**. The span looks long but is exactly the same as a stock Pitts, just squared off on the tips. Also note the aerodynamic counter balances on the elevators. The pitch forces are, according to Jack "very, very light". As you can see, the lower wings have no dihedral.

I think Jack has some interesting features on his Pitts, but he is a very modest man. Let the facts speak for themselves: Jack emerged as the Arizona State Champion and also the Advanced Category winner in the Arizona State Aerobatic Championships held in November at Casa Grande.

To date, no IACer has advised of finding a klunk/abrasion problem and then finding a completely satisfactory fix. Presently, we are suggesting that members flying A/C using a klunk try to visually inspect the inside of their fuel tanks for signs of klunk-to-tank abrasion. An inspection mirror might be of help, but in some cases removal of fuel system components would be necessary to make an in-the-tank inspection. If the klunk is abrading on the tank, often "tracking" is visible — the inside of the tank looks like it has been sanded with coarse sandpaper. Besides making a visual inspection for klunk/tank rubbing, it is recommended that frequent fuel filter changes be performed and that you drain (into a glass container to check for water and foreign matter) a goodly amount of fuel from tank and gascolator drains at each preflight inspection.

An IAC thanks to those who have supplied info on this problem. Any other IAC members who can help with this potential problem are encouraged to contact the IAC Technical Safety Committee with their suggestions, ideas, etc.

KLUNKS

Over the past few years the IAC Technical Safety Committee has received several reports of the weighted end (the "klunk") of the inverted fuel system pick-up tube abrading on the inside of the fuel tank generating small metallic particles of fuel tank and/or klunk material. Just recently a report was received of an incident where complete engine stoppage occurred due to fuel filter blockage caused by an accumulation of foreign aluminum particles produced by klunk-to-tank abrasion. In an earlier report, an IAC member indicated that foreign matter in his Bendix PS-5 pressure carburetor poppet valve guide came from klunk-to-tank abrasion. He reasoned that the small particles produced by the klunk rubbing on the inside of the fuel tank had initially been trapped in the fuel filter but when he used his wobble pump to build up fuel pressure prior to starting the engine, pressure spikes occurred during vigorous "wobbling" which popped open the fuel filter by-pass on his system, thereby inducing the metallic particles into the engine's carburetor.

The reports received by IAC have related to steel, brass, and aluminum "klunks." Also, the practice of machining a groove on the outside of the klunk to accept an "0" ring in order to prevent klunk-to-tank wall contact has been reported not always to be successful. After the "0" ring treatment, subsequent inspections have revealed missing "0" rings (dissolved?), broken "0" rings, and parts of "0" rings floating in the tank. (Obviously, the type of "0" ring material would have a direct bearing on the service life of the ring, but IAC reports on the "0" ring malfunctions have **not** indicated material type.)

In talking over this problem with several IAC members, one member suggested that perhaps a Teflon sleeve pressed over the klunk would be a satisfactory fix. As an on-the-ground test of this suggested fix, it was discussed that putting the flop tube/klunk assembly in a drill motor and letting this combination flail inside an aluminum bucket for a couple of hours might simulate several years of service of aerobatic flying. The above is strictly conjecture; to our knowledge it has not been tried and is presented here only to stimulate some thinking/input on this problem.

NOTICE TO CITABRIA & DECATHLON PILOTS

Two field reports relating to incidents with a Citabria and a Decathlon have been recently received by the IAC Technical Safety Committee. These two reports are as follows:

(1) "The single cross shoulder harness strap is very long. If, after a flight, the pilot casually drops the strap (left side of pilot's seat) the strap can, and has twice wound around the rear right rudder pedal. There will be enough rudder travel to taxi and become airborne but if the pilot decides on spinning or a snap roll, he finds he only has about 50% rudder travel.

"The two times this happened to me I was fortunate enough to catch it before leaving the hangar line. The seat belt with cross shoulder strap can easily be fastened with the strap wound around the left rear rudder pedal. I think it might bear looking into. I'd hate to see anyone get hurt, especially me. JOKE?"

(2) "While practicing in my (8KCAB) Decathlon I rolled over to inverted flight; as I pushed forward on the stick to hold the nose up, the control stick jammed. I rolled back to straight-and-level and checked again. The stick would go side to side and back but would hang on something when I tried to move it forward. I flew back to the airport and landed without incident. I got the local "Decathlon expert" and we started taking off inspection plates. Bingo! — directly under the cockpit there is an inspection plate. The safety wire around the turnbuckle for the elevator cables had bowed out and caught on one of the fingers that hold the inspection plate on. You might want to pass this on to other Decathlon lovers to check during their next preflight."

These are two good "tune-up tips" from brother IAC members. Do **YOU** have any info that may be of help — possibly to the extent of saving a life — to your fellow IAC members? IAC provides the forum for the exchange of safety info, but the info must come from the membership — that's you.

Streamline Tie Rods Revisited

By F. H. "Moon" Wheeler

Last August I was sitting in a Forums tent at OSH listening (with many others) to Herb Andersen of Pitts Aerobatics expound on Pitts aircraft. I remember that, in answer to a specific question, Herb said that to his knowledge there had never been a structural failure of a tie rod (flying wire) on a Pitts. It was good to hear that, since I took it to mean that one worry could be eliminated, right? WRONG! On August 25, Herb phoned Fred Cailey, our very efficient technical safety program chairman, to report four (count 'em - 4) tie rod failures. Fred told me, and I immediately reinstated the worry, even though none of the failures caused any problem other than sudden wallet deflation after brief high blood pressure readings.

But none in all these years, then suddenly four? That had to be more than coincidence, and it was. As it happened, all failures were on S-1 Pitts that were equipped with aluminum javelins. Aha! Eureka! Voila! (etc., etc.) Obviously aluminum javelins are the problem, so if we eliminate them we have solved the problem, right? WRONG! (Again). Many pilots have used aluminum javelins for years, with no problems. So we've got to dig a little deeper to find the answer, and Fred is the guy who knows how to get to the bottom of a technical problem.

He started the process by writing to the pilots who had the tie rod failures, asking for information that might be significant. Our members being cooperative types, all responded promptly and completely. To summarize their replies;

1. All failures reported were Pitts S-1 aircraft.
2. All were fitted with aluminum javelins.
3. All failures occurred at or near the javelins.
4. Three rods broke in acro flight, one in X-C flight.
5. It was difficult to determine the hours that each aircraft had accumulated with aluminum javelins installed, due to changes in ownership, but one had at least 800 hours.
6. At least one pilot had noticed movement between the tie rod and the javelin prior to the break.
7. And one pilot sent the broken wire to Fred.

Not being as knowledgeable as Fred, I began my spade work by re-reading two fine articles on tie rods. The first, "All About Streamline Tie Rods" by Bob Whittier, appeared in the March 1969 issue of *SPORT AVIATION*. The second, "A Classic Example," had to do with a tailbrace wire failure on a 450-hp Stearman, and was in the July/August issue of *Sport Aerobatics*. These served to "get me up to speed" on the subject.

Fred then asked a fellow EAA member who is a professional metallurgist to examine the broken tie rod and give an opinion on the cause of the failure. That opinion follows;

> "Fracture initiation located at leading edge. Initiation was caused by wear and fretting of aluminum mating member. Initial crack propagation was rapid followed by slightly slower crack propagation prior to rapid fracture. Suggest use of wood instead of aluminum for javelin. A better/tighter fit between javelin and wire, perhaps with some kind of organic material between the two, might have prevented the failure."

Fred then sent the broken rod to me, and I took it to the Macwhyte Company, in Kenosha, WI, our sole source of streamline tie rods. Mr. Harry Data, vice-president, manufacturing, very kindly agreed to my request that a failure analysis of the broken rod be conducted in the Macwhyte test lab. (Harry is more sympathetic to our problems than most manufacturing types - he's WWII vintage, with many hours in Stearmans, N3Ns, P-47s, P-51s, lots of instructing, etc.; well known and highly respected by his fellow pilots at the Kenosha Airport. He has listened to a lot of wires sing, before and after he started making them.) When the analysis was completed, Harry and I sat down with Ray Stukel and Tom Brunner of Macwhyte to discuss the report. Well, it really wasn't a discussion. It was an education. These three people took time out of their busy day to educate me, and I am going to try to pass at least some of it on to you.

First, the results of the lab tests for the integrity of the material used were examined. They are as shown here;

	Requirement	**Test Results**
Width	.348 ± .010"	.349"
Thickness	.087 – .091"	.090"
Ultimate Strength	4200#	5060#

These results show conclusively that the tie rod tested met or exceeded all required specifications as to dimensional characteristics and tensile strength. In fact, the pull test to failure showed that the rod would develop a load that was 20.5% over minimum requirement.

Second, this is where the manufacturer's responsibility ends. It was carefully but emphatically explained to me that Macwhyte Company makes tie rods to specs, but does not and cannot concern itself with how or where the rods are used. And I said: "Hey, fellas, we use them on acro aircraft." And they said: "Yeah, and other people use them on ag aircraft, sailboats, ice boats, windmill towers, hovercraft, and to hold wingtip floats on amphibs, just to mention some of the uses that we know about." They also said that no flutter or vibration tests are made, since none are required in the specs, and that anyway it would largely depend on the installation. Besides, history indicates no need for such tests, since so few problems have been experienced. In answer to my question, it was also stated that Macwhyte Company has no recommendations as to tension required in any installation, other than to stay below the elastic limits of the specific tie rod.

Well, right about there it became obvious that there was no way Macwhyte Company could reasonably test for every application of their tie rods. That has to be left to the users. But they could and did offer their opinion as to the **probable** cause of the failure of this specific rod. The gist of their analysis was that this rod failed due to vibration-induced fatigue. Microscopic inspection disclosed possible fretting between the rod and the javelin, as evidenced by a layer of aluminum deposited on the rod. It appeared that this fretting started a crack at the leading edge of the rod, and the vibrations encountered in aircraft operation caused the crack to progress until the rod failed. (This explains why one rod failed in X-C flight.)

From all the above, a few conclusions float to the top:

1. Wood javelins would probably eliminate any such problems.
2. If aluminum javelins are used, they should be fitted to the rods in such a manner that javelin-to-rod fretting is eliminated, especially at leading and trailing edges.

3. An inorganic material (such as tape) could be used to insulate the rod from the javelin and thereby avoid fretting.
4. The fitting of the rod to the javelin should be tight enough to preclude relative movement due to vibration.

Years ago I owned a Piper Tri-Pacer, a very enjoyable aircraft. And while investigating this problem, I remembered Piper AD 60-01-07, which had to do with inspection of tailbrace tie rods on several Piper models for damage due to stones and such being thrown against them by prop blast. It seems that cracks were being started in the leading edge of the tailbrace rods that led to premature failure. The AD mandated cleaning and inspection for cracks with a 10-power magnifying glass, and it might not be a bad idea to do this on our aircraft.

Personally, I have come to the conclusion that the care and feeding of tie rods is much more of an art than a science. It seems that I am constantly plucking and tweaking the rods on my Pitts, without satisfaction. At FDL '81, besides checking tail wheels, I also strummed a whole bunch of tie rods, and I found their tensions to be as individual as their owners. Sure wish the more experienced of our members would give some of us newer and younger members the benefit of such experience by writing them up for publication.

Our thanks to Harry Data, Tom Brunner, and Ray Stukel at Macwhyte Company for their efforts to help us. Even though they had no obligation to do so, they responded to our requests most generously, and we are truly appreciative. Let's put their information to good use by careful inspection of tie rod-to-javelin fit, with corrections as necessary.

"Editor's Note: IAC members should note that all factory-built Pitts aircraft are equipped with wooden javelins which Aerotek Pitts recommends using in all Pitts aircraft, and that Christen Eagle II aircraft, which use aluminum javelins, use rubber javelin-to-tie rod insulators."

AEROBATIC AIRCRAFT ACCIDENTS

By Price Downey
Vice-President, Forest Agency

In reviewing approximately twenty recent accidents involving IAC members, it is not difficult to find a constant as the accidents cover a wide range of action from aerobatic accidents to minor taxi mishaps.

Three of the reported claims involve collision or near misses with another aircraft while either in approach or landing configuration.

Landing short or off runway and hard landings accounted for five more with one blown tire another cause.

Various ramp and taxi situations developed into accidents accounting for five more claims.

The remainder were from IAC's main activity, aerobatics.

This article is not intended to be Monday morning quarterbacking, nor is it intended to place blame. Prevention and safety is the theme and in the above-cited accidents quite possible alertness to every detail, no matter how insignificant, might have helped.

To put emphasis on the way we scan might also improve our track record. When scanning inside the cockpit, take a little more time with each instrument. If an engine backfires, look at all the gauges that might show the cause — not just the obvious ones. When scanning outside, really be sure you see what you're looking at, especially when in the traffic pattern. A shadow passing by or a momentary glint might warrant another look.

When you climb into the cockpit to take a spin, the feeling of anticipation is exhilarating and exciting, but when you have finished tying down and you take one last look at your prize possession, no matter whether you were executing some complex maneuver or taking an easy spin around the pattern, the feeling of satisfaction and pride can only be total if you and your machine pulled it off without a hitch.

KEYS AND THINGS

By Jim Lange

I've been flying aerobatics for about 5 years now, and I know you shouldn't have loose objects floating around inside airplanes. Two weeks ago on a Saturday I took our Pitts, 21RK, out to practice the 1982 sequences. Before I started the engine I took my jacket off and carefully pushed my car keys, hangar keys and canopy lock deep inside one of the pockets. I then wrapped the jacket tightly around the pocket and put it in the baggage compartment behind the seat. I started the engine, took off and flew for about a half an hour, working on both Intermediate and Advanced maneuvers. I worked pretty hard pulling inside and pushing outside. I returned to Capitol Drive Airport, landed, gassed up and pushed the Pitts over to the hangar. I removed my jacket to get out the hangar keys and, to my surprise, the pocket was empty; hangar keys, car keys and lock were all missing. Not only were they missing from my jacket, they were not to be found in the baggage compartment. It seemed impossible. There was no way they could have fallen out of that airplane, but they were missing. In the rear bulkhead of the baggage compartment there are three 2" diameter lightener holes. Could all three pieces have fallen through into the inside of the fuselage? Extremely unlikely, but maybee . . . I removed the parachute, the seat back, moved everything I could, felt under everything I could reach but no keys and things. I finally got a strong light and a mirror. That did it. I found my elusive things. All three were lodged way back, deep in the tail of the Pitts against the tail post. By removing some inspection plates, we were able to retrieve the missing items.

I thought I'd share this with you to show how situations happen that could cause potentially dangerous conditions. I leared a good lesson. I thought I had those keys really in a safe place, but where they ended up could have jammed the controls, especially the elevator. The next time they will be in a zipped pocket or I'll leave them on the ground!

MORE FUEL SYSTEMS

Fuel systems have been continuing problems for IACers. The following two articles were submitted by a concerned IAC member and should be of benefit to many.

"PS5C Carbs

"A considerable number of our IAC aerobatic aircraft with naturally aspirated engines are still equipped with the PS5C carburetor which is relatively trouble free. Most adjustments are made at the Bendix plant when new or on the bench when overhauled and are sealed to avoid any 'field' tinkering. About the only problem a PS5C will experience is perhaps the idle mixture in the 600 to 1700 rpm range.

"To reiterate the meaning of PS5C, the P is Pressure Operated, S is Single Barrel, 5 is the bore size and is used for matching a carburetor to a particular engine, and C is for Manually Controlled power enrichment valve.

"Recently, my PS5C began to blow black smoke at idle and seemed to run rough but with no vibration up to 1700 rpm where it ran smoothly above this setting. I checked into my Bendix manual and found the cure. It was running too RICH in the off idle range.

"On most PS5C carburetors a limiting device has been incorporated which permits safe adjustments of the Discharge Nozzle in the field. It is identified by a small knob projecting from the discharge nozzle housing and has an 'R' with an arrow pointing in the direction of rotation for richer or leaner mixture.

"The most frequent fuel metering complaints of operators have been the above-mentioned engine roughness in the off idle range. Variations in climatic conditions, particularly where severe changes in ambient air temperatures occur, contribute to this condition. Carburetors incorporating the limiter device may be safely adjusted to shift the off idle schedule in a Rich or Lean direction to compensate for variations in engine requirements.

"If engine roughness occurs only in the off idle range and all other probable causes for roughness have been eliminated, adjust the discharge nozzle as follows:

"1. With engine oil and cylinder head temperatures at normal, make a mixture check at 1700 rpm by slowly retarding the mixture control toward idle cut off. As the fuel flow is being leaned, observe any change in rpm. If an rpm rise over 25 occurs, the carburetor setting is on the RICH side of best power mixture. If there is NO rpm rise, then the carburetor setting is at or LEANER than best mixture.

"2. If the mixture check indicates a poor mixture setting, adjust the discharge nozzle to get a maximum rise not to exceed 25 at 1700 rpm, or until smooth engine operation is restored.

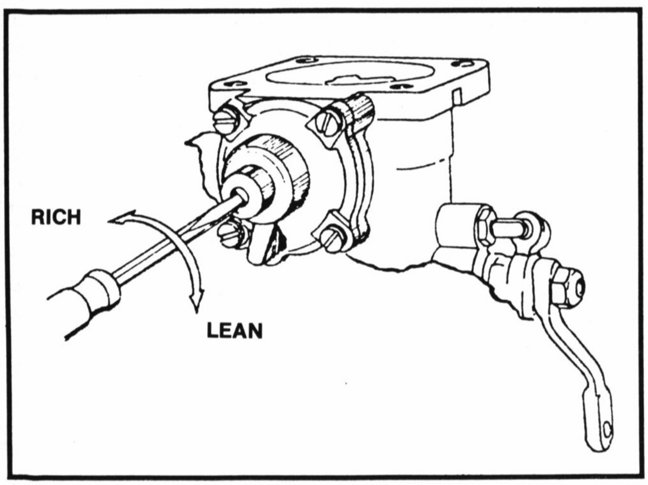
"3. To RICHEN the off idle range, turn the discharge nozzle adjusting knob in a COUNTER-CLOCKWISE direction ONE notch at a time until the desired operation is obtained.

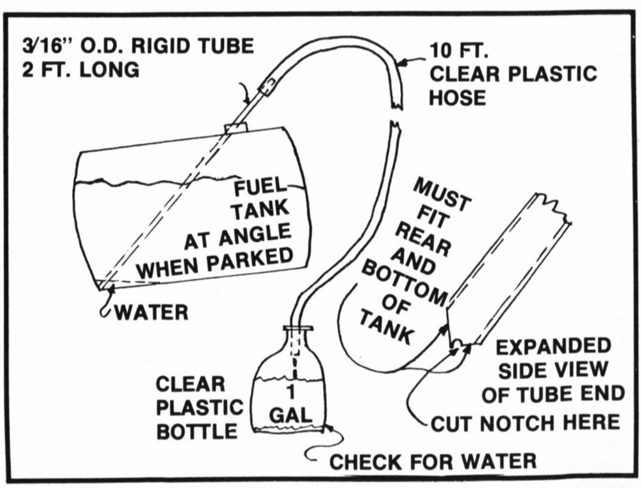
"4. To LEAN the off idle range, turn the knob in a CLOCKWISE direction.

"5. Make a mixture check at 1700 rpm and look for a 5-25 rpm rise.

"6. After the off idle mixture has been adjusted it will be necessary to readjust the IDLE stop setting with the throttle closed. (Ref: a previous article in *Sport Aerobatics*, June 1976 or IAC Technical Tips Manual, page 49, concerning setting the idle to about 650 rpm to prevent the engine from quitting during spins and particularly in a tail slide where the propeller is exposed to a negative load and the ram air to the carburetor is nil.)

"It is recommended that these adjustments NOT be made on your short coupled aerobatic aircraft with the cowling removed and the engine running. Adjust the discharge nozzle knob one click with the engine off; then replace the cowl for the 1700 rpm check. Usually TWO clockwise clicks are all that is needed to correct this too-rich condition in the higher idle range.





"If frequent adjustments to the discharge nozzle pressure are necessary to maintain normal operation, the carburetor should be removed and completely overhauled and recalibrated.

"There are only a few companies who can overhaul this type of carburetor. One is Precision Air, 3610 N.W. 41st St., Miami, FL 33142, phone 305-635-5293. Mr. Gene Wrigley originally overhauled the PS5C's for the Pitts Specials built at Homestead, FL. Be sure and send in the displacement figure for your engine, i.e., 360, 320, 290, etc., as this is most important when they flow test the carburetor after overhaul."

* * * * * * *

"FUEL TANK/WATER

"On a recent practice flight in a Pitts S-1, I experienced a partial loss of power during the sequence. Upon landing, a full power check revealed nothing to indicate why the engine had suddenly hesitated then picked up normal RPM. Water in the fuel was suspect.

"Now, on the early model Pitts there was no way to drain out water that may collect in the bottom rear of the tank as the only outlet was the flop tube. Later fuel tanks incorporate a drain valve at this position and can be drained from the cockpit.

"The flop tube does not seem to pick up any water that may be present under normal flight conditions; however, during aerobatics, when vertical and roll maneuvers are performed, any water in the tank may be drawn into the carburetor or injector through the flop tube.

"A simple device can be used to rid the system of any water that may have collected in the fuel tank under extremely high humidity conditions. All you need is a length of clear, plastic hose, a bottle, and a bit of straight tube. (See Sketch)

"It is advisable to use clear plastic hose to watch the flow of fuel after applying suction in order to avoid raw fuel in the mouth.

"Note: The rigid tube may be bent slightly to bottom out at the corner of the tank."

Again, an IAC thanks to the member who submitted the above. All IACers are strongly urged to pass along info/tips so we can all benefit from each others' experiences.

The Willie II

By Marshall Collins
IAC #7330, EAA #161422

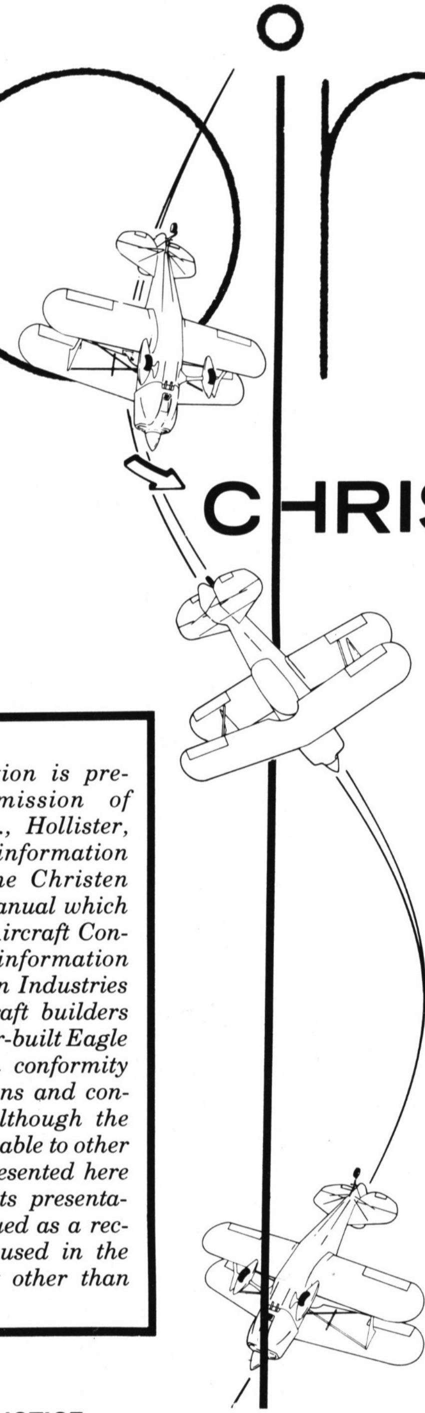
Originally built in 1974 in Wagner, Oklahoma, this homebuilt sport biplane was rebuilt by the author and test flown for the sportsman level aerobatic maneuvers. Powered by the popular economical 150 hp Lycoming engine, from a twin engine Piper, it's now a pleasure to do rough maneuvers like snap rolls knowing that the plane was given the right attention in the right places. For fun aerobatics and skywriting, the Homsley Super Smoke System was installed by the author.

After a day's work, the Willie II fits all needs for relieving the author's tensions. Just go up and roll, loop and spin till you feel free as a bird. It doesn't take much tail wheel time to fly this little biplane with its 20 foot wing span and quick responding tail wheel. It operates with a fuel consumption of 7 to 8 gallons an hour.

The Willie is equipped with dual controls and instruments and is flown solo from the rear seat. With a gross weight of 1276 lbs. and an empty weight of 907 lbs., it is stressed for +6/−5 G's. To the knowledge of this author, there are only 3 Willie II's in existence.

A private, multiengine pilot, the author loves the challenge of unusual attitudes and the "seat of the pants" flying. This type of flying is about as close as you can come to the type of fun enjoyed by those barnstormers of the early days. Beginning flying 6 years ago in a Cessna 152, half of the time logged by the author has been in unusual attitudes and fun aerobatics. Having also acquired a few hours with instructors in Pitts, the author admits that a lot was picked up by mistake!

spins IN THE CHRISTEN EAGLE II



Editor's Note:
The following information is presented with the permission of Christen Industries, Inc., Hollister, California 95023. The information has been taken from the Christen 924 Flight Kit Product Manual which is a part of the Eagle II Aircraft Construction System. The information was developed by Christen Industries for use by Eagle II aircraft builders in the operation of amateur-built Eagle II aircraft constructed in conformity with Christen specifications and construction information. Although the information may be applicable to other aerobatic aircraft, it is presented here for reference only, and its presentation should not be construed as a recommendation that it be used in the operation of any aircraft other than the Christen Eagle II.

NOTICE

The information in this publication is a selected portion of the Flight Manual for the Christen Eagle II, taken directly from Section 5 of the product manual supplied with the 924 Flight Kit of the Christen Eagle II aircraft construction system.

The general physical principles which cause spins are similar for all small aircraft of conventional design. Standard recovery procedures will generally apply to most of these aircraft types.

However, the **specific proecures described** *in this publication* **apply only to the Christen Eagle II aircraft.** *Other aircraft types may require other specific recovery procedures, and some aircraft types may not respond to standard recovery procedures. For other aircraft types, always refer to the manufacturer's operating or flight manuals for specific information on aircraft spin characteristics and spin recovery procedures.*

Section 5
SPINS
NOTE

Although the general principles involved in spin recovery are similar for all aerobatic aircraft, there may be significant differences in specific procedures for different aircraft types. Specific procedures in this manual apply only to the Christen Eagle II aircraft.

5-1 Introduction

This section of the manual describes spin avoidance and spin recovery procedures for the Eagle II aircraft. Spins of all types are frequently experienced during aerobatic flight: Unintentional spins may occur after faulty performance of some aerobatic maneuvers, and intentional spins are required in competition aerobatic sequences. This section is not an attempt to describe sophisticated spin techniques for competition; it is designed to provide a broad background of safety information for pilots who will be encountering various types of spin situations for the first time.

The Eagle II aircraft has docile and controllable stall characteristics with no tendency to spin: however, the aircraft will spin immediately and well if the proper control inputs are made following stall. It has normal spin recovery characteristics in all four basic spin types. Because both intentional and unintentional spins will be encountered in aerobatic flying, it is essential that pilots understand the four basic spin types and the correct recovery procedure for each spin type. Unintentional spins frequently result during aerobatic practice when certain maneuvers are poorly executed. Accidental spins resulting from maneuvering errors can be of any of the four possible spin types.

All theoretical explanations and all procedures in this section should be studied to develop thorough understanding. All procedures should be memorized and then rehearsed in the aircraft on the ground. Spin recovery procedures must be practiced in flight so that if and when any procedure is required, it can be performed instinctively and unerringly.

Inexperienced aerobatic pilots, in particular, must be extremely careful in learning spin recovery procedures. Although spin recovery procedures will become simple, automatic responses when mastered, do not assume that previous flying experience plus limited study will suffice. **DUAL INSTRUCTION MUST BE CONSIDERED MANDATORY.** Some pilot instincts must be relearned for safe spin recovery, since some control inputs that are instinctively used during normal flight are totally inappropriate for spin recovery.

WARNING

Before attempting any maneuvers that could conceivably deteriorate into a spin, all pilots must receive **dual instruction** from a competent aerobatic instructor in spin recovery techniques including, as a minimum, both **normal upright spins** and **normal inverted spins** (both directions).

All aerobatic maneuvers including spins should be performed at safe altitudes which ensure adequate time for recovery from unanticipated conditions. Minimum altitudes of 3000 to 5000 feet agl are recommended.

WARNING

Until spin recovery from intentionally induced spins has been practiced so that recovery from all spin types can be performed with confidence, pilots must not attempt any aerobatic maneuver which, if poorly executed, could easily result in an unintentional spin. Do not attempt any maneuvers (a) in which low airspeeds are required, (b) which could easily deteriorate into low-airspeed conditions, or (c) which are intended to use stalling within the maneuver. Several commonly performed maneuvers must therefore be avoided until spin-recovery procedures have been mastered: Do not attempt (a) hammerhead turns, (b) tail slides or whip-stalls, (c) vertical rolls, and (d) snap rolls or flick rolls.

5-2 Terminology

Throughout the following text, relative directions are given from the pilot's viewpoint. For example, an inverted spin to the right is toward the pilot's right, even though an exterior observer might think of the spin as being a "left-hand spiral" or "toward the left".

Spin direction is always considered to be the direction of yaw, so a spin to the right can also be described as a right-rudder spin, and a spin to the left can be described as a left-rudder spin. Rudder input which tends to stop the yaw during a spin is called "opposite rudder". For example, during a spin to the right, opposite rudder would be a left-rudder input.

Aileron and elevator position are described in terms of control stick position, such as "stick forward", "stick back", "stick right", or "stick left".

The relative direction toward the spin axis is referred to as "inside", and the relative direction away from the spin axis is referred to as "outside". For example, in a normal upright spin to the left, the left wing (which is toward the spin axis) is referred to as the "inside" wing, and the right wing (which is away from the spin axis) is referred to as the "outside" wing.

NOTE

Because aircraft attitudes, relative directions, and control inputs can be confusing when studying spins, use a model airplane to represent spin conditions while reading the explanations of spin types and spin recovery procedures throughout this section.

5-3 Basic Spin Mechanics

All spin types include two essential and fundamental characteristics: (1) the wings are stalled and (2) the aircraft yaws continuously. For intentional entry into a normal spin, the pilot simply sets up a stall in level flight (upright or inverted) followed by firm rudder input; the spin starts immediately when the aircraft yaws.

During normal spins, the wings on the outside of the spin axis, although stalled, produce a greater lifting force than the inside wings, causing the aircraft to roll as it spins. When the spin becomes stabilized, usually after several turns, all forces acting on the aircraft reach an equilibrium state, and the aircraft yaws and rolls uniformly around the vertical spin axis as it descends.

The spiralling roll that occurs during a normal spin must be clearly understood to be a secondary effect of the spin, even though the roll is a prominent visual feature of normal spins both to ground observers and to the pilot. In a normal upright spin, yaw direction and roll direction are the same (that is, a right-rudder upright spin is accompanied by right roll, and a left-rudder spin is accompanied by left roll). In a normal inverted spin, yaw direction is opposite to roll direction (that is, a right-rudder inverted spin is accompanied by left roll, and a left-rudder spin is accompanied by right roll).

Flat spins result when forces are introduced both to lift the nose of the aircraft and to counteract the roll that occurs during a normal spin: (1) the nose is lifted by gyroscopic precession produced by the engine and propeller as a result of aircraft yaw and (2) the normal-spin roll is stopped by aileron forces. For intentional entry into a flat spin from a normal spin, the pilot simply applies full power and full right stick. After several turns, gyroscopic precession will lift the nose of the aircraft and aileron forces will reduce roll to zero, resulting in a nose-high flat spin. (Gyroscopic precession produces nose-lifting forces only in upright spins to the left and in inverted spins to the right; in either case, right stick stops the roll to flatten the spin.)

5-4 Spin Recovery, General

By making use of inherent aerodynamic stability, the Christen Eagle II will recover from normal upright spins, normal inverted spins, and flat inverted spins simply by (a) cutting engine power and (b) neutralizing the stick and rudder pedals. The application of this procedure is explained further in paragraph 5-6. In the case of a flat upright spin when the aircraft is loaded to produce a CG near the aft limit, power reduction and neutral controls are insufficient; the proper recovery procedure, described in paragraph 5-8, must be used.

The recovery techniques described in paragraphs 5-7 through 5-10 are standard procedures which provide faster, controlled recovery with minimum altitude loss when the spin type is known.

All recovery procedures are based on removing or reversing the forces that originally produced the spin. To appreciate the fundamental principles that are involved, three main points must be understood:

POINT 1. Application of power increases the difficulty of spin recovery. During an inverted right-rudder spin or an upright left-rudder spin, gyroscopic precession tends to lift the aircraft nose, flattening the spin; continued application of full power may hold the nose of the aircraft up, making a normal diving recovery impossible. In a normal unflattened spin, excess power always increases descent rate, thus increasing the hazards of pull-out near the ground.

The first basic rule for spin recovery is this:

CUT THE THROTTLE.

POINT 2. The spin is a yaw maneuver. Yaw-producing forces must be neutralized or reversed to stop the spin. Since the rudder controls yaw, it must be neutralized or reversed ("opposite rudder") to stop aircraft yaw.

The second basic rule for spin recovery is this:

STOP THE YAW.

POINT 3. In all spins, the wings are stalled, and the aircraft is "falling". Stall-producing forces must be neutralized or reversed to stop the spin. Since the elevator controls angle-of-attack and thus the stall condition of the wings, the elevator must be neutralized or reversed to reduce the angle-of-attack and eliminate the stall condition.

The third basic rule for spin recovery is this:

STOP THE STALL.

5-5 Recovery Problems

The Christen Eagle II aircraft will recover from any spin type with proper recovery techniques, provided that the aircraft is loaded within CG limits. In this regard, the spin-recovery characteristics are enhanced when the CG is in the mid-range; therefore pilots flying solo should fly with **full fuel,** if it is desired to simplify spin recovery. Never attempt aerobatic maneuvers with less than 6 gallons of fuel. Never carry anything in the baggage compartment when performing aerobatics. If there is any doubt about aircraft loading, calculate CG location and verify that the CG is within limits before flight.

WARNING

Any particular Christen Eagle II aircraft will recover from any spin type using standard recovery techniques ONLY IF THE AIRCRAFT IS PROPERLY BALANCED. The CG of the aircraft must be within design limits to ensure safe spin recovery. Any aircraft can be dangerously loaded (CG beyond design limits) making spin recovery extremely difficult or impossible. Weight-and-balance considerations must be taken seriously and pilots must be absolutely certain that the flight CG of their aircraft is within design limits.

Each level of pilot experience and training produces somewhat different problems in spin perception and in pilot reaction to his perception of the spin.

For inexperienced aerobatic pilots, as well as experienced pilots who are unfamiliar with the spin characteristics of the particular aircraft type, inadvertant and unanticipated spins may produce a dangerous sequence of events. Severe disorientation is caused by the spin and by the previous maneuver which produced the spin. The spin type then becomes extremely difficult to identify and therefore produces uncertainty as to the correct recovery procedure. The pilot may then, in panic, conclude that the only approach is to experiment haphazardly with various control inputs, hoping to discover the correct combination for fast recovery.

A primary problem in spin recovery is failure of the pilot to identify the true spin type followed by application of erroneous control forces that hold the aircraft in the spin. For example, if controls are set for recovery from a normal **upright** spin when the aircraft is actually in a normal **inverted** spin, the pilot will unwittingly hold the aircraft in the inverted spin, and recovery will be impossible.

All control inputs for recovery from a spin should be gentle but positive. Violent or extreme pressure on the controls must be avoided. For example, if violent control inputs for recovery from a **normal upright** spin are made (that is, violent forward stick and violent opposite rudder), the aircraft will recover from the first spin and immediately transition to a **normal inverted spin with reversed rotation.**

Control inputs should be held long enough for recovery to occur, but not so long as to produce entry into a new spin of opposite direction or type. For example, if correct rudder input is initially made for recovery from a spin (that is, firm application of opposite rudder), but the rudder is not neutralized when the original spin stops, the aircraft may transition to an opposite-direction spin.

Many pilots erroneously consider the spin to be a rolling maneuver. **ALL SPINS ARE YAW MANEUVERS, AND RUDDER IS THE ESSENTIAL CONTROL.** The spiralling-type roll associated with a spin is secondary, and pilots must guard against any temptation to "roll out" of a spin using ailerons.

If the spin is erroneously thought of as a rolling maneuver, there will be a compulsion to use ailerons in the direction opposite to the observed roll. Any aileron input that is opposite to the direction of spin yaw tends to flatten the spin and makes the spin worse (more difficult recovery). That is, during an upright spin the spin will tend to flatten with stick away from the spin axis and in an inverted spin the spin will tend to flatten with stick toward the spin axis. Ailerons must therefore be neutral, or even slightly in a position that rolls the aircraft in the direction of spin yaw, for recovery. Therefore, always use rudder to control the rotational yaw in the spin; NEVER USE AILERON IN AN ATTEMPT TO "ROLL OUT" OF A SPIN.

A serious problem in perception of spin direction can result if pilot attention is directed, perhaps unconsciously, to roll direction. In most flight situations, the direction of roll and yaw are the same. That is, in a normal turn in upright flight for example, the aircraft is turned to the left by left roll plus left yaw. Also in normal **upright** spins, the direction of yaw and roll will be the same. For example, an upright spin to the left will be caused by left yaw and will be accompanied by left roll. The frequent correspondence of yaw and roll may cause the pilot to **unwittingly equate** yaw direction with roll direction. However, **IN INVERTED SPINS, YAW AND ROLL DIRECTIONS ARE OPPOSITE.** For example, an inverted spin to the left will be caused by **left yaw** and will be accompanied by **right roll.** Recovery will not occur during an inverted spin if the pilot observes direction of roll, assumes that yaw is in the same direction, and then uses the wrong rudder input for recovery. Always concentrate on determining yaw direction by visual reference between the engine and upper wing, which always permits yaw condition to be sensed accurately and unambiguously.

During inverted flight, it is common for pilots to look "up" through the canopy top over the upper wing, to maintain visual contact with the ground. Another serious problem in spin perception will develop during inverted spin if the pilot attempts to sense yaw direction by looking up through the canopy top because visual ground reference is then made **behind the spin axis,** leading the pilot to misinterpret yaw direction and use the wrong rudder input for recovery. (This condition is discussed further in paragraph 5-9.) NEVER LOOK UP THROUGH THE CANOPY TOP DURING A SPIN; always concentrate on determining yaw direction by observing the ground between the engine and the upper wing.

Recovery problems are easily compounded by combinations of limited pilot experience, possible overconfidence, severe disorientation in the spin, reaction to sensory miscues, and failure to recognize recovery, followed by re-entry into another spin type.

FIGURE 5-1 Example of Overcontrol Spin Reversal

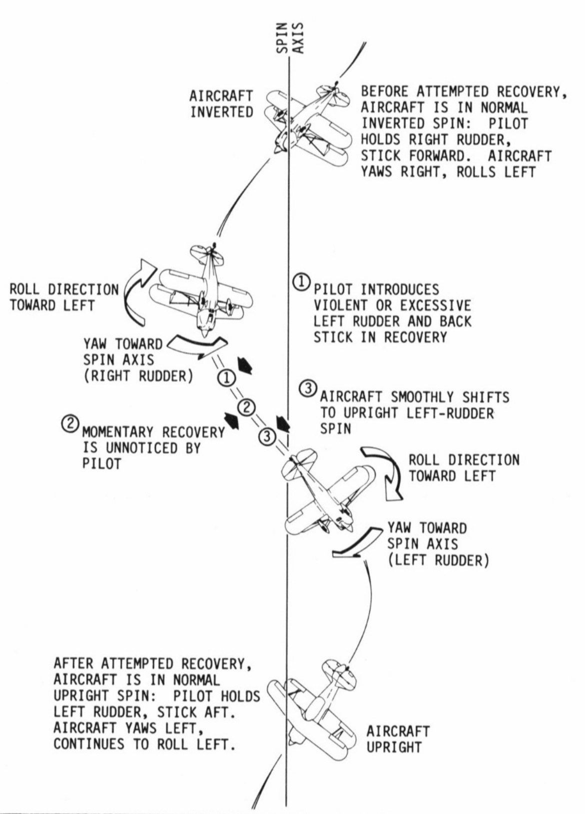


Figure 5-1 illustrates a spin sequence in which overcontrol causes the aircraft to transition to a new spin type. The sensations experienced by the pilot can be extremely disconcerting, and the pilot may conclude that the spin cannot be controlled. At the outset, the aircraft is in a normal inverted spin to the right (right rudder, stick forward). The pilot at this time could mistake the spin for a left spin, because the aircraft is rolling to the left and, if the pilot looks up through the canopy, visual miscues will suggest left yaw.

In this case, the pilot correctly interprets the spin type and direction, but then introduces recovery inputs (left rudder, stick back) violently or holds the inputs too long. The aircraft then stops spinning (no yaw, no stall) but immediately transitions to an upright spin to the left. The pilot has no feeling of abrupt stopping or restarting a spin in the opposite direction. The aircraft is unstalled momentarily, and yaw shifts to the left, but the transition is smooth and goes unnoticed by the pilot. Aircraft pitch also shifts, changing from inverted to upright. Although the aircraft is now upright, the total angular change in pitch is slight and goes unnoticed by the pilot.

Because roll direction is opposite to yaw direction when inverted but in the same direction when upright, the roll direction during the inverted right spin (left roll) is the same as the roll direction during the upright left spin (left roll). The pilot, failing to notice that yaw direction has reversed, while clearly perceiving that the roll condition has continued without change, can easily conclude that nothing has happened. Continued application of the original control inputs for attempted recovery will hold the aircraft in an upright left spin and recovery will be impossible.

Safety Summary

1. Be sure aircraft CG is safe before any flight.
2. Never attempt any maneuvers that could accidentally cause spins until spin recovery procedures are mastered.
3. Do not attempt any spins without first obtaining adequate dual instruction.
4. The first step in all recovery procedures is to cut power (throttle aft).
5. Observe yaw by looking straight ahead, through the cabane struts. Never look above the upper wing.
6. Ignore roll direction during spins.
7. Set ailerons neutral or even slightly in the direction of spin. That is, the stick may be slightly in the yaw direction during upright spins or slightly opposed to yaw direction during inverted spins. Never use ailerons in an attempt to "roll out" of a spin. That is, never use stick opposed to yaw direction during upright spins, and never use stick with the yaw direction during inverted spins.

5-6 Recovery from Unknown Spin Type

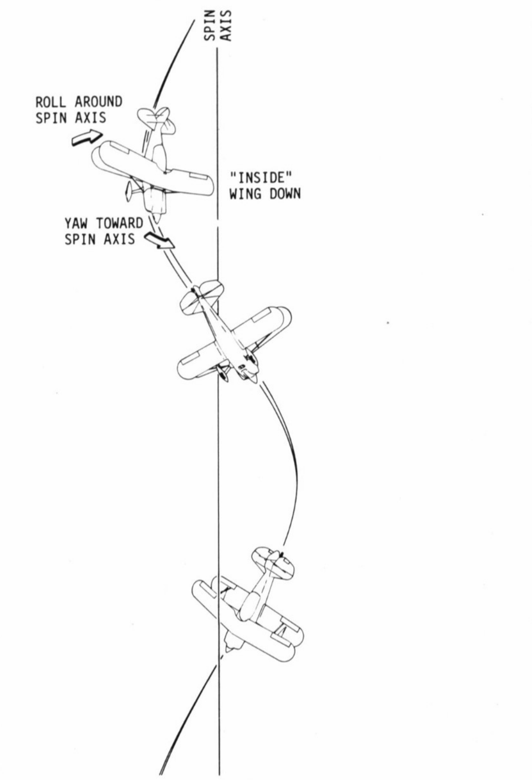
If the aircraft is in an unknown out-of-control spin situation after any disorienting maneuver, the following immediate-action recovery procedure should be used before the spin is fully developed, if possible:

1. Pull the throttle full aft to cut engine power.
2. Neutralize (center) the control stick and rudder pedals.
3. Hold the controls neutral for at least three rotations of the aircraft. While counting rotations, evaluate the nature of the spin to prepare for possible use of the specific recovery procedure for that type of spin.
4. Within three rotations, the aircraft should recover from most spins. That is, the spin will have stopped (no yaw, wings unstalled), but the aircraft will be diving with increasing airspeed, and it may be in an unusual attitude. Simply pull out of the dive smoothly, make other required corrections to aircraft attitude, and reapply power.
5. If the aircraft is within normal CG limits and is aerodynamically similar to Christen factory test aircraft, the aircraft will always recover using the procedure described in steps 1 through 4, unless the aircraft is in a flat **upright spin** with the CG near the aft limit. In this case, the specific recovery procedure for the flat upright spin must be used for recovery (paragraph 5-8). Also, in case of out-of-limit CG conditions or nonstandard aerodynamic conditions on a particular aircraft, it is possible that recovery from other spin types may not have occurred. Therefore, if recovery has not occurred and the aircraft has made three rotations, the specific recovery procedure for the actual spin type must be used.

5-7 Normal Upright Spins (Figure 5-2)

In a normal upright spin (a) the aircraft is nose down, yawing toward the spin axis, rotating with the inside wing distinctly lower than the outside wing and (b) the axis of rotation near the aircraft is **above** the aircraft centerline (that is, on the canopy-side). The aircraft rolls around the spin axis, with roll in the same

FIGURE 5-2 Normal Upright Spin (Part 1 of 2)

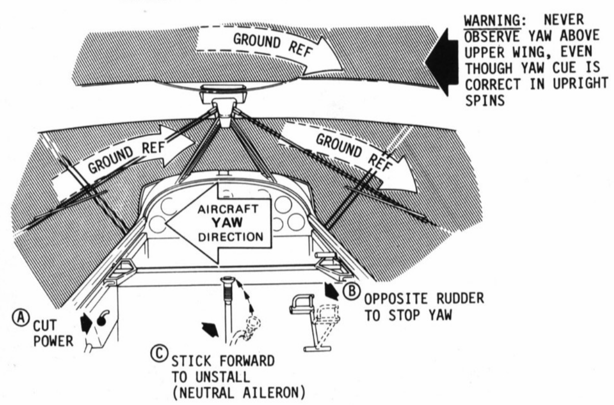


EXTERIOR VIEW: NORMAL UPRIGHT SPIN TO PILOT'S LEFT

direction as yaw. Usually, this type of spin is entered from an **upright** flight attitude, stalling with stick back while applying firm rudder input. The aircraft can rotate either to the right or left.

The spin axis intersects the ground below the aircraft (that is, belly-side). All visual cues permit accurate determination of yaw direction during any upright spin. Safe practice, however, requires that yaw direction be determined only by observation of ground reference cues between the engine and the upper wing.

FIGURE 5-2 Normal Upright Spin (Part 2 of 2)



PILOT'S VIEW: RECOVERY FROM NORMAL UPRIGHT SPIN TO PILOT'S LEFT

If the spin is known to be a normal upright spin, the standard recovery procedure, which places the aircraft into a steep dive, is as follows:

1. Pull the throttle full aft to cut engine power.
2. Push the rudder pedal gently but firmly in the direction **opposite** the spin to stop yaw.

WARNING

Excess or violent rudder may cause the aircraft to recover from the original spin and transition to a spin in the reverse direction.

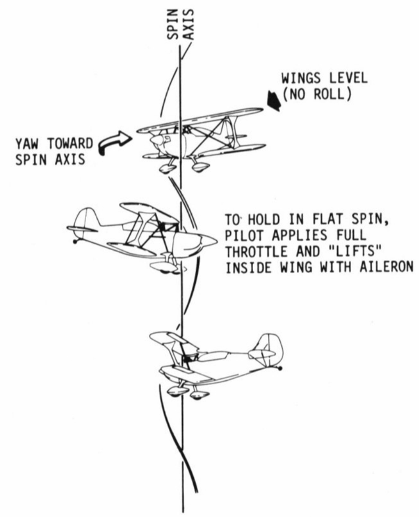
3. **Push** the control stick gently but firmly forward to unstall the wings.

WARNING

Excess or violent forward stick may cause the aircraft to transition to an **inverted** type spin.

4. When the spin stops (rapid build-up of airspeed), complete the recovery by pulling out of the dive, correcting aircraft attitude as required, and reapplying power.

FIGURE 5-3 Flat Upright Spin (Part 1 of 2)



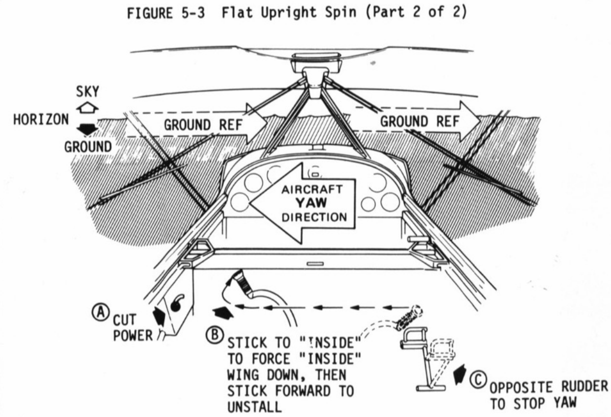
EXTERIOR VIEW: FLAT UPRIGHT SPIN TO PILOT'S LEFT

5-8 Flat Upright Spins (Figure 5-3)

In a flat upright spin (a) the aircraft rotates with the wings approximately level (that is, zero roll), usually with the aircraft nearly horizontal in pitch or slightly nose up and (b) the aircraft is upright. This type of spin is entered from a normal left-rudder upright spin by applying full power while holding right stick (that is, stick away from the spin axis). Gyroscopic precession lifts the nose only during left yaw; in an upright spin to the right, gyroscopic forces are in the wrong direction to lift the nose.

The spin axis intersects the ground under the aircraft (that is, belly-side). All visual cues permit accurate determination of yaw direction during any upright spin. Safe practice, however, requires that yaw direction be determined only by observation of ground reference cues between the engine and the upper wing.

FIGURE 5-3 Flat Upright Spin (Part 2 of 2)



PILOT'S VIEW: RECOVERY FROM FLAT UPRIGHT SPIN TO PILOT'S LEFT

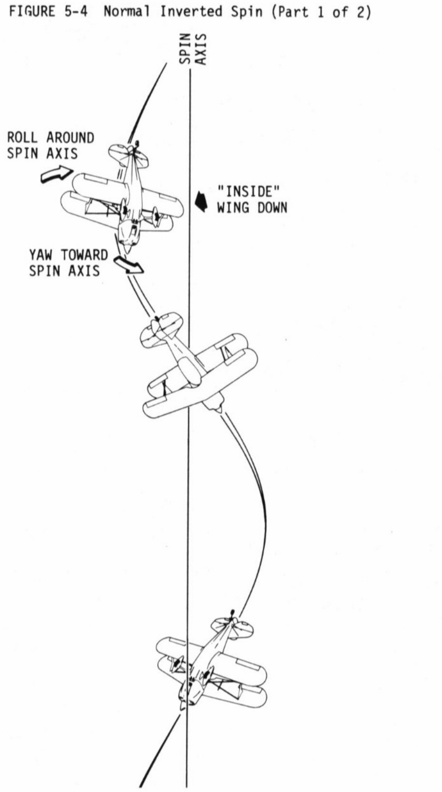
If the spin is known to be a flat upright spin to the left, the standard recovery procedure, which basically places the aircraft into a normal upright spin, is as follows:

1. Pull the throttle full aft to cut engine power.
2. Move the stick full left (that is, toward the spin axis and in the yaw direction), to force the inside wing down.
3. Hold the controls until a normal upright spin has developed (½ to 3 turns, typically less than 1 turn), and then recover from a normal upright spin using moderate forward stick and moderate right rudder (paragraph 5-6). These control inputs are typically introduced at the same time as aileron deflection, producing a smooth single-motion recovery.

WARNING

Recovery from flat spins must be initiated no lower than 2500 feet agl to allow for altitude loss during the pull-out phase of recovery.

FIGURE 5-4 Normal Inverted Spin (Part 1 of 2)



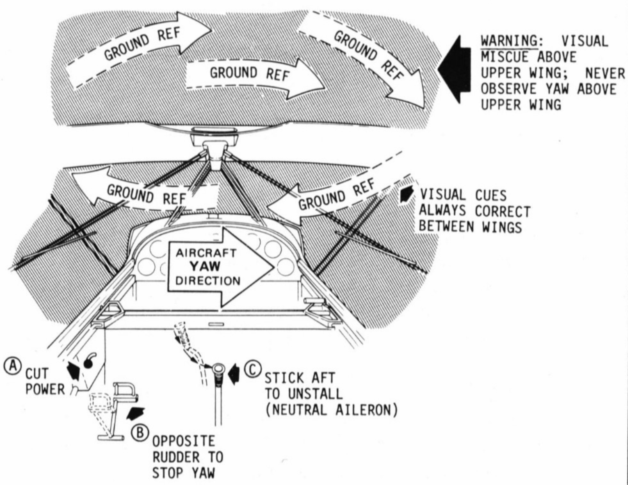
EXTERIOR VIEW: NORMAL INVERTED SPIN TO PILOT'S RIGHT

5-9 Normal Inverted Spins (Figures 5-4, 5-5)

In a normal inverted spin (a) the aircraft is nose down, yawing toward the spin axis, rotating with the inside wing distinctly lower than the outside wing and (b) the axis of rotation near the aircraft is **below** the centerline of the aircraft (that is, on the belly-side). The aircraft rolls around the spin axis with the roll direction opposite to yaw direction. Usually, this type of spin is entered from an **inverted** flight attitude, stalling with the stick forward while holding firm rudder input. The aircraft can rotate either to the right or left.

The spin axis intersects the ground above the aircraft (that is, canopy-side). Usually the point of intersection is behind or slightly over the upper wing. Visual cues between the engine and the upper wing always permit accurate determination of yaw direction.

FIGURE 5-4 Normal Inverted Spin (Part 2 of 2)



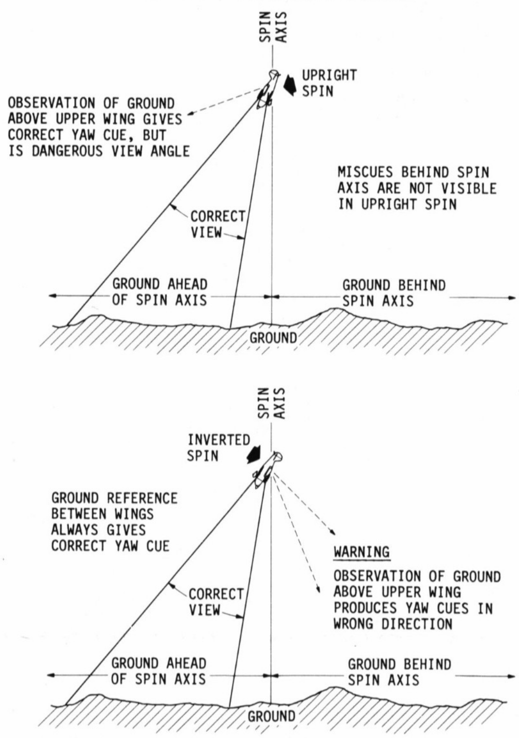
PILOT'S VIEW: RECOVERY FROM NORMAL INVERTED SPIN TO PILOT'S RIGHT

WARNING

Visual cues **above the upper wing (that is, canopy-side) are misleading,** because the ground reference cues are behind the spin axis. Such miscues produce an illusion that can lead to the erroneous conclusion that the spin direction is opposite to the true direction. **Always observe ground reference cues between the engine and the upper wing** to provide unambiguous determination of yaw direction.

If the spin is known to be a normal inverted spin, the standard recovery procedure, which basically places the

FIGURE 5-5 Yaw Reversal Illusion



aircraft into an inverted dive, is as follows:

1. Pull the throttle full aft to cut engine power.
2. Push the rudder pedal gently but firmly in the direction **opposite** the spin.

WARNING

Excess or violent rudder may cause the aircraft to recover from the original spin and transition to a spin in the opposite direction.

3. **Pull** the control stick gently but firmly aft.

WARNING

Excess or violent back stick may cause the aircraft to transition to an **upright** type spin.

4. When the spin stops (rapid build-up of airspeed), complete the recovery by pulling out of the dive, correcting aircraft attitude as required, and reapplying power.

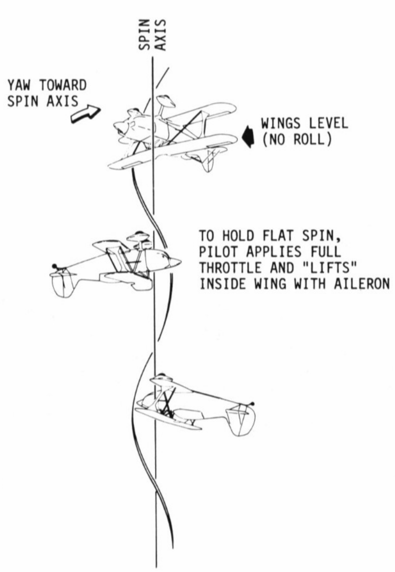
The condition that produces the illusion of yaw reversal to a pilot who looks up through the canopy is caused by observation of relative ground movement behind the spin axis, as shown in Figure 5-5.

The tendency for a pilot to look up (canopy side) to maintain ground reference during many inverted maneuvers can produce a dangerous psychological trap that must be avoided during any spin. The relative movement of the ground behind the spin axis will be easily misinterpreted as yaw reference ahead of the spin axis, and the pilot will erroneously conclude that the spin yaw direction is the reverse of the true yaw direction. The resulting **misapplication of rudder input will then hold the aircraft in the original spin, and recovery will be impossible.**

Yaw cues must therefore always be taken ahead of the spin axis; this can be assured during all spin types only if ground reference for yaw determination is always made between the wings.

NEVER LOOK ABOVE THE UPPER WING (CANOPY SIDE) FOR GROUND REFERENCE DURING SPINS.

FIGURE 5-6 Flat Inverted Spin (Part 1 of 2)



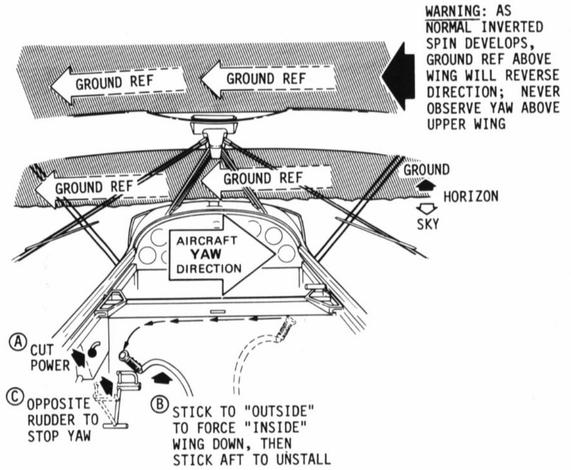
EXTERIOR VIEW: FLAT INVERTED SPIN TO PILOT'S RIGHT

5-10 Flat Inverted Spins (Figure 5-6)

In a flat inverted spin (a) the aircraft rotates with the wings approximately level (that is, zero roll), usually with the aircraft nearly horizontal in pitch or slightly nose up and (b) the aircraft is inverted. This type of spin is entered from a normal right-rudder inverted spin by applying full power while holding right stick (that is, stick toward the spin axis). Gyroscopic precession lifts the nose only during right yaw; in an inverted spin to the left, gyroscopic forces are in the wrong direction to lift the nose.

The spin axis intersects the ground well above the aircraft (that is, canopy-side). The point of intersection is normally beyond the pilot's visual scan during the flattened portion of the spin. However, the point of intersection moves to its normal position behind or near the upper wing during the recovery procedure, as the spin transitions to a normal inverted spin. This may create the illusion that the spin has reversed direction if ground reference cues are taken above the upper wing. Visual cues between the engine and the upper wing always permit accurate determination of yaw direction.

FIGURE 5-6 Flat Inverted Spin (Part 2 of 2)



PILOT'S VIEW: RECOVERY FROM FLAT INVERTED SPIN TO PILOT'S RIGHT

WARNING

Always observe ground reference cues between the engine and the upper wing to provide unambiguous determination of yaw direction.

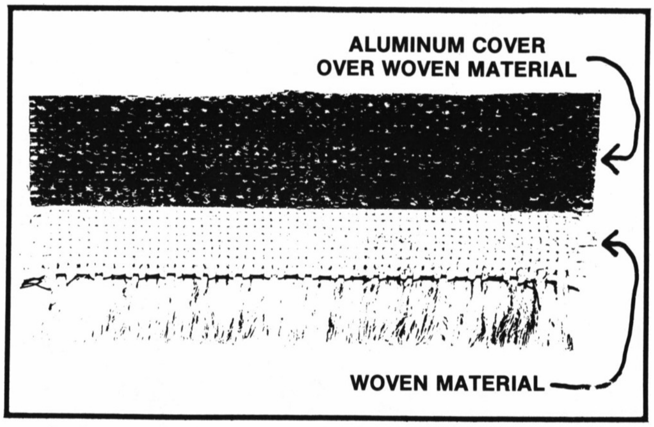
If the spin is known to be a flat inverted spin to the right, the standard recovery procedure, which basically places the aircraft into a normal inverted spin, is as follows:

1. Pull the throttle full aft to cut engine power.
2. Move the stick full left (that is, toward the outside of the spin, away from the spin axis and opposite to yaw direction), to force the inside wing down.
3. Hold the controls until a normal inverted spin has developed (½ to 3 turns, typically less than 1 turn), and then recover from a normal inverted spin using moderate back stick and moderate left rudder (paragraph 5-9). These control inputs are typically introduced at the same time as aileron deflection, producing a smooth single-motion recovery.

WARNING

Recovery from flat spins must be initiated no lower than 2500 feet agl to allow for altitude loss during the pull-out phase of recovery.

Because high negative-g forces (as great as 2 to 2½ g) will be experienced during inverted flat spins, and because these forces may be experienced over a substantial period of time, final recovery should be inverted so as to avoid abrupt g-load reversal and the possibility of blackout near the ground.



Individual IAC members are urged to submit any safety suggestions, tune-up tips, etc., so they may be shared and be of benefit to all IAC members. The aerobatic community is a relatively small group and we must work together for the good of each other and the sport. IAC thanks to the member who submitted the above tip. Thanks.

BUNGEE PROTECTION

The following tip to extend bungee cord service life was recently received by the IAC Technical Safety Committee:

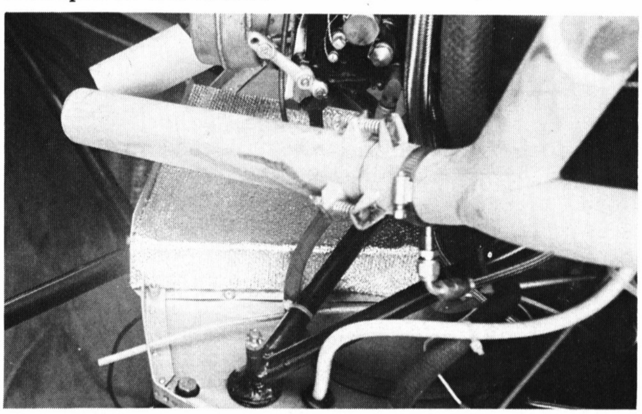
"I am writing concerning the protection of the bungee cords on the Pitts Special. I had my project in a hangar which suffered a fire during the night. The plane was not damaged very much because it was in an opposite corner from the fire, but the bungee cords went completely to pieces with the low heat that existed. This was new bungee cord and had not been on over a month.

"I have a friend who put an asbestos and aluminum covered material inside the cowling of his turbo charged twin Comanche. This is used by Piper to protect the outside paint from the extra heat of the turbo units.

"I reasoned that if this would protect the paint it would protect the bungee cords of the Pitts during flight. I put this material on the outside of the metal bungee cover between the bungee cords and the exhaust pipes. This will protect the bungee cords from the radiated heat of the exhaust stacks and should extend the life of the bungee cords by quite a bit.

"I am enclosing a photo of the installation and a small sample of the material. I realize that many people have gone to the all-metal gear to get away from this problem, but there are many who haven't and this tip is for them."

A photocopy of the above mentioned material sample accompanies this article.



GLUE JOINTS

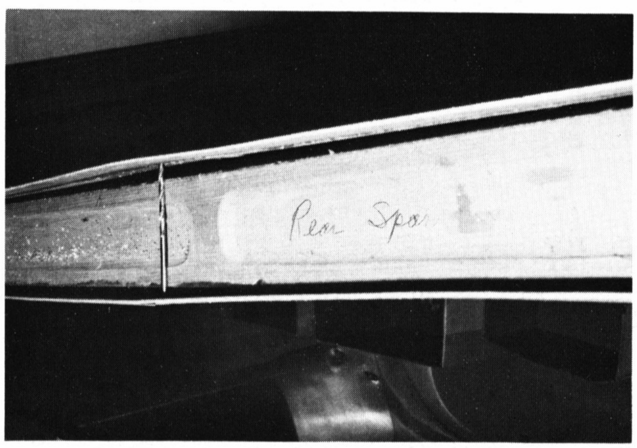
Within the last year or so, the IAC Technical Safety Committee has received several reports of failed glue joints. One IAC member made the following report:

"I . . . did have a glue joint problem. It was an all-wood wing and Weldwood glue was used. The wing had a 3/32 plywood cover.

"While working on the wing, I happened to bump the skin at the trailing edge and knocked some skin loose. Upon applying a small amount of pressure, was able to lift skin from entire trailing edge. The glue was very brittle and separated very easily."

Naturally, when fabricating any components involving gluing, standard practices relating to mixing ratios, pot life, surface preparation, joint fit, clamping pressures, temperature, humidity, cleanliness, etc., should be followed. However, the one thing that will tell you how well you are accomplishing all of the above-noted items — i.e., how good are your glue joints — is simply to make up sample-test pieces (with wood scraps) each time you are involved in a gluing operation. Later testing of your sample pieces (to destruction) will show either failure at the glue line (bad bond) or failure in the wood fibers (good bond). Don't forget to make sample test pieces and then to give them a destructive test.

Thanks to the IACer who submitted the above report and accompanying photography. Remember, we can all help ourselves and the sport by helping each other.



Some New Pitts ideas

Aerobatic Aircraft Design

ULTIMATE AEROBATICS LIMITED™ CANADA

By Gord Price

Notice squared wing tips moved inboard 9", Lexan tip plates and oversize symetrical ailerons.

Participation in the last World Aerobatic Championships brought me to the conclusion that my Pitts had to change if I was to be competitive. Work started in October 1980 on a new design for the wing to dramatically improve the roll rate. The wing tips were squared and moved inboard 9" to reduce rolling resistance. Lexan tip plates were added to improve tip efficiency, effectively replacing the 9" that was removed. Oversize, symetrical ailerons were fabricated from aluminum. I have nearly 25' of aileron on a 15'8" span. The design of the aileron with blunt trailing edge and special gap seal to reattach laminar flow keeps the aileron control pressure in harmony with the elevator control pressure. I cleaned up the rear face of the rear spar to allow for a large aileron tight to the spar. This necessitated a slave strut fitting that functions forward of the rear spar. Lead fill in the strut provides a degree of balance. The ailerons have three hinges each with four hinge bolts. Particular attention was paid to flutter possibilities and for that reason the tip hinge is only 1½" from the tip.

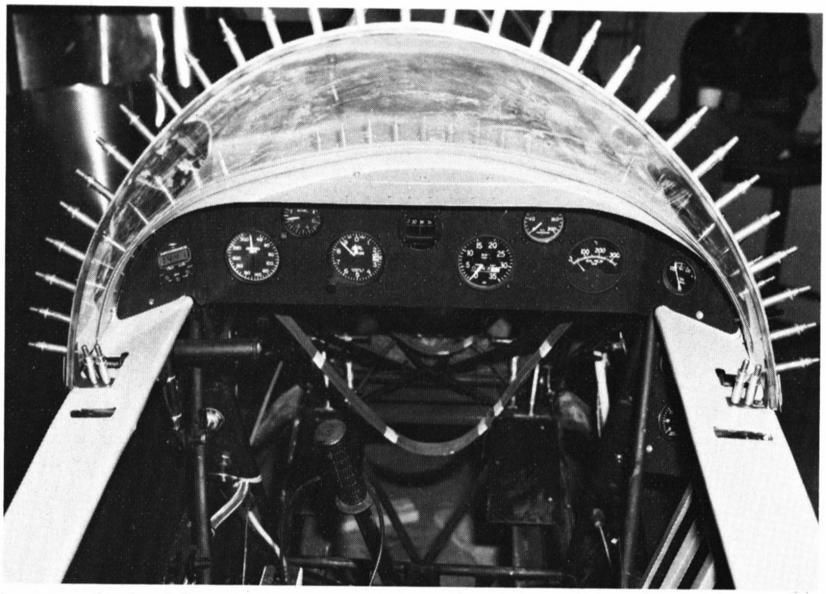
I performed a stress analysis on the wing and was amazed at the loads created by these changes. Spar butt fittings were designed with a new bolt pattern and a wrap around feature to prevent elongation. This feature enabled me to obtain load limits of ± 8.5 g from Transport Canada. Tremendous torsional loads necessitated rear flying and landing wires. This in turn required a new design for the upper cabane fittings. These wings will fit any S1 Pitts.

The EAAC Technical Committee in Ottawa evaluated the aircraft with the new wing in May of 1981 and found it to have exceptional aerobatic qualities and no bad habits. The roll rate was pegged at 360°/sec. at 160 mph but the real benefit is the slow speed roll rate which is 180/sec. at 90 mph, due to the large aileron in the prop wash. It also gives excellent recovery control during flat spins. Last summer I accumulated 100 hours of unlimited aerobatics with no problems. The wing does 3 vertical rolls on take-off with a 180 hp. (70°, 1100' MSL, 145 mph, pull up and fly away at 700').

In addition to control power I needed horsepower so we changed the 0-360 extensively and now get 230 hp without the extra weight of the I0-360. 10.25 : 1 compression and a high speed camshaft provide the bulk of the power including piston cooling jets and high speed (expensive) rods.

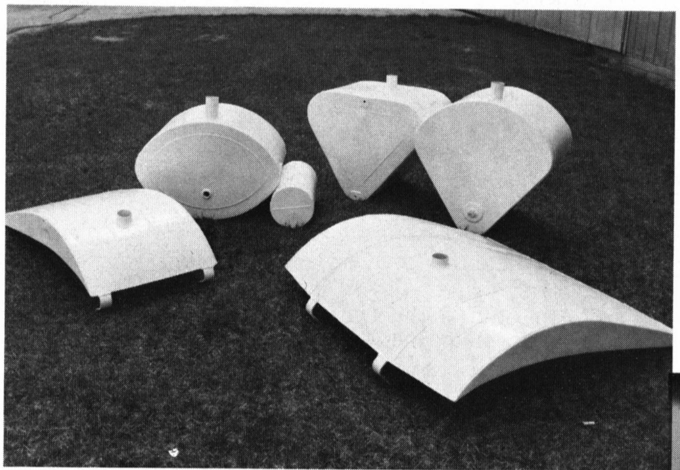
The big change last winter was in the fuselage. The top of the instrument panel was lowered 4" and flattened for better visibility and horizontal reference. We chopped the top off the gas tank and added an internal header tank, so it still holds 20 gallons. The turtle deck was angled back to allow better visibility. A special side opening canopy was designed which comes down to the longerons. No need to step on the wing now. You just step right in. Some 7/16 .035 tubes were welded onto the center section of the top longerons making the fuselage 6" winder. The turtle deck was also made wider.

My pride and joy is the new 2-piece fiberglass cowling which is as tight as you can get. A new 16" spinner was also made which has a front and back plate for my Hoffman. We are also making a spinner to fit the Sensenich. Some newly designed ferry tanks for the upper wing which hold up to 15 gal. will come in handy when I have to do some European cross-country this summer with NOD and the Canadian Team.



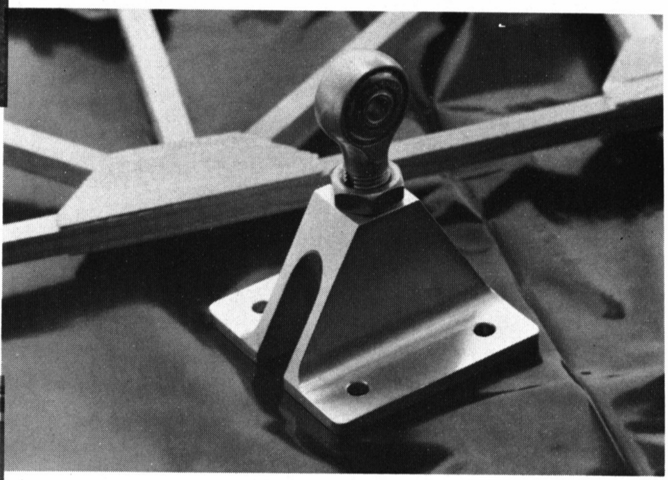
(Photo by T. Comery)

Lowered instrument panel.



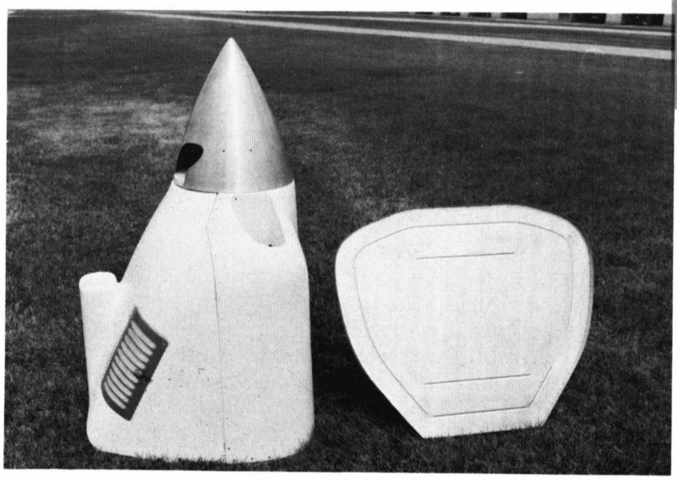
(Photo by T. Comery)

Gas tanks with internal headers and overwing ferry tanks.



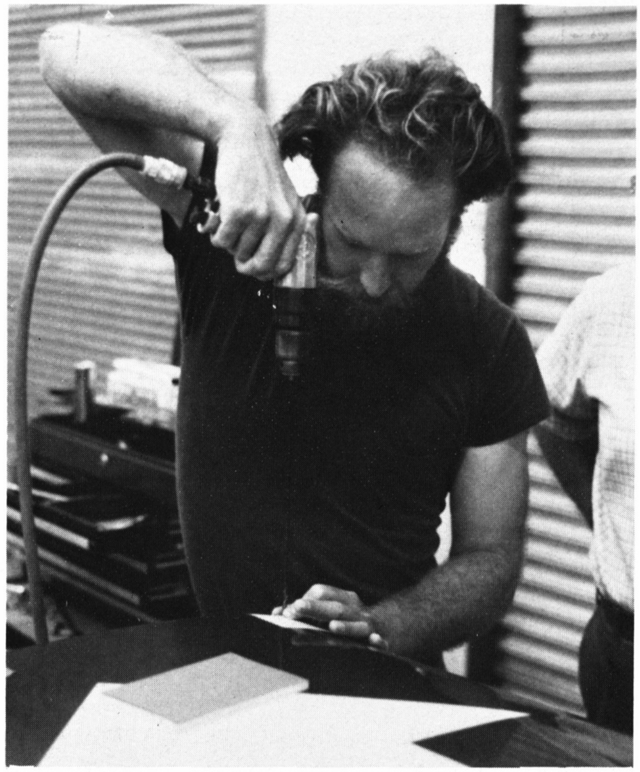
(Photo by T. Comery)

Aileron hinge machined from 606-T6 aluminum.



(Photo by T. Comery)

Cowling Kit.



Jim Roberts virgin wingtip about to be drilled to attach "shaker".

ATTENTION: ALL STEPHENS-TYPE MONOPLANE PILOTS

By Kermit Weeks
Photos by John Ford

As most of you know, Jerry Thomas, one of our top Unlimited competitors, lost his life last year in the crash of his Stephens-type monoplane. It was a tradgedy for all of us who knew him well, as Jerry was a fun-loving guy and a very dedicated pilot-builder and aerobatic enthusiast. This article is to present some background to the accident and to share what we have learned from it.

The day of the accident Jerry climbed into his monoplane and took off for a routine practice flight. The weather was good with a light breeze as he headed for the box. We practice over a X-roads in the very edge of the Everglades about 10 miles SW of Tamiami Airport. It is uninhabited, other than an occasional target shooter who comes out to practice. An eyewitness, who himself was a charter pilot, watched Jerry practice for about five minutes, and then returned to shooting his gun. With his ear muffs on he heard what he described as "a loud resonant sound, similar to a snap-roll but 10-times as loud". He looked up and observed the aircraft in a near vertical dive at around 700 feet. Pieces of wood and fabric were fluttering down as if the wing had "exploded". The right aileron was in trail and the aircraft hit at an angle of about 60 degrees, wings level. Jerry was killed instantly.

At first we all had suspected that the prop, a 3-bladed Hoffmann, had slung a blade and hit the wing. Leo Loudenslager had lost a blade on his 2-bladed Hoffmann several months earlier (see *Sport Aerobatics*, March '82). After investigation, there was found no indication of wear between the engine and the mounts, cowling, baffles etc. as would have been the case with an unbalanced engine. No blade pieces were found, other than at the crash site.

The left wing and tail were intact other than impact damage and the right wing main spar was intact. Most of the right wing structure was gone except for the aileron, which was still attached to the fuselage by the torque tube. Pieces were found for ½ mile downwind.

Strong indications showed that the aileron had fluttered. The aileron hinges had torn themselves out of the rear spar and were intact with the portion of rear spar to which they were bolted. Pieces of the rest of the spar were found with the furthestmost pieces from the wreck, indicating departure from the wing early in its destruction. The balance weight pieces were found at the crash site, so flutter due to imbalance was ruled out. Almost all of the right wing leading edge strip was found intact which indicated even more that the prop had not separated. No prop pieces other than at the crash site were found.

From all the studying of the evidence and discussing the pros and cons of our theories we still didn't have a concrete answer. The wing had fluttered at some point in its destruction, but we didn't know if the flutter had caused a structural failure or a structural failure had caused the flutter.

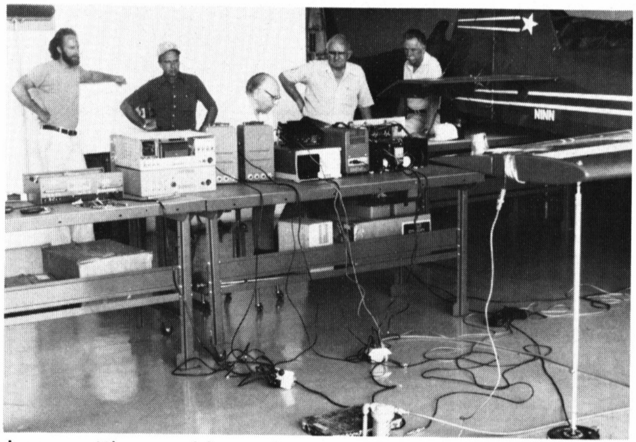
To help understand what had happened, the idea of running flutter tests on the monoplanes was brought up. In talking with Curtis Pitts we were refered to a man who had done testing for the factory and was well reputed in his field. This man was Leon Tolve from Atlanta, Georgia.

Leon is probably the World's most leading authority on Flutter. He was in on the beginning of the science, back when airplanes were venturing into new speed realms and encountering these new problems. He has done flutter tests on almost every aircraft that has been in the Air Force inventory, from the P-38, P-51 and B-17 to the F-86, F-104 and C-5A. He worked for Lockheed for 16 years and now still consults for them and other aircraft manufacturers.

We had the opportunity to bring him to Miami and have him look at the wreck and other Stephen-type aircraft. During this first meeting we, of course, had many questions about flutter: If a blade had come off, could the resulting vibration induce flutter? No, there would be no correlation between the engine vibrating frequency and the natural frequency of the wing. Does it help to flutter test your airplane at different speed increments and "hit the stick" to prove that your aircraft is flutter-proof? No, a certain condition or conditions may be needed that these type tests may never show up. Does 100% or more balancing prevent control surface flutter? No, as we shall see in the case of the Stephens-type wing. Our questions were endless and the more we asked the more we realized how little we knew and how much there was to learn.

We concluded that the tests should be done and arranged for a date to start. One concern we had expressed was the difference in the construction of the different Stephens-type wings now flying; some have stringers while others do not, some have different aileron sizes, some have different skin thickness etc. After discussing the possibilities, we decided to arrange for two different aircraft with dissimilar wing constructions.

The first aircraft was built by Norm Nielsen, N1NN. It was built literally side by side to Jerry's in my shop and was, for all practical purposes, identical. The second aircraft was Jim Roberts, N20JJ, and is a sister ship to Leo Loudenslager's (N10LL), Jim's wing has different rib construction and also has span-wise stringers while Norm's does not. Soon both aircraft were at my new shop and we were helping Leon set up his equipment.

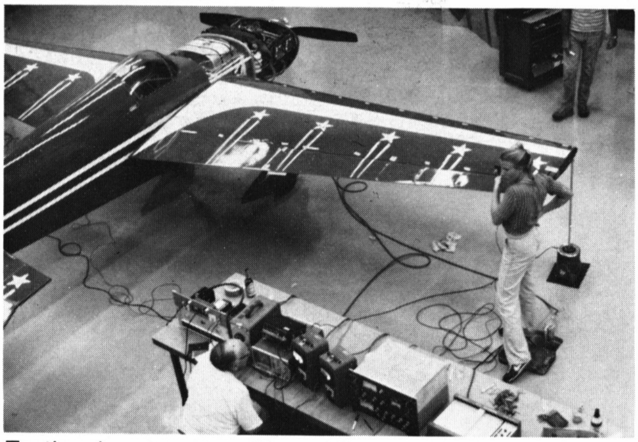


Leon setting up his equipment. Note: the shaker on the floor and accelerometer in place on wing.

After having taken all the root fairings off, the aircraft were set up in a level attitude. A "shaker" was set under each wing-tip on the floor. After a small hole was drilled in each wingtip, a rod was attached between the tip and the shaker. The shakers were used to induce vibration to the wing which could be measured by a small accelerometer placed at various fixed positions on the wing. Leon could change the frequency (amount of shakes or cycles per second) and the amplitude (the distance the wing moved through each cycle). This was used to determine the wing's natural frequencies.

All wings and ailerons have certain natural frequencies at which they will flutter. The speed at which they will flutter changes with different constructions and design techniques. Certain precautions and design considerations can be taken to increase the speed range beyond which the aircraft flies. The frequency at which they will flutter is related to the speed at which they will flutter.

There are two modes of flutter that the wing has. A torsional mode, where the wing rotates around a lateral axis, and a bending mode where the wing bends around a longitudinal axis. These modes occur at different natural frequencies of the wing. The axis of rotation, which doesn't necessarily have to be a straight line, is called the "node" line. Our concern, was to plot these node lines and the different natural frequencies, and note their relationship to how the aileron should be balanced.



Testing in progress with cowling and fairings removed for wing freedom. Note: the tape locations on the wing where accelerometer was placed for different readings.

Within five minutes of shaking the wing, Leon said that we had a problem. For proper flutter dampening the aileron counterweight had to fall outside the bending mode node lines and behind the torsional mode node lines. The torsional mode node lines on both airplanes tested fell behind the balance weight at the tip (Fig. 1). The bending mode node lines were obviously well inside the tip counterweight an were not a factor.

While both airplanes tested the same in the torsional mode, the span-wise stringers in Jim's wing gave him a higher frequency in the bending mode, but this was not a problem area. The builder who thought he was doing himself a favor by over-balancing his aileron at the tip was making things worse. Any extra weight at the tip was like adding it directly to the trailing edge of the aileron!

For me to try to explain about something which I don't totally understand would not be appropriate. Leon

Linda Meyers helping by moving accelerometer to the different positions.

Author looks on as Leon records data.

Leon explains data with interested onlookers.

has agreed to write an article at a later date that would explain the concepts of flutter and how they relate to us. For now he states that the "aileron was not adequately dynamically balanced to preclude flutter in a wing torsional aileron-rotation mode. The aileron was statically balanced but was not adequately dynamically balanced." He also feels that "the wing is not tied into the fuselage as good as it should be." While not a structural problem, the wing would have a higher frequency (hence higher flutter speed) if it were more securely attached.

After several weeks of sorting out his data and running computer programs, Leon came up with the attached data (Fig. 2). Realizing the difference in certain aileron sizes, several weights are given for a particular aileron case. Unless you plan to red-line your Stephens-type monoplane below 160 mph, this is a MANDATORY modification!

Basically all ailerons should be balanced with 1.75 lbs. at the tip and with a "spade" type balance 42" in from the tip. This inboard weight will depend on the size of your aileron but **must** be located 8⅜" from the hinge centerline. Conforming to these changes should give your aircraft a flutter speed in excess of 300 mph.

Another problem that has arisen is the construction of nose-ribs in certain wings. Henry Haigh recently sent his wing back for re-skinning after noticing small cracks in his leading edge and small slivers of wood coming out of his drain holes. When they de-skinned the wing they found that every nose-rib, other than at the tip and root, was broken. Henry's wing had 160 hrs. on it.

Apparently, early in the design, the nose-ribs were constructed with a single hole cut out of the plywood for lightning. Later, after a redesign, a larger cut-out was noted in the plans, following the same shape as the nose section (Fig. 3). Henry's ribs were all cracked in the corners as shown. Jerry's ribs were of the same construction and may have contributed to the accident. As the ridgidity of the wing is lost, the speed at which it will flutter will be lower.

I would strongly suggest to anyone with a Stephens-type monoplane to determine what type of rib construction your wing has and make sure that it is properly designed. While not a flutter consideration, Leon suggested that the span-wise stringers are of good design technique and should be installed during construction or re-skinning. In talking with Leo Loudenslager, he stated that he had the original nose-rib design and stringers installed. With over 700 hrs. on his wing he has had no apparent leading edge problems.

I'm saddened that it took the life of a close friend to realize a problem about which we were unaware. At times it seems that sacrifices are made so that others may learn. As back in the 30's, our homebuilt designs are going faster and faster into higher speed realms and problem areas. I can't help but wonder how many of the faster homebuilts are flying today without the testing for flutter tendencies. I can only hope that we can benefit from a science that has already made it's mistakes.

Fig. 1

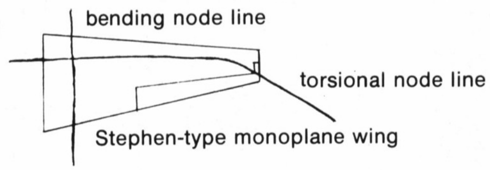
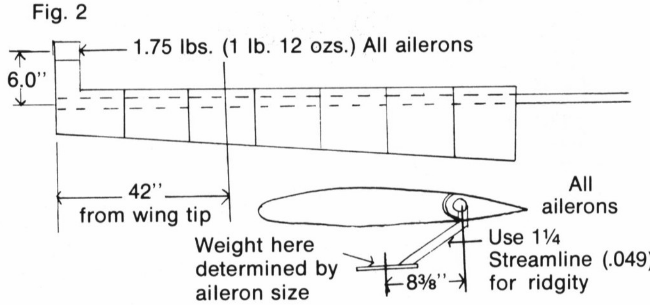


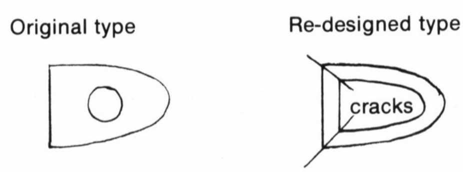
Fig. 2



Aileron Size	Weight at Tip	Weight at 42" Station
Standard Length (83")	1.75 lbs.	2 lbs. 8 oz.
One bay longer (95" approx.)	1.75 lbs.	3 lbs. 1 oz.
Two bays longer (107" approx.)	1.75 lbs.	3 lbs. 6 oz.

1. All weights are in addition to supporting arms.
2. Measurements are from aileron hinge centerline to C.G. of weight.
3. 42" Station Weight may be in the form of spades, ball, tear-drop etc. but C.G. of weight **MUST BE** 8⅜" from hinge centerline. It **may not** be moved for or aft and be compensated for by more or less weight.
4. Tip Weight **MUST BE** 6" from hinge centerline.

Fig. 3.



TAILWHEELS, AGAIN

There are several subjects which seem to be perennial Tech Safety subjects, and "tailwheels" is certainly one of them. The following article submitted by an IAC member concerning a common tailwheel malady is excellent in its detail and instructions.

"Why Lock Up Your Maule?

"I think everyone will agree that the Maule SFS is a great tailwheel for taxiing around an airport, particularly since you can steer with the rudder and because it is full swivel. Unfortunately, if you're landing a short coupled airplane like a Pitts, on pavement, in a crosswind, it can be a real handful, especially for a low-time pilot.

"So, I tried one of the popular locking tailwheels on the market today. The locking tailwheel which I tested made the plane extremely difficult to steer when there was any kind of a wind because it wasn't linked to the rudder. In addition, the use of a tortion bar instead of a leaf spring caused an omnidirectional bouncing in the tail which I didn't like. It was a little lighter but you usually need extra weight in the tail of a Pitts anyway; it was also more aerodynamic, but someone who needs a locking tailwheel is probably not ready for unlimited competition anyway, so a few extra miles per hour doesn't make that much difference.

"To solve my problem, I decided to try to modify the Maule tailwheel which I originally purchased for my Pitts. It was relatively simple and worked extremely well so I decided to share my experience. Following is an explanation of how to convert the Maule SFS to a lock tailwheel as I did.

"The first step in the conversion is to replace the ring on the steering arm. To remove the old ring, I used a mill. Prior to welding on the new ring, you must be sure to **completely** remove any remaining brazing allow. I used a sandblaster for this.

"Next, clamp the new ring on the center line of the steering arm. Since the steering arm is hardened, I recommend tig welding using Tigtectic 680 filler rod, a product of the Eutectic Corporation. Weld size should be no more than ⅛" to avoid warping the steering arm. To complete the steering arm, reassemble the locking pin in the arm making sure it slides freely.

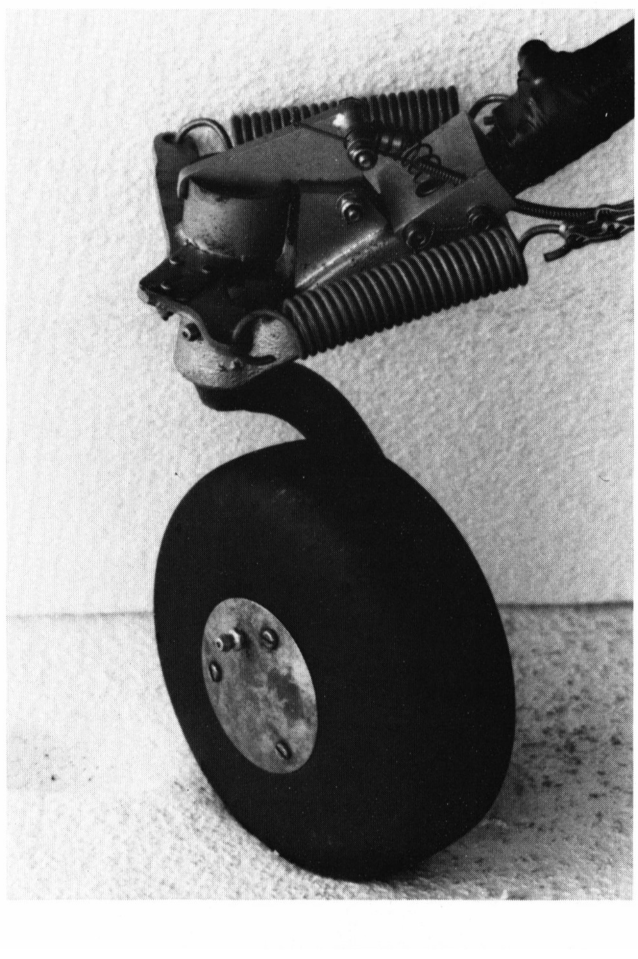
"Next, a flat must be machined into the upper surface of the casting with a 1" mill cutter, removing only enough material to present a flat surface for the mounting block to seat on. Corners near the king pin can be squared off with a ¼" mill cutter. See Figure 1.

"The milled slot must line up with the bushing center line and must be parallel with the spring surface.

"The mounting block can now be attached to the casting with an AN6 bolt to assure that all parts will line up. This should be done before the final brazing is done.

"If all parts fit and move freely, the mounting block can be brazed to the casting in the following manner: silver brazing alloy sheet can be obtained from your local welding supplier. Cut a piece of the sheet to fit exactly under the block. Cut a generous clearance hole (¾") for the bolt. You don't want to braze the bolt in place. Coat both sides of the sheet liberally with flux; then bolt the block to the casting, sandwiching the silver sheet between the two. Torque the bolt, as you want a preload on it when the silver melts. Heat the entire assembly until silver is seen to flow from under the block. The idea is to heat the entire block and casting in this area broadly and uniformly to the flow point of the brazing alloy. When the silver is seen to flow from under the block, you can add a small amount to form a fillet around the block to help relieve stress at this point. The casting must be cooled down slowly. An easy way to accomplish this is to wrap insulation around a large can and place it over the part as soon as the brazing is finished. The part can be sandblasted clean **after it is cool.**

"Final Assembly: the push pull cable and all other hardware are AN quality and can be purchased from any aircraft parts supplier. Mine came from B&F Aircraft in Oak Lawn, Illinois. Attach the cable inside the fuselage using ty-raps. Safety wire all bolts. The ½" compression spring can be found in any hardware



store. Get several sizes of springs so you can adjust the locking tension. A strong spring, aided by vibration, will assure that the wheel is locked on landing, even if you forget to lock it. Mine is this way, and I had to make a positive lock to keep it open while taxiing. With the tailwheel locked, the tailwheel connector springs allow full use of the rudder; you can also make small corrections with light braking.

"The AN3 bolt and sleeve for the push wire are simply drilled as shown in Figure 2 and then adjusted with washers.

"If your machine work is accurate, you will have a tailwheel that makes your airplane track straight. If the all-important silver brazing and welding were done properly, your tailwheel will withstand even the most severe side loads.

"My locking Maule is on a Pitts which has been landed mostly on pavement. I had only seven hours in a taildragger before I flew my Pitts. My locking Maule tailwheel improved the landing performance so much that I can boast of over fifty hours and hundreds of landings without even being close to a groundloop."

The above article exemplifies the worth of the IAC Technical Safety Program: a forum where we can all pool our experiences/knowledge for our mutual benefit. A large IAC "thank you" is due the IAC'er who made the effort to assemble the above article and share his knowledge and experience with other IAC members. Each IAC member should remember that he is part of the IAC Tech Safety Committee and that his input is essential to the operation of this Program.

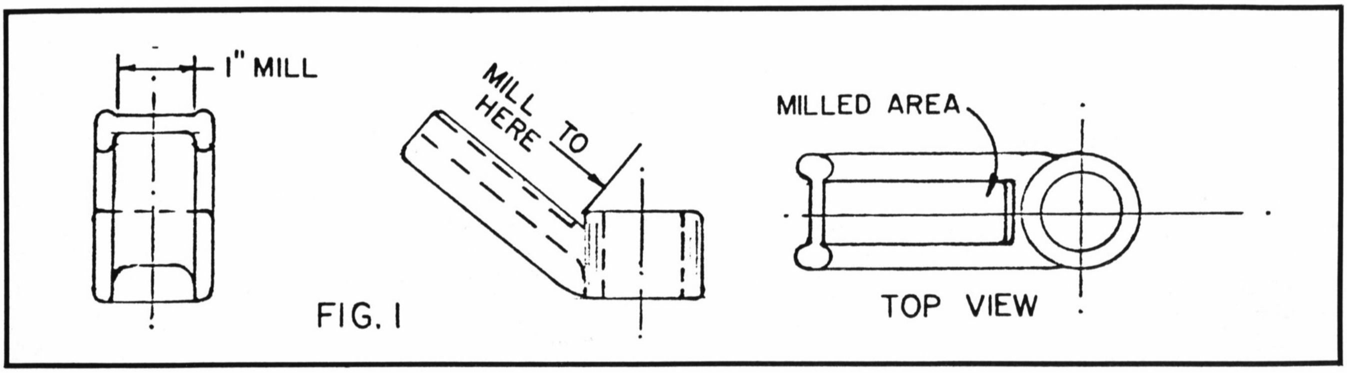


FIG. 1

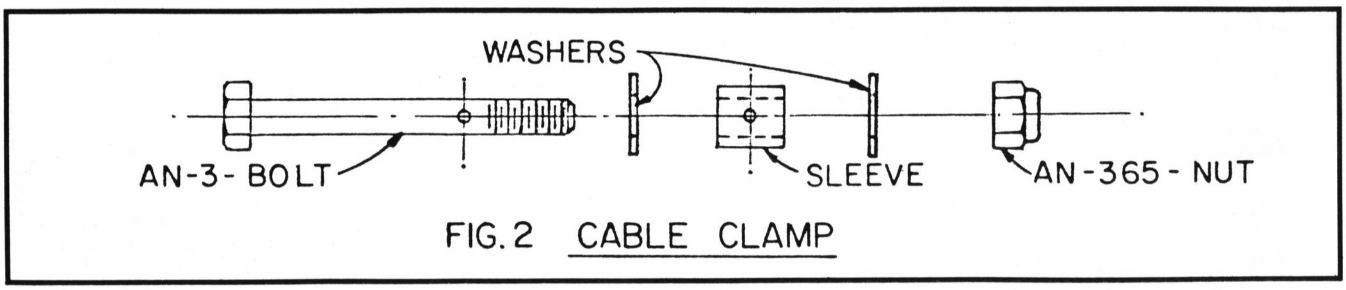
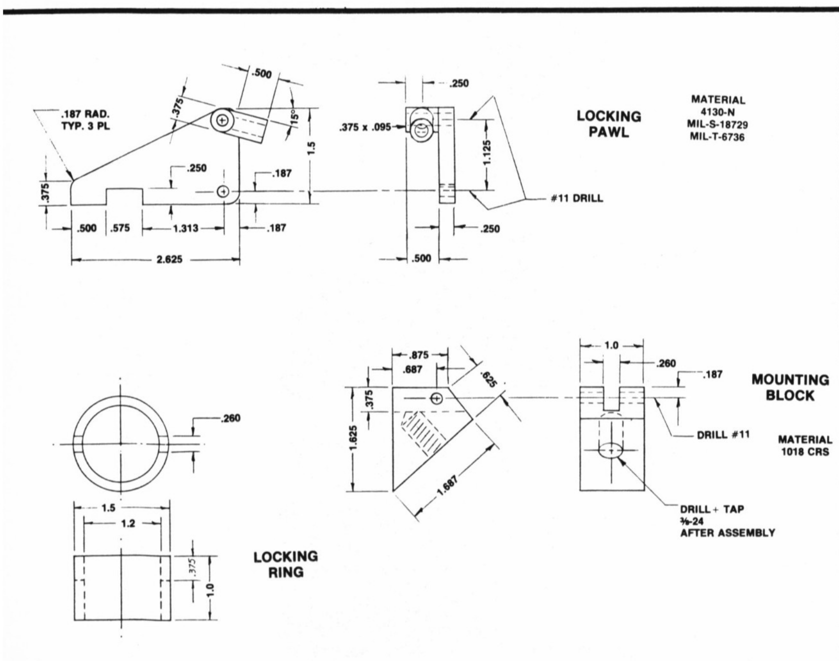
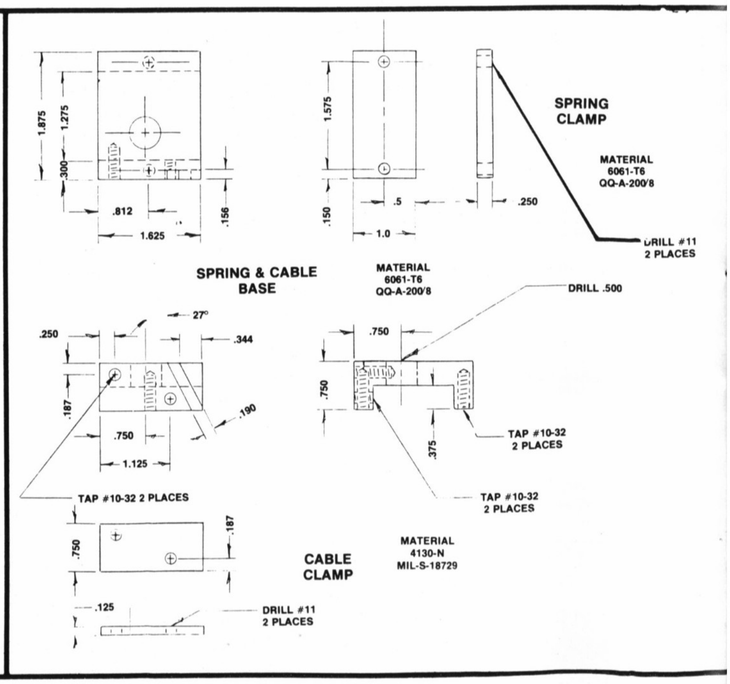


FIG. 2 CABLE CLAMP





S-2A PROP CONTROL

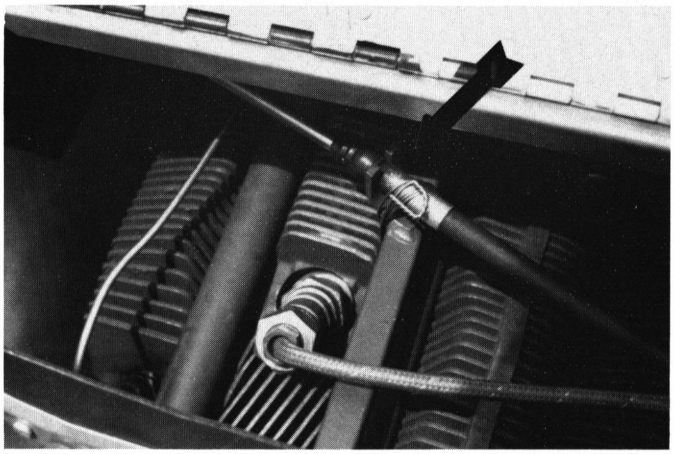
The IAC Technical Safety Committee just recently received the following report from an IAC member:

"We own a Pitts S-2A delivered from the factory in August, 1981. We've experienced two problems with our propeller control.

"While flying hammerheads I noticed RPM had changed after each maneuver. First thought was that I hadn't properly tightened the propeller control, but the problem continued and the control had a soft abnormal feel. Problem was identified when the prop control cable housing was found to have lifted out of its forward attachment, a U-shaped bracket which engages a slot in the end of the housing. We safety-wired the cable down and thought that was the end of that.

"The RPM started drifting again to prove us wrong. This time the strut holding the bracket for the cable had broken loose at its outer end, through a weld. The strut passes side-to-side over the front left cylinder. It's easy to remove and fix."

The party who submitted the above info and pictures is a relatively new IAC member but one who already has taken advantage of the IAC Tech Safety Program to help fellow IAC members and promote safety in the sport of aerobatics. A large IAC "thank you" is due this member. Thanks.



A MORAL OBLIGATION

By Sam Burgess
IAC #23

This is an appeal on behalf of the IAC Technical Safety Program to promote more interest among the members in the reporting of any aircraft discrepancies you may experience on your aerobatic mount. It is a topic that has been sadly lacking in response to past requests for input.

Any organization with fleets of aircraft (airlines, military, etc.) all have in being a working system to catalogue these discrepancies. In fact, it is mandatory that they be reported and a card file is maintained on each type of aircraft to note any trend **BEFORE** it becomes an accident. The number of aircraft and lives saved by this procedure is inestimable.

In the IAC we have no authority to demand these reports nor do we desire to take a dictatorial approach, however, we have something that should work just as well. We, as competition aerobatic pilots, should feel a **MORAL OBLIGATION** to our fellow airmen to be more free and informative with our findings. Anything short of this is disregarding an unwritten code our camaraderie is a part of.

No matter how inconsequential, insignificant or isolated any problem you experience with your aircraft seems, it may be all the IAC Technical Safety Program Chairman needs to tie a trend together and publish a warning in *Sport Aerobatics*. You, and only you, are the soul source of this input.

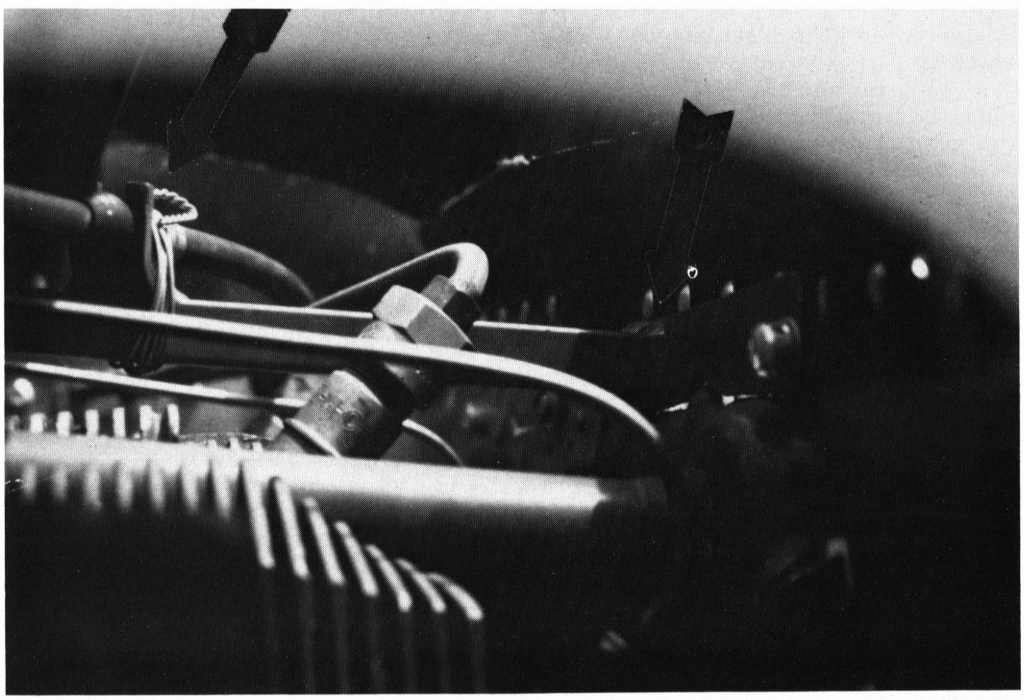
We should feel this **MORAL OBLIGATION** even more so than in any other flying organization when we consider the extra hard use our aircraft are subjected to and the proximity to the ground in which we operate.

So, the next time you discover a discrepancy on your bird think of Mac, that new friend you met at Fond du Lac, and ponder a while on whether or not he would like to know of your problem.

I bet he would.

Send in your tips to:

Fred Cailey
Technical Safety Program Chairmen
1004 Woodland Ave.
Batavia, IL 60510
312/879-6183



Leo Loudenslager holds the Laser 200 in the vertical line.

VALUABLE INFORMATION

By Dan Rihn
IAC #3836

Valuable Information is information that fellow pilots pass along, sometimes known as good advice. Usually this information is obtained through experiences your peers have survived. This is a story of how I had to re-learn a few lessons I had already known through others' good advice.

Last season I made the big decision to move up to Unlimited. After a bit of practice I was flying the Known well enough to be scrutinized by 5 judges at one time. During one of my practice sessions at Santa Paula I pushed up into a tailslide, pulled the power back and held my vertical line. This slide was one of those rare ones that seem to balance right on the tail for an extra long time. When the nose finally came down through the horizon I checked the engine to see if I still had power, it had been very quiet during that long slide. A quick glance at the prop, yes, it's still turning; but wait, it's turning **backwards**. I quickly did a ¼ roll down to get me pointed towards lower ground. The practice area at Santa Paula lies on an uphill slope of a steep valley, below are orange groves and a river, and absolutely no place to dead stick a Pitts. I had one choice, **DIVE**, get speed and hope I have enough altitude to get the engine running again (non-electrical system S-1S). By this time I am really smoking and Charlie Larkey, my critiquer, is wondering what the heck am I doing. Charlie understood immediately when I silently blasted over his head, prop stopped.

It seemed to take an eternity for the prop to stop rotating counterclockwise, then stop completely and finally start turning the proper direction.

When the Lycomming started back to life I was indicating 190 mph, and I was VERY low over the orange groves. Wow, I had just learned some valuable lessons.

A few years ago Sam Burgess wrote an article in *Sport Aerobatics* concerning tailslides and engine idle rate. Sam explained that it is necessary to increase the idle speed when doing tailslides to prevent the engine from quitting. It seems when an airplane is backing up it puts an additional load on the prop and can easily kill an idling engine.

Armed with this valuable information when I began doing tailslides I upped the idle rate and proceeded to do tailslides. I quickly found that there was more than meets the eye when it comes to obtaining the proper idle rate for aerobatics. Too much engine speed and I would torque off in the tailslides and get a lousy spin entry. It took a lot of trial and error but I felt I had finally reached a happy medium.

For years fellow Unlimited competitor Jim Rossi had told me not to do a full blown power off tailslide at Santa Paula, just in case you lose the engine. Jim does a partial power tailslide that really looks pretty good. I never got the hang of it and always torqued out of the maneuver. So I began doing them power off; after all, I had the idle rate worked out to a science.

Well obviously I was wrong, damn near **dead** wrong. That particular tailslide was a little longer than any I had done up to then, and who knows why the engine suddenly decided to kick back that day. Since then I re-adjusted my carb. and re-adjusted my thinking. From that day on I will **NEVER, NEVER,** do another tailslide unless I can easily make a dead stick landing onto a very good surfce. And, most importantly, I will listen even closer to the experience of others when they pass on their "Valuable Information".

INSTRUMENTS & ENVELOPES

Our flying machines are basically mechanical devices and as such they are subject to certain structural limitations. These limitations are usually described by a maneuvering envelope (sometimes referred to as a V-a, V-G, or V-N diagram) which plots airspeed vs. loading. The two instruments we rely on for information relating our aircraft maneuvering to our aircraft's design structural limitations are the airspeed indicator and the accelerometer (G-meter). The data output from these two instruments is especially important to aerobatic pilots who fly their aircraft to the extremes of its maneuvering envelope. Since we are operating our machines near their design limits it is apparent that we must have **accurate** outputs from the airspeed indicators and accelerometers. Below are a couple of simple tests anyone can conduct to check the accuracy of these two instruments. (Note these tests are not meant to replace instrument repair station service.)

AIRSPEED INDICATOR. We determine the velocity of our aircraft through the air by relating speed to differential pressure. That is, by sensing the difference between the static air pressure and the dynamic (impact) air pressure we can relate this pressure difference to speed.

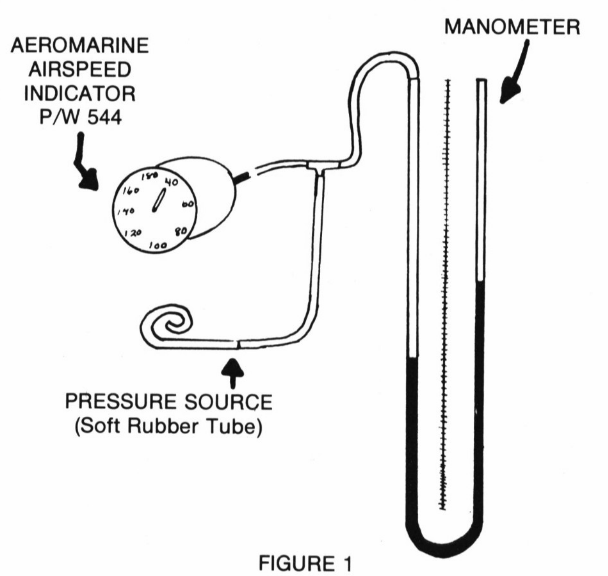


FIGURE 1

Therefore, our airspeed indicators are just sensitive differential pressure gauges which are calibrated in MPH or knots. Now, if we know the relationship between pressure and indicated airspeed, we can check our airspeed gauges. The equations we need are in Fig. 1.

$$\text{Pressure in Inches } H_2O = .0006521 \times (\text{Knots})^2$$

or

$$\text{Pressure in Inches } H_2O = .0004931 \times (\text{MPH})^2$$

For example
1.23 inches of water press = 50 MPH
4.93 inches of water press = 100 MPH
11.09 inches of water press = 150 MPH

Obviously, we are dealing with pretty small pressures. (To help put things in perspective, remember 1 PSI approximately equals 2 inches of Hg and 1 inch of Hg equals 13.6 inches of H_2O.) Anyhow, using a water manometer (which is just a U-tube) as illustrated in Figure 1, you can easily check the accuracy of your airspeed indicator throughout its entire range. Naturally, this test does not account for installation error/pitot-static system or possible leaks in the pitot static system. (IAC members are referred to the April 1978 issue of *Sport Aerobatics* or the IAC Technical Tips Manual for a simple method to check for pitot static system leaks.)

ACCELEROMETER (G-METER). In order to change either the directional velocity of your a/c or the magnitude of the velocity of your aircraft, a force must be applied. This force is directly proportional to the rate of change of the velocity, or the "acceleration." Our accelerometers are just devices which measure these rates of change and give us an indication of the forces applied to the a/c. Accelerometers are calibrated to indicate the magnitude of accelerations as compared to the acceleration of gravity (32.2 ft. per sec. per sec.). Accelerometers are constructed to "read" in the vertical plane of the instrument dial. We can easily check the accuracy of our accelerometers by holding the instrument in three different planes and noting the reading. First, hold the accelerometer in the vertical plane with the zero at the top of the instrument — it should read "1 G." Now, turn the accelerometer upside down (in the vertical plane) with the zero at the bottom — it should read "-1 G." Next, hold the accelerometer with the dial in the horizontal plane — it should read "0." Lightly tap the instrument before taking any readings. The accelerometer should be considered serviceable if it reads within ± 0.2 G of any of the above three indications.

As with our simple airspeed indicator check, these accelerometer checks do not take installation error into account. Since we are using our accelerometers to relate the forces we impose on the a/c to the design strength of the a/c as noted on the vertical axis of the maneuvering diagram, and since the maneuvering diagram is based on accelerations at the aircraft's center of gravity, our accelerometers should be mounted on the a/c C.G. Also, the loads (accelerations) noted on the maneuvering diagram are loads in the aircraft's vertical plane — therefore, our accelerometers should be aligned with the a/c's vertical plane and any "inclination" of the instrument will give erroneous readings. Installing an accelerometer in a shock-mounted instrument panel will also affect the accelerometer's readings.

To reiterate, accurate information is essential to determining the stresses we impose on our aircraft while flying aerobatics. The above simple tests should help assure us of "good information."

THE EVOLUTION OF THE J-BIRD

By Jay Hunt
IAC #1816
President
Aerobatics Canada

This story had its beginning almost six years ago following my return from the World Aerobatic Championships in Kiev, U.S.S.R. Competing on the first Canadian entry to a World Championship had been the achievement of a ten year dream. During this post-partum period I began to ask "what now?" Clearly the thought of winning a world championship in my tired little stock Pitts was out of the question. I had neither the time nor the financial resources to embark on the extensive modification and testing program required to make it a contender against the super machines from south of the border. The prospect of a multi-year effort at building a new more competitive Pitts was equally unappealing as was the thought of thrashing through future contests in a non-competitive mount for the sake of Canadian presence. A new challenge was needed. One which would put Canada on the map competitively.

The Pitts was still state-of-the-art in competition aerobatics but was showing its nearly forty year age. Its labour-intensive construction and need for extensive drag-reducing, performance-extending modifications had put it out of reach to all but the most talented, affluent, and patient aerobatic pilot. A newcomer could not rise to Unlimited at the world level without spending years designing, building, and mastering one of these temperamental beasts.

Based on seven years of Pitts flying, I had developed a list of 'desireables' for the ultimate aerobatic aircraft:

1. It must have performance which exceeds that required for any figure in the Aresti Catalog.
2. It must have control response and effectiveness in roll, pitch, and yaw which exceeds the maximum required for any aerobatic maneuver.
3. It must meet criteria 1 and 2 above with a speed range low enough to stay within the box in a competition sequence.
4. It must be inexpensive to build.
5. It must be possible for a novice builder to construct over a single winter at home.
6. It must be easy to fly and have good visibility in all directions.
7. It must be inexpensive to operate and maintain.

"If only we could design and build in Canada, a new competition aircraft which would be accessible to all aspiring aerobats," I thought. Therein lay the seed of the new challenge; to introduce a Canadian aircraft to the unlimited aerobatic competition arena.

Over the ensuing months this idea slowly developed from conception into embrionic detail. The aircraft would have to use simple construction methods and be produced as a ready-to-assemble kit needing no modification for unlimited competition. It must be available at a price accessible to any pilot who could afford a Citabria. Its flying characteristics would have to be easily handled by the average taildragger pilot. None of the totally blind, pray and ricochet landings could be tolerated. It had to be durable and easy to maintain; suitable for outdoor tiedown through our most outrageous seasons. Finally in stock form it had to fully meet the rigours of Aresti at the World level. It did not have to satisfy the devotees of the maximum that five vertical rolls were better than two but it did have to perform well enough that pilot skill, not equipment would become the determining factor in the results. All in all, coming up with such an aircraft was indeed a tall order for someone who was neither designer or homebuilder.

Fate, however, has a habit of smiling with occasional favour upon someone who has the vision (or stupidity) to dream the impossible dream. In this instance the favour came in the form of Chris Heintz, developer of the Zenith line of homebuilt aircraft and an aircraft designer of world repute. Now Chris is no aerobat, and indeed looks upon those of us who would so abuse ourselves and his aircraft with at least a little suspicion about our sanity. Nonetheless, with considerable prodding from Zenair demonstration pilot, Red Morris, he realized that lunatics get more publicity than normal people and that perhaps a Zenith in such hands could be worth a bundle of advertising. His basic all metal designs were simple, strong, and inexpensive. With relatively simple structural changes they could be strengthened to withstand the stresses of aerobatics. He already had an aerobatic wing option for the CH200 so starting with the single seat CH100 mono-Zenith he introduced the first aerobatic Acro Zenith complete with a red flame paint job straight off a 1950 Ford and put it in the hands of the local lunies (e.g. Canadian Aerobatic Team member Frank Jenkinson and myself) to see what would happen. Frank flew it at Oshkosh and Orillia while I decided to push it towards competition having recently unloaded my Pitts. The CH150 was a lovely little sport; great fun to fly, but unfortunately not quite unlimited calibre. The good news however was that with a larger engine and a few design alterations, it could be.

Through the summer of 1980 I flew the "Lil Red Devil" and made careful notes of its flying characteristics and the changes I would need. Sitting down with Chris I discussed each change and asked him to design a Super Acro Z. His answer was "It's not the kind of airplane I design and you are not the type of pilot I usually design for, but since it will do what you want, I will design it for you. It will be up to you to find a market for it."

That winter brought numerous long weekend trips from Ottawa to Nobleton, Ontario much cutting, drilling, fitting, deburring, (oh how we came to hate that job) and at long last rivetting. Painstakingly, with a lot of help from Chris, Gerry Boudreau, and many friends the prototype, now dubbed The J-Bird, took shape. Less than eight months from first cut the J-Bird first spread its stubby horizontal wings and leapt off its perch at a small field north of Toronto. And what a flight that was! The enormity of the achievement still escapes me. The Super Acro Z has lived up to every one of its design criteria. It rolls faster, climbs higher, and lands easier than a Pitts. First flight was followed by over 50 hours of careful testing as we explored each new area of its flight envelope. The aircraft was remarkably bug-free. Its performance left virtually nothing to be desired. It proved to be simple to fly with no bad habits at all. Its spin and recovery characteristics are the best the EAA Technical Committee pilots have ever seen. Its forward and rear fuel tanks allow it to be loaded to any C of G position in its range as well as providing 650 miles of cruise range. Late last fall we knew we had a winner.

The winter of 1981 was time to clean up the minor snags we had uncovered and add finishing touches and a point job so it would be ready for competition in the spring. Aside from cosmetic finishing, the only changes we made over the winter were to the stick gearing and the ailerons. The ailerons were made thicker with blunt trailing edges to icnrease their effectiveness counterbalanced at the tips. End plates were added to the wings to minimize vortex interference with the airflow. The aircraft now rolls 180° per second at **sixty** miles per hour!

Rolled out in mid-April in Gulfhawk orange and blue, the J-Bird will soon be seen cavorting over the competition zones of Ontario, Quebec, and the Northeastern United States. As of this writing, it is uncertain whether it will travel to Austria for the World Aerobatic Championships this summer or to Oshkosh and Fond du Lac, Wisconsin, but it is our hope to be one place or the other.

Wherever it goes, it is sure to attract a lot of interest and its low cost, short construction time, and superb all-round performance will open the world of unlimited aerobatics to more fledgling aerobats than ever before. It can be built in just eight months (we did it) for less than $25,000.

AIRCRAFT SPECIFICATIONS TECHNICAL

Single seat, low wing monoplane, blind riveted aerobatic aircraft stressed to - ±12g's ultimate.

Wings: Single spar, stressed skin, blind riveted, outer panels removable for transportation. Airfoil NACA 0015; full span, symmetrical airfoil-shaped ailerons, aerodynamically balanced.

Fuselage: Rectangular section, four longerons, stressed skin, rounded top.

Horizontal and Vertical Tail: 2-piece stressed skin fin plus movable surface horizontal and vertical tail, airfoil NACA 0012. Trim tab on horizontal tail.

Cockpit: 25" wide, 52" long for seat, parachute and harness. 1-piece bubble canopy.

Gear: 1-piece aluminum spring leaf landing gear with 500 x 5 wheels. Speed fairings and hydraulic toe brakes, steerable tail wheel, cockpit tie-down release hook.

Engine: 4 cylinder horizontally opposed up to 200 HP. Inverted fuel and oil systems. Front and Rear fuselage fuel tanks, 1 gal. aerobatic header on rear tank. Zenair fixed pitch wood propeller. No electrics.

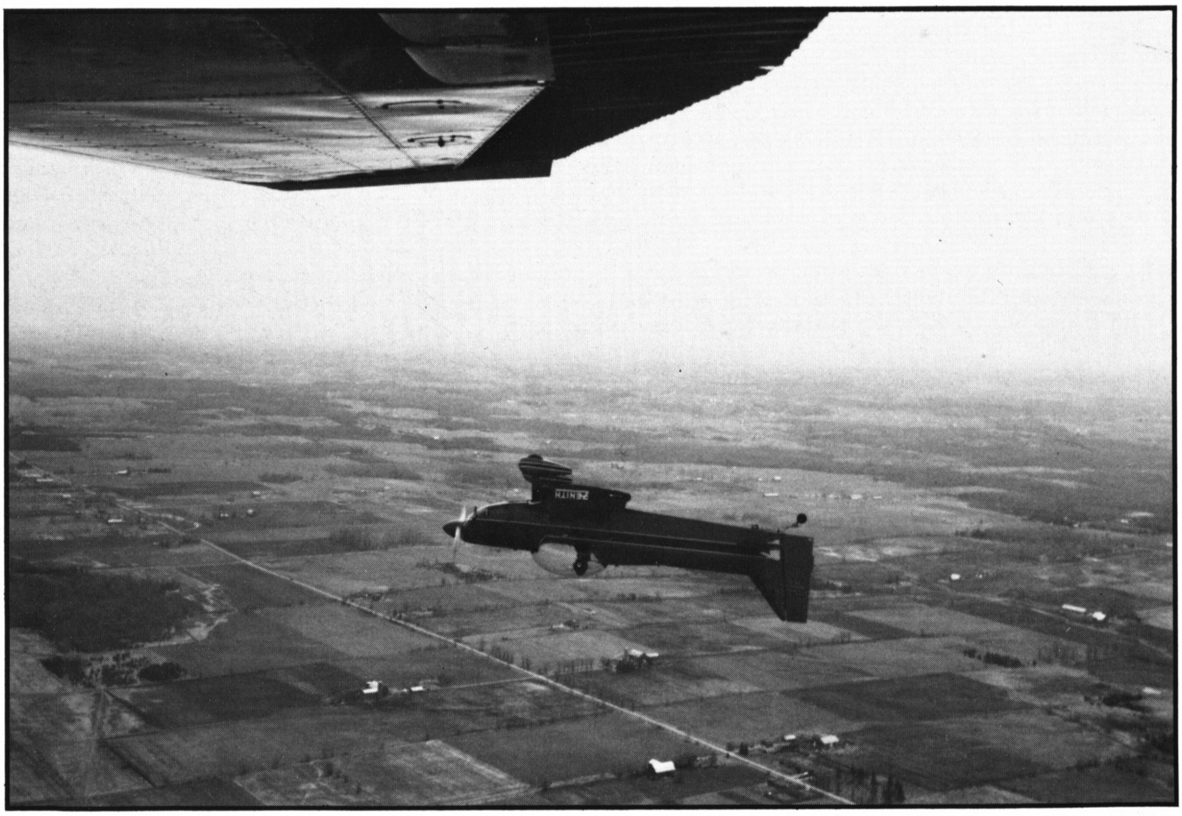
Gross Weight (Aerobatic)	1150 lbs. (520 kg.)
Empty Weight	800 lbs. (360 kg.)
Useful Load	350 lbs. (160 kg.)
Fuel Capacity: Front	12 US gal (45 L.)
Rear with header	20 US gal (77 L.)

PERFORMANCE
(200 HP)

Stall Speed	52 miles per hour (84 kmh)
Rate of Climb	3,000 feet per minutes (915 m/m)
Cruise Speed (75% Power)	190 miles per hour (305 km/h)
Never Exceed Speed	260 miles per hour (415 km/h)
Range at 55% power	650 miles (1,040 km)
Rate of Roll	270° per second
Flight Envelope	±8g

DIMENSIONS

Fuselage Length	20 ft 3 in (6.170 M)
Wing Span	20 ft 2 in (6.140 M)
Removable Wing Panels (each)	6 ft 4 in (1.940 M)



Wing Area	85 sq ft (7.9 sq M)
Elevator Span	7 ft 5 in (2.260 M)
Height	5 ft 5 in (1.350 M)
Horizontal Tail Area	17.4 sq ft (1.6 sq M)
Vertical Tail Area	9.5 sq ft (0.9 sq M)

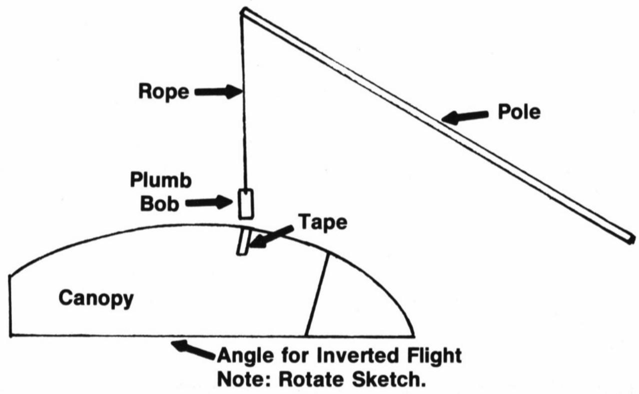
Landing Gear:

Main Wheel Base	4 ft 10 in (1.460 M)
Main to Tail Base	14 ft 0 in (4.300 M)

Kit Cost $13,000 U.S.; available from:
Aerovol, 2689A Sandalwood Drive, Ottawa, Ontario
K1V 7P4 Canada
Telephone: (613) 621-6839

Terminating The Tics

By Sam Burgess
IAC #23



After judging at Fond du Lac it was evident that when most contestants approached the end of the aerobatic box when inverted they would pull or push TOO SOON.

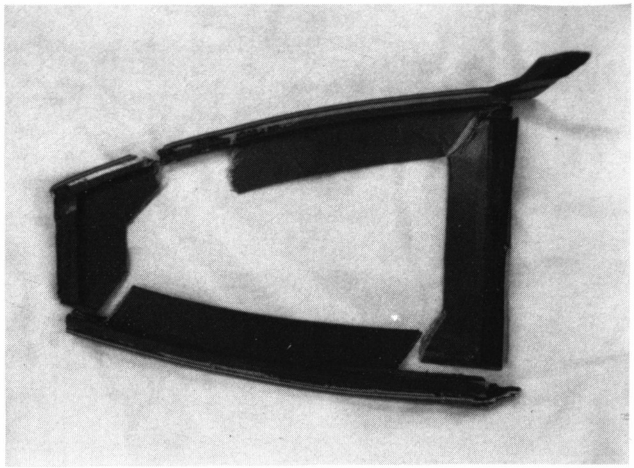
This was discussed with several pilots and the consensus was that they invariably came up short. Most figured they were not looking back far enough for that imaginary vertical line. This is probably caused in part by the increased angle of attack in inverted flight.

Most aerobatic aircraft, especially the biplanes, have "see through" floors where you can accurately judge when to pull, push or retard the throttle when right side up. Most two wingers have canopys so why not utilize it when inverted as we do the lexan floor?

Experimenting around with a strip of tape on the inside of the canopy varified that I was indeed not looking back far enough to fix the end of the box when inverted.

An inverted vertical line can be located by placing the aircraft tail wheel in the level flight position then raising the tail a few more degrees to allow for the increased angle when inverted. (As a safety precaution place some weights on the tail wheel). Have the tire kicker hold a plumb bob on the end of a six foot length of light rope attached to the end of a long pole exactly over your head. Tilt your head back and have him move the plumb bob until you are sighting along the rope. Mark the spot then lay a one foot length of tape spanwise on the inside of the canopy.

After several practice flights you may have to move the tape slightly but this will improve your positioning considerably especially if you have been pushing or pulling to soon at the end of the box from inverted in a strong headwind. This will put you "out south" downwind everytime.



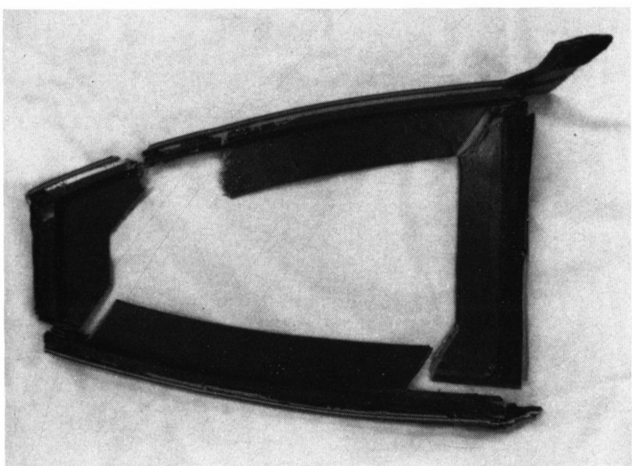
NOTICE TO ALL OWNERS & BUILDERS OF STEPHENS TYPE AIRCRAFT

The following IAC Tech Safety report was submitted by Henry Haigh relating some wing problems he encountered on his Superstar — a highly modified Stephens-type a/c. This is the same a/c that Henry flew to second place at the 1982 World Aerobatic Contest in Austria. (Note that Henry was second by 5 points out of 16,000 points — that is .03 percent!)

"The accompanying photo shows the total disintegration of one of the nose ribs from my Superstar. This is typical of every rib except the butt and tip ribs.

"While practicing for the Nationals last year, some small cracks in the skin started showing up just ahead of the spar and at the same time I noticed some small tooth-pick-sized pieces of wood coming out of the drain holes. The wing was deskinned during the winter for inspection. Total time on the wing at that time was 100 hours.

"Some early Stephens wing drawings showed a round lightening hole in the ribs with a minimum edge distance of 1⅛". A later drawing changed from round holes to a square cutout with a minimum edge distance of 1⅛" all the way around. The latter is a poor design as evidenced by my failure. The ribs should either have the round holes or be of a truss-type construction."



IAC members should refer back to the July 1982 issue of *Sport Aerobatics* which contained Kermit Weeks' Tech Safety article, "Attention: All Stephens-Type Monoplane Pilots," which also mentioned nose rib failures on Stephens-type a/c wings.

To comment briefly on Henry's article, IACers should note that IAC Tech Safety files reflect wing rib failures at the corners of the rectangular lightening holes, similar to the accompanying photo, on routed plywood ribs that have been used on some homebuilt Pitts aircraft. Also, cracks have been reported on Citabria and Decathlon aluminum ribs starting at the corners of the rectangular lightening holes. And, the butt rib on the RV-3, which has a large rectangular lightening hole. Trying not to take things too far out of context, an old (1925) NACA Report on the design of airplane ribs notes that ribs which have rectangular lightening holes usually reflect a poor strength-to-weight ratio when compared to other types of rib construction.

We have often noted that although some of the IAC T.S. reports are directed mainly to a particular aircraft, IAC members who operate aircraft of a similar design or construction to that of the a/c in question can benefit greatly from this input. Perhaps one very general conclusion that can be drawn from the above is that if you are operating an a/c which uses ribs (either plywood or aluminum) with rectangular lightening holes, keep a close watch at the corners of those holes for this is the area that is most likely to show signs of failure first.

Again, many IAC thanks to Henry for submitting the above info — we can all benefit from this kind of reporting.

NOT QUITE RIGHT

The following Tech Safety report that was submitted by an IAC member should serve to remind all of us (in a pretty dramatic way) of "a lesson" we have all learned before but that is easy to forget. When you have that "gut feeling" that something "doesn't fit right," "doesn't feel quite right," "doesn't sound right," etc., — that little clue, whatever it may be, that something is wrong but you can't quite spell out what it is — chances are pretty good that your senses are not being fooled and there really is a problem that warrants further investigation.

We all fly sport aerobatics as an avocation and we really don't want to have problems arise that interfere with our fun. But we are dealing with mechanical things which are subject to wear, breakage, etc., so we are always going to have to cope with these "normal" problems. As you read the following report think about the above and remind yourself that no matter how heavy the "psych" is to ignore strange noises, vibrations, etc., and just keep on flying, those little "clues" may just be trying to tell you something.

"About two years ago I bought a Starduster II — a beautiful airplane but it flew lousy. I say this because I flew a Great Lakes back in the old days and have several thousand hours in taildragger-type aircraft.

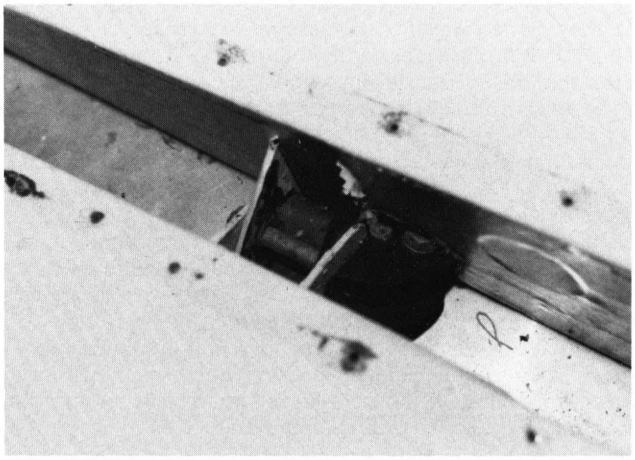
"Well, to make a long story short, I was just not satisfied with the Starduster, and I neglected to fly it regularly, in fact. This airplane was squirrelly on the ground, always wanted to ground loop to the right, and always flew right-wing heavy. I could just feel something was wrong, but I went over that thing over and over again. Oh, I still flew it but I did not like it and even contemplated selling it at one time.

"You know how the screws will get to looking bad and rusted; well, the plane was beginning to show a little of this so I decided to replace all the screws with stainless steel and clean up the plane a little. Also, this gave me a chance to get a little better acquainted with the plane. Even though the plane flew terribly I still think the Starduster II is one of the most beautiful ships ever built.

"I have done loops, rolls, snaps, stalls, spins, hammerheads, etc., in this plane. I might point out that all of the acro time has been flown off many hours previously. In fact, there are 460 hours on the airframe, and many violent maneuvers have been done in this particular machine. One day I snapped the airplane, and the left front flying wires really vibrated. I knew then that something was wrong; I landed and went to work looking again. I continued to remove and replace the rest of the screws from the top fairing. On the last one I looked down into the wing root attaching point to the center section and here is what I found. Where the center section cabane strut was to go through the wing fitting, whoever put the bolt through just simply missed the fitting, as you can see in the picture. I spent a night of no sleep just wondering what would have happened if I would have done a tail slide or some other violent maneuver???

"I am not sure if this was done to eliminate vibration or was an oversight on the part of the builder or what. But I called my mechanic and we proceeded to put the wing back where it belonged. Would you believe we just simply loosened up the front wires six turns, pushed the wing right in place, and I put the bolt through all of the fittings with my fingers. Absolutely no slop in the fittings whatsoever. I tightened up the front wires and test-hopped the airplane. You can't imagine what a difference this made in the performance of this airplane. The right ground-looping tendency is all gone, it will fly hands off, and lands perfectly.

This is my old girl, I got the wheel pants on her now.



What do you think of this? Over 460 hr. on this wing fitting. I checked with the previous owner, they had never touched a thing.

"I've really got me a bird now! I know why so many Stardusters are built now.

"Enclosed is a picture of just the way the fitting was found — might be worthwhile to pass on."

For this IAC member, his basic acceptance that "something was wrong" and his persistence in looking for that "something" finally paid off. There is a good lesson here for all of us. Many thanks to the IACer who submitted the above — hopefully we will all learn (and relearn).

In The Interest of Safety

LAST FLIGHT OF THE ACROSTAR

By Eric Müller (translated by Annette Carson)
Reprinted from British Aerobatic Association Newsletter. #38. November 1982

On 19 September 1982, a Sunday characterised by a flat high-pressure system all over the Continent, I started the day with an airshow in Freiburg (S.W. Germany) and then at 11.26 a.m. I made my way south west to Pau in France, 521 miles distant at the foot of the Pyrenees. At flight level 105 I enjoyed the pleasure of a 13.5 kt headwind component, bright sunshine (but I was wearing my hat), and a frugal lunch of 1 tomato-juice, 2 bananas and 2 orange-juices. At 15.05 the Acrostar and I touched down at Pau, where my next performance was due to start at 16.55, leaving me plenty of time to make unhurried preparations for my final airshow booking of the year.

Out with the overnight bag and the battery first, then a full preflight check, then time to seek out the commentator for the display, Pierre Peyrichout, a good friend of mine, to tell him that my show will be the same as he has already described to the public several times this season. Details were unnecessary, because he knew my show almost as well as I, so we had a little more time to catch up with the latest bush-telegraph news, a very important part of life on the airshow circuit.

At 16.47 I got take-off clearance and climbed to 6600 ft.; then 15 seconds before 16.55 I was cleared to begin my program, and at 16.55 precisely I was in position over the southern part of the runway, about 1000 ft. from the public. I started as usual with my power-off flat spin, but for no particular reason I suddently decided to recover at 2300 ft. instead of my usual 1640 - a decision which I was to realize one minute later gave me the chance to save my life. Such spontaneous decisions are fine as long as they are on the side of safety, and intuition can indeed be amazing.

I initiated the spin at 59 mph, pulled the pitch control to coarse, leaned off the mixture to idle, crossed the controls, and after three and a half turns was in a stabilized flat spin with the motor off.

In the hushed silence of the descending spin the Pyrenees speed past from left to right every 1.4 seconds. The needle of the altimeter turns constantly, and I check this at the half-way mark (4100 ft.) when 28 seconds have elapsed. Two thousand five hundred feet, two thousand four, two thousand three hundred feet and in that moment I simultaneously put in opposite rudder, in-spin aileron and up elevator - but I cannot get the stick into its normal position. Something has jammed. Although the elevator is in a roughly neutral position (I cannot get it back any further) I realize that the spin is nevertheless slowing down and, for the moment, I do not have to think of jumping out. In fact I recover in about 4 rotations instead of the normal two, and I manage to get the aeroplane into an almost horizontal attitude. No thoughts now of diving in order to get the motor started: first I must find out what's wrong with the controls. I try all possible stick and trim positions, but can get no improvement in the elevator efficiency. On the contrary, it simply gets worse and worse: the aircraft continues to become more unstable and the nose goes into a most unpleasant diving attitude.

I tell the tower that I have something wrong with my controls and I am going to crash. I have an attitude 30° below horizontal and increasing. The controller replies that he will send the fire engine, and I think to myself "Idiot, what I need is an ambulance!" - but no, in fact an ambulance won't be any use to me either. The altimeter is indicating nearly 1000 ft. and I see the place approaching where I will crash. I want to open the canopy to jump, but the uncorrected path of the Acrostar will go straight into the crowd if I do. I am at a 45° angle now and I register with a little regret, but without emotion, that I am going to leave this world.

But then I take the decision to survive, and the computer in the back of my mind begins to work at high speed: a CAP10 in New York state with a screwdriver stuck in the elevator system - crew saved by a parachute jump; a Zlin 526 crashed in Triengen, Switzerland, with a pair of pliers wedged in the elevator system - I remember thinking at the time that they should have inverted the aircraft to free the obstruction.

Of course, from a position of calm on the ground afterwards it is easy to work out what should have been done, but I remembered it now and instantly gave full aileron to half- roll inverted and then push the stick. The nightmare was over. I had a wonderful aeroplane - a glider, in fact, and one that only worked inverted - but otherwise it was quite normal. I was able to turn back to the airfield, happy in the knowledge that I would not have to leave this world after all.

Ovcer the field I turned into the wind and realized now that the last phase of the operation must be carried out with great precision. My computer reminded me that Neil Williams had once landed after an inverted approach, when the port wing of his Zling Akrobat failed. The wing had started to fold upwards in erect flight, and Neil had to keep the aircraft inverted (in which position the wing stayed nicely in place) until the moment came to land. I concluded that he and I had the same problem at this point, which was to turn the aircraft back upright as late as possible: if you turn too low, however, the wing will hit, the aircraft will yaw, and the nose will be impaled into the ground. If you turn too high, the nose will drop and the same thing will happen. Both very unhealty!

So I established an approach speed of 90 mph and waited until I was low enough (about 20-25 ft.), then gave full aileron and saw the ground come rushing up to meet me. I registered that this would be an uncommonly hard landing; and the last thing I saw was the individual grass-seeds just below me. There the film breaks off.

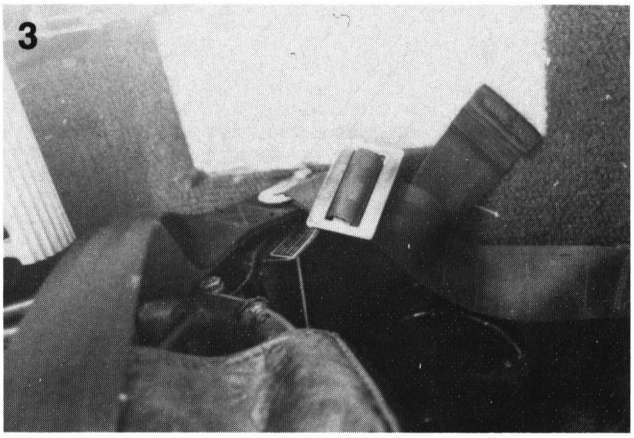
Some of my later fragmentary memories are of seeing the Acrostar lying broken on the ground with gear fully retracted . . . I can remember the noise of turbines of the rescue helicopter . . . the big X-Ray machines turning around me . . . and gentle hands stitching various parts of my moth back together again.

At 21.00 hours I woke up in a hospital bed with head injuries and four broken vertebrae. Gingerly testing my toes and legs, I realized that they were still working - marvellous! Everybody was so wonderful: the aero-club members from Pau, my fellow-pilots from the show (not least John Taylor) who came to my help, the Swiss Air-Rescue service, all served to prove just how close a family we are in aviation, especially in times of trouble.

It was not until three weeks later that I saw for the first time a video recording of the whole flight, and observed that my recollection of its duration was far longer than the few seconds that it lasted in reality - particularly the final moments.

The investigation revealed that the tube in which the Acrostar's stick is mounted had broken due to fatigue on one side and was displaced from its proper position, which reduced the extent of elevator deflection available to me.

This story is one more to add to the endless list of accidents and mishaps that happen to aerobatic aeroplanes which are not equipped with starters. If I had had a self-starting system, after turning to inverted I would have climbed safely to 3000 ft. and then enjoyed the experience of my first parachute jump!



CONDEMNED?

"Those who do not know the past are condemned to relive it." - Santayana

The above line of Santayana's might well reflect one of the major thrusts of the IAC Technical Safety Program, i.e, to disseminate as widely as possible collected aerobatic tech safety information so we can learn from other's experiences and each of us is not "condemned" to experience/relive every problem himself. Over the past summer the IAC Tech Safety Committee has received a variety of T.S. reports from the membership concerning problems (some with minor variations) that have been previously reported and noted in *Sport Aerobatics*. We all need recurrent training, so a brief review of these particular problems seems to be in order.

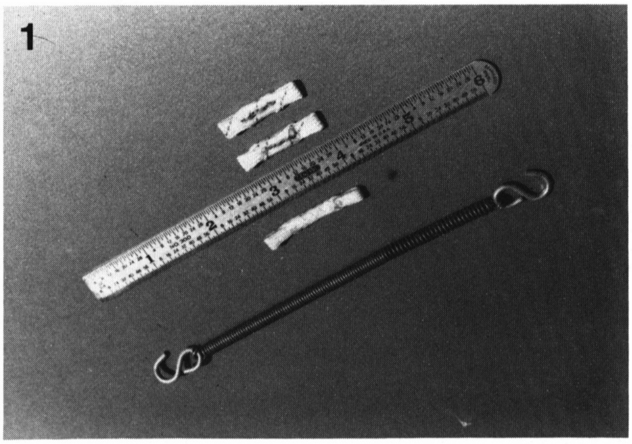
Past *Sport Aerobatics* T.S. articles have mentioned parachutes opening inside a/c and the need to use a cover on Citabria and Decathlon seat backs when the seat back cushion is removed. This summer an IAC'er reported that the metal straps on her Citabri seat back chaffed through the seat back cover and somehow entangled the "spring-S-hook" retention on the back of her Security Parachute. If you look closely at photo #1, you will see one end of the spring which connects the two "S" hooks has been stretched and deformed. IAC'ers will recall that early Security Parachutes used lacing cord between the "S" hooks and the ripcord pins and that the lacing cord was then replaced with a flat woven loop. Photo #1 shows the woven loop (between the scale and the spring) which replaced the lacing cord. This woven loop has now been replaced with a **shorter** woven loop (the two loops below the scale are examples of the **latest** loop). (For those who use Security Parachutes, if you are not familiar with the location and/or function of the spring, S-hooks, and loops, please consult your parachute owner's manual and/or previous IAC parachute T.S. articles for details.)

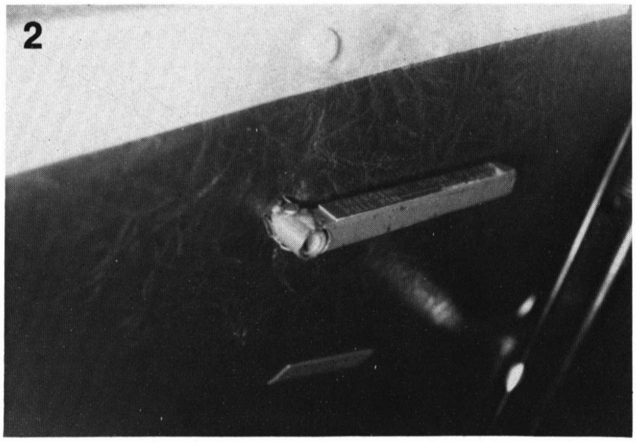
There have been several IAC T.S. reports regarding Citabria and Decathlon cabin door emergency release mechanisms — usually paint, rust, misalignments, etc., which render the emergency release mechanism inoperational. A new twist was found this summer when one member's Decathlon had the pull-pin which unlocks the handle mechanism replaced with a clevis pin and cotter key. (See photo #2). Obviously, this defeated the emergency release feature on the cabin door. (Note: This IAC'er had just purchased the a/c which had just been "annualed.")

Some Citabrias and Decathlons equipped with seats with folding backs have had problems at the seat back hinge area. In a recent report an IAC member stated he was checking this area on a Decathlon because he was aware of other a/c experiencing problems with folding seat backs when he found the nuts on the bolts at both hinges were only partially installed and only finger-tight.

Another IAC member who was acting as an IAC Tech Safety monitor at an IAC contest reported finding one aircraft on which the propeller retaining bolts were too short. Way back in 1976 at the IAC Fond du Lac contest, one a/c was found by the Tech monitors to have prop retention bolts that were too short.

Broken belly stringer supporters (spreaders) on Citabrias and Decathlons have been previously noted in *Sport Aerobatics* T.S. articles. Additional reports





of broken string supports have been received. Checking the condition of these supports should be part of each Citabria or Decathlon pilot's preflight inspection.

The MLG attach thru-bolt on Citabrias and Decathlons is a high-strength internal wrenching bolt that is a 500 hour time change item. Real early Citabrias were built with a standard AN-7 bolt for the MLG thru-bolt. Years ago Bellanca advised that the old AN-7 bolts should be replaced immediately with the stronger, internal wrenching type thru-bolts. At an IAC Aerobatic Seminar last summer one of the attendees' early model Citabria was observed to still have the old AN-7 thru-bolts. These bolts are almost **guaranteed** to break.

Citabrias and Decathlons have gone through a series of brake line changes. Early production a/c used a straight aluminum line from the fuselage bulkhead fitting to the wheel cylinder. The same Citabria noted above with the old-style thru-bolts also had the old-style straight aluminum brake lines — and like the AN-7 thru-bolts, the straight lines are an "almost guaranteed to break" item.

Control blockage due to foreign objects running around loose inside acro a/c has been reported to the IAC Tech Safety Committee many times. Bolts, washers, P-K screws, combs, ballpoint pens, tape measures, coins, keys, etc., are some of the things that have been found in a/c tail sections. Last summer a report was received of a broken pop bottle in an acro a/c tail section. A visual inspection into your a/c tail section and a "belly pat" should be part of the preflight ritual.

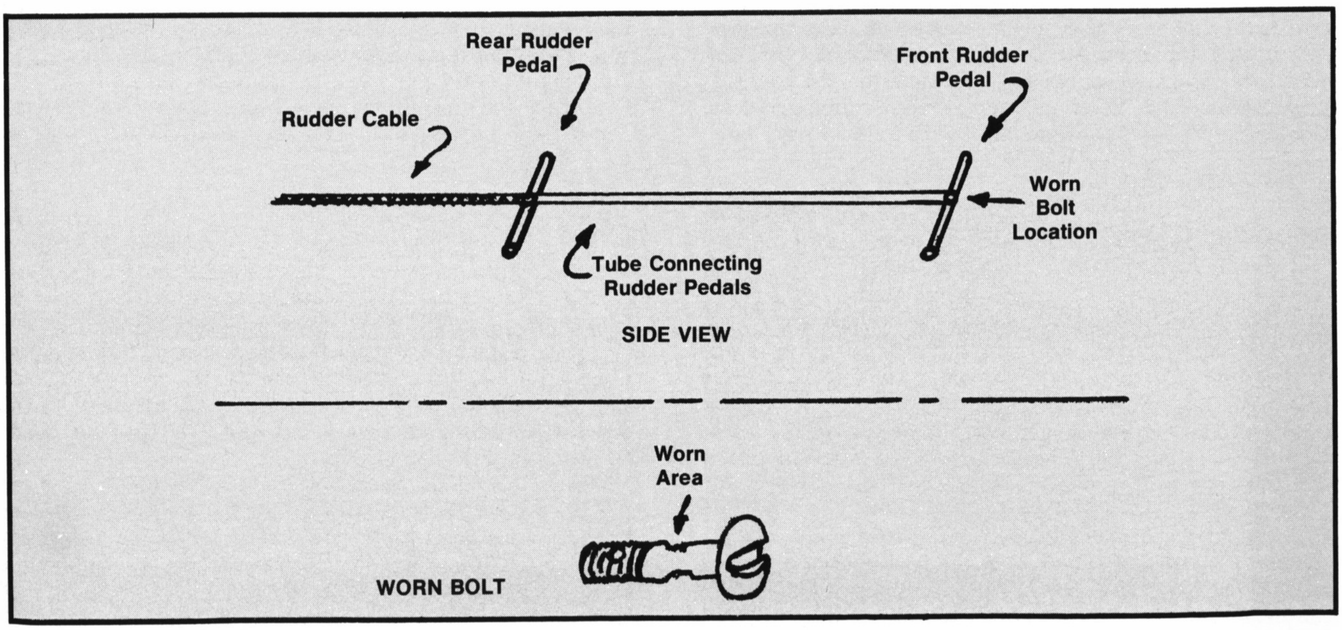
IAC contest rules require (and good sense dictates) the use of dual set belts **with separate attach points.** Several years ago a Pitts S-2A showed up at a contest with both belts attached to the same bolt. Last summer a Decathlon was observed to have the same belt attach arrangement. (Photo #3)

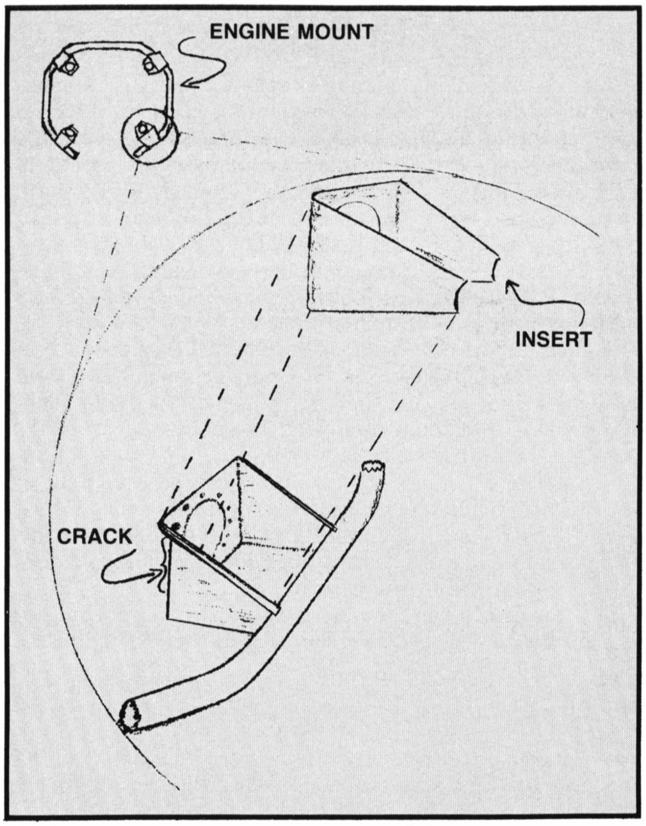
Cracked crankshafts/crankshaft flanges have been a reoccurring problem on high performance/upper category acro aircraft. This year at the IAC Fond du Lac contest another cracked crankshaft (on a Pitts S-1) was discovered. (Photo #4) Perhaps periodic dye penetrant checking of crankshafts would be a good idea for acro aircraft that are subjected to high (and frequent) loads.

All of the above service difficulties, with some variations, have previously been mentioned in IAC *Sport Aerobatics* Tech Safety articles. The intent of this T.S. article is to remind all of us to be constantly alert to possible problems related to aerobatic flight and aerobatic aircraft. A thank you is due to all the IAC'ers who took the time and made the effort to share their experiences so, hopefully, not all of us will be condemned to coping with the same problems.

DECATHLON RUDDER LINKAGE

The accompanying shop sketches and photograph show the location of a severely worn rudder linkage connecting bolt that was forwarded to the IAC Technical Safety Committee by an IAC member. The bolt was from a late model Decathlon with approximately 1500 hrs. total time and the wear problem was discovered during an annual inspection. The consequences if this bolt had failed are obvious. All IAC'ers who operate Citabrias and Decathlons which have the same type of rudder linkage would do well to closely inspect all connect/pivot points for wear. The IAC member who submitted the worn bolt info has previously contributed to the IAC Tech Safety Program — so, **again**, a thanks is due. Thanks.





"SAME-O, SAME-O"

Many times we have noted that if a problem with a certain component or certain a/c is reported, not only should members with exactly the same item or same model a/c pay close attention, but also should members with a/c that have **similar** components or are of **similar** construction.

Ben Owen from EAA Headquarters recently relayed some info to the IAC Tech Safety Committee that was in one sense **new** info but in another sense just a repeat of old problems.

One EAA member reported to Ben that one of the 10-32 top tail brace wires on his homebuilt Great Lakes had failed under approximately a 3 to 3½ G load. The a/c was flown back to the airport without further incident. It is suggested in the report that any Great Lakes type that is used in aerobatics use ¼" top tail brace wires. This is the first report IAC has received of broken tail brace wires on a Great Lakes, but there have been several reports of broken tail brace wires on Stearmans.

Ben also forwarded to the IAC Technical Safety Committee and FAA Service Difficulty Report noting that a pilot lost control of a Cessna C-A150L Aerobat when the lower frame of the pilot's seat broke during aerobatic maneuvers and the seat back reclined. This is the first seat failure report on a Cessna Aerobat that the IAC has received but several seat failure reports have been received (and noted in *Sport Aerobatics*) relating to Citabrias and Decathlons.

Again, thanks to the EAA member who reported the tail brace wire breakage and to Ben Owen for relaying the info to IAC. And, again, we should all remember that we can all learn from **each** and **every** report.

GREAT LAKES ENGINE MOUNTS

The quantity and quality of Technical Safety reports that have been recently submitted by IAC members have been excellent. The following report on Great Lakes engine mounts is an excellent example of how **our** organization can make **our** Technical Safety Program work for **our** mutual benefit.

"I have been competing . . . with some success the last three years in my 1929 Great Lakes. The plane has been updated, and is virtually identical to the modern version including the 180 H.P. Lycoming and engine mount which was purchased from the factory in Enid, Oklahoma.

"I had heard from various sources that this mount was prone to crack in the corners of the box section which the rubber engine mounts bolt through. Sure enough, after 220 hours time a crack approximately 1½" long showed up in the welded corner of the top left box.

"The cure was to remove the engine and mount, fabricate inserts with formed corners rather than welded corners, and weld them inside the original boxes, doing all four mounts. The original material is .065" and the inserts were made of .092" 4130 plate which is probably much thicker than necessary.

"It may be possible that this problem was corrected on later versions of the Great Lakes, perhaps the ones made in Georgia. If the corners of the box structures are formed rather than welded, then it is an improvement.

"At any rate, any Great Lakes owner, particularly aerobatic competitors (and all tech inspectors), should be aware of this flaw. It can occur in an area that is difficult to see and will only be noticed upon very close inspection. Needless to say, if this condition were allowed to progress, the results could be disastrous.

"The Great Lakes showed no other weaknesses and proved to be a fine competitor through intermediate category."

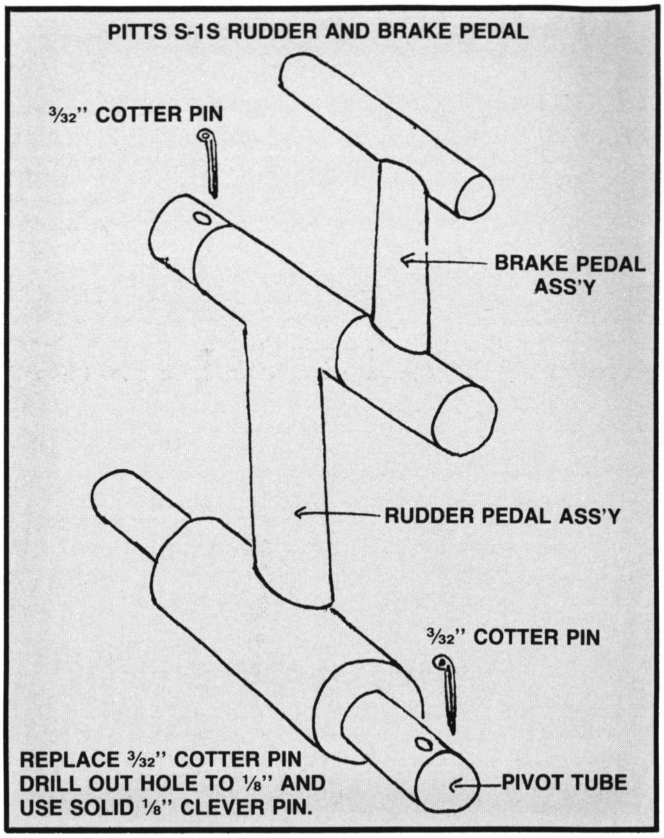
There are many things to be learned from the above report, but one of the most notable, outside of the crux of the report, is that this IAC member had been made aware of a critical area that needed close and constant inspection. One of the main purposes of the IAC Technical Safety Program is to point out these areas on the equipment that IACers use so that problems can be detected and rectified before they become catastrophic in nature. Many thanks go to the IAC member who submitted the above report on Great Lakes engine mounts — it reflects the essence of the IAC Technical Safety Program. Thanks.

PITTS PEDALS

An Australian IAC member reported that the Department of Aviation, Australia, issued an advisory circular concerning Pitts a/c rudder pedal retention pins. According to the report, the Pitts S-1 rudder pedal pivot pin is located in the mounting by a 3/32" cotter pin (see drawing) and in the particular aircraft alluded to in the advisory circular both rudder pedal cotter pins had sheared making it possible for the tube to drop out in certain maneuvers. This aircraft was modified by drilling out the 3/32" hole to 1/8" and using a solid 1/8" clevis pin.

A check with Pitts Aerobatics revealed that they were not aware of any other Pitts S-1 rudder pedal retention problems — and, in fact, had not previously heard of the rudder pedal problem in Australia. The guess is that insufficient end clearance was allowed when the pedal assembly was constructed so the cotter pins were subjected to a continuous side load. It is not known if the S-1 encountering the sheared cotter pins was homebuilt or factory-built. Pitts operators may well want to make a quick inspection of their rudder pedal retention pins.

IAC thanks to the member making this report and to Pitts Aerobatics for their continued interest and help.



Kermit Weeks, flying the "Weeks Solution", has become the 1983 National Aerobatic Champion.

STALL STRIPS

A couple of months ago an IAC member wrote to the IAC Technical Safety Committee and requested an IAC T.S. article in *Sport Aerobatics* on stall strips — theory, location, size, etc. Believing that a stall strip article would be of interest to many IAC members, the IAC T.S. Committee went to the "well of aerobatic knowledge" — the IAC membership. First, we contacted Dan Rihn who has written several good technical articles for *Sport Aerobatics* and asked if he would put together some basic stall strip information. The following is Dan's input:

"Stall Strips -

"Stall strips are used on several light planes; they are those small triangular strips located on the leading edge of the wing. The basic function of the stall strip is to disturb the laminar airflow (smooth) into a turbulent airflow (stall) at a lower angle of attack than the wing would normally stall. A secondary function of stall strips occurs when the turbulent air passes over the top of the wing — it creates a boundary or a fence. This fence will slow or stop the natural spanwise flow. Now, what does all this mean to this aerobatic pilot?

"If an airplane had a bad tip stall problem or if one wing were to drop during the stall, you could adjust the stall strips to help correct this. An aerobatic pilot might want an airplane to stall with a more definite break; the addition of these small strips could help make the airplane "break" more reliably. If the airplane were to have very ineffective ailerons during the stall, the use of stall strips just on the inboard side of the ailerons would help stop the spanwise flow and the turbulent air would actually be more effective on the aileron at high angles of attack. By installing the stall strips out near the wing tip on the leading edge, the outboard section of the wing will stall before the wing root. This is not a standard application, but for an aerobatic airplane it could help the snap roll characteristics.

"How the big aircraft factories determine where the stall strips should be located seems to vary from factory to factory. Mooney and Beechcraft install the strips after each airplane has been test flown, and then the strips are tailored to fit the needs of each individual airplane. Both Cessna and Piper determine the stall strip configuration on the first few test airplanes; then all the production models will be made exactly alike.

"All this boils down to mean that each airplane and especially each airplane configuration will have very different airflow characteristics during the stall. There is really no good way of determining your particular stall characteristics unless you are a qualified test pilot.

"If you feel you must install stall strips on your airplane, here are a few **very** general guidelines to follow:

"1) Always start with small (in length) stall strips;

"2) Start off by installing the strips near the wing root and move outboard on the wing very gradually;

"3) The smaller the airfoil nose radius, the lower in height the stall strip should be; and, conversely, the larger the nose radius, the higher the stall strip height can be. Here, again, it is better to start small at first.

"In closing, I would like to STRONGLY recommend that before anyone installs stall strips on their airplane they get good professional advice before they take off. Also, the FAA and your insurance company might not like the idea very well. Remember that stall strips are a very major modification to the airfoil and any modification will be altering the airplane in a way its designer may never have intended."

To supplement Dan's input, the IAC T.S. Committee contacted two aerobatic aircraft manufacturers, Pitts Aerobatics and Christen Industries, and a couple of well-known competition aerobatic pilots and asked about their experiences and feelings regarding the use of stall strips.

Herb Andersen, General Manager of Pitts Aerobatics in Afton, Wyoming, advised that they had tried stall strips on the new Pitts S-2B (see cover of November 1982 issue of *Sport Aerobatics*) to try to improve the snap roll characteristics of the aircraft. Herb further advised that with the stall strips they encountered an undesirable buffet above 140 mph IAS and with 5+ G's. The stall strips have subsequently been removed from Pitts S-2's and snap roll performance improvement is being linked to pilot technique. Herb said that the stall strips were not developed by Pitts Aerobatics but were Frank Christensen's idea and suggested that Frank would have more detailed info on stall strips.

Before following up on Herb's suggestion, we contacted an IAC member who had flown the Pitts S-2B for about 3 hrs. (competition practice and competition) with the stall strips installed. This pilot stated that he had **not** flown the S-2B without stall strips but felt the stall strips were a **disadvantage** to the aircraft and he personally could not live with the strips. The stall strips used were 60°/triangular in cross section. This IAC'er felt that with the strips it was almost impossible to make a positive "G" turn without "breaking loose" and when inverted, it would not "turn the corner". He said he felt the S-2B had a reasonably good snap roll, but not outstanding, and felt that possibly the a/c would snap as well without the strips. He also went on to say that he believed he did not know how to snap the a/c, i.e., he did not know the proper pilot technique. This IAC'er thought that many Pitts S-1S pilots become spoiled by the outstanding snap roll characteristics of the S-1 and really never learn snap roll techniques. In the same vein of thought, he stated that since flying the S-2B in competition, he was forced to learn to fly better and since that time has found that he now does better snaps in an S-2**A** than he previously had done. Again, an emphasis was placed on pilot technique. This gentleman then stated that he believes the Pitts S-2B to be the "finest aircraft to come along in aerobatics — a great airplane." As an aside, this pilot advised that after World War II he had done some airshow work with a Stearman which had full span stall strips on the lower wing and he felt that this a/c was better with the stall strips than without stall strips. (More Stearman comments below.)

Next, we talked to Frank Christensen of Christen Industries (Eagle aircraft) in Hollister, California, who had some very interesting comments on stall strips. Frank said they have used stall strips on the Eagle I. He said that when the constant speed prop was installed on the Eagle I, the greater weight of the propeller (as compared to a fixed pitch prop) moved the aircraft C.G. forward which resulted in a deterioration of snap roll performance. Stall strips were then installed on the aircraft to try to improve snap roll performance, i.e., to try and compensate for the negative effects of the further forward C.G. Frank noted that the size and placement of the stall strips on the Eagle I were important. The strips used on the Eagle I were 60°/triangular in cross section, ⅝" high, 18" long. They started with the strips installed midway between the wing tip and the wing root. Frank advised that locating the strips near the wing root was not very effective and placing the strips toward the outboard section of the wing, in front of the aileron, was the most effective location. With the stall strips in place, there was a deterioration in Eagle I high speed — high "G" stall characteristics. They felt it was harder to turn, "square-off," the corner from a horizontal line to the vertical. Frank made an interesting comment on pilot preference. He stated that one pilot (an unlimited competitor) who has flown the Eagle I does not like the stall strips. This particular pilot flies the a/c at high speeds and high "G's". Another pilot (advanced category) usually flies the a/c at lower speeds and lower "G" loadings (than the first noted pilot) and he prefers the stall strips. Frank emphatically stated that he feels that stall strips are a "patch" — a fix for something that is "not right". The Eagle I originally had a swept-back upper wing and a straight (non-swept) lower wing. Frank noted that the ultimate fix on the Eagle I was to sweep the lower wing rearward (wing tip location remained the same — wing root moved forward) which moved the a/c C.G. rearward — and snap roll performance improved. Importantly, Frank cautioned that stall strips may change an aircraft's spin characteristics — this may be especially true on aircraft with an aft C.G. location which normally spin rather flat.

Since we now had some input on stall strips as related to two high performance acro aircraft, the Pitts S-2B and the Christen Eagle I, we felt some comments on a "mid-performance" acro ship would be in order. We already had one pilot's opinion on stall strips on a Stearman (see comments above) so we contacted another pilot whose well-known father flies a 450 hp Stearman. He advised that his dad has flown the 450 Stearman both with and without stall strips. The purpose in installing the stall strips on the Stearman was to try to improve the snap roll characteristics on the a/c — which, indeed, the strips did accomplish. However, the installation of stall strips on the Stearman was accompanied with a buffeting, both positive and negative "G," when pulling and pushing. Since this particular a/c is used for low altitude airshow work, the pilot felt he wanted a "more honest" aircraft so the stall strips were removed. It was also mentioned that with the engine/ prop combination that is employed, the pilot isn't particularly crazy about doing snap rolls anyway.

Moving to what is generally considered a low-performance acro aircraft, we checked on stall strips on Clipped Wing Cubs. Giles Henderson wrote a series of articles for *SPORT AVIATION* in 1972 on "The Clipped-Wing 'Cub' and Competition Aerobatics". These articles were reprinted in *Sport Aerobatics* in 1979 and also appear in the IAC Technical Tips Manual. When listing modifications and improvements for the Cub, Giles mentioned the following: "Some pilots prefer to add stall strips to the leading edge of the wing (typically 7 in. long, installed directly in front of the strut fittings). This will change the flight characteristics considerably. In particular, snap rolls may be executed at substantially lower wing loadings. The abrupt, high-speed stall characteristics may or may not be desirable." We also checked with an advanced category pilot who used to own and compete in a Clipped Cub. He stated that he installed stall strips with the intent of trying to improve snap roll performance. He said that they started with **full span** stall strips and with this configuration the Cub would sometimes exit a loop at 90° to the original heading with no change in control input by the pilot, and, in fact, the pilot would not notice any change in "the feel" of the aircraft. From this point they started reducing the length of the strips and ended up with stall strips approximately 12 inches long located 12 to 18 inches outboard from the wing root. The strips were made from moulding from a hardware store and taped on the wing. In its final configuration, the Cub did have improved snap roll performance with no adverse characteristics. This gentleman reported the Cub experienced no buffeting — but pointed out that all maneuvers were low G, low speed (max. 120 IAS), and positive. As an additional comment, he stated that he once built up a Clipped Taylorcraft and, because of a slight twist in one wing, ended up using one stall strip. this corrected "a one wing down" stall problem. He also stated he believes stall strips should be tailored to **each** individual aircraft.

In general, it seems the higher the performance capabilities of the a/c and the harder the a/c is flown, the more critical stall strips become.

In conclusion, a very large thanks is due Dan Rihn for his input related to basic stall strip theory; to Herb Andersen and Pitts Aerobatics, to Frank Christensen and Christen Industries, and to the other IAC members who so freely gave their time to relate the products of their efforts in stall strip investigations on a wide range of acro aircraft; and to the IAC member who initially brought this topic to the fore. The number and variety of people who contributed to this article should serve to remind us that we are all members of the IAC Technical Safety Committee — and more importantly, of the aerobatic community — and by pooling our knowledge/experiences we can advance our sport and maintain safety in our community. Again, an IAC thank you to all who helped.

P.S. No doubt the NACA must have published several technical reports on stall strips. But during our brief inquiry into stall strips we did not turn up any NACA reports. If any IAC member would have a copy of an NACA stall strip related report, it would be appreciated if the same were forwarded to the IAC T.S. Committee.

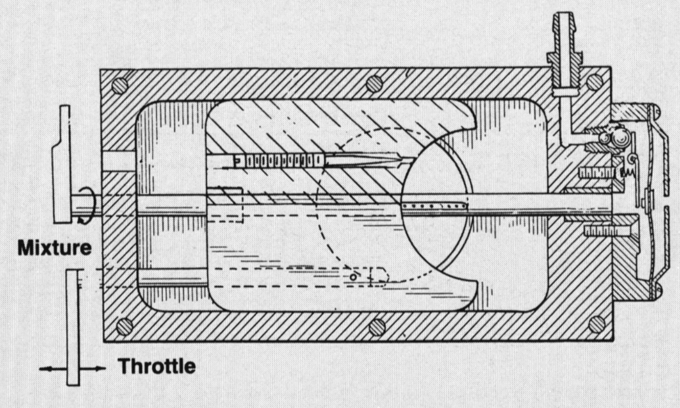


FIGURE 2

EFS THROTTLE BODY INJECTOR

EFS THROTTLE BODY INJECTOR

By Ben Ellison

Now that Quiche eating has been established as one of the things that "Real Men" don't do, I am interested in making "Pitts Propping" a similarily excluded pastime for us hairy-chested he-men. It is not my intention to eliminate manual starting altogether, but to make it simple and dependable enough that any women or child can provide the muscle power while "Real Men" remain seated in the cockpit.

In support of this objective we have developed the EFS fuel metering system pictured in figure 1. This device allows very dependable, consistant, engine starts as well as several other performance benefits described later in this article.

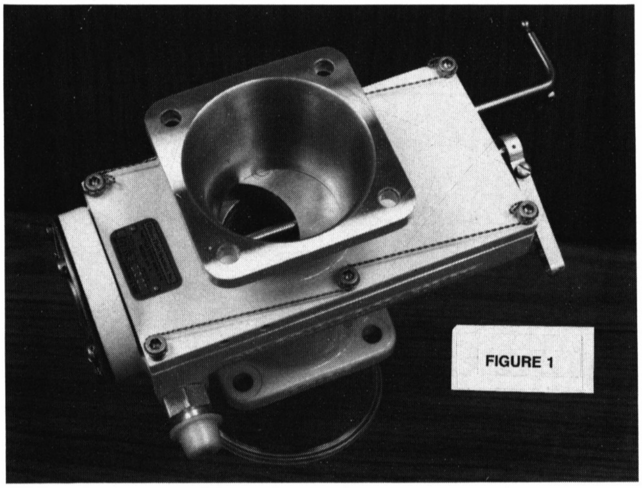


FIGURE 1

In order to give this simple system an aura of sophistication as well as to obscure its similarity to the block carburetor used back in 1918, we are refering to it as a Throttle Body Injector. The numbers in the model designation (EFS-4, EFS-4-5, etc.) refer to the SAE flange and bore configuration. This is similar to the nomenclature used by Marvel-Schebler (MA-4-5 and Bendix (PS-5, RSA-5, etc.). The letters EFS denote Ellison Fluid Systems Incorporated, the corporation formed to develop and market this device along with some other accessories I will mention later.

The EFS system shown in cut-a-way in figure 2, is a variable venturi device in which the fuel injection always occurs in the plane of minimum airflow area. Fuel injection occurs through a matrix of very small metering holes located in a tube extending across the entire width of the airflow passage. Fuel is admitted to this metering tube by a demand regulator designed to maintain fuel pressure in the metering tube at -0.1 psig. The metering tube is positioned in a bore through the throttle slide. Movement of the throttle slide thereby controls fuel flow as well as airflow by changing the number of metering holes exposed to the airstream.

Rotation of the metering tube through a maximum angle of 90 degrees changes the orientation of the fuel metering holes with respect to the airflow. This rotation serves as the pilot's mixture control. Idle cut-off occurs when the holes are facing directly into the on-coming airflow, and a progressively richer mixture is obtained as the holes are rotated away from the zero angle of attack position.

Because the fuel pressure in the metering tube is maintained below ambient pressure, fuel will not flow from the metering holes unless induction air is flowing through the air passage. This feature permits the engine to be shut down without the necessity of turning off the main fuel valve.

Fifty percent of the idle fuel is supplied from a hole in the idle range of the metering tube, and fifty percent from a needle valve provides the necessary idle mixture adjustment, while that portion of the idle fuel discharging from the metering tube assures that the engine will kill when the mixture control is placed in the idle-cut-off position.

The idle throttle setting is adjusted by a set screw attached to the throttle control arm.

STARTING:

Cold starting an engine equipped with the EFS system requires priming the induction system. This can be accomplished with a primer or by the momentary activation of an electric or manual fuel boost pump. The primed engine, after being pulled through 3 blades with the ignition switch off, will start on the first or second pull following "contact".

Hot starts are made in the same way except that the addition of prime fuel usually is not necessary.

FIGURE 3

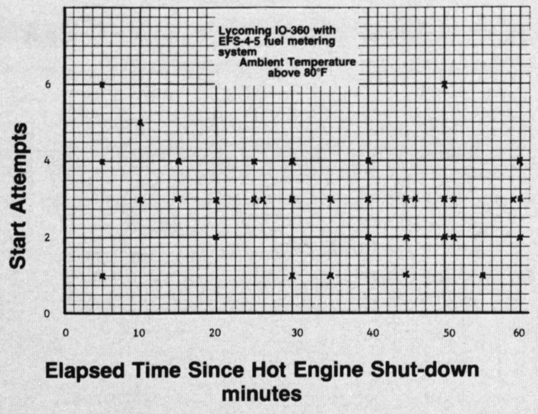
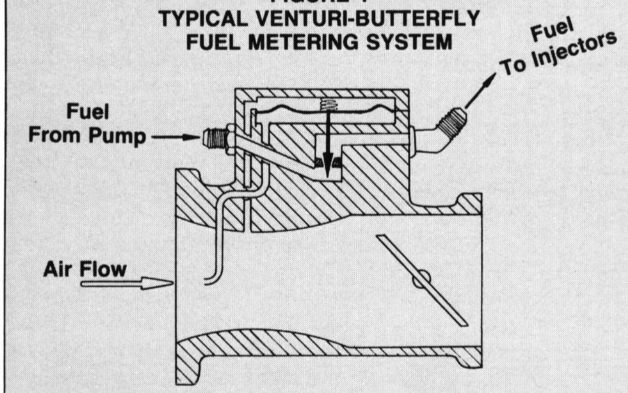


Figure 3 documents 35 consecutive starts of an IO-360 equipped with an ESF-4-5. The horizontal coordinate of each point represents the elapsed time since hot engine shutdown. The vertical coordinate represents the number of propping attempts necessary for starting. Each start was accomplished after the engine had initially been flown, then shut-down and allowed to heat-soak for the time indicated. This data was taken with ambient temperatures equal to or greater than 80 degrees F.

ALTITUDE ENRICHMENT:

Nearly all aerobatic aircraft use either the Bendix RSA-5 fuel injection system or the Bendix PS-5 pressure carburetor. These two systems are similar to each other in that: a) airflow is controlled by a butterfly valve located downstream of a venturi section, and b) diaphrams are used for fuel metering. This basic configuration is illustrated in figure 4, and throughout the remainder of this article will be referred to as the butterfly/venturi system.

FIGURE 4
TYPICAL VENTURI-BUTTERFLY
FUEL METERING SYSTEM



In the butterfly/venturi system the venturi serves to amplify the difference between total pressure and static pressure in the airflow passage. These signal pressures are a function of air velocity through the venturi throat, and are transmitted to a series of diaphrams which meter fuel into the air at a rate proportional to air velocity.

As the aircraft altitude increases, the lower air density requires opening the throttle to maintain the desired engine manifold pressure. Opening the throttle produces a higher air velocity through the venturi, causing the diaphram to schedule more fuel. This extra fuel, caused by the pilot's efforts to maintain the same engine power, is the source of the altitude enrichment which we correct for by proper use of the mixture control.

The fluid dynamics at work inside of the EFS system is entirely different; here's how . . .

In the EFS system, an increase in altitude requires opening the throttle to maintain engine airflow, just the same as with the butterfly/venturi system. The important difference is that opening the throttle of the EFS unit causes the air velocity to decrease rather than increase as it did in the butterfly/venturi system. This is true because opening the throttle of the EFS yields a larger flow area in the plane of the metering tube. Actually, this lower velocity would result in less fuel, except that as the throttle is opened more metering holes are exposed to the airstream. When the metering tube is properly matched to the engine these two effects cancel out giving the relatively flat altitude enrichment character shown in figure 5. Also shown in figure 5, is the altitude enrichment characteristic of a typical butterfly/venturi fuel metering system.

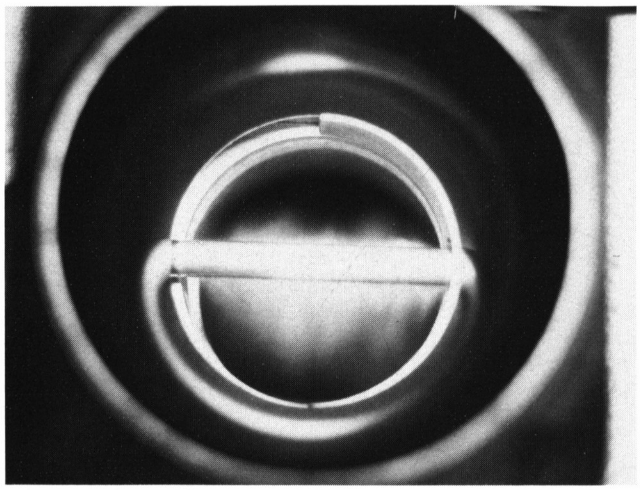
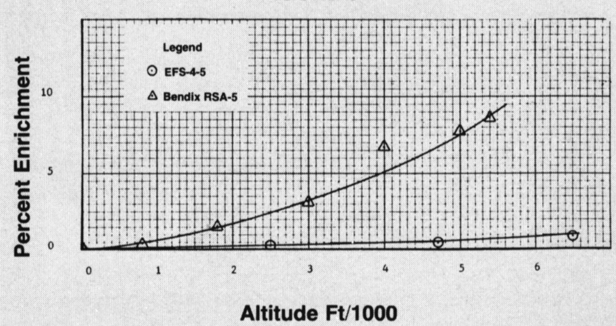


FIGURE 5

FUEL DISTRIBUTION:

Fuel distribution, as measured by EGT uniformity, is equivalent to that observed in the Bendix RSA-5. Figure 6 pictures fuel discharging from the metering tube of an EFS-4 installed on a Lycoming O-320 engine.

FIGURE 6



INDUCTION PRESSURE LOSS:

In conventional fuel metering systems, the venturi diameter is defined by the minimum signal pressures required to drive the metering diaphrams. Fuel metering in the EFS system is accomplished with unusually low signal pressures. Consequently the air inlet diameter can be larger than the venturi diameters used in either the RSA-5 or the PS-5. This larger inlet area results in a measurable increase in full throttle manifold pressure. Table 1 below lists the cross sectional airflow area of the EFS- 4-5 as well as three other fuel metering systems commonly used on the O-360 series engines.

Table 1

Manufacturer	Model	Airflow Area (sq. in.)	Weight (lbs.)
Ellison	EFS-4-5	2.64	3.11
Bendix	PS-5	2.07	6.85
Bendix	RSA-5	2.40	7.64
Marvel-Schebler	MA-4-5	2.58	5.25

Figure 7 shows inlet pressure loss of the above listed fuel metering systems. These curves can be related to full throttle manifold pressure as follows:

For a comparison of the EFS-4-5 with the MA-4-5, the inlet loss for each unit is read from figure 7 at full throttle airflow (1220 lbs. per hour for a 200 hp engine). The inlet loss for the MA-4-5 is 12.5 inches of water while the loss for the EFS-4-5 is only 5.5 inches of water. The difference in loss between these two systems is:

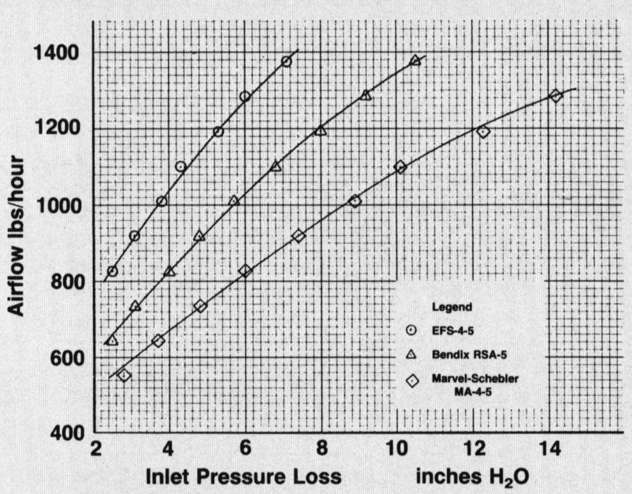
$$12.5 - 5.5 = 7.0 \text{ inches of water.}$$

This difference is divided by 13.6 to get its equivalent value in inches of mercury.

$$7 / 13.6 = .5147 \text{ inches of mercury}$$

This shows that an increase in full throttle manifold of about 0.5 inches of mercury would be obtained by substituting a MA-4-5 with a EFS-4-5.

FIGURE 7



FUEL PRESSURE:

The EFS-4-5 is usually operated with a conventional 4 to 6 psi A/C diaphragm fuel pump. It can, however, be configured to give satisfactory, all-attitude performance without a fuel pump provided that a floor level header tank is installed.

WEIGHT:

The weight of the EFS-4-5 along with the other popular fuel metering systems are listed in Table 1 above. Table 2 below illustrates the airframe weight reduction available if the EFS-4-5 replaces a Bendix RSA-5 injection system in an aircraft equipped with a header tank.

Table 2

Item Removed	Weight (lbs.)	Item Installed	Weight (lbs.)
Bendix RSA-5AD1	7.64	ELLISON EFS-4-5	3.11
Christian 844 Manual Pump	2.64		
A/C Fuel Pump	3.00		
TOTAL	13.28		3.11

Net weight reduction 10.17 lbs.

G-LOAD TOLERANCE:

During flight tests on a Lycoming IO-360 with the EFS-4-5 installed, no change in exhaust gas temperature was observed with changes in attitude or G-load. Similar tests with a Bendix RSA-5 revealed a 50 degree F drop in EGT when going from +1G to −1G.

FUEL FILTRATION:

A 150 mesh removable finger screen is built into the EFS body and serves as a "last chance" filter. In accordance with good design practice, an airframe mounted filter of equivalent or finer mesh should be installed between the fuel tank and fuel pump.

AVAILABILITY:

There was a brief description of the EFS system in the April 15 issue of Aviation Consumer. This short piece resulted in a flood of correspondence from the home-building market. Because we have a very limited production capacity and because we have only developed the EFS models for the O-320 and O-360 series engines, we are delaying serving this market until a production agreement with a suitable manufacturer can be arranged. Until then we will reserve our small production capacity (about 10 units per month) for interested IAC members. Accordingly, the EFS-4-5, configured for the O-360 series engines, will be available to IAC members for an exchange price of $965. We will accept in exchange, any of the units listed in table 1.

In addition to the fuel metering system herein described, we have also developed the following:

1. A front mounted propeller governor system: This unit, which uses a lightweight Woodward governor, mounts on the alternator drive pad and is belt driven from the crank shaft.
2. A light weight, 4 quart oil sump: This sump eliminates the annoying oil pressure fluctuations which are common with the standard 200 hp sump. It is a remanufactured unit originally built by Lycoming for a Photo-reconnaissance drone that used an IMO-360-B1B engine rated at 225 hp. This sump will permit stable oil pressure to the 1 quart level and yields a net weight saving of 8 pounds.

Ellison Fluid Systems, Inc.

Hi-Performance Fuel Metering Systems
Aircraft / Automotive / Marine

20820 Bristol Ln.
Olympia Fields, IL 60461

Ben Ellison, President
(312) 748-9338

Tech Items From Last Summer

By F.H. "Moon" Wheeler

As I write this, a cold wind is howling around the house. It's the middle of December, the winter solstice less than a week away, and the Pitts is in hibernation. Resigned to a long Wisconsin winter, I was leafing through *Sport Aerobatics,* thinking about how the judges failed to appreciate the brilliance of my flying last summer. The calendar of events caught my eye, and it suddenly occurred to me that we would be flying again in less time than it takes to run your chute pack card out of date. It was time to put the pencil to the paper.

Last summer I was fortunate enough to attend 6 contests, and was involved in tech inspections at 4 of them. It was interesting to see how tech problems varied from contest to contest, and how often old problems turned up. I saw only one problem that had never been written up in *Sport Aerobatics* (more on that later). Here's a list of some of the problems;

Contest #1. The chapter that mounted this contest is very tech oriented, and also has held many contests over the years. Their expertise results in a well-run contest with many contestants coming back year after year.

Item A. A large chunk of foam rubber from a seat pad found in the tail post area.

Item B. Several prop nicks, some needing immediate attention (filing).

Contest #2. This contest exhibited more tech problems than the others, probably because it was attended by several 1st time contestants, and several contestants who do not have the benefit of chapter membership. Members of IAC Chapters seem to have airplanes that are better inspected than others; more eyes see more things, I suppose.

Item A. A Citabria with a broken belly former lying loose in the tail. Also found part of broken pop bottle in the tail. Pilot was very surprised.

Item B. Biplane with all prop bolts at least ½" too short, and prop tips deteriorated (wood prop).

Item C. Three tail wheel casting to spring attach bolts loose, all causing tail wheel shimmy.

Item D. Three loose wheel pants.

Item E. One tire almost flat (rental airplane).

Item F. Several prop nicks that needed filing.

Item G. One pilot who had left his pilot certificate at home, a long way away. He couldn't compete, but stayed and worked anyway.

Item H. Two airplanes with questionable fabric. Cracks in dope, peeling paint, one trailing edge reinforcing tape peeling off.

Item I. A Pitts S-2 with aileron movement restricted to ½ normal by gap seals. Like a fool I told the pilot about it before I found that he was flying in my category.

Item J. One worn aileron slave rod end bearing, one slave rod with oversize bolt holes.

Item K. Here's the new one. In a Citabria, the pilot's chute opened due to the chute locking pins working on part of the seat back structure which was exposed by a hole in the canvas seat back cover. (This canvas cover remains on the seat back when the cushion is removed to accommodate a chute.) The pilot kept her cool, landed without incident, and immediately started warning other pilots to check those seat covers for holes.

Contest #3. Another established, well organized contest, with no tech problems that I know of. An interesting flight problem, however. A student pilot on cross country flew through the box after two radio contacts (which he acknowledged) warning him of aerobatics in progress and advising **right** traffic pattern. He flew through the box on **left** downwind, but made up for it later on take-off by taking the active in front of a landing Pitts which was 200 yards out on final, forcing the Pitts to make a close go-around. We were all glad to see that pilot leave the area.

Contest #4. A new contest, put on by a technically aware, well-organized chapter. Almost no problems, but we did find a Pitts S1 slave strut rod end lock nut and fitting loose.

Contest #5. This contest was about average as to the number of tech problems, except for paperwork. In this area it was much worse than the others, but I have no idea why.

Item A. One loose tail wheel bolt with resultant shimmy.

Item B. Two biplanes with prop bolts too short. One because a spinner change led to a spacer which required longer bolts, but the requirement was not noticed.

Item C. One homebuilt Pitts with almost no aileron to wing clearance.

Item D. Several trim tabs with slop in the linkage, inviting flutter.

Item E. A Decathlon that was a classic textbook example of the damage that battery acid can do to an airframe. It was a rental airplane with a recent annual that was flown a lot of miles to the contest. The pilot was not aware of the need to inspect the battery area and did not do so. Acid had been splashed all over the inside of the fuselage from the battery location back to the tail post. Stringers were warped and distorted, one belly former was loose, the fabric was loose and sagging, control cables were badly corroded, and the airplane required repairs to make it safe to ferry home.

Item F. Several loose odds and ends found floating around the tail post area in several airplnes.

Item G. Broken crankshaft found not by the tech committee, but by a sharp-eyed IAC member who was consulted on the failure of the crankshaft seal.

Contest #6. Not many airplane problems, but like #5, a lot of paperwork problems. In both contests it took over two days to get them all sorted out. Pilots collectively forgot **everything,** and it caused a lot on unnecessary headaches. Hope everyone makes a New Year's resolution to come prepared next time, like the pilot who handed the tech committee one sheet of paper on which he had photocopied his pilot certificate, medical, insurance certificate, and waiver. He got a big smile and fast service!

I was bitching to a group of judges about the tech paperwork, and they filled me in on the paperwork problems that judges experience. Some of it was so bad that there was no way the contestant could be fairly scored. Add judges paperwork to the above resolution (unless you're in my category - I need all the edge I can get). And by the way, don't forget the new insurance requirement - it's $1,000,000.00 now.

All in all it was a most interesting year, and I'm looking forward to 1983. If maybe I could put a little nitro in the fuel, lifts in my shoes, dye my hair and get a brain transplant, then I could show 'em!

WILSONAIR

Ocala *Florida*

AEROBATIC AIRCRAFT OF THE MONTH

H'lo Folks —

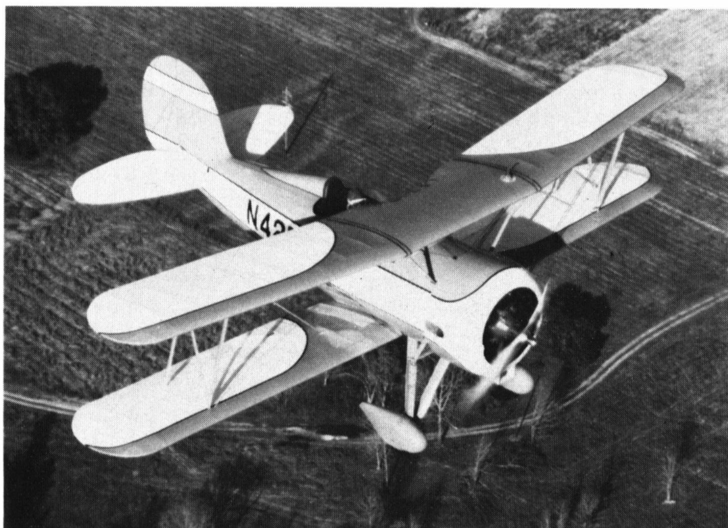
I've had a lot of inquiries about this airplane as it's the only one I know of with a 220 Continental engine. Dave McKenzie from Detroit built a similar Great Lakes several years ago but it was destroyed in an airshow accident.

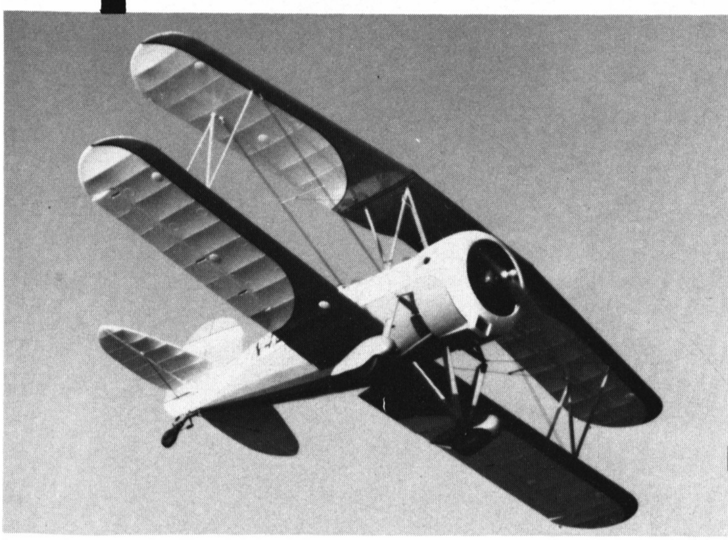
This airplane was built by Art Henderson of St. Paul, Minnesota in 1972. It is built from the original factory plans with a few changes, such as, all wood ribs, all steel tail and of course the engine installation. It had very little use until I bought it a year ago. I sealed the ailerons and made up some spades which has doubled the roll rate. It makes a great sport aerobatic machine that is a joy to fly. The thing I like so much is that it looks like real antique of the 30's and has the "Laird" or "Gee-Bee" look and yet has a reliable, available engine, modern hydraulic breaks with steerable tailwheel and cruises at a respectable speed. I flew it to Lakeland "Sun 'n Fun" and won the Grand Champion Replica Award for 1982.

Best Regards,
Robert E. Wilson
IAC #97
EAA #9702

GREAT LAKES 2T1C (1931 REPLICA)

N 425 Serial #6926
Wing Span — 26' 8"
Length — 20' 4"
Empty Weight — 1400 lbs.
Gross Weight — 2000 lbs.
Stall Speed — 55 mph
Climb @ S/L — 1400/min
Fuel — 35 gals. - 12 gph
Engine — Continental W-670 - 220 hp
Cruise — 125 mph @ 1850 rpm
Max. Speed — 150 mph @ 2100 rpm (full throttle)





J-BIRD UPDATE

The September, 1982, issue of *Sport Aerobatics* had a feature article by Jay Hunt on the CH-180 Super Acro Zenith — "The J-Bird". (The cover photo of the September *Sport Aerobatics* issue was also the J-Bird.) Since that time several IAC members have contacted the IAC Technical Safety Committee for more information on this aircraft. The onnly "related" info that was available was an EAAC Flight Test Report on the precedessor to the J-Bird — the CH-**150** Acro Zenith. Therefore, the IAC Technical Safety Committee contacted Jay Hunt and suggested that because of the apparent interest in the J-Bird, perhaps he would want to publish a follow-up article/report in *Sport Aerobatics* on the aircraft. The following letter is the reply received from Jay which will explain what has been "happening" with the J-Bird and also will pass along some hard-learned safety tips.

"Dear Fred:

"Thank you for your letter of January 2, 1983. Enclosed is a copy of the EAAC Flight Test Report on the CH-180 Super Acro Zenith. The aircraft has been fully evaluated and is approved by the Canadian Department of Transport for ± 8g's and a V_{ne} of 265 mph. We have made a few non-structural mods to the aircraft for competition to lighten the stick forces and have enlarged the rudder somewhat. These modifications will be included in a supplemental approval this spring.

"The J-Bird was entered in unlimited competition last summer at the Quebec Open June 11, 12, and the Canadian Open Championship June 26-27, at Centralia, Ontario, where I flew it to fourth place. The aircraft has met or exceeded all of its expectations in competition. In fact, at the Canadian Open, the compulsory sequence was flown under a 1700 ft. overcast and the aircraft performed the whole sequence, without break to climb, beginning at 700 ft. AGL and never coming below the altitude. It has truly superb altitude and speed control capabilities.

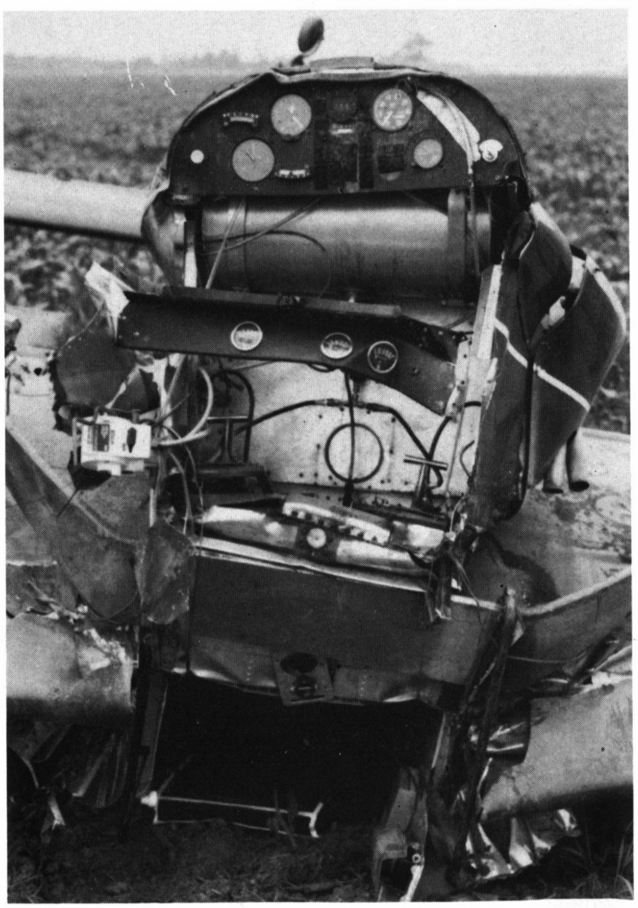
"Unfortunately, the next day, June 28, during a test flight by my partner, John Gill, to evaluate a new propeller, the propeller came off in flight and the J-Bird was substantially damaged in the forced landing. Miraculously, John walked away from the accident, avoiding potentially tragic results. Briefly, here is what happened.

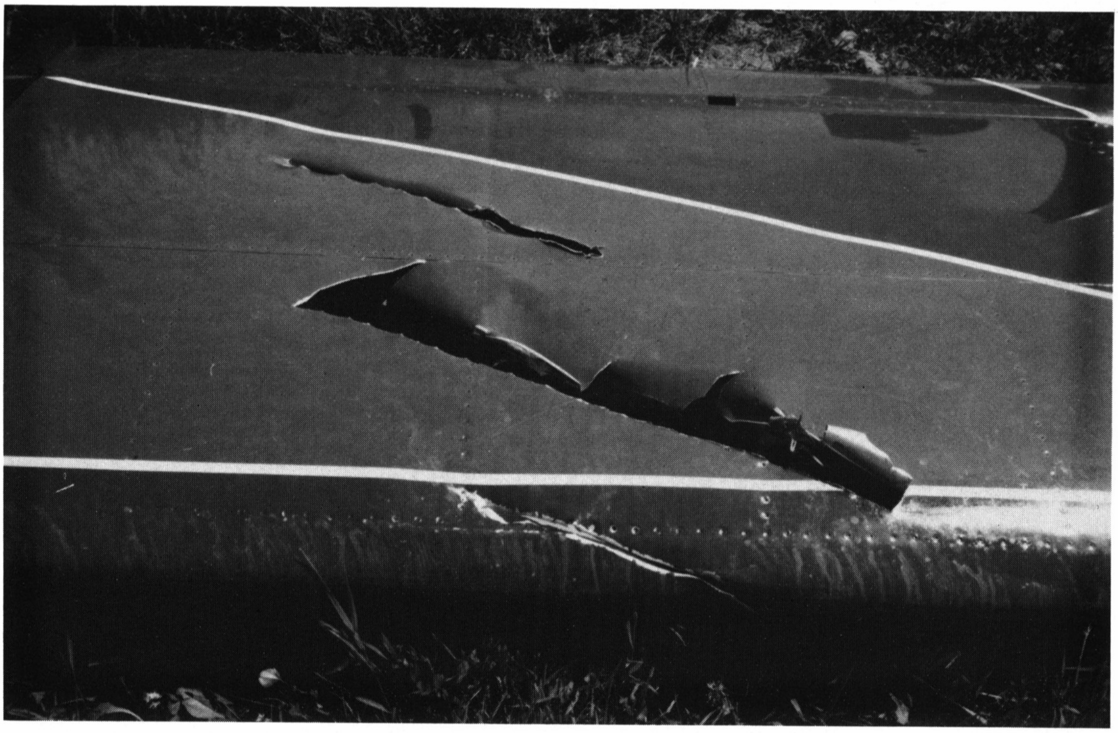
"The aircraft had completed nearly 100 hours of flying and has just returned from the Canadian Open Aerobatic Championships. Enroute to the contest, I had flown through some rain which had damaged the leading edge of the wooden prop I was using, so I had decided to replace the prop with a Hoffman I borrowed from Gord Price.

"On Monday, June 28, I installed the Hoffman using the hub plates and bolts provided. The bolts were magnafluxed AN bolts which Gord had previously used to run the prop on a Pitts for 6-7 hours. I personally installed the prop, torqued the bolts to 25 ft. lb. as per Hoffman instructions and lock-wired the bolts. Having done this many times before, I paid careful attention to the torquing, ensuring that the bolts were really tight and not just binding in the bolt holes. The bolt threads were somewhat shorter than my propeller bolts and I do not remember checking to ensure that the bolts had sufficient thread length.

"After a ground runup check, a test flight was flown by my partner, John Gill. He took off from Rockcliffe, Ontario, at approximately 1830 and headed north of the airport for some cruise tests of the propeller which was of finer pitch than our original. Approximately 5 minutes later, I heard him declare an emergency over the clubhouse radio and immediately went off to search for him in the club Decathlon. The aircraft was found inverted in a corn field approximately 5 miles north of the airport. John had crawled out and was uninjured, except for a sore neck and small cut on one ear. A view of the small space remaining in the cockpit as it was crushed against the ground indicates what a miracle this was. What had transpired was as follows.

"John had made a normal takeoff and was headed for our practice area at about 3,000 feet AGL when he sensed something wrong. He says he smelled a faint





odor of burning wood and, wary of the propeller, throttled back some and began to turn for home. Suddenly, without further warning, the propeller left the aircraft, coming off diagonally to the right, cutting three slices through the upper wing skin as it went by. John's impression was of the fiberglass cowling exploding to bits. He does not remember cutting the throttle, but must have as the engine suffered only minimal overspeed damage.

The aircraft commenced a steep glide with a sink rate John estimates of 1,700 feet per minute. He attempted to jettison the canopy but in the excitement, broke the emergency release handle. The sideways opening canopy opened and came to rest on the left wing. The sink rate being much higher than ancitipated, John abandoned an attempt to reach a road and selected a soft cornfield on which to land. The corn stalks were about 12 inches high and he came in across the furrows. The aircraft struck flat on all three walls and bounced, turning over and coming to rest inverted about 35 feet from the point of initial impact. The shock of the first contact was such that the main landing gear attach fittings tore the fuselage sides upward and fractured the upper longerons so that everything forward of the wing flipped under the aircraft and came to rest on the underside of the wing, miraculously creating an escape route from the cockpit as you can see from the enclosed photographs.

"The ensuing investigation revealed that the bolts had failed, due to high cyclic load of short duration. Evidence suggests that the probable cause was a loose assembly, possibly the results of the bolts shouldering in the flange.

"Although the aircraft was badly damaged, it was nowhere near written off and is well on the way to flying again. Fortunately for all of us, both partner and partnership remain intact.

"Hard lessons were learned which bear repeating.

"1. No matter how many times you have performed an operation, NEVER take it for granted that you have done it right. Bolt threads that were not long enough should have been detected prior to installation.

"2. Whenever you alter an aircraft or re-install a critical assembly, a test flight should be made OVER THE AIRPORT so that an immediate landing can be made in the event of trouble.

"3. If an emergency landing is required, select a landing site as close as possible to the aircraft and stick with it. Your glide will probably be half what you expect and you can always lose excess height, but never gain it back.

"The short aerobatic season for ZEN confirmed its competition capability and its configuration will remain essentially the same as before. Although ZEN will not appear in Europe until 1984 now, next summer may still see a Super Acro Zenith in competition, as a kit has been purchased by Bernard Collière of France and he intends to have it ready to fly for next season.

"Incidentally, we are considering modifying our sales literature to include the phrases:
'-strength tested to destruction' and
'-high survivability factor.'

"Happy to report that the J-Bird is now nearly restored to new condition and will fly again in April. God willing, we will see you all at Fond du Lac.

"Please feel free to use this article and accompanying photos in *Sport Aerobatics*.

Regards,
Jay Hunt"

AEROBATIC AIRCRAFT DESIGN

DALOTEL LIGHT AIRCRAFTS

Dear Sir,

I am the designer of the Dalotel DM 165 aerobatic aeroplane and constructed the prototype which has been flying since 1969.

Reluctantly, as I am unable to afford to manufacture this aircraft myself I have decided to either sell the complete set of plans and in consequence the rights to the aircraft, or to form an association to manufacture the aircraft.

In your capacity as President, I thought that you might be in a position to help me in obtaining possible names of people who might be interested in becoming part of this association.

It might be of interest that a reduced model of the aircraft piloted by Hanno Prettner won the world aerobatic championships at Las Vegas in November 1978, a report of which was contained in the following magazines:

Modèle Magazine, No. 328 - January 1979
Adepte Modèlisme, No. 46 - February 1979

The reduced aircraft was one-third of the size of the original.

I am enclosing for your information documentation appertaining to the Dalotel aircraft both in English and in French, together with the specifications of the Club Dalotel (DM 125 and 160) and the professional Dalotel (DM 160).

I would appreciate any help that you might be able to give me and remain,

Yours truly,
Michel Dalotel
Parc de La Nove - G.3
93420 Villepinte
France

****

1. INTRODUCTION

Since its initial flight, the prototype DM165/01 has caused many press articles, reports and summaries to be written and published in France and abroad.

Some highly specialized reviews wrote as many as six double pages on the subject and the French TV presented the aeroplane in various broadcasting programs on the two channels.

In either case, the DM165/01 has always been considered as an aerobatic aeroplane for competition.

It may be in fact considered as an aerobatic aeroplane because of flight quality and coefficients, but the prime objective of the designer is to have it used as:

- A scholar plane for airclubs,
- An aeroplane for training, and
- For advanced training.

This is the context in which it has been designed and developed; this is just how it is presented in this manual.

2. PRESENT CONJUNCTURE

In an interview recently published in aeronautical reviews, a representative authority for civil aviation said:

> "We are still expecting the simple, sturdy, and economical aircraft aimed at training young men until they get licensed"

and he further stated:

> ". . . aerobatic may be considered as a sport, but it is also regarded by our department as an advanced training necessity, very useful to our future airline pilots".

This statement gives a perfect definition of the main features to be expected for a plane intended to be used for training. On the other hand, it sets the term "aerobatic" back into its proper place, that is, in line with "advanced training".

In fact, no private, professional or army pilots can claim to perfectly master their plane, thence insure their own security and that of others, if they have not practiced a minimum aerobatic while they were advanced training.

Assuming this is no matter for arguing any more now, a question may arise:

What are the planes used in our airclubs and professional institutions to bring this training operation to a good end?

Since the second world war, the term "scholar plane", was generally applied to any type of low powered aircrafts.

However, the job to be performed by a training plane is a pretty hard one, quite different from that of a normal light aircraft for touring.

The machine selected for that job must permit all pilots to be fully trained, so as to provide them later with the possibility to easily switch to other types of planes, from the simplest to the most sophisiticated machine such as: light aircrafts, military planes, or commercial aircrafts.

It is a fact, that most of our airline pilots' career begins in airclubs. For these men and all future light aeroplane pilots, France must have an aeroplane capable of being adapted to the requirements resulting from its vocational attitude.

The brilliant services rendered by the STAMPE machines in the aerobatic field are coming to an end and foreign aircrafts are too expensive to be bought and maintained by airclubs or their members. On the other hand, no plane, whatever national or international meets the specifications required by a true plane for training. The only one satisfactory today is the DALOTEL Model, whatever the version selected:

- **Competitive buying price;** quite reasonable for an airclub (a bonus may be obtained from the state for French machines).
- **Easy maintenance work;** extremely fast and easy interchange of all plane elements (wings, glass-frame, undercarriage, etc.) which consequently does not make it necessary for the plant to interfere, airclub mechanics being able to do it just the same.
- **Flight safety,** resulting from the streamlined features of the machine in normal and aerobatic configurations (see CEV[1]) report.
- **Structural safety,** due to an exceptional resistance of the body to fatigue up to ± 14g max., which is not to be found the whole world over.
- **Limited inverted flight duration,** free from any restraint and permitting all students to get accustomed to inverted flight.
- **Excellent coordination of all controls;** (see CEV reports).
- **Simple line geometry,** giving an excellent visual reference and permitting students to alter any wrong position.
- **As a tandem two-seater,** the DM165 is the only logical approach for a plane designed for training.
  a) Due to absence of parallax error existing in side by side two-seaters, pin-pointing of land-marks by instructors and students is remarkable.
  b) Excellent air flow to feed the plane horizontal stabilizers insuring reliability and accuracy in getting out of spinning and in all flight configurations (side slip, sliding, etc.).
- **Lift-drag ratio of the fuselage,** gives a better homogeneity and harmony to sinking controls when switching from normal to inverted flight and reduces in great proportion the lengthwise weather-cock effect of the plane while performing in inverted flight.
- **Better CX of the fuselage** and consequently higher operational features.

In spite of all these advantages, tandem two-seaters are not so easy to find on the market due to complexity encountered by manufacturers in design work. This is painfully resented by all civil and army pilots, airclub instructors and students, who really appreciated such planes are: FOUGA-MAGISTER, ZLIN, STAMPE, etc.

DALOTEL & C° however, made the decision to build and market tandem two-seaters, "CLUB," and "PROFESSIONAL" models, meeting all necessary requirements.

A table of all features for the various models is included in the attachment; this will confirm the quality and flying performances of these planes, which certainly incorporate the most advanced and modern features.

3. DALOTEL DM165 LIGHT AEROPLANES - History

The DM165/01 designed by Michel DALOTEL and jointly developed by POULET & C°, took off for the first time in April 1969.

Various checking operations, carefully conducted through long range flights and constant search for improvements quickly led to a total of several hundred flight hours.

Then, the Administration Authority requested that the plane should be delivered to the Flight Test Center (CEV) in ISTRES for four months in view of having it tested to standard AIR 2052A. All test results recorded by the CEV have been written up in an official report (Report No. 4CEV/IS/SE/AV7), a few sections of which are included in the attachment.

4. SHORT TERM OUTLOOK

The DM165/01, used as a basis for developing the DALOTEL program has permitted to check how it met, from dynamic and structural point of view, not only the standard AIR 2052, but also all data used for designing it.

Taking advantage of the experience gained and the remarkable results obtained and recorded by the CEV, DALOTEL & C° decided to go on its program in an effort to still improve its initial prototype.

These improvements are as follows:

- **Reliability** by increasing structural resistance from +9 to +14g and from −6 to −14g.
- **Comfort** by providing more room inside.
- **Reduced pilot workload** by fitting flaps.

On account of the above, DALOTEL & C° is now terminating a new model, the DM160/02 that meets FAR 23 specifications, A category, in every detail, though getting beyond it in many points, especially load factors.

This model will become type definition as soon as it is tested by the CEV Center.

As no dynamic alteration has taken place compared with the DM165/01, it is reasonable to think, if we refer to the first report issued, that certification should not entail any delay.

DALOTEL & C° will also deliver a DM160/02 to the Flight Center, together with another cell No. 02 to the CEAT (Aeronautical Test Center in TOULOUSE) meeting all specifications, to make sure it conforms to the previously announced structural resistance factors estimated to ± 14g.

MEDIUM AND LONG TERM OUTLOOKS

Development and all checking operations of the DM160/01 and the cell to be tested in ISTRES and TOULOUSE will take from 18 to 24 months. It is expected to build the first series of planes in about 2 years.

- Will these light aeroplanes find a good market?
- What are the manufacturing options?

Marketing enquiries conducted in France and abroad have shown that a first selling operation could be initiated and go on over 10 years, as follows:

---

1) CEV = Flight Test Center

Starting point:
D year .... 15 machines
D+1 .... 30 machines
D+2 .... 50 machines
D+3 .... 60 machines
D+4 .... 80 machines
D+6 to D+10 .... 100 machines
D+11 ....

This forecast is a very prudent and simple piece of information in which international market outputs have not been practically taken into account.

This analysis shows that as early as D+2, a yearly turnover of 9 million including spare parts should be reached and by D+6, this amount should round up to 18 millions.

As far as building is concerned, it has been planned to have firms licensed, acting as sub-contractors in charge of all manufacturing work. This will be quite possible since all DALOTEL plane elements (wings, fuselage, undercarriage, etc.) are perfectly identical, whatever the version specified.

Manufacturing work will be controlled by DALOTEL & C° in charge of coordination, control and assembly work. It is reasonable to think that this contribution will amount to 30-35% of the cost price of all types of planes.

This procedure will allow DALOTEL & C° to limit investments, having only an assembly plant to control and a suitable support to give to all sub-constractors over the national territory.

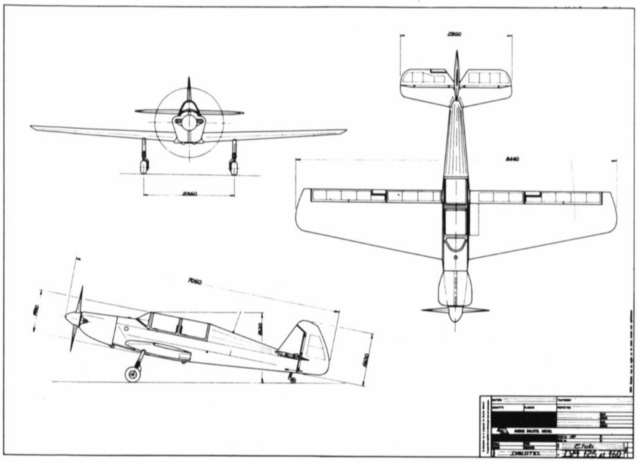
Until now, census taken and contacts with some sub-contractors have shown that this option was the right one. As most of these factories are not overworked, due to few orders in hands, they can contemplate a collaboration agreement with DALOTEL & C°.

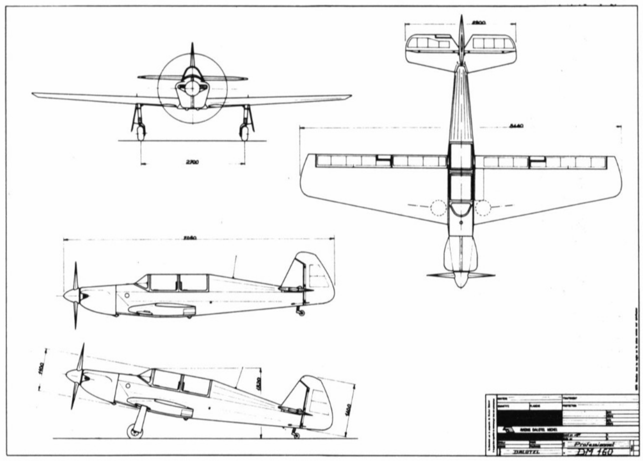
5. CONCLUSION

Piloting accuracy is certainly a factor to increase safety on board a plane. However, this can only be obtained with an aircraft specifically designed for training activities. This type of plane should be easy to control, clean and demonstrative though requiring from all students the necessary participation to make them "feel their flight" and draw the consequences resulting from their initiative.

This is the type of plane that has been designed and developed by DALOTEL & C°. All plane versions, namely: CLUB DM 125 and PROFESSIONAL DM 160 models, cover all possible requirements for training; all these planes have actually been developed for training and incorporate exceptional features, at a price comparing that of a normal light aircraft.

Type Features	**Prototype DM165/01**	**Club DM 125**	**Club DM 160**	**Professional DM 160**	**Comments**
Engine	165 HP Continental (inj.)	125 HP Lycoming (carb.)	160 HP Lycoming (inj.)	160 HP Lycoming (inj.)	Very high engine potential (1,800/2,000 hrs.)
Propeller	Fixed pitch	Fixed pitch	Fixed or variable	Variable pitch	
Limited inverted flight	Yes	Yes on option	Yes on option	Yes	This DALOTEL Process permits continued inverted flight performance without oil oozing.
Main undercarriage	Electrically retractable	Fixed	Fixed	Electrically retractable	Undercarriage centering permits brake operation without limitation
Max. speed (alt. 0)	300 km/h	235 km/h	265 km/h	310 km/h	Speed unequalled on same type of two-seater
Cruising speed and petrol consumption at 75%	270 km/h - 28 l	215 km/h - 25 l	245 km/h - 28 l	280 km/h - 28 l	High cruising speed - Fruit travelling
Speed and petrol consumption at 60%	235 km/h - 22 l	180 km/h - 22 l	200 km/h - 23 l	240 km/h - 23 l	Schooling speed - Petrol consumption as low as that of a 100 HP Piper; low flight hour cost
Climbing speed	5.5 m/s	4 m/s	6 m/s - 8.5 m/s	10 m/s	
Stalling speed, Flaps in	90 km/h	88 km/h	90 km/h	90 km/h	Performance clearly above average
Stalling speed, Flaps out	-	79 km/h	80 km/h	80 km/h	Sound and classical stalling, as it should be for all school-aeroplanes
Tare	630 kg	600 kg	620 kg	640 kg	
Max. authorized Weight	840 kg	900 kg	900 kg	900 kg	
Load Factor Limit at max. Weight	+9/−6g	+14/−14g	+14/−14g	+14/−14g	Resistance never met on the market, nearly three times as much as that of a standard light aircraft, clearly above the international aerobatic category: +/−6g extreme
Load Factor Limit at max. Weight	+6/−4g	+9.33/−9.33g	+9.33/−9.33g	+9.33/+9.33g	
Petrol tank (1)	84 l	100 l	100 l	100 l	
Cruising range at 75%	550 km + 1 h	650 km + 1 h	600 km +	700 km + 1 h	Reasonable range for an aeroplane dedicated to school
Standard Price all charges incl.	Not on Sales Manual	100,000 FF	120,000 FF	160,000	A real school-aeroplane, showing exceptional instructive features at a price comparing that of a normal light aircraft.





FLYING - CHARACTERISTICS C.E.V. BRANCH in ISTRES

Compiled from Report No. 4 CEV/IS/SE/AV71
Dalotel DM165/01 - Flying Test Results

1. GENERALS

On arriving at ISTRES on December 19, 1970, the DM165/01 had already flown a total of 109,5 hours . . . the plane was delivered back to its owner on March 25, 1970 and was flown 46,75 hours during the corresponding period. Its nice mechanical availability did not require any action from the runway department.

2. FLYING TESTS

5.3. **Stalling speed**

"compensated speed at stalling time is: 90 km/h ± 3 km/h.

5.4. **Operation**

5.4.2. *Rate of climb*

". . . b/ flaps in normal position, full throttle open (fast climb or aerobatic), rate of climb is 5,15 m/s which is pretty good given the relatively low power engine and the type of propeller it is fitted with.

5.4.4. *Level speed*

". . . the DM165 performs beautifully for such a type of plane fitted as it is with a fixed pitch propeller; compensated speed is on the order of 300 km/h, full throttle open at 500m altitude.

5.5. **Flying features**

5.5.1. *Maneuverability and control*

The aircraft remains under control and is easy to fly within imposed limitations in all flight phases and configurations; an exceptional skill from the pilot is not required.

5.5. **Flying features**

5.5.1.1. *Lengthwise control*

a) Lengthwise control when nearing stalling speed: Whatever the configuration, with or without engine and starting from speed very close to stalling speed, the pilot can at any time initiate a sufficient pitching motion to return to normal balance within suitable lapse, on the order of 3 to 4 seconds.

f) Turn strain : At all speeds and in any flying configuration, ". . . these values show a nice compromise between aerobatics, when the plane is operated by fully qualified pilots, and safety when being used by average trained students.

5.5.1.2.2. *Sideway and rudder controls*

Crosswise control is easy in any flying configuration, the ailerons are highly efficient, showing no dead range and a good compensating operation; direct rolling appears immediately and induced swaying takes place in less than a second . . . Rudder control is perfect and has been made a real success on this plane, where it is as efficient in normal flight as in aerobatic or spinning configurations; swaying action is immediate with practically no induced rolling. Strain and shifting motions have been signalled as extremely pleasant by all pilots.

5.5.4. *Stalling - Flight at low speed*

Immediate control availability in all cases by simply easing on stick; no particular problem.

5.5. **Flying features**

5.5.5. *Spinning flight tests*

5.5.1. *Generals:*

The miniature model of the DM165 has never been seen under spinning tests in the vertical wind tunnel of LILLE, but the CEV Center exceptionally accepted to thoroughly investigate its spinning reactions in ISTRES.

5.5.5.3. *Accuracy results*

Spinning starts quite normally, and rolling and swaying appear without reaction to inverted flight. The first two spirals are slightly shaky and by the third one however spinning is balanced, remarkably quiet, without buffetting, while the plane remains on its diving angle.

5.5.5.7. *Conclusion*

The DM165 presents perfectly normal and classic spinning features.

5. FLYING TESTS

5.6.1. **Generals**

This section is a summary from flying reports written by all pilots who flew the DM165.

Aerobatic is featured by:

- A suitable engine power,
- A very good petrol feeding and oil drain in inverted flight.
- Very pleasant flight controls with well adapted strain conditions, except for sideway controls getting a little heavier at speeds over 230 km/h.
- Slight or often inexisting secondary effects; this is perfect for an aerobatic aeroplane.

5.6.3. *Conclusions*

All aerobatic features of the DALOTEL165 have been extremely appreciated by pilots having little experience in aerobatics, by fully qualified specialists in this field and by light aeroplane pilots. It will prove to be a training aircraft for aerobatics and even for national competition, as soon as its load factor limitations are changed. Its features could be improved by fitting a variable pitch propeller, and air-brakes and this could eventually make it reach international standards in competition matters.

5.7. **Ground control**

5.7.3.

Landings with 20/25 knots crosswise wind have been made and it appeared that the DM165 could enter D category. This category is valid for planes capable to stand 22 knots crosswise wind - optimum classification -.

N.B. Ground tests have been made over several hundred yards tarmac runway with sideway wind blowing at 40 knots.

7. GENERAL CONCLUSIONS

The various tests performed by the CEV Center have shown that this aeroplane is remarkable for training, advanced training and aerobatic purposes.

As far as general technology and product finish are concerned, only a few points should be improved. A particularly good execution for the following essential points is to be pointed out:

— Access,
— Repair, and
— Safety.

All results obtained with the 165 hp engine and fixed pitch propeller are quite good, but these could still reach higher figures by fitting a variable pitch propeller; finally, the satisfactory flight quality already recorded (stalling, spinning, easy controls) will be improved by alterations planned by the builder (sideway kinematics, tab-butts, air-brakes, etc.).

All those future improvements must permit the plane to conform to specification AIR 2052A, A category, and become a competitive aerobatic aeroplane capable of performing on the same scale as its challengers.

From:

Mr. E. RACCA	Test Engineer, Aircraft department.
Mr. GONIN	First Engineer and Aircraft department Manager.
Mr. TERRAZZONI	First Engineer and Technical vice-Director in ISTRES.
Mr. TAMAGNINI	Executive Engineer in charge of the CEV Branch in ISTRES.

1984 U.S. Aerobatic Team: Standing: Gene Beggs (left), Harold Chappell, Henry Haigh, Kermit Weeks, Alan Bush; Kneeling: Debby Rihn (left), Brigitte de St. Phalle, Julie Pfile, Linda Meyers.

AEROBATIC FUEL SYSTEMS

By M. Russell, IAC #5851

Having recently begun my fourth aerobatic homebuilt I have had occasion to acquire some fuel system information that was helpful to me. Additionally, some earlier problems were brought to mind, and I thought perhaps some of the information might be of use to other IAC members.

Bendix Pressure Carbs. - I had a PS5-C installed on a 160 hp Lycoming 0-320. During an aerobatic flight the engine failed to respond to throttle application and a dead stick landing was made at a nearby airport. After clearing the runway normal starting procedures resulted in the engine immediately starting and running smoothly.

I discussed the incident with Bendix. They thought it over and got back to me saying that they had encountered the problem on other aerobatic (only) installations. They felt that very fine contamination was passing through the system strainers and causing the poppet valve to stick. Bendix felt that in non-aerobatic installations where the fuel is not agitated so severely that the contamination remains the fuel tank. They recommended tank removal and thorough cleaning (I had only 60 hrs. on the installation at the time).

Pressure carbs. (PS-5C) are becoming less plentiful than they once were. Apparently core prices run from $150-$350 and overhaul costs run from $850-$1050. The newer diaphragms are orange/red. Old black diaphragms have reportedly inferior life when compared to the new parts.

I had a lengthy discussion with engineering personnel at Bendix. They apparently feel that the fuel injection system is superior to pressure carburation. They indicated that engine power output with fuel injection should be superior due to the equal fuel distribution that is inherent in the system. I made it perfectly clear to Bendix that I was going to buy a used unit for rebuilding (eg. Bendix would not see a sale) for an aerobatic installation and they were none the less firm in their recommendation that I go to injection.

What I had not realized in the past was the ease with which one can inject a carburated Lycoming (0-320 or 0-360). Apparently, virtually all of the wide deck cylinders are drilled for both the primer fitting (the lower port when viewing the cylinder mounted on the engine) and the fuel injector nozzle (the upper port). The plugs are usually very tight. It was necessary to drill out two of the four plugs in my engine.

Once the plugs are removed all that is necessary is to bolt on the servo, flow divider, nozzles, lines, and fuel pump.

There are two sizes of Bendix RSA-5AD1 fuel servos. A small venturi unit used with the 150 and 160 hp Lycomings and a large venturi unit used on 180 hp, 200 hp even 260 hp Lycomings. These two injectors are identified by, what is referred to as their "basic" number. The small unit is PL2524476 and the large unit is PL2524469.

Aside from the "basic" number there are dozens of specific servo part numbers. These numbers are of little significance to the homebuilder. All they signify is variations in the throttle and mixture levers. There are basically two flow dividers - one for 4 cylinder engines and one for 6's. For non-turbocharged engines all the nozzles are the same, PL2524107.

The injection system requires a fuel inlet pressure of 14-45 psi. The AC diaphragm pump #41234 is normally utilized. There are manual and electric boost pumps readily available for back up.

I was able to purchase an injector system as a "core" and have it overhauled for a total cost about 20% higher than a pressure carb would have been. The core was purchased from Penn Yan Aero, Airport, Penn Yan, New York 14527 and it was overhauled by Aircraft Fuel Specialist, 5300 N. Rockwell, Bethany, Oklahoma 73008. Personnel at both of these companies were extremely helpful.

A manual on the RSA-5 fuel injection system is available from The Bendix Corp., Energy Controls Division, 717 N. Bendix Dr., So. Bend, Indiana 46620.

In the June, 1980, issue of *Sport Aerobatics,* there was a Tech Safety article entitled "Egress" which dealt mainly with aircraft canopies and canopy release mechanisms. The article also made reference to a canopy breaking tool used in the military and asked if any IACers could give the specifications for such a tool. Since that time the Technical Safety Committee has talked to several persons about a canopy breaker and got several general and varied descriptions. One fellow advised he was aware of such a tool and, in fact, thought he had one "somewhere around the house" — but he could not locate it. Another person advised he thought that in the military each unit made its own canopy breakers (from its own design). Recently, while trying to locate some info for an IAC member, we stumbled across an article by Duane Seymour in the August, 1976, issue of *SPORT AVIATION* describing a canopy breaker tool. This article, with drawings, is reprinted below. Not only should IAC members who operate a/c with canopies consider such a tool, but perhaps so should IAC contest chairmen. Note how many accidents have been reported where the a/c flips over on its back. If such an accident would occur at a contest, could persons on the scene, the contest officials, be able to help the pilot out of the aircraft? A canopy breaker might help in such an instance.

CANOPY BREAKER TOOL

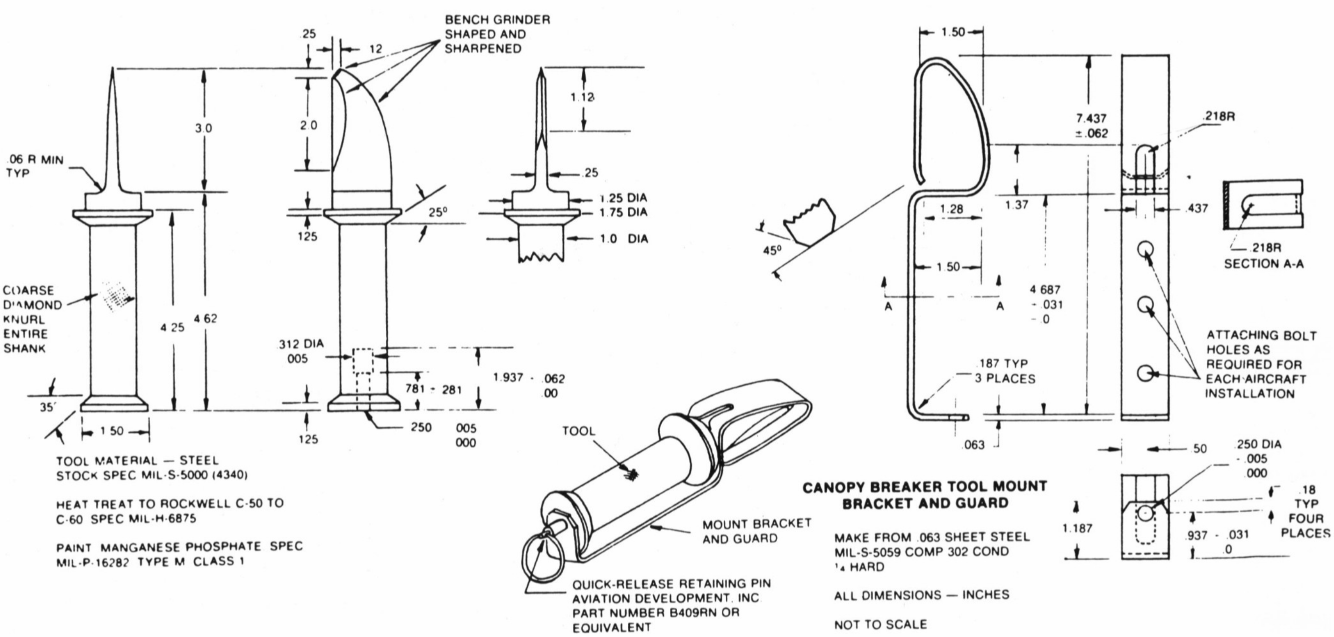
By Duane Seymour (EAA 13513)
P. O. Box 16012
Tel Aviv, Israel

Today, many homebuilt aircraft have large blown canopies (Mustang IIs, T-18s, PL-2s, etc.) that are very functional, pretty and provide excellent visibility. These canopies are made of relatively thick Plexiglass in order for them to withstand normal flight and ground operational loads. In the case of the PL-2 it is ⅛ inch thick. Did it ever occur to you how you would get out of your pride and joy if you should crash and the canopy is jammed closed? Plexiglass is tough stuff, something you may not be able to break through with your bare hands regardless of the amount of adrenalin flowing in your veins. You can try this if you ever have to replace your canopy. Close the old one and try beating your way out with your hands while imagining it is jammed and the aircraft is on fire (!!).

A solution used in some jet fighters is a canopy breaker tool (see drawings). This tool is just that . . . it is not a knife. A knife blade is too sharp and brittle, which would mean a snapped blade if you tried to use one to break through a canopy. The canopy breaker tool is blunt, compact and heavy — which allows it to be used to punch a hole through the Plexiglass from the inside.

To use it, grasp it in your left hand (if right handed) and put the heel of your right hand under the tool. Now heave up with the tool and punch a hole in the canopy with the pointed end. This sort of tool has been successfully used in emergency situations in jet fighters with ⅜ inch canopies. Once a hole is made, it can be enlarged by repeated hitting around the edges of the original hole until it is large enough for personal egress.

Since the tool is made of steel, it should be degaussed and mounted as far from the compass as possible — yet easily accessible, even in the dark. Obviously in tandem seating aircraft where the cockpits are separate, there should be one tool for each occupant.



CANOPY BREAKER TOOL P.S.

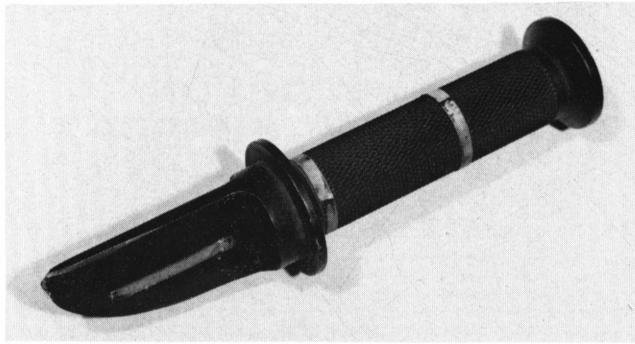
Two days after the above article was completed and sent to *Sport Aerobatics* Editor, Steve Morris, IAC member Sam Burgess called the Tech Safety Committee and advised he had located and copied the drawings for a canopy breaker knife. The news that knife drawings had already been obtained did not slow Sam down — as he then offered to try and get some photos of an actual canopy knife for publication in *Sport Aerobatics*. Bob Haack took the pictures of Sam's knife which are shown.

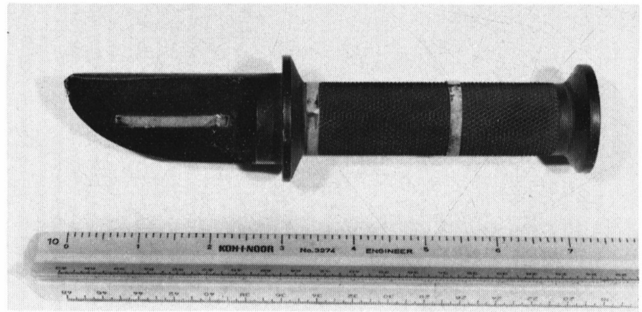
During the above-mentioned phone conversation with Sam, the use of a crowbar in WW II Spitfires as an emergency egress tool, as previously noted in *Sport Aerobatics,* was mentioned. Sam added that some P-80's were equipped with a lead mallet as an egress tool. Obviously, a lot of people have been thinking about emergency cockpit egress — an item that should be part of every IACer's flight planning.

Continuing with some of the thoughts relayed in the first *Sport Aerobatics* T.S. "Egress" article, Sam also sent the following:

> "In conjunction with this we should be looking into a decal for canopy release similar to the one you will find on all military aircraft with a canopy. We have the same egress problem in an emergency. I have enclosed a sample. These can be made easily at any decal dealer. The tabs on a Pitts canopy are so obscure that I doubt if a layman could figure out how to get you out of the cockpit in time. It may not be a bad idea to place one of these decals inverted as this is the likely position in a forced landing. There are very few emergency landing fields where a Pitts would not go over on its back."

Many thanks to Sam Burgess and Bob Haack for their help — and to the other IACers who have helped on this mini-series on emergency cockpit egress.





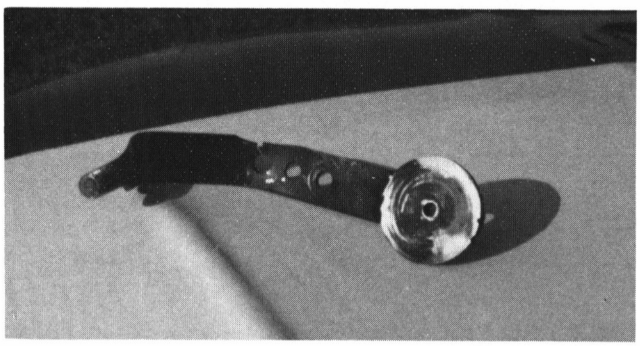
THROTTLE LINKAGE

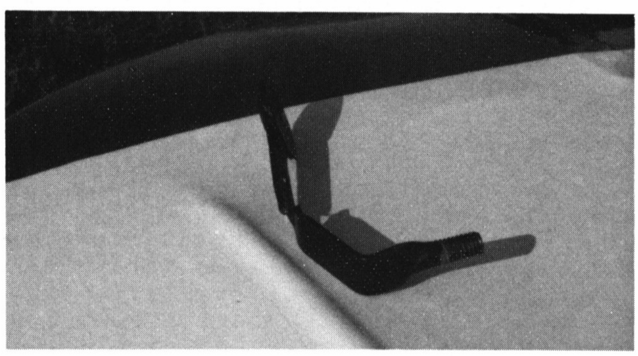
Throttle linkage/levers on acro aircraft are probably subject to more use/abuse than the same components on aircraft used for X-country flying — and, therefore, they should be more often and more closely inspected.

IAC members will recall that on some real early model Champion Citabrias there were reports of throttle lever breakage at the base of the threaded portion of the throttle knob stud. Also, there were some reports of throttle cable breakage on early Citabrias prior to a factory change in 1974 to a Gerdes throttle cable. The following report, just recently received, is of a failed Pitts S-2A throttle lever.

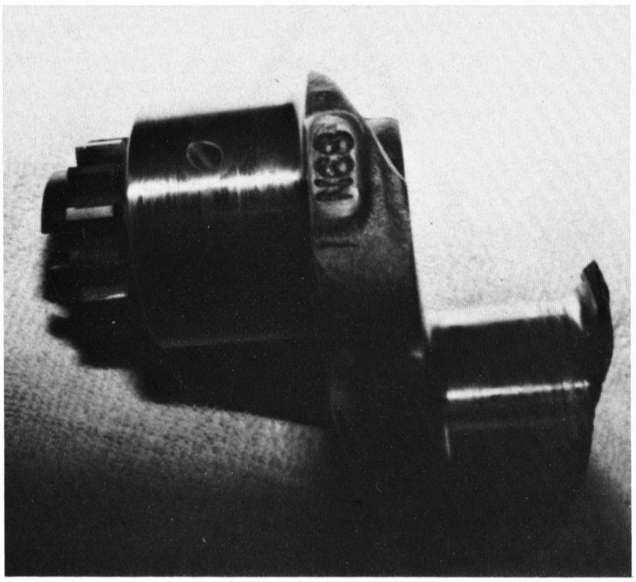
> "Please find enclosed photos of the throttle lever off my Pitts S2A.
>
> "Damage found by checking throttle prior to starting. The throttle cable was attached to the first hole from the pivot fixing. The bracket is hidden behind the quadrant. I like to fly with a fairly stiff feel. Maybe this was too stiff, or maybe I am too rough.
>
> "I have had one made with only one hole in, and not three."

Reports like the one above are what keep all of us alerted to potential problems. An IAC "Thanks" to the member who took the time and made the effort to make this report to help keep our sport safe and fun.





CRANKSHAFT!



Several months ago two IAC members were making some "touch and goes" in a recently completed Christen Eagle II. On the fourth take-off at about 150 ft. above the runway, a mild vibration ran through the airplane. The pilot advised that for an instant he thought it was just the common landing gear vibration sometimes experienced when the MLG wheels are still spinning after take-off and he started to apply the brakes to stop the wheel rotation. At the same time he noticed that the engine had lost power so he set up a forward slip to get the a/c back on the runway. Since they were operating out of a fairly short field, his intention was to ground-loop the a/c if it looked like they would run out of runway. After the a/c was back on the ground, it was evident that they could not stop on the remaining runway so an intentional ground-loop was attempted. However, the a/c was equipped with a locking tailwheel, which was in the locked position, so it resisted the attempted ground-loop. By this time they were at the end of the runway, so they "steered" between two posts, went 30 feet into a cornfield, and came to rest on the nose and right wing. The a/c did not flip over, there was no fire, and no one was hurt.

The engine was an O-360 Lycoming, and a tear-down revealed that the crankshaft had failed between the number 3 and number 4 rod journals. The engine had 8.9 hrs. total time since major overhaul.

A couple of months after the accident, after the initial "hurt" was over, after the FAA had their look at the matter, and after arrangements had been made between the aircraft owner and the engine rebuilder, the IAC Technical Safety Committee became involved. The IAC T.S. interest was strictly from an educational point of view — i.e., what **positive** things could be learned that might prevent a reoccurrence of the problem. Naturally, both IACers who were directly involved, one of whom owned the a/c, were extremely helpful providing detailed information and allowing the IAC T.S. Committee to borrow half of the broken crankshaft for examination. Help was also received from Lycoming, the local FAA GADO office, a metallurgist, and a mechanical engineer.

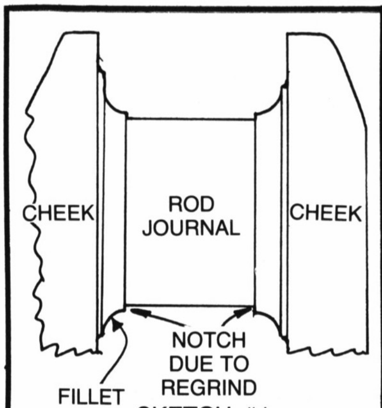
This inquiry turned up several possibilities as to what lowered the strength of the crankshaft sufficiently to cause the failure: notch effect, effects of grinding, removal of nitrided surface, sudden engine stoppage, etc. Discussion of these possible factors will follow below, but first some more background information is necessary. The failed crankshaft had somewhat of a clouded history. One party advised that it had 2000 hrs. total time and that log books indicated no sudden stoppages/ground strikes. Another person we talked with said he understood the crankshaft was obtained from a third party and its history was unknown.

The IAC T.S. Committee was advised that during the engine rebuild, the crankshaft had been turned .003". The section of crankshaft available for examination consisted of the rear main journal and the number four rod journal. The manufacturer's specifications for the main journal diameter are 2.3745"-2.3760" and for the rod journal diameter are 2.2485"-2.250". The main journal miked 2.3747", and the rod journal miked 2.2444". From this it appears that the main bearing journals were **not** ground but the rod bearing journals were ground .0041" to .0056" undersize. On each side of the rod journal there was a small but definite notch in the fillet between the journal and the crankshaft cheek — i.e., when the shaft was ground there was no blending in the fillet area. Shop sketch #1 shows an exaggerated view of this situation. To reemphasize, this notch was very shallow — you could see it and could feel it when you ran a pencil tip across the area.

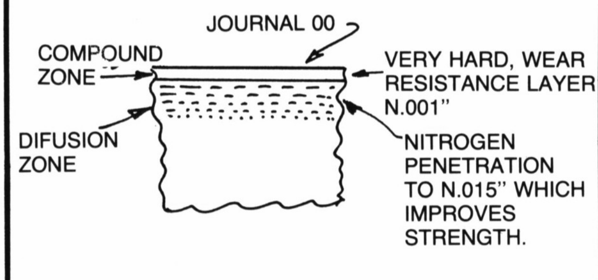
Another bit of information needed to understand this report concerns nitriding. To save some of us from retrieving an old A&P textbook to refresh our memories on nitriding, we will quote from a popular mechanics' textbook, the Northrop Institute of Technology "Maintenance and Repair of Aerospace Vehicles". Nitriding is a method used to improve metal structure. Northrop lists nitriding under "Case Hardening Treatments" and states,

> "Case-hardening treatments are given to iron-base alloys to produce a hard, wear-resisting surface and, at the same time, to leave the core of the metal tough and resilient. Nitriding (in gas) is accomplished by holding special alloy steels at temperatures below the critical point in anhydrous ammonia. Nitrogen from the ammonia is absorbed into the surface of the steel as iron nitride and produces a greater hardness than carburizing, but the hardened area does not reach as great a depth as it does in carburizing."

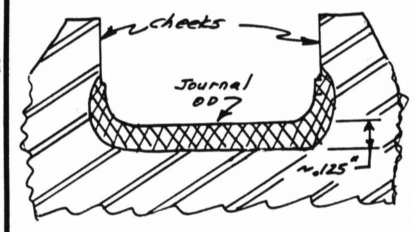
This is O.K. as far as it goes. Actually, there are two types of nitriding — gas and liquid. The results of both processes are similar with, according to a metals handbook we looked at, better "stop off" control with gas nitriding. Liquid nitriding is often referred to by its trade name "Tufftride". (Tufftride is a registered trademark of Kolene Corp.) Also, nitriding improves metal structure by **BOTH** giving the material a thin super-hard wear resistant sur-



SKETCH #1



SKETCH #2



SKETCH #3

face **and** changing the metals substructure to a certain but limited depth. Shop sketch #2 illustrates, with some rough dimensions, how nitriding improves a metal's strength properties. The depth of the nitriding depends on immersion time, temperature, and the specific material being treated. The fatigue strength improvement depends on the material being treated. A tufftride brochure shows strength improvements from 20% to 100% on various steels. One other point to remember about nitriding is that when a part is nitrided, the entire surface of that part is subject to the treatment.

Another bit of background that relates to the text below is strength and wearing improvement by induction hardening. In this instance, the part being treated, for example, a crankshaft journal for that is what we are discussing, is induction heated and then quenched. The layer of material hardened in this manner is considerably much deeper compared to nitriding. In fact, on sectioned induction hardened crankshafts we have had a chance to examine, the hardening extended to a depth of approximately .125" (⅛"). Also, note that if a crankshaft journal is treated by induction hardening, the hardened area is localized, i.e., the entire surface of the crankshaft is not hardened. (See shop sketch #3) The last bit of background info that may be helpful in understanding this report is knowing what is meant by a "cored" crankshaft. This simply means that the crankshaft's rod journals are hollow. This is done to save weight and minimize rotating moment of inertia. Lycoming crankshafts are "cored" cranks. Possibly related to this is a note in the Tufftride brochure which states "tufftriding will frequently . . . make significant weight reductions possible without compromising service life."

If you have hung on this far, we can get back to the IAC T.S. inquiry. We contacted the FAA GADO inspector who examined the broken crankshaft in question for his opinion. The FAA felt the crank failure was due to the notch left in the fillet area after the crankshaft was ground. The notch was the most obvious possible cause. The FAA had not considered the effect of grinding as related to the removal of the nitrided surface.

We also contacted Lycoming Service Rep, Ernie Tyler. Many IACers may know Ernie — he mans the Lycoming booth at Oshkosh each year. Ernie did not have the advantage of examining the broken crankshaft. He did advise that all Lycoming crankshafts are "gas" nitrided at a temperature of 975° for 48 hours. Naturally, our phone call did not give him the opportunity to research the subject, but he did hazard a guess that the nitriding depth was somewhere in the neighborhood of .012-.017". Ernie also advised that Lycoming keeps on record a small sample that is included with each batch of crankshafts being nitrided. Therefore, if any crank problems might arise that could be traced to poor nitriding, Lycoming would have a handle on the situation. This is good control. As an aside, interestingly, Ernie advised that nitriding cylinders builds in the wanted "choke" bore. Ernie forwarded to us several Lycoming Service Bulletins and Service Letters: S.B. No. 222C, 8-21-81, "Crankshaft Renitriding Recommendations;" S.L. No. L163B 12-23-77, "Recommendations Regarding Accidental Engine Stoppage, Loss of Propeller Blade or Tip;" and S.B. No. 201C, 6-20-81, "Inspection and Straightening of Bent Crankshaft Flanges." The Service Bulletin (222C) on renitriding states:

> "In the event the crankshaft has been reground on the main or connecting rod journals, it is necessary that it be renitrided. Previously Avco Lycoming recommended renitriding only for crankshafts that were reground .010 inch undersize, however, it is now recommended that all reground crankshafts be renitrided. This is necessary because of the nonuniformity of grinding tools. The possibility exists wherein the grinding wheel will cut through the nitrided surfaces on one or more of the journal radii causing areas of stress concentration that can develop into fatigue cracks and ultimately in a broken crankshaft.
>
> "Minor wear marks on the crankshaft journals may be removed by polishing the journal diameter to a maximum of .006 inch undersize with fine abrasive cloth, thus providing a proper fit for .006 inch undersize bearings. Check the journals with a calibrated micrometer. Renitriding is not required on crankshafts thus repaired.
>
> "Through an Avco Lycoming distributor, the crankshafts may be returned to the factory for reconditioning and renitriding."

(As a note, several persons with whom we discussed this crankshaft problem and the above Lycoming Service Bulletin, mentioned they felt it would be a very difficult task to polish .006" of material off of a hardened crankshaft journal, and it would be extremely difficult to keep the journal round.) Ernie was concerned about the crankshaft's history — or lack of history. He related several "war stories" of broken and damaged crankshafts caused by sudden engine stoppage — some ground strikes which were never noted in logbooks. As a tip, he suggests that a logbook entry of a propeller change might be a clue of a ground strike. He also noted that he has seen an abnormal number of propellers damaged by "lift fork accidents" — or so at least that is what the logbooks state. Since the history of the broken crankshaft in question is somewhat in doubt, the question of possible prior damage from a ground strike will never be resolved.

We were also fortunate to have one metallurgist and one mechanical engineer look over the broken Lycoming crankshaft. Both expressed very similar opinions. The latter of the gentlemen, Mike Semenek, took the time and made the effort to write the following report. Mike works for a large engine manufacturer so he is very familiar with crankshaft manufacturing and crankshaft problems. This adds a lot of weight to his observations.

"FACTORS THAT AFFECT THE LIFE OF REGROUND NITRIDED CRANKSHAFTS"

"This article resulted from a recent fracture experienced on a rebuilt Avco Lycoming crankshaft. The fracture occurred after 8.9 hours.

"In a Service Bulletin (No. 222C) dated 21 Aug 81, Lycoming recommends that all reground crankshafts be renitrided to avoid the development of fatigue cracks that can ultimately lead to a broken crankshaft. Previously, Avco Lycoming recommended renitriding only for crankshafts that were reground .010 inch undersize. The reasons for this change go into an area of engineering called Mechanical Metallurgy — an area that deals with the combined relationship of a metal's response to heat treating coupled with the metal's response to applied forces. Add to this the response of the nitrided surface to grinding and you have a rather complex combination of disciplines. In the following paragraphs, an attempt is made to present a layman's (pilot's?) view of this engineering area, and how it relates to the above fracture. This article is not a complete thesis and should be looked upon as a general overview.

"FRACTURE ANALYSIS

"The fracture surface of the crankshaft indicates that failure was primarily due to a bending fatigue load with minor influences from a torque load. The crack initiated at the end of a reground area adjacent to the fillet that blends the No. 4 crankpin to the cheek surface. The stress that caused the crack to initiate was tensile, caused by firing pressure loading.

"The crack initiation portion of the fracture surface is multi-faceted, meaning that the crack started from many sites, about the same time. This type of crack initiation is indicative of a high mean stress relative to the available strength in the shaft. The crack started at the surface, at the end of the reground area, then propagated into the cheek and back out into the remaining part of the pin body. From the fracture surface one can observe the depth of nitriding on all exposed surfaces including the lightening hole in the pin body. CAUSE OF FRACTURE: STRESS EXCEEDED AVAILABLE STRENGTH . . . Why?

"FACTORS THAT INFLUENCE STRENGTH

"There are a variety of rebuilding techniques that can have a significant influence on the final surface strength of a crankshaft — one of which is grinding. Aside from the effects of surface finish and bearing journal O.D. variations on oil film thickness, it is possible for grinding to greatly influence surface hardness and surface residual stress conditions. If the grinding is done properly, removing surface metal can expose a new surface that has a small reduction in hardness and residual stress condition. If done improperly, a significant change can occur in the surface microstructure with the creation of micro and/or macro surface cracks during the grinding process. This is commonly referred to as "burning". The grinding wheel hardness, wheel binder material, coolant efficiency, wheel speed and feed, are some of the major factors that must be considered to reduce the probability of grinding damage. As an example of what temperatures are encountered during the grinding operation, a researcher named Wulff made electron-diffraction studies of the metallurgical state of surfaces prepared by grinding. He found that flash temperatures in the surface layer of atoms could exceed 1300°F. Substrate layers have been recorded above 400°F.

"A fellow by the name of Staudinger conducted a study where the effects of grinding were observed using bending fatigue specimens. Using an eyeball analysis of his fatigue data, grinding cracks in case-hardened steels decreased the fatigue strength to one-third the value of perfectly ground specimens, whereas poor grinding and grinding away too much of the case layer decreased the strength by 50%. Nitrided steels were found less sensitive to grinding cracks and decreased the fatigue resistence about 35%. Another researcher, Tarasov, confirmed the findings of Staudinger and others, and developed a chemical etchant that could detect "grinding damage," the type of damage that was detectable by eye. It was a 5% nital solution, and when applied to a damaged ground surface it would highlight a light-dark surface condition conducive to the degree of grinding damage (consult your local metallurgist for details and don't let this acid solution get on your body — it is harmful to skin tissue), and, yes, it can be used on a finished crankshaft if used sparingly in a low stress area.

"In general, perfect grinding with a soft wheel usually decreased strength. Grinding damage significantly reduces strength. The bottom line of this article is not to discourage the use of grinding (and make all pilots land lovers!) since it is being used successfully today. Regrinding crankshafts is common for a wide variety of engines, from diesels to aircraft. However, the crankshaft must either be designed for regrinding to insure that an adequate strength gradient remains in the shaft after the regrind, or, that a reheat treatment is specified to be used after regrind.

"Inductioned hardened crankshafts tend to be best suited for regrinding since the depth of hardening is relatively deep. Its strength gradient and residual stress distribution are favorable to regrinding operations. Deep case carburized and hardened crankshafts are also suitable for regrinding if the grinding operation does not significantly change the surface microstructure and residual stress distribution. Nitrided crankshafts are most sensitive to regrinding since depth of hardening is relatively shallow. As a result of this shallow depth, nitrided shafts have a steeper strength gradient and shallower residual stress distribution which makes them more difficult to regrind. A small amount of surface removal from nitrided crankpin surfaces could take large amounts of residual stress out of the shaft and weaken the shaft.

"This can be seen in Figure 1 — small amounts of surface removal may not significantly affect residual stress provided the grinding is done properly. Larger amounts of surface removal like .004 inch can signficantly reduce the residual stress even if the grinding is done properly.

"It is possible to completely remove all of the beneficial residual compressive stress by burning the surface during grinding, as shown in Figure 2. As a result, the surface no longer has the beneficial residual compressive stress necessary to insure good fatigue life; it, in fact, has very little resistance to fatigue loading. Once a fatigue crack is started, total fracture is evident. It is possible for this to occur for very small amount of surface removal.

"The algebraic relationship between stress and strength distributions are major concerns to design engineers. Ideally, the goal is to reach a condition where stress never exceeds strength, as illustrated in Figure 3. In Figure 3, if any portion of (3) (stress) exceeds any part of (4) (strength), failure will occur. It can initiate subsurface as well as at the surface. A surface-initiated failure is shown in Figure 4.

"Regrinding can also induce a notch at the end of the regrind area. If the notch is in or next to the fillet, it creates a compound stress riser (notch effect of the

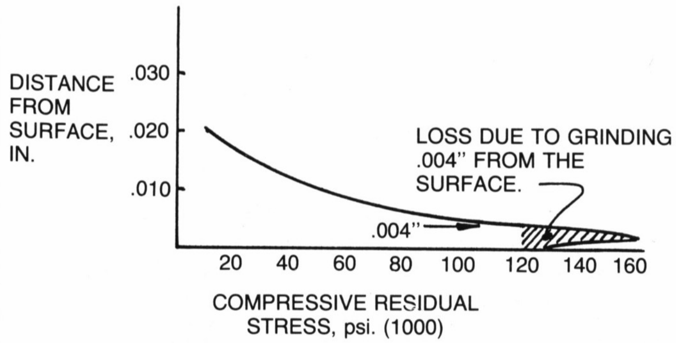


FIG. 1

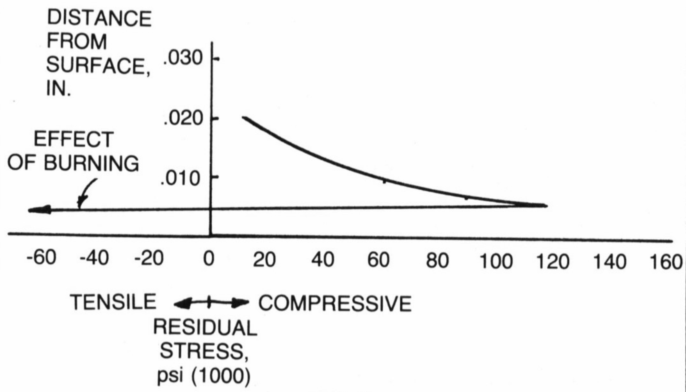


FIG. 2

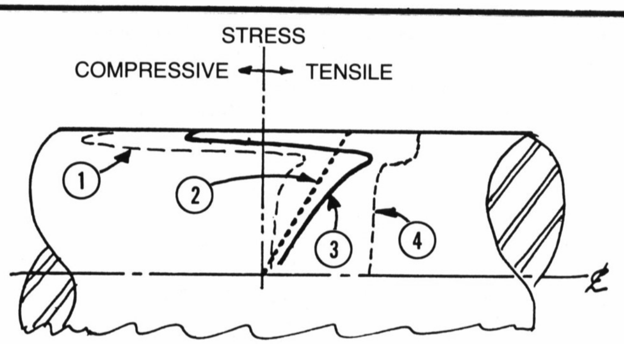


FIG. 3

(1) Residual stress distribution due to nitriding
(2) Stress distribution due to external load
(3) Resultant of (1) + (2), algebraically
(4) Strength limit of material

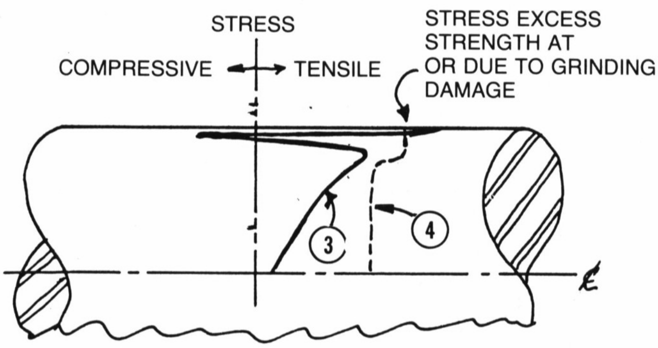


FIG. 4

fillet plus the notch effect of the regrind). This will lower the allowable strength of the shaft and possibly cause fatigue cracks to form.

"The last item to consider as a factor that influences strength is the straightening of crankshafts during the rebuilding process. This subject was extensively studied by Schmidt and he found that plain heat-treated shafts with no surface hardening lost 20% in bending moment capacity due to straightening. His study showed that the straightening process can induce unfavorable residual stresses. Inductioned hardened shafts are best suited for straightening since they have a greater strain capacity and relatively soft material in the cheek area where some deformation can occur. Case hardened shafts (case carburized and hardened or nitrided) have very little plastic strain capacity and no soft surface areas for plastic deformation to occur during the straightening process. As a result, **it is not advisable to straighten nitrided crankshafts.** The reason is that you may induce unfavorable residual stresses or actual cracks in critical areas.

"In closing, it must be emphasized that these are very general views of a very complex subject and they were purposely simplified for the ease of understanding. Each case must be studied in detail from a mechanical-metallurgical standpoint to fully understand the exact cause of failure. No two cases are exactly the same."

After that education not too much more can be added. We did, however run a hardness check on the section of broken crankshaft that we had. The main journal, which **was not** ground, tested at 45 on the Rockwell "C" scale, while the rod journal, which **was** ground, tested at 25 on the Rockwell "C" scale. Because of the odd shape of the section of broken crankshaft, it was difficult to properly support the shaft while testing it for hardness, therefore, there is some doubt about the above-stated values. However, the numbers did trend in the direction that suggests the hard nitrided surface of the crankshaft had been reduced on the rod journal where the failure occurred.

The FAA has an advisory circular (AC No. 20-103, 3/7/78) entitled "Aircraft Engine Crankshaft Failure" which states:

> "Most crankshafts are nitrided to increase the bearing journal surface hardness. The removal of nitride during overhaul or repair of a crankshaft can result in a stress riser and eventual crankshaft failure. Accordingly, particular attention should be given to the grinding limits recommended by the engine manufacturer."

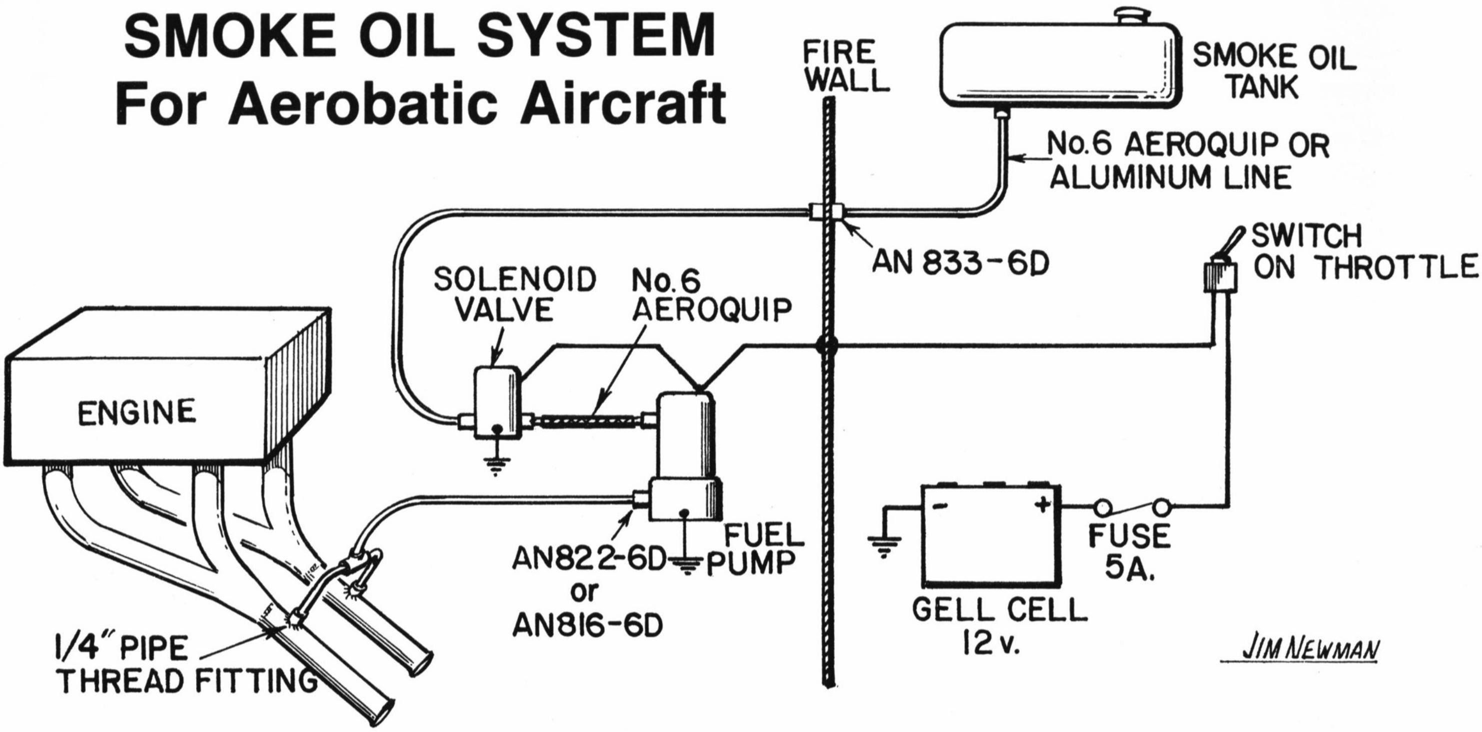
And one last note. Recall that nitriding can be accomplished by two methods — liquid and gas. As mentioned before, one trade name for liquid nitriding is Tufftride. IAC members who peruse such things as the **Chevrolet Power Manual** published by General Motors know that all Chevrolet small block and big block high performance engines use Tufftride crankshafts. To quote from this manual:

> ". . . Crankshafts are 'Tufftride' heat treated to improve journal harndess and give greater fatigue strength for high performance durability. This feature is an improvement to any high performance forged crankshaft and should be included in any engine build. Do not grind crankshaft journals . . . as this removes the Tufftride case."

The above is a ton of good information, and a brief recap closing paragraph would fall far short of a thorough re-reading of this article. A very large IAC Thank You is due to all those who contributed to this report.

(Reprinted from June Sport Aviation 1983)
Edited by Chuck Larsen, EAA Designee Director

SMOKE OIL SYSTEM For Aerobatic Aircraft

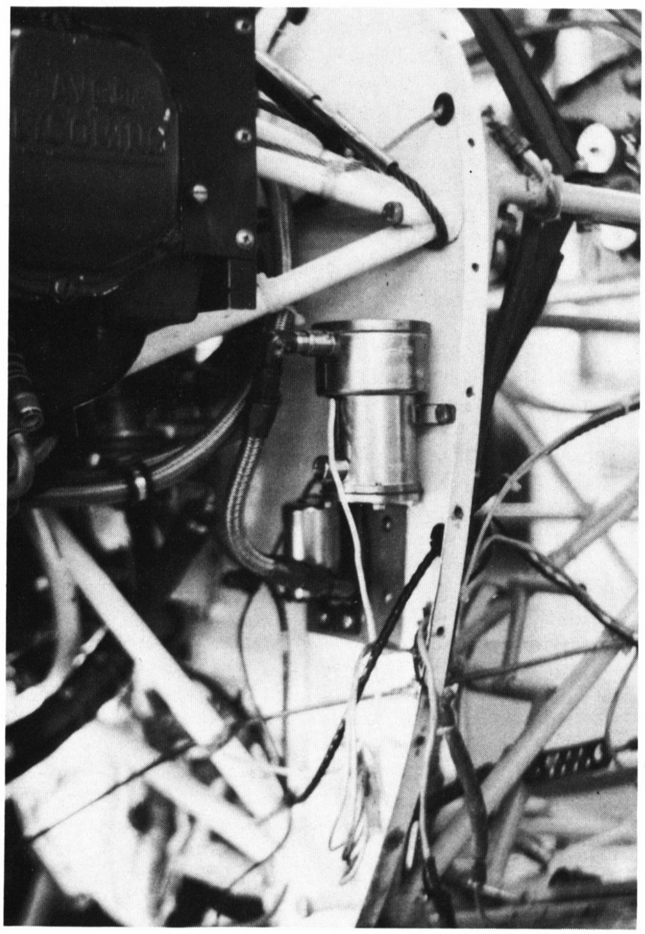


The basic system uses a smoke oil tank with an internal flop tube on the Pitts plans.

An electronic pump and electrically actuated solenoid valve are mounted on the front of the firewall. The solenoid valve is needed if the tank is higher than the pump and would continue to gravity feed with the pump off. These are hooked up in parallel to a switch mounted at the pilot's throttle quadrant position, both are 12 volt actuated. The pump and solenoid operated valve are connected with aircraft braided hose using aircraft fittings with ¼" pipe thread.

At the exhaust stack an AN flared tube fitting is screwed into a nut which is welded to the stack. This nut is a cut off AN 817 or similar. The material from the flared tube fitting must be removed from the end by brazing it over and drilling it out in progressive stages until the proper smoke output is reached. This should be about ⅛" but depends upon the engine, location of the output fitting in the exhaust stack, etc. The output nut in the exhaust stack is about midway between the engine and the end of the tube.

The pump, solenoid valve and electronic switch are available through auto supply houses. The tubing, flared ends and braided hose are aircraft quality items.



PUMP USED:	SOLENOID VALVE USED:	SWITCH USED:
Stewart Warner 12 Volt-82050 (D.C.) 7 psi (low pressure Has a built in filter on the bottom.	Skinner Electric Valve Co. 12 Volt D.C. 10 Watts V52DA2008	Any of Suitable 12 Volt type

NOTE: Prior to developing the above system an engine mounted pump was used. Due to lack of adequate lubrication this pump frequently failed. On one occasion failure of the line caused the pump to fill the cokpit with oil spray because it was controlled by a valve located in the cockpit. The electric system above avoids these problems.

DECATHLON AND CITABRIA WINGS

The following is a recent exchange of correspondence between an IAC member and the IAC Tech Safety Committee. This article contains several good bits of information that should be of interest to all Decathlon and Citabria owners (as well as other IAC members) and, also, this article is an example of how the IAC Tech Safety Program operates.

"Dear Fred:

(first paragraph omitted)

"The second reason for my letter is to let you know that we can still expect problems with the Bellanca Decathlon wing ribs. As you know, we have been operating a Decathlon in our school for several years now. The first aircraft was a 1973 model with the light wing ribs. I was able to fly this aircraft for 1100 hrs. before the first cracks showed up in the area that was required to be modified per the A.D. This area was about two inches aft of the front spar. The thing that got my attention was all the rib cracks and separation that we found along the spar and ahead of the spar when we removed the leading edge of the wing. Because of the wing rib deterioration in this area on the first aircraft and due to the lack of inspection openings in this area, I made it a point to immediately install inspection openings on the second aircraft, a 1978 model. This aircraft has the heavier ribs, however, I was not satisfied that the problem had been solved.

"I was correct in assuming that the problem was still there. First of all we developed the problem with pulling nails that attach the ribs to the spar. This occurred and had to be repaired at 700 hrs. No further problems showed up until 1400 hrs. when the first small rib cracks appeared in the area where the added inspection openings were installed. I maintained a close watch on the area and after another 300 hrs. it is now necessary to make repairs to the wing ribs to maintain an airworthy airplane.

"The first problems with rib failure in both aircraft showed up in the right wing and the greatest amount of continued rib breakage and nail pulling also occurred in the right wing although both wings are affected in the same general area. This pattern indicates to me that probably the cause is not high G loads but torsional loads caused by rolling maneuvers. Since most rolls are to the left, this would account for the greater deterioration in one wing as opposed to the other.

"My aircraft has been flown continually as an aerobatic trainer but only for Sportsman category maneuvers. No outside maneuvers are flown with the exception of inverted spins. Recommended entry speeds were always used and loads were kept at 4+ and −2G. Also, an effort was made to not exceed the recommended gross weight when flying aerobatics.

"My feeling is that of all the current Decathlons flying, if they are flown constantly for aerobatics, the wing ribs are probably limited to around a 1200 hr. life if the airplane is only flown for inside aerobatics. If the aircraft is flown outside or the entry speeds exceeded, the time will be less.

"When inspecting aircraft at the Fond du Lac contest, I have noticed that several Decathlons with several hundred hours of time on them still had not had all of the inspection openings cut out. Due to my previous experience with two airplanes, I would recommend that all inspection openings be cut and that the two additional inspection openings be placed where I have indicated on the enclosed drawings. The first indication of rib breakage will occur along both the top and bottom of the spar in this area. By placing the openings as indicated you are able to check both sides of the spar.

"If you have any questions regarding this problem, let me know. I thought it might be important to get this information out prior to next year's contest season.

Yours truly,
Jim"

"Dear Jim:

(first paragraph omitted)

"Before I forget (again), we finally got a photograph of the inside of a Decathlon showing the location of the worn rudder linkage bolt that you gave us earlier this year. That, plus a shop sketch, was sent to Steve Morris for publication in *Sport Aerobatics*. A belated 'thank you' on that one.

"Jim, your report on the Decathlon wing rib breakage and 'nail pulling' is excellent. Many of the reports the IAC Tech Safety Committee receives are not nearly as detailed as yours — a fact which makes your reports so valuable. You recall a few years ago when the problem of Citabria and Decathlon wing rib nails first came to the fore, there were several theories as to what was causing the problem. At that time Bellanca had a Decathlon wing panel they were testing trying to duplicate the reported field experiences of the loosening of the rib-to-spar attach nails. Bellanca cycled their test panel to max. positive and negative limit loads for what they figured to be several times the service life of the a/c. Also, because some of the first reported problems involved a/c in the Southwestern part of the U.S., it was felt that heat (lowered moisture content in main spar) was related to the problem. So, Bellanca, while cycling their Decathlon wing panel, heated the wing to 130°F. For all their efforts, they succeeded in getting **one** nail to slightly back out. Obviously, they were not duplicating the in-service stresses placed on the wing. Making their best guess for a fix, Bellanca issued the 'ringed nail & epoxy' S.L. They never did get a real handle on the problem. Your assumption that the nail pulling is due mainly to torsional loads as opposed to strictly high G loads sounds like a very good possibility to me, and I have heard other members express the same thoughts. Remember the T.S. report in the Oct./Nov. 1979 issue of *Sport Aerobatics* (also on pages 135-

136 of the IAC Tech Tips Manual) regarding 'nail pulling' in a Citabria? This was also a detailed report such as yours, and although it was not noted in the *Sport Aerobatics* article, this particular a/c was reported to have been operated within (usually below) recommended limit loads with **most** rolls to the left and **most** snap rolls to the right — most 'nail pulling' occurred in the right wing. On the Citabria in question, since most of the loose and missing nails were in one wing, it was suspected that some kind of torsional loads were causing the problem but it was questionable whether it was the **left** rolls or the **right** snaps. Here is the key question: Can you tell us which way your Decathlon is usually snap rolled? If it is to the left, your report, plus the Citabria report, gives some pretty strong support to the 'left rolling' supposition. If the snaps are usually to the right, I think we may be back to where we were with the Citabria — left rolls or right snaps? I think there is a real opportunity here for IAC to correlate a couple of field reports that might give some real insight to a continuing problem. Hope you can give us an answer about your Decathlon's snap direction habits.

"You will also note that the Citabria referred to in the *Sport Aerobatics* article reported nail problems at a lot lower airframe time (330 hrs.) than you have noted on the Decathlon. I believe there is a greater aerodynamic moment on the NACA4412 airfoil section used on Citabrias compared to the NACA 1412 section used on Decathlons. If the nail problem is really related to torsional loads, the greater moment on the Citabria section compared to the Decathlon section could account for the problem occurring on the Citabria sooner than on the Decathlon.

"(Just as a note for your info, Great Lakes a/c use the same type of wing construction as the Decathlons and Citabrias; i.e., formed aluminum ribs and wooden spars. When Great Lakes Aircraft Corp. was still in business, I wrote and asked about their method of rib-to-spar attachment and if they had had any problems in this area. They advised they **bolted** the ribs to the spar — bolt passed through spar and picked up rib flange on either side of spar — and had no knowledge of any problems with this type of attachment. Also recall that one time while talking to Andy Vano, Chief Engineer for Bellanca, I said something about screws instead of nails for the Bellancas and I think he almost fell off the other end of the phone — he advised a definite **NO.**)

"Jim, as you suggest, I think it would be a good idea to get your info into *Sport Aerobatics* before the next flying season, but I think we should do two things first. One, get your report on Decathlon snap roll direction, and two, since the Champion line is now back in production (B&B Aircraft), check with the **new** Citabria and Decathlon people for any possible new developments/thinking they may have regarding the nail problem and the rib breakage problem.

"Thanks again for your excellent input — IAC should have more members like you.

Sincerely,
Fred"

"Dear Fred:

(first paragraph omitted)

"In response to your question on snap rolls, I almost always snap to the **LEFT.** This is contrary to the norm but I have found that even though it is easier to produce snap entry to the right, I have found that when I snap to the left the roll radius is slightly smaller, the aircraft more near level (pitch) on recovery and there is less problem with either over or under rotation on the stop; so, 95% of my snap rolls have been to the **left** in both of the aircraft that I have operated and both had the same general wing deterioration pattern. Also, Bob _______ who owns a Decathlon about twenty numbers newer than my present aircraft and has about 500 hrs. on it flying Sportsman category, is showing his first signs of wing rib deterioration and nail pulling in the right wing and he also snaps **LEFT** in his aircraft.

"The man who is doing the repair on my aircraft is a craftsman with decades of experience working on wood and fabric aircraft, particularly Stearmans. He is also of the opinion that the rib problem is related to torsional loads but attributes the problem directly to the way the compression members are designed in the Decathlons and Citabrias.

"The compression members consist of single tubular units about 7/8" O.D. and fastened at the spar with two bolts right on the spar center line. He feels this allows wing flex during rolls putting compression loads on the ribs. He told me that in the Stearman a truss type compression member is used which butts up to the spar along its full face and gives good torsional rigidity.

"The total count on cracked ribs on my aircraft was 4 in the right wing and only one in the left wing. The man doing the repair is an excellent craftsman and was able to complete the repairs without removing the wings from the aircraft, but even at that the cost will run in the $1500 area for the repairs.

"One additional item we found was looseness of the front strut fittings to the spar. This apparently was due to wood shrinkage causing the spar face to not be in contact with the fitting. A shim was installed which solved that problem very nicely.

"On the positive side, we also dismantled the entire tail section of the aircraft and with the exception of worn hinge bolts found no real structural problems anywhere in the tail of the aircraft after 1800 hrs. of aerobatic flight. I was particularly concerned with the front horizontal stabilizer attach point but found that to be in good shape and of heavier tube dimensions than I expected.

"I hope this will help you out with the questions you had. As I mentioned, I think this problem is going to occur in most Decathlons that are used for extensive aerobatic operation and will require some close watching in the future.

Yours truly,
Jim"

"Dear Jim:

"Thanks for your last letter regarding snap roll direction, rib breakage, compression members, etc. Perhaps we are starting to see a pattern:

"(1) Nail pulling and rib breakage predominantly in areas adjacent to front spar to front strut attach point, i.e., opposite aileron bay,

"(2) more damage in one wing than the other — usually right wing, and aircraft usually rolled one direction — usually to the left,

"(3) perhaps damage occurring in Citabrias sooner than Decathlons (greater pitching moment in Citabria airfoil section).

"The thought in your last letter of rib breakage related to torsional loads — and this problem related to compression member design, is a good one. Perhaps it could be argued that you can't compare wing structural loading between a monoplane (Decathlon) and a biplane (Stearman) as was noted in your letter, but the comparison between a Cub wing and a Decathlon/Citabria wing is harder to argue against. Below is a comment made by Giles Henderson when listing modifications to be made on Clipped Wing Cubs for use in aerobatics:

'Modify the compression members (such as using double tubes, one above the other) to prevent torsion of the spars. Abrupt, high G maneuvers such as multiple snaps or square loops can cause torsional stresses in the wing which may result in multiple rib failures.'

Sure sounds similar to Stearman compression member sketch you enclosed in your letter.

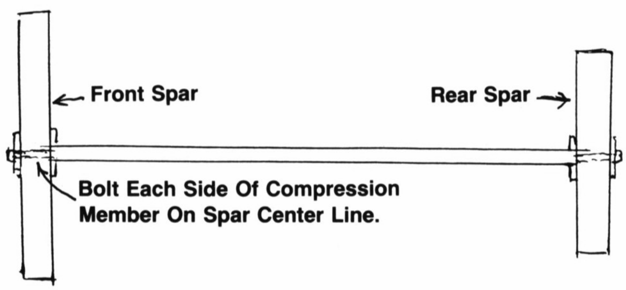
"Jim, I think it would be a good idea if we could run some of this by the B&B Aircraft people (the new owners of the Citabria and Decathlon line) for their comments/help. We have written B&B and inquired about who to contact (who is their Chief Engineer) regarding field problems such as rib breakage, etc. You know that we had a good working relationship with Bellanca (and received a lot of help from them) and hope we can establish the same kind of relationship with B&B.

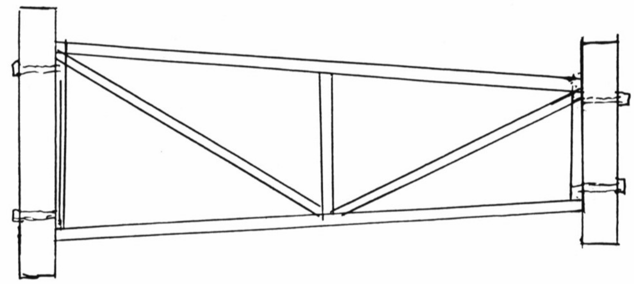
"Thanks again for the input. We will keep on it and get a report into *Sport Aerobatics* as soon as possible.

Sincerely,
Fred"

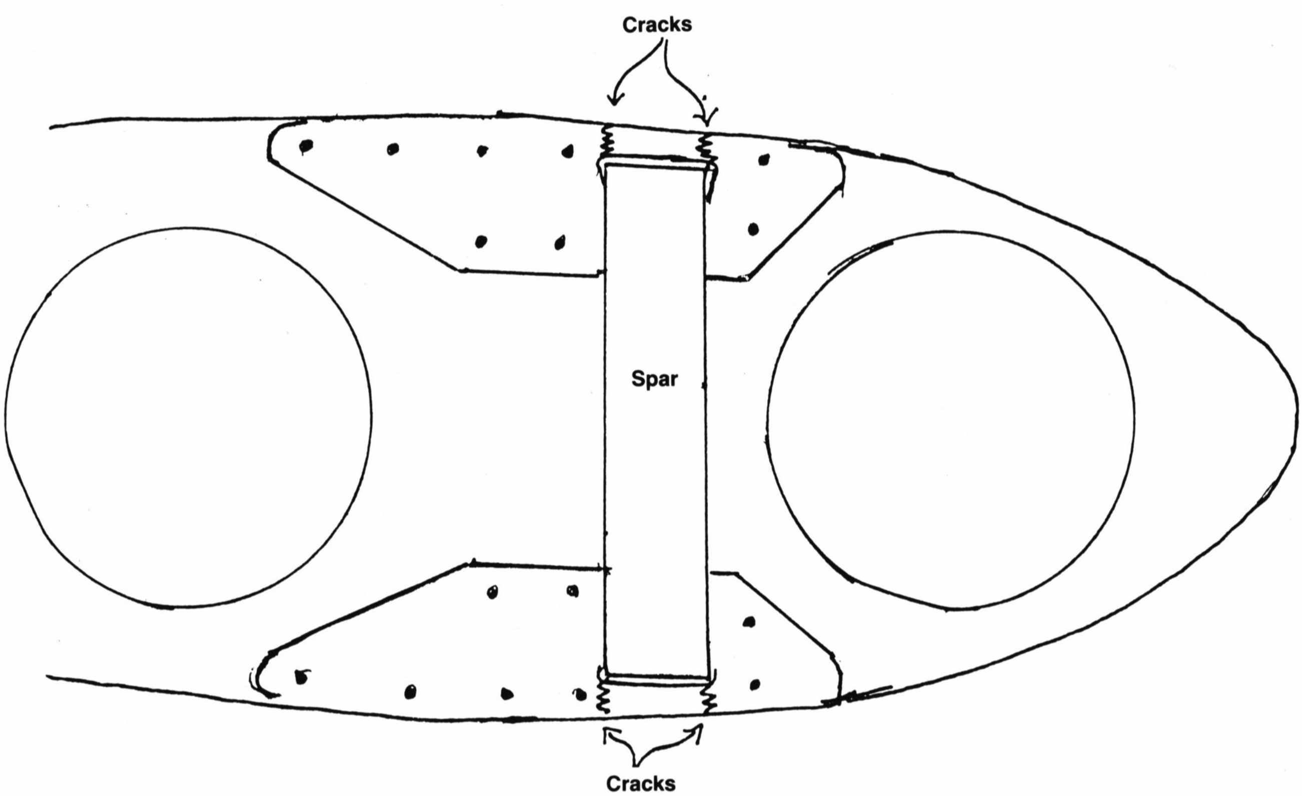
As a final note, the IAC T.S. Committee did contact B&B Aviation; however, B&B was still struggling with some FAA paperwork and were presently not in a position to help. They did express interest and willingness to help IAC in the future.

Current Method Of Compression Bracing In Decathlons.

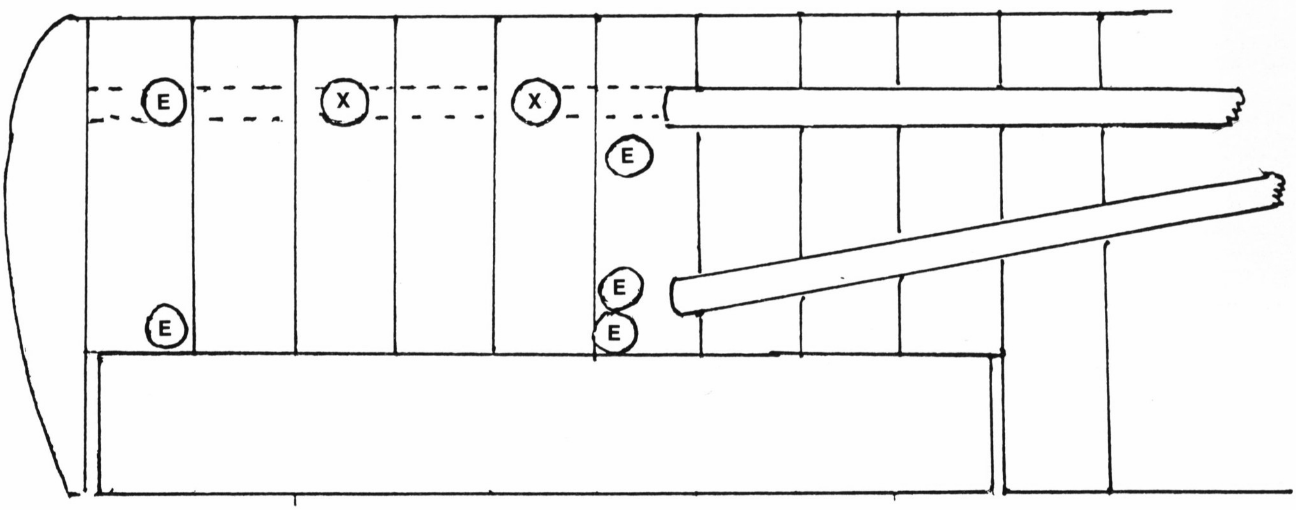




This is approximately the type of compression member that was described to me as being a better alternative since it would give torsional rigidity.



Add Inspection Covers Along Spar Marked With (X) Covers Marked (E) Already Exist.



DECATHLON AND CITABRIA WING ADDENDUM

In this issue of *Sport Aerobatics* there is a Technical Safety article concerning problems with "nail pulling" and rib breakage in Citabria and Decathlon wings. Based on just several reports, it was theorized that torsional loads, imposed mainly by left rolls, were the cause of the breakage problems. Also, some guesses were made as to total flying time before breakage problems might be expected to occur. Here is an opportunity for IAC, as an organization, to get a better handle on this problem. If **each** IAC member who owns and/or operates a Citabria or Decathlon a/c would take the time to drop a note to the IAC Technical Safety Committee relating their experiences, possibly a more definative and accurate analysis of this problem can be made. Would each IAC Citabria and Decathlon operator send the following info to the IAC Technical Safety Committee:

1) Year and model aircraft
2) Total time on airframe
3) Direction aircraft is usually rolled (left or right)
4) Direction aircraft is usually snap rolled (left or right)
5) If rib "nail pulling" has occurred, note airframe time and if damage was more predominant in one wing than the other.
6) If rib breakage has occurred, note airframe time and if damage was more predominant in one wing than the other.
7) Any additional comments that may relate to this problem.

The IAC Technical Safety Committee will tabulate all input information and report the results in *Sport Aerobatics*. Please help.

A CALL FOR ASSISTANCE

An IAC member who owns a Bellanca 8KCAB Decathlon is in need of help and this is an appeal to the IAC membership for assistance. The problem concerns an in-flight tail vibration/buffet which has been difficult to define or eliminate. To be a little more specific, when the aircraft is slow rolled to the left with an entry speed of 125 MPH IAS or less and with a fairly low roll rate, **sometimes** in the quarter roll from left knife edge to (and slightly beyond) the inverted position, the tail, namely, the leading edge of the right stabilizer, vibrates. The stabilizer's leading edge is displaced approximately 1 to 1½ inches and "buzzes" as a "moderate frequency" — the guess is approximately 2-3 cycles per second; it is "blurry". To repeat, this vibration/buffet or whatever is not constant; i.e., the pilot cannot consistently induce this condition.

The Decathlon has been checked for breakage or mechanical defects by the owner and by two A&P mechanics who kind of specialize in acro aircraft, and no problems have been discovered.

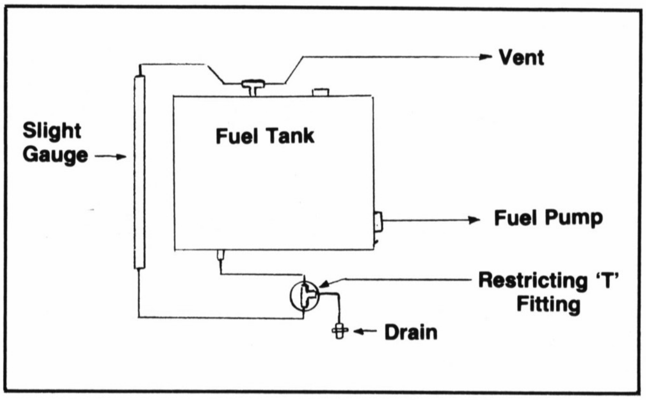
The possibilities of the tail vibration being induced by some other component, e.g., deteriorated engine mount bushings, have been discussed as have the possibilities of disturbed air flow over the tail surfaces caused by something like loose wing root fairings.

Two former Bellanca engineers, a former Bellanca test pilot, and several well-known Decathlon pilots have been contacted in this regard. Only one of the persons contacted, a Decathlon airshow performer, stated that she had experienced the described problem several times in a couple of different aircraft, but had no idea what the cause was.

The above is not meant to discourage any input by IAC members but only to illustrate that before this appeal to IACers for help, a considerable amount of effort has been expended to try to resolve the problem. The owner of the particular Decathlon in question is definitely convinced that the tail vibration/buffet is **not** a normal condition — there is "something" wrong with the aircraft. Any ideas or suggestions that any IAC member may have as to what may be the cause of this problem would be **greatly appreciated**. Please contact the IAC Technical Safety Committee with your comments or suggestions. Thanks in advance for the help.

MORE BLOCKAGE

'Way back in the July 1978 issue of *Sport Aerobatics* there was an IAC Tech Safety article entitled, "Blockage," which dealt with fuel line blockage due to damaged inner walls on fuel hose. (This article is also in the IAC Tech Tips Manual.) Since that time other "blockage" problems have been reported. The latest of these reports is as follows:



"When I was building my Pitts, I added a bottom-of-the-tank fuel drain to the fuel system by running a hose from the bottom rear tank opening down to a bulkhead 'T' fitting about 6" aft of the firewall, as shown here.

"The sight gauge has been unreliable — the fuel level would vary considerably, and could not be counted on to return to the same place after a maneuver, or even after draining fuel on pre-flight. I always thought that I had too much hose length to allow it to work properly. Finally, I decided to alter the system so that the bottom of the gauge was connected to the bottom of the tank by aluminum tubing, hoping that would improve the action. In the process, I removed the 'T' fitting (circled) and put a regular (not bulkhead) fitting in the bottom of the tank. Thought I would look for obstructions, so blew through the hose (O.K.) and looked at the fitting. VOILA! One-quarter inch down in one side of the old 'T' fitting was a tiny metering orifice! A constant, accurate, and totally unwanted restriction. Once again, the light that says 'DUMB' lit up. I had installed this fitting several years ago, before I knew that the first thing to do after buying, and the last thing to do after buying, and the last thing to do before installing, is to check for restriction. So, now I can once again try to calibrate my sight gauge, with the hope that it will be accurate this time."

In addition to the above report, one IAC member advised that recently while talking to an 18-wheeler driver (truck driver), the driver told of several fuel system blockage problems encountered by a large freight shipping company because the inside wall on some Aeroquip fuel lines that had been made up in their shop were "cut" when the hose ends were installed. This is exactly the same problem as discussed in the July 1978 *Sport Aerobatics* Tech article.

Related to the above fuel sight gauge restricted fitting problem, another IAC member advised he was installing

DIPSTICK "O" RINGS

A couple of months ago an IAC contest technical monitor reported to the Technical Safety Committee that at a contest he attended, one of the contestants had to break off his flight and land because the oil dipstick had come loose and the engine was losing a lot of oil. The pilot advised that he had been having a dipstick sealing problem. If he tightened the oil dipstick too much, the "O" ring under the dipstick head would be pushed out from between the dipstick and the filler tube — and if the dipstick was not tightened to the point that the "O" ring was "forced out," the dipstick would sometimes back off and come loose in flight. And the latter is exactly what had happened at this contest. The tech monitor who made this report advised he was suspicious of the "O" ring because it was **orange** (silicone?) and most of the disptick "O" rings he could recall were black. Anyhow, he and the pilot checked with an FBO at the contest site and they were advised the orange "O" ring was the correct part.

After the IAC T.S. Committee obtained the above information, Ernie Tyler of Avco Lycoming was contacted to see if he could help resolve this problem. Ernie advised that Lycoming engines have used **three** different dipstick "O" rings'; #74065 large black, #74068 small black, and #72312 small red. To determine the correct dipstick "O" ring, it is necessary to have the engine model and serial number. And this approach would only be valid if the oil filler tube had not been changed since the engine left the factory.

The IAC T.S. Committee did not have enough detailed information to further pursue the problem on the particular aircraft in question — and, also, to date this is the only problem of this nature that has been reported to the Tech Safety Committee. Therefore, it was decided to presently not dig any deeper but just to advise IAC members of the existence of **three** different Lycoming dipstick "O" rings. Ernie did forward three sample "O" rings and the small black and the small red have an I.D. of approximately 1", and the large black had an I.D. of approximately 1⅛". If further problems regarding dipstick "O" rings are received by the IAC T.S. Committee, perhaps then a more complete inquiry will be necessary.

A thank you is due the IAC tech monitor who brought this problem to the fore and to Ernie Tyler of Avco Lycoming for his help and support.

a turbocharger oil supply line and "just happened" to look closely at the fitting that attached to the engine oil gallery oil supply point. The fitting had not been drilled internally — the passageway was completely blocked. Had this not been discovered, it would have been almost instant turbo self-destruct.

Hopefully, the above-noted "blockage" problems will help remind all of us to be constantly alert to possible fuel or oil supply problems due to restricted or totally blocked lines, hoses, and fittings. An IAC "thank you" is due these members who supplied the above reports. It is this kind of input that will help keep our sport safe and enjoyable.

TIE ROD CLEVIS TERMINALS

In the past there have been several EAA/IAC articles on streamline tie rods (flying wires). The March 1969 issue of *SPORT AVIATION* had an article by Bob Whittier entitled, "All About Streamline Tie Rods". In the July-August 1976 issue of *Sport Aerobatics* there was a Tech Safety article called "A Classic Example". And, lastly, the April 1982 issue of *Sport Aerobatics* contained a Safety article by Moon Wheeler entitled, "Streamline Tie Rods Revisited". A review of all this material might be timely.

Recently, there has been some concern expressed about the AN-665 clevis terminals that are used on the ends of the tie rods. There was a report that some of these clevis terminals were out of spec in the alignment of the pin hole and the threaded shank. IAC'er Moon Wheeler has been following the dialogue associated with this situation and has made a couple of reports to the IAC Tech Safety Committee. The last "report" made by Moon was a copy of a letter from the Macwhyte Company, the makers of streamline tie rods and AN-665 clevis terminals, to EAA headquarters relating to some tests Macwhyte conducted on the clevis terminals, flying wires, and clevis pins. This letter is reprinted in its entirety below:

"The referenced letter addressed a possible out-of-tolerance condition on AN-665 terminals. The specific tolerance addressed was the $\pm \frac{1}{2}°$ allowable variance on the 90° angle between the axis of the pin hole and the axis of the threaded shank. It appears that some terminals have been discovered in the field that do not meet this tolerance and concern was expressed over the possible non-symmetrical loading of the terminal.

"As part of our normal quality control procedures, we routinely break test sample fittings, and this testing has revealed that the fittings exceed the rated tie rod strengths by wide margins. To determine the results of a non-symmetrical loading of a terminal such as could be caused by a severe out-of-tolerance condition between the two axis, we performed an additional series of tensile tests. To evaluate the worst possible non-symmetrical load, fittings were tested with one 'ear' removed and the fittings still developed over 70% of the rated tie rod strength. In addition, Macwhyte engineers have conducted field investigations to look at tie rod installations on various biplanes. These investigations have revealed that the wing and fuselage fittings could produce a more critical alignment condition than the one existing in the AN-665 pin and fitting.

"Macwhyte has installed additional testing equipment and improved machining fixtures and has increased sampling quantities to insure that fittings leaving our plant comply with all specifications of the 'AN' drawings.

"The Macwhyte Company is proud of its reputation as a manufacturer of high quality components for all types of aircraft. We stand behind our products and we will replace, at no charge, any out-of-tolerance fittings returned to us. I have enclosed a summary of the fittings tested to verify the load capabilities.

"Sincerely,
T. E. Brunner
Manager-Fabricated Products
Macwhyte Company"

To date, the IAC Tech Safety Committee is not aware of any streamline tie rod clevis terminals that have failed in service. The purpose of this Tech Safety report is to keep IAC members informed of items of technical interest.

Much thanks to IAC'ers Moon Wheeler and to Tom Brunner of Macwhyte for their input. It is this kind of interest and action that will keep our acro aircraft safe.

SUBJECT: STRENGTH COMPARISON OF AN665 CLEVIS VS. STREAMLINED FLYING WIRE — MARCH 1983

AN665 CLEVIS TERMINAL				STREAMLINED FLYING WIRE					CLEVIS PIN
P/N	Required MIL SPEC Strength (Lbs.)	Actual Average Tensile Results: Standard Clevis (Lbs.)	Actual Average Tensile Results: One Ear Only (Lbs.)	P/N	Thread Size	Required MIL SPEC Strength (Lbs.)	Actual Average Tensile Results: Streamline Section (Lbs.)	Actual Average Tensile Results: Thread Section (Lbs.)	Required MIL SPEC Strength In Double Shear (Lbs.)
-46	5,290	8,575	4,268	AN675	5/16-24	6,900	7,263	8,150	11,500
-61	7,935	10,725	5,800	AN675	5/16-24	6,900	7,263	8,150	16,580
-80	11,500	13,541	7,125	AN676	3/8-24	10,000	11,713	12,950	16,580

MACWHYTE COMPANY
Kenosha, Wisconsin

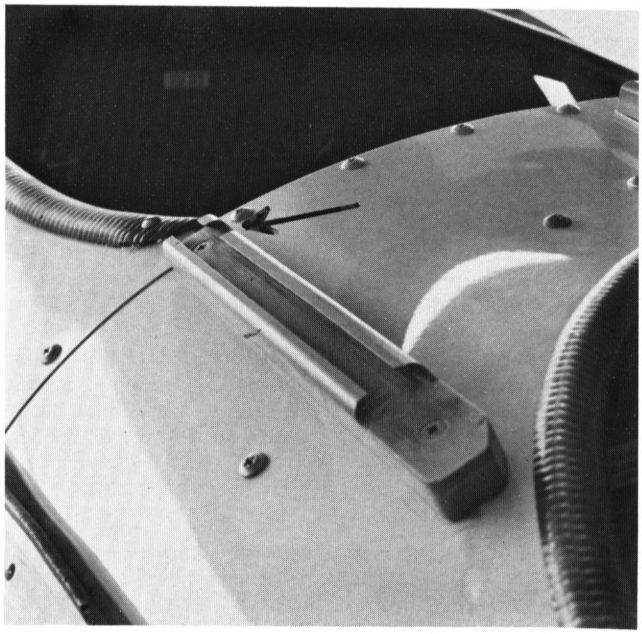
Any Point in Time

jibberish by;
'OL MOSS FACE

No one would ever believe what has been going on around my airspace in these last 15 months, so, even if you don't care, let's talk about some of it anyway. I have a feeling there might be a lesson or two to be learned.

I would have to say my problems really started when my greedy eyeballs began to refuse to look at anything but monoplanes, specifically the Lazer. I began by looking for talented, usually recommended individuals to do most of the specialized construction. Those of you that know me know why someone else would have to do the building; those of you that don't know me might be considered by most to be fortunate. Never-the-less I will try to enlighten you as to my not-so-well-hidden talents while those that do know me go to the kitchen for a beer. I would probably be able to bet my 25 acres of Libyan beach front property against a donut, chocolate covered, that the most profoundly ignorant aerobatic pilot knows a plane would have to take more than 3 G's to do competition aerobatics. That is roughly 2 G's more than any airplane I built could take, giving or taking a G, This was probably attributed to the fact that I thought it appropriate to use SNAP ROLL construction on an aerobatic airplane. I once tested my abilities in aviation craftsmenship by building model airplanes like a lot of you. Unlike a lot of you I am the only guy I know that could bring a beautiful scale model of a B-29 home from the hobby shop at 4 P.M. Friday and be ready to fly it, (I THOUGHT), by 8 A.M. Saturday at the local radio control club meet. I'm sure you're getting the flick. I can remember thinking, "There ain't no justice! How come Billy Jo Rudder's plane there looks ten times better'n mine when I got mine built ten times faster?" In short, though I have never been accused of having a four digit IQ, I realized the **big** difference between those models and a Lazer is **I would be strapped to the Lazer.** One thing I forgot to mention that I still think about; Not one single model I ever built ever got back to earth in one piece. Anyway, I began to get my list of builders and craftsmen together, along with well intended promises. Parts of my plans began to be distributed to the four corners of the United States. Most of these folks quite understandably did not want to start building a plane with-out some out front remuneration, usually in full. We're talkin' **big bucks** here! For a lot of you guys out there this may not be a problem but for the majority of us ($40,000.00 a year or less) it can be a heart breaking "AH SHUCKS". Where is a BEAN like 'ol Moss Face gonna get all this needed green? After several unsuccessful attempts to trade my daughter's swing set for an IO-360 B4A 200Hp I began to look toward the only possible way to get the collateral . . . **MY PITTS** . . . sob, sniff.

The day that Curtis Hawks gave me the check for my plane I began calling my would-be contractors, (to save my sanity, WHAT HAD I DONE??), believing that my new Lazer would be in the box by that summer and that all the pain would soon go away. From this point on I wish to say I **will not** mention names of these good folks. It is not my intention to slander or retaliate against anyone, no written contracts were ever signed. If anybody is to learn a lesson it is you and I, **boy did I learn a lesson! Get it in writing.** People that were to do the welding no longer would be able to because they had more commercial business than they could handle and did not really want to get involed with custom-type work. The guy building the wing went so far as to split without leaving a forwarding address or phone number; I still don't know where he is. I wonder if I have a hygiene problem? The story goes on, I have a hangar full of tubing and wood and no hope of being in the sky with a Lazer for a few years. I'm already fed up and, if I am going to be back in the box by next year, I am going to have to buy a plane, probably another Pitts. And why not? It **is** the best airplane in the sky. I only wanted to do something different for a while, I had no heartaches. After all, I had experienced some degree of success after owning a Pitts for almost 10 years, and we all know what NOT to do with success.



Arrow points to broken section of alignment rail (Pitts S2). Hinges on other side of cockpit were ripped from the plane.

At any Point in Time one can be snatched from the pinnacles of euphoric rapture and thrust into the pits, (no relation), of total deprivation. One minute you have grabbed the world by large hunks of fleshy posterior, possessing a flying Pitts and attending contests' as a pilot. The next moment one owns nothing more than a dream, piles of lifeless metal and cords of fire wood. What does one aerobatic pilot-type do to keep from becoming alienated to his previous life, his love? Well, for one thing I bought a computer, mostly for the word processing, as some may have noticed in some of the magazines around I am trying to get our thoughts, yours and mine, into the public's eye. Or one might do a lot of instruction, trying to keep in touch with the aerobatic feel such as I do at the PITTS STOP in Santa Paula. Recently, I lost a canopy on the S2S and I have had several calls and so has Charley Larkey as to what could have caused this incident. (I hope Herb Andersen is reading this to note that I referred to it an an INCIDENT and not a FAILURE). I have an article on this subject that I will present later when all the facts are in. As it stands right now no one is sure if the canopy was secured properly or if in fact it failed outright. Briefly, I was up in the air for about ten minutes with a student and had done a series of basic maneuvers when we decided to do more advanced maneuvers. The first thing we went into was the rolling 360 turn to the outside when BANG, SHATTER, SLAM! The next thing I knew I was flying an airconditioned Pitts. Besides the Plastic rail on the left side of the fuselage being broken off, (see photo) the canopy seemed to have ripped loose simultaneously from the hinge on the right side. The thing that I remember most vividly was the cross tubing coming straight back trying to decapitate me. No matter whether it's my fault or a failure of the system, we should be made aware of the cross tubing on the canopy itself. In all fairness to Herb and the Pitts folks, I tried to break the plastic rail by hand on the ground to test its seemingly weak appearance. Herb told me the name, Super hardicous, no ripous, plastic steelocus. In any case, I could not break it. However, that does not leave out the possibility that the rail was cracked or broken before I went up by forces much stronger than I. Please, if you own a Pitts S2 with the new full canopy, **preflight thoroughly.** If you **do** have a cracked plastic **lock block** or alignment rail let Herb Andersen, (Pitts Factory), or myself know, and **don't** do any rolling three sixties.

At some other point in time you probably will lose a good friend in our aerobatic "clique" as I have. During the last paragraph of this article, I have just learned of the tragic end of one WES WINTER.Can there be any greater shock than while sitting at a typewriter writing to ones friends to look over your shoulder at the TV, hearing "TRAGIC PLANE CRASH KILLS PILOT IN AIRSHOW" and seeing a newscast so graphically producing the end of one of your best friends? My feelings are mixed with remorse and guilt. It was I, after all, who taught Wes Winter how to fly aerobatics way back when he and I were trying to get the Phoenix Aerobatic Club off the ground. Thanks to a conversation with Bill Rummer, my guilt feelings subsided as I am convinced that Wes learned well. There was not a safer, more conscientious aerobatic pilot in the sky. Wes had done several shows in his Italian-built twin engine airplane without incident and the odds of both wings folding on an aircraft simultaneously in what had to be less than 3 G's is astronomical . . .IS THERE A GOD,???? **YOU'D BETTER BELIEVE IT!!** I can love no one more than I love you, MY AEROBATIC CONFIDANTES. I cannot bear the loss. I know you are the best but **PLEASE BE CAREFUL HOW YOU PROVE IT!** A crowd of unknowledgeable, unappreciative spectators is certainly not the arena to produce that proof. I must quit now. The thought of my friend Wes is beginning to numb my fingers and my mind. I will be with you at some other point in time.

Charley Larkey and I examine recovered canopy frame to see if we can find any reason for it coming off.

UNIVAIR'S BELLANCA/CHAMPION PMA PARTS

A few months ago Univair Aircraft Corporation, Rt. 3, Box 59, Aurora Colorado 80011, phone 303-364-7661, published a sales brochure listing many FAA-PMA approved parts which they manufacture for Citabria and Decathlon aircraft. After reviewing Univair's brochure, several questions — questions that would probably be asked by IAC members interested in purchasing these parts — arose, and, therefore, the IAC Technical Safety Committee contacted Univair for clarification.

The following is the discourse of questions and answers between the IAC T.S. Committee and the president of Univair, Stephen Dyer:

(1) **Wing Ribs**

IAC: "Early Citabria wing ribs, through 1968, were .020; 1969 and later a/c use .032 ribs. What is the thickness of the Univair Citabria ribs?"

UNIVAIR: "Our PMA replacement ribs for the Champion aircraft are all manufactured of the .032 material and all incorporate the heavy gusset at the spar openings just as the latest Citabria ribs did."

(2) **Lift Struts**

IAC: "Early Citabrias had wing struts made of streamline tubing with an .035 wall thickness, and later model Citabrias used struts with an .049 wall. The .035 wall struts had a section of round tubing at the spar attach end while, for identification purposes, the .049 wall struts had a section of square tubing at the spar attach end. If the .035 struts are used, the aircraft must be red-lined at 153 MPH and if the .049 struts are used, the red-line is set at 162 MPH. What is the wall thickness on the Univair struts and what shape tubing (round or square) is used at the spar attach end of the struts?"

UNIVAIR: "Univair P/N U5-392 Citabria front strut incorporates an .049 streamline section and square end tube just as the latest design Champion struts did; likewise, the Univair rear strut U5-268 incorporates the heavy end fitting like the Champion factory strut.
"Another point of interest to your members: Our PMA approved high strength alloy steel strut fork ends for the rear struts are manufactured with rolled threads to eliminate any possible weak points that seemed to be associated with the original cut threads, as in the Piper strut forks and original Champion forks."

(3) **Tail Brace Wires**

IAC: "Some Citabrias and Decathlons had round steel tail brace wires and some of these model a/c used streamline stainless steel wires. Are the Univair tail brace wires plain carbon steel or stainless steel?"

UNIVAIR: "Univair supplies only stainless steel tail brace wires in both round and streamline. Although most Citabrias came out with the round wire, Bellanca Champion approved the streamline wire for the Citabria as well as the Decathlon in a speed kit shortly before the plant closed in Osceola."

(4) **Engine Mounts**

IAC: "As you know, early 7ECA and 7KCAB Citabrias used a rubber cone-type engine mount bushing while later model a/c were equipped with Lord mount bushings. The Lord bushings require a hole and a locater pin (roll pin) in the engine mount pad face. Do the engine mounts supplied by Univair have the locater hole/roll pin?"

UNIVAIR: "At this time we have only received approval and manufacture the mounts for the pre-1974 aircraft. These mounts carry P/N U4-1033 and U4-1033-10. The mount that you refer to as having the roll pin in the rubber mount pad face are P/N 7-1522-2 or -3, depending on aircraft model. At this time we do not supply them, however, if sufficient demand arises for them we will work up engineering and tooling and apply to the FAA for an approval to produce these parts."

(5) **Landing Gear U-Bolts**

IAC: "During the production run of Citabrias and Decathlons, several U-bolt material and metal treatment changes were made (e.g., later U-bolts were shot-peened, Rockwell checked, etc.). What are the specs on the Univair-made U-bolts?"

UNIVAIR: "Univair manufacturers FAA-PMA approved replacement U bolts. Due to the problems Bellanca Champion encountered with this part, our specifications call out a heat treatment and Rockwell inspection to a C-29 to C-32 reading which corresponds to 132,000 to 144,000 PSI strength. The bolts are then magnafluxed and finally stress relieved through shot peening. This results in a tough, high-strength part that is equal to, or superior to, the final design part produced by Bellanca Champion."

(6) **Tailwheel U-Bolts**

IAC: "Early model Citabria tailwheel "U"-bolts were a section of "U"-channel stock with studs welded to the sides while later a/c had a true "U" bolt securing the tailwheel springs. Are the Univair U-bolts the late style "U-bolts"?

UNIVAIR: "Univair manufactures both the early Ul-555 and Ul-8854 channel design still applicable to the early Aeronca Champ series with 1½" tail wheel spring and the later Ul-10325 and Ul-10589 "U" bolt, both of which are true "U" bolts and manufactured for use on the 1¾" wide tail springs on later Citabria, Decathlon and Scouts. The parts book should be consulted for the actual part number required on specific model and year of aircraft."

(7) **Tailwheel Springs**

IAC: "Citabrias and Decathlons used two different width tailwheel springs. How wide are the springs supplied by Univair?"

UNIVAIR: "The Aeronca Champ and pre-1974 Citabria used the Ul-428 design spring of various dash numbers; all of these springs were 1½" wide. The later 1974 and after Citabrias, Decathlons, and Scouts all used the 1¾" wide spring with the basic design part number of Ul-1543. Univair manufactures approved parts of both part numbers. The aircraft model and year manufactured must be supplied, or the specific part number provided, at the time of ordering to assure the proper spring is shipped.

(8) **Ailerons**

IAC: "In 1974, an additional brace was added to Citabria ailerons. Are the Univair ailerons the early or late style?"

UNIVAIR: "You bring up a very interesting question in your statement that an extra brace was added to the aileron in 1974. Our FAA approved aileron is part number U5-180 left and right uncovered and part number U3-447 left and right for covered part. We do not know of any extra brace in the aileron from the early Champ up through the Citabria and Scout. The approved aileron has always been a part number 5-180 left and right or 3-447 left and right. The only changes we were aware of was a material change 5052-H-32 to 2024-T-3 alloy in the aileron spar which was an increase in strength of approximately 20% of the spar itself. Bellanca Champion was always good about changing the part number when they made a structural change, such as the early .035 wall wing strut you mentioned was a P/N 5-144, when the problem appeared Bellanca Champion changed the design incorporating the .049 tube and square end, likewise the part number of the new strut was changed to 5-392.

"I checked with two knowledgeable companies who were Bellanca Champion dealers when Bellanca was in business and neither one of them was aware of any difference. One was even good enough to strip the fabric off of an old Aeronca Champ aileron he had salvaged and in stock. He compared it with a new factory-produced 5-180 Citabria aileron he still had in stock and measured all of the material thickness, checked general configuration and could not find any difference. Please help us solve this question, for your information as well as ours."

To further check on the question of the extra aileron diagonal brace, the IAC T.S. Committee went through the IAC M&D files and all *Sport Aerobatics* Tech Safety articles. The IAC M&D files did show a couple of reports of "bent ailerons" on early Citabrias but with no further comment. A January, 1976 *Sport Aerobatics* Safety article, however, did make mention of an extra diagonal aileron brace. However, based on Univair's research, this may have been erroneous information. Can any IACers help us with this question? Was an extra diagonal brace added to Citabria ailerons in 1974 or was there some misunderstanding surrounding the 1976 *Sport Aerobatics* report?

In addition to all of the above background info on Univair's FAA-PMA Citabria/Decathlon parts, Univair also donated to the IAC Technical library a set of Citabria and Decathlon parts manuals.

Obviously, the sport of aerobatics is very much dependent on the availability of aerobatic aircraft and the components to keep these aircraft operational. Therefore, we are extremely pleased that Univair is supplying some parts for Citabrias and Decathlons and for the interest they have shown in our activities. IAC thanks to Univair and to Stephen Dyer.

Fred L. Cailey
Chairman
Technical Safety Committee

GREAT LAKES TAIL BRACE WIRES

IAC members will recall a Technical Safety article in the February, 1983, issue of *Sport Aerobatics* (entitled "Same-O, Same-O") which noted the failure of a tail brace wire on a Great Lakes. This information was relayed to the IAC T.S. Committee by Ben Owen at EAA Headquarters. Well, Ben just contacted the T.S. Committee again advising that a second Great Lakes failed tail brace wire has been reported to him. An EAA member told Ben that he was shooting landings and had done the usual walk around pre-flight before getting back into the airplane when he saw a tail brace wire hanging loose. As a fix, he replaced all the tail wires on his Great Lakes with the next larger size.

Thanks to the EAAer who made this report and once again thanks to Ben Owen for relaying this report to IAC.

"TOPCAT"

By Mike Tomalesky, IAC #3007

I have been a member of the International Aerobatic Club for a number of years and have always enjoyed reading *Sport Aerobatics*. I am particularly interested in the articles on new aerobatic aircraft. So here is some information about a new sport aerobatic and competition airplane called the Topcat, which has been designed and recently completed by my father, Peter Tomalesky.

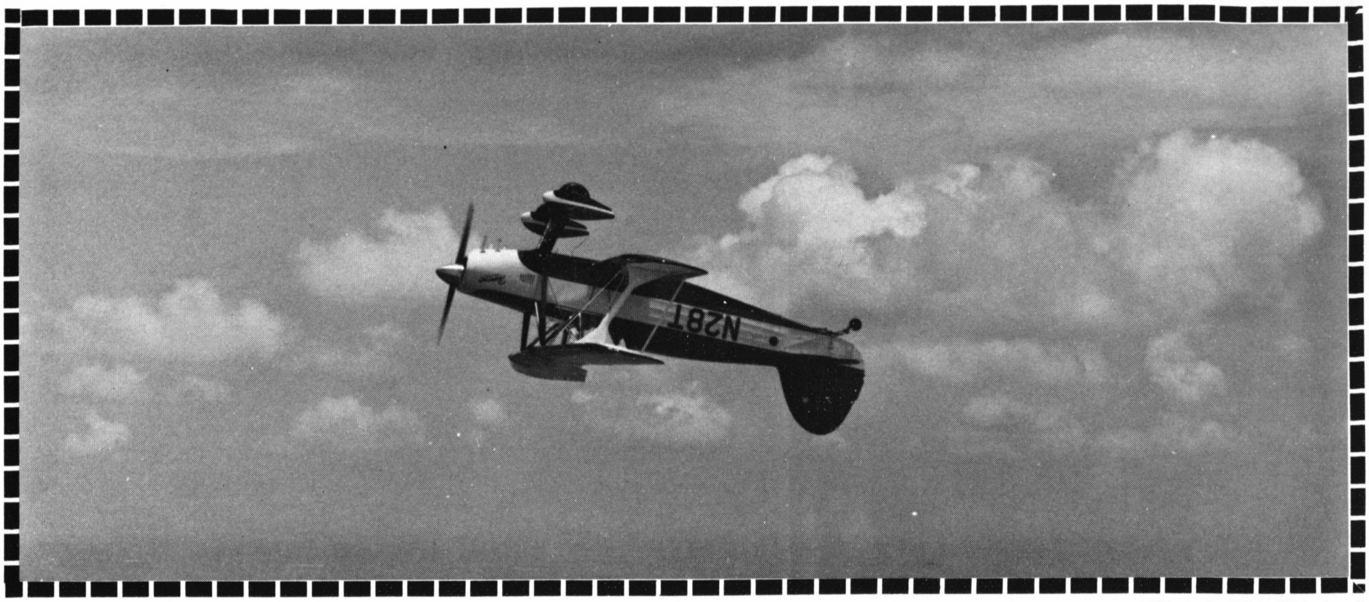
The first flight of the Topcat occurred in January of 1983. The aircraft is presently undergoing flight testing in both normal and aerobatic conditions. Rate of climb solo is more than 3,000 feet a minute and at gross weight is 2,100 feet a minute. Cruise at 65% power is 140 miles per hour indicated and at 25 square the Topcat will loop out of cruise without additional power. Both wings have symmetrical airfoil sections and have four interconnected ailerons. This configuration results in a very healthy rate of roll although at this time the roll rate has not been calculated. Aileron rolls either to the right or left are very smooth without any oscillation of the nose. Point rolls are executed without difficulty. The ailerons are very strong and stopping at any number of points is very easy. The elevator is both statically and dynamically balanced and has servo tabs which are controllable from the cockpit and serve as trim. Rudder control is positive. Control feel in all three axis is harmonized. The Topcat has a very predictable stall, with some control shake before breaking. Once into the stall, aileron and rudder control is acceptable. Recovery is quick without the application of power. Spin entry is rapid with recovery from three or four turns in less than half a rotation. Inverted flight maneuvering at this time has been limited to straight and level to assess the functioning of the inverted system.

(Photo by David Heller Photography)

Topcat in flight over Umatilla, Florida. Designer/builder Peter Tomalesky.

The design phase of the Topcat was begun in 1980. During the course of the next several years construction continued on the aircraft. It is of conventional construction with a welded steel tube fuselage rounded out by wooden stringers and aluminum turtle deck. The wings have spruce spars and built up ribs with aluminum leading edges. The airframe is covered with fabric and painted with enamel. The engine is a Lycoming IO-540-D4-A5, rated at 260 horsepower. The engine is driving an aerobatic Hartzell controllable speed propeller.

Since the Topcat is intended for sport and competition aerobatics the airframe has been designed to handle up to a 300 horsepower engine. The 260 horsepower engine makes the Topcat quite a performer. Engines of less horsepower would offer the pilot a docile sport plane capable of aerobatic flying.



(Photo by Tom Nicholson)

Tomcat (side by side) Biplane designed/built by Peter Tomalesky.

(Photo by David Heller Photography)

Topcat N2036T flown by Peter Tomalesky, Designer/builder.

(Photo by Mike Tomalesky)

Topcat #2036T.

The Topcat specifications are: top wing span of 24'-0"; lower wing span of 23'-0"; length of 20'-6" and overall height of 7'-0". Empty weight is 1270 lbs. with a useful load of 680 lbs. which results in a gross weight of 1950 lbs. The wing area is approximately 156 square feet. At gross weight the power loading is 7.5 lbs. per horsepower and the wing loading is 12.5 lbs. per square foot.

The immediate plans for the Topcat are to continue to evaluate its flight characteristics, and to begin exploring all aerobatic capabilities, including inverted, and vertical maneuvers. The Topcat is the second biplane designed and completed by my father. His first aircraft was a side by side biplane called the Tomcat. The Tomcat was completed and first flew in 1972. I had the pleasure of competing several times in IAC competition in the Tomcat. It is powered by 160 Lycoming with the fixed pitch propeller. The Topcat utilizes the same airfoil section and approximately the same wing configuration. The choice of the 260 horsepower engine in the Topcat was made at my urging since the Tomcat always needed just a "little bit" more horsepower to be competitive.

My father has been involved in aviation for nearly 35 years and is a licensed A and P. He does custom work on home built aircraft including welding fuselages and building various components on an as-ordered basis. At present there are no complete blueprints for amateur construction of the Topcat. However, if public interest is great enough for plans I will have to tie my father to the drawing board until he completes them.

I hope the above information will be helpful and sufficient. If there are any further questions I may be reached at 2575 Elderberry Drive, Clearwater, Florida 33519. My telephone number is (813) 784-4206. Or, if interested, you may contact my father directly: Peter Tomalesky, Box 34, Rt. 2, Umatilla, Florida 32784, telephone number (904) 669-6270.

A PITTS REPORT

The following detailed report was recently received from an IAC member concerning a variety of problems he encountered with his homebuilt S-1 Pitts. There are many good "tips and hints" in this report, so a close reading should prove "educational" to many IAC members.

"Three years ago I bought a homebuilt Pitts S1. The builder had constructed one Pitts before. I was the third owner. The logs showed the following: At 79.4 hrs. the landing gear was replaced with factory gear when the right gear leg was found cracked. The right brake was found to be defective. The top wing landing edge skins were removed and the right lower wing tip was opened for inspection. The tail wheel and springs were replaced. The Hoffman 56" prop was replaced with a 60" Sensenich which has already flown 1000 hrs. on another aircraft and had been overhauled. The insertion in the log book said only 'to make more use of available horsepower,' though why anyone should change from a Hoffman for such cause is beyond me.

"There was no indication of any ground loop or other damage in the logs. The engine was, of course, decertified, and there was no history available. It had been purchased as a rebuilt homebuilder's engine.

"In my first year of ownership I had so many problems, including a hand prop starting accident in which no one was hurt, that I decided to completely rebuild. The project took two years. I believe that the engineering problems discovered during the year of flying and during the rebuild may be useful information for the Technical Safety section.

"Unless there are two identical histories, I am sure that my machine is the one discussed in *Sport Aerobatics* of July, 1979. I subsequently learned that there had been a series of ground loops in which a Hoffman prop was broken, the right lower wing tip was damaged, and the landing gear was cracked. Anyway, on to my sad experiences!

"#1. Fuselage Mainframe.

"All the welding was of good quality and withstood careful inspection. Two serious problems were found. The front flying wire to fuselage attach brackets were angled incorrectly when the wing was properly rigged, creating bending stresses in the flying wires close to the bracket. This was, of course, easily rectified. The cluster of cross tube and diagonals in the cockpit floor just above the front torque tube attachment showed crushing of the cross tube, as though it had been squeezed by the diagonals either during welding or during the ground loops. This was repaired by welding a six-finger plate over the cluster.

"#2. Undercarriage.

"We assume that the axle clusters had been realigned in the way described in the article mentioned above. The undercarriage cross tubes were not properly aligned with the fuselage cross tube, but were angled slightly forward, which would have given toe-out to the wheels. As a result, only part of each compression block rode on the fuselage cross tube, with the result that the blocks were tearing to pieces. The channels on the undercarriage crosstubes in which the blocks ride had caused indentation in the fuselage cross tube. I suppose this fault would be expected where the axle clusters are realigned by heating and twisting, since if the fuselage did not allow proper alignment of the wheels it would have to be out of alignment in some other place, too. The lesson obviously is that in bending one part to fit, all of the other alignments of that part must be checked. Although we rebuilt the undercarriage, I have since changed to factory spring gear and a Haigh locking tailwheel. The difference in the landing is unbelievable.

"#3. Wings

"We removed and stripped the wings. The leading edge skins were loosely applied to the nose ribs, in some places with a gap of more than ¼ in. During the rebuild I used a set of Christen-type clamps and solved the problem. Several of the nose ribs near the centre section were broken, presumably during a turn-over on ground loop. These were replaced. All of the corner blocks between the ribs and the spars — it is a Sparcraft wing with mahogany ribs — were either split by the tacknails used during glueing, almost finger loose, or could be separated from the spar by only the lightest of effort with a thin-bladed knife. I do not know what glue had been used, but it was crystalline in places. All of the blocks were replaced using aircraft Epoxy and clamps. Several of the drag and anti-drag wires were misaligned, throwing bending stress into the wire ends. The upper wing centre bow was detached from its reinforcing blocks. The lower right tip bow had been repaired by splicing, and the tip rib repaired, but we still discovered undetected cracks in the tip rib. The whole tip was rebuilt. All tip reinforcing blocks were replaced and glued with Epoxy.

"The lower wing front and rear spar attach brackets and the cabane strut to wing attach bushings were not properly aligned, so that the wings rig with 1.5 degrees "toe in" at the leading edge. I spoke to Herb Andersen about this. He said I would not notice the difference. He was right.

"Before covering the wings, we glued 5/16" by ¼" spruce cap strips to all ribs.

"#4. Engine.

"I had the engine boroscoped. The cylinders were markedly glazed. We dismantled the engine, finding worn cam lobes, worn cam followers, pitting in the cylinder walls beneath the glaze, corrosion pitting in the connecting rods, a crankshaft needing grinding, and a keyed oil pump drive instead of the correct splined drive. The propeller was found to have a fine crack, and the prop flange bushings were of the wrong type, projecting into the prop holes hardly at all. The engine was majored, a new prop was purchased, and the correct prop flange bushings were fitted. These were five of P/N 74249 and one of P/N 74248.

"I do not like flying behind an engine without a history, and that fear was justified.

"The mixture control cable broke at the mixture control arm during an early run-up. We found that the clamp bracket on the angled oil fitting under the sump, which clamps the mixture control outer cable, was incorrectly angled. (Detail E on Pitts drawing 1-600, Power Plant Installation.) As a result, during movement of the control arm the inner cable was flexed at the mixture control through too great an angle and developed a fatigue break. We changed the angle of the attach clamp and fitted an offset control arm. The inner cable is now well aligned throughout its range.

"#5. Instrument Panel and Gas Tank.

"As with the rest of the machine, a great deal of tidying up was needed. Most important, however, was the oil pressure line fitting in the oil pressure gauge. Instead of using right angled AN822 type fittings in the fuel and oil pressure outlets of the pressure gauge, the builder had used AN823 type fittings with 45 degree angles. As a result, the oil pressure line was angled outwards from the gauge and had no clearance from the rear wall of the tank. During slight movements of the tank rear wall in aerobatics the wall had flexed slightly around the line and cracked. I had two successive leaks repaired before I found out what was wrong. Inserting the correct fittings immediately gave adequate clearance.

"#6. Tail Group.

"We were aware of the problems with horizontal stabilizer support tubes and fitted the stronger support tube supplied by the Pitts factory. This required replacing the appropriate fuselage cross tube so that the bushings would align. The stabilizer support tube which was removed had been fitted to factory produced horizontal stabilizers. In order to make them fit, the builder had put a small backward bend in the support tube on each side, but in producing the bend the tubes had been wrinkled on the bend line, creating a wall weakness.

"I have recounted those defects which had structural or safety significance. In retrospect, I am alarmed at the many defects which could not have been discovered without disassembly. The propeller, the fuselage aluminum plates, the horizontal stabilizer, and the wing covering would all have needed to be removed to complete the inspection, and a pretty extensive engine check with removal of cylinders would have been needed. Now that I have gone through the experience, I know a very great deal more about Pitts aircraft than I did, and I could perform a fairly adequate inspection. I hope that this report might be useful to others looking for a used airplane, and may save them from the troubles which I faced. I do know that the machine was not safe for use in the condition revealed during the rebuild."

Naturally, a "Thank you" is due the IACer who made the above report. Remember, the IAC Technical Safety Program only works through membership input — i.e., the Tech Safety Program **reflects** the interest and concern of the members for each other and the sport of aerobatics. IAC, itself, only provides for forum by which we can help ourselves.

TAILWHEELS, AGAIN AND AGAIN

A review of past issues of *Sport Aerobatics* or the IAC Technial Tips Manual shows many, many safety articles concerning tailwheels and tailwheel problems. Reports of problems with tailwheel springs, thru-bolts, U-bolts, chains, links, locking pins, locking pin retaining plates, geometry, etc., have been submitted to the IAC Technical Safety Committee. The following report concerns a tailwheel problem not previously noted and one that could very easily be overlooked during aircraft construction and assembly.

"After four years of building, I finished my Pitts S1-D and was really enjoying flying it and learning aerobatic flying. I had just finished practicing a routine and was coming in to land. There was a slight crosswind from the left, about 5 mph, and I came in with a combination crab and slip. Just before I touched down I straightened out the plane with the right rudder. I touched down straight with the runway and with the left wing low. The left main and the tailwheel touched down at the same time, with the right main just clear of the runway. I was landing on an asphalt runway which was dry. At the instant of touchdown the tailwheel came unlocked and started spinning very rapidly in a clockwise direction. Since my right wheel was not in contact with the runway, all I had going for me was the right rudder. The plane started weathervaning into the wind and as it slowed down the right wheel touched down and with the brake I was able to stop the ground loop, but the plane was going sideways and collapsed the right main gear. The damage was minimal, but I will be out of service for a couple of months.

"Fortunately for me there was an ag pilot with 12,500 hours standing beside the runway and he relayed the above description to me about the landing. The subsequent investigation of the Maule tailwheel disclosed that although the wheel did not unlock with full left rudder, it did indeed unlock with the rudder in full right deflection. I called Mr. Maule and talked with him about the problem and he said that the factory would adjust the tailwheel so that it wouldn't unlock during the normal movement of the rudder. The movement of the rudder on aerobatic aircraft is more than that of most conventional aircraft and therein lies the problem. Mr. Maule said that the locking pins had to be longer to prevent this type of accident.

"Although I bought the tailwheel new from Pitts Aerobatics of Afton, Wyoming, apparently the tailwheel had not been adjusted for the rudder travel of the Pitts aircraft. I have a friend who has a factory-built Pitts S-2 and we checked out his tailwheel and it unlocked with right rudder just like mine did. His plane had 300 hours on it and mine had 5 hours.

"The way you check the tailwheel for unlocking is to move the rudder either direction after supporting the tail of the aircraft so that the wheel is clear of the ground. Move the rudder full deflection, against the stops, and move the tailwheel in the **opposite** direction. You should not be able to move the tailwheel out of the detent position without considerable pressure. There should be a definite detent position, and the tailwheel should be locked during the full movement of the rudder in both directions.

"I hope that this information will keep someone else from doing damage to their aircraft."

Besides the main point of the above report, i.e., locking pin length vs. rudder travel, the last sentence of the report is also noteworthy: "I hope that this information will keep someone else from doing damage to their aircraft." Isn't this exactly the purpose of the IAC Tech Safety Program? Remember, the T.S. Program is just a "tool" that is provided by IAC — it takes us, the IAC membership, to make it work. An IAC "Thank you" to the member who submitted the above report.

AVCO LYCOMING SERVICE BULLETIN

On August 26, 1983, Avco Lycoming issued a Service Bulletin (No. 465) which deals with a redesigned crankshaft for their aerobatic engines. Numerous models are affected. To quote from the Bulletin, "It has been determined that excessive stress for aerobatic maneuvers can cause cracking and the eventual failure of the crankshaft propeller mounting flange. To reduce the risk of propeller flange failure, Avco Lycoming has re-designed the propeller mounting flange on crankshafts assembled in engines built for installation in aerobatic aircraft. These new crankshafts incorporate a thicker flange. In addition, the lightening holes are omitted, where applicable. Operators of Lycoming powered aircraft involved in aerobatic maneuvers are urged to install this new crankshaft at the earliest convenience."

In addition, Lycoming calls for inspections of existing crankshafts visually every 25 hours after removing the propeller and by the use of portable magnetic particle inspection equipment after 200 hours of operation and at 100 hour intervals thereafter. The Bulletin also calls for the replacement of the crankshaft at overhaul.

Numerous models of AIO-320, AEIO-320, AIO-360, and AEIO-360 engines are included in the Bulletin. Avco Lycoming or a nearby engine shop should be consulted for details.

CUMULATIVE

Several years ago at a State of Illinois Aerobatic Safety Seminar one of the speakers was an aircraft accident investigator, and during his presentation he stressed that many, many accidents were **NOT** the result of a single cause but were the result of the cumulative effect of a number of "small" items. This speaker noted that most of the time one or two of the accident-causing items the pilot could cope with, but as the number of "small" problems accrued a point was reached that was beyond that which the pilot could handle. He went on to state that through training and practice, one can increase his problem-handling capacity, but there is a limit for even the best trained and practiced individual.

Recently an IAC member submitted an accident report to the IAC Technical Safety Committee describing a crash during an aerobatic low altitude practice session from an inverted spin in his Skybolt. Interestingly, this gentleman listed seven (7) factors which he believed contributed to the accident. They are as follows:

"1) Too much hurried by linking all the routine together.

2) Not taking time to tighten belts as the aileron shovels kept snatching stick left and right; should have landed and tightened shoulder and seat belts.

3) Started inverted spin too low, 2,000 ft AGL, little hill and trees lowered safety margin, but these I had been doing repeatedly.

4) Should have scrapped this maneuver with aileron shovels on — 'til adjustment was perfected.

5) Too light a gas load in the nose.

6) Too much forward trim.

7) Entered spin with too much speed, nose high, inverted."

(A couple of brief clarifying comments on items #2 and #4 and item #5 are in order. Prior to this mishap difficulties were being encountered in obtaining the proper rigging of this a/c's aileron shovels. Several letters with ideas and suggestions were exchanged between this IACer and a couple of other IAC members relating to aileron shovel size and alignment. As noted above, "stick snatching" due to improper shovel rigging was still a problem at the time of this incident. Item #5 notes that the a/c had a "light" gas load. For those IACers who may not be tuned in, in aircraft like the Skybolt, Pitts, Eagle, EAA Acro Sport, etc., which have a forward placed fuel tank, as fuel is burned off, the aircraft's center of gravity moves aft. And, naturally, aft C.G.s are not conducive to good spin recovery.)

The idea of "cumulative cause" sure seems to be substantiated in this report. Besides the seven-point accident analysis, the reporting IACer passed along several other ideas:

"On the stress points of the aircraft, the top wing and engine and cabane struts took most of the impact.

"Welding and tubing under left seat let go and pilot's head hit the ground — mild concussion and black eye and broken vertebrae; all OK at this time.

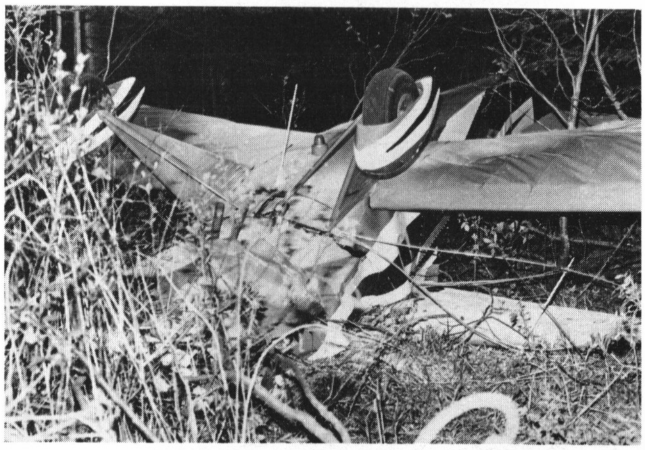
"Engine mount could have been stressed for positive and negative as well as pilot's seat.

"The Skybolt was built very strong and the high cabane and rugged top wing saved the pilot. If the seat would have held, the pilot may have just walked away with no scratches."

And this IACers report closed with a comment that reflects this gentleman's exemplary attitude — "This information is intended to help builders and others."

Remember, the IAC only provides **the forum** through which we can help ourselves and promote our sport. It is member input, like this report, that makes things work. A large IAC "Thank you" is due this member — and wishes for a speedy and complete recovery.

Skybolt crashed during inverted spin.



EARLY CITABRIA EXHAUST

An IAC member recently submitted a report on an early (pre-1974) Citabria exhaust system problem. This report is interesting not only from its direct application to early Citabrias but also from some general exhaust system comments that could be applied to any aircraft exhaust system.

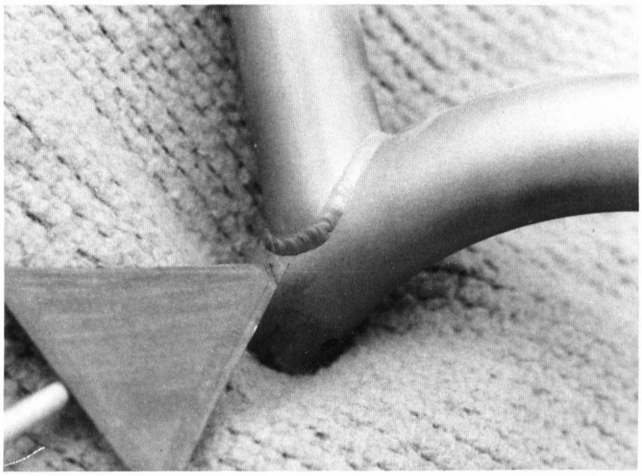
Specifically, the report noted that during an annual inspection a small crack was discovered in an exhaust pipe adjacent to the weld at the junction of the number 3 cylinder and number 4 cylinder risers. (See photos) A quick check of some FAA M&D computer printouts by the IAC T.S. Committee indicated several exhaust system problems on early Citabrias listed as "cracked at Y". Obviously, IACers operating early Citabrias should make note of this and closely monitor this area on their aircraft.

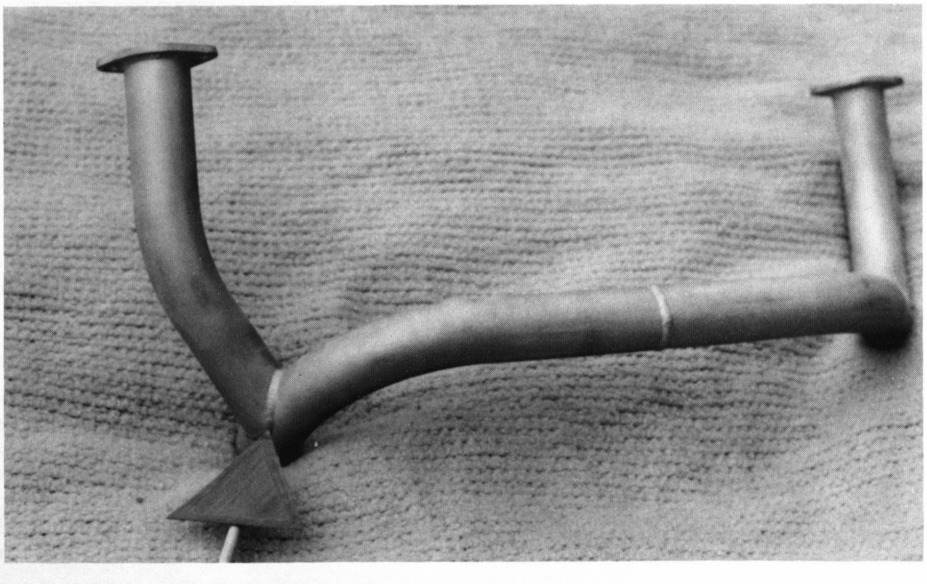
In general, a couple of good ideas also came to the fore. The crack in the first-mentioned IAC member's exhaust system which is made of approximately .040 stainless steel was repaired by a brother IAC member who by profession is a welder. The repair was made by heliarcing — the same method as used by the factory to fabricate the original exhaust system. The second gentleman pointed out the granular or "sugary" appearance of the original weld on the **inside** of the pipe — i.e., the **backside** of the weld. He advised that this was due to the weld being contaminated with impurities during the welding process and this was probably because the **inside** of the pipe was not purged (with argon gas) when the pipe sections were being joined. Needless to say, during the repair welding a separate source of argon gas was forced into the exhaust pipe section to purge any air from the backside of the area being welded in order that a better/stronger weld could be accomplished. This is a tip that is applicable to any stainless steel exhaust system repair.

Several comments as to exhaust system design/construction were also noted. First, it was stated that when the exhaust system was removed, all the exhaust-pipe-to-cylinder-head gaskets showed discoloration indicating some exhaust leakage at this point. And, although none of the gaskets had failed, one was pretty well distorted and probably would have failed in the not-too-distant future. All the exhaust pipe flanges showed some "bowing" (not flat). It was felt that the pipe flanges which were approximately .250" thick were not thick enough, i.e., they did not have enough beam strength. Also, it was mentioned that the exhaust pipe mounting studs were only ¼ x 20, and perhaps this did not permit sufficient clamping pressure. If new pipes were being made from scratch, a good idea might be to make thicker pipe flanges. A "fix" for the ¼ x 20 studs might be something like a header plate — a small plate that would mount between the cylinder head and the pipe which would have countersunk cap screws to secure it to the head and larger diameter studs to which the pipe flange would mount. This might not be possible because of space limitations. Anyhow, when the standard exhaust pipes were reassembled on this particular Citabria, "blow-proof" exhaust gaskets were used. It is guessed that these will probably still leak but will probably not blow out completely.

This Citabria's exhaust system is of the "cross-over" variety, i.e., where cylinders 1 and 2 are connected to a common pipe and cylinders 3 and 4 are connected to a common pipe. The IAC member making this report felt that a slip joint should have been incorporated into each of the long "side-to-side" exhaust pipes to relieve some of the strain on the joints — for example, the area where the crack was found. He believes the pipe will probably fail again and probably in the same area where it failed this time. He also felt that .040, although a common exhaust pipe wall thickness, was a bit on the small size and would have preferred a heavier pipe.

This Tech Safety report relates some specific Citabria-problem information and some good all-around exhaust system ideas. Thanks to the IACers who supplied this input.





IAC Technical Tips Manual
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