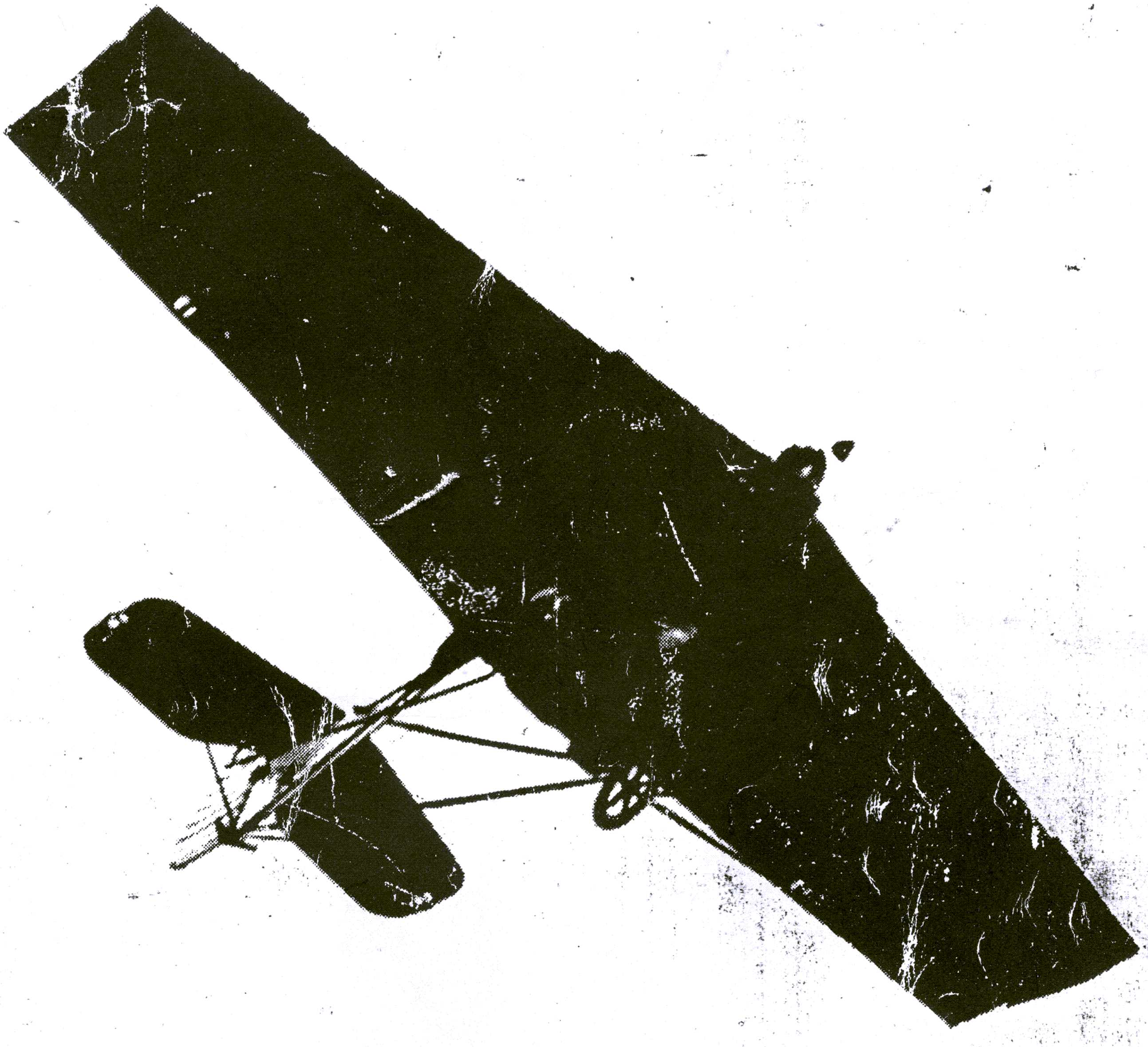


All About
WEEDHOPPER

by Rick Ferguson

A Technical Aid To The Weedhopper "C" Owner

This book is not associated with the Weedhopper Company

Forward

The information contained in this publication is intended for use on Weedhopper "C" ultralight aircraft only. While some of the techniques and methods are transferable to other aircraft, modifications discussed herein should not be attempted on any other type or make of aircraft without first consulting a licensed aircraft mechanic or the manufacturer of that particular aircraft. All modifications discussed herein have been researched and designed in close consultation with current aviation information and knowledge published by the FAA (Federal Aviation Administration). They have been performed and tested by the author, who is licensed by the FAA as an air-frame and power-plant mechanic as well as holding a degree with honors in aviation technology from Spartan School of Aeronautics. These modifications and deviations from the original design are the result of ten years, and over 400 flight hours of testing. Each of these changes can be an improvement to your plane, but please, ***"Don't do anything until you have read the whole book!"*** You will need to understand how the aeronautical principles interdependently effect each other.

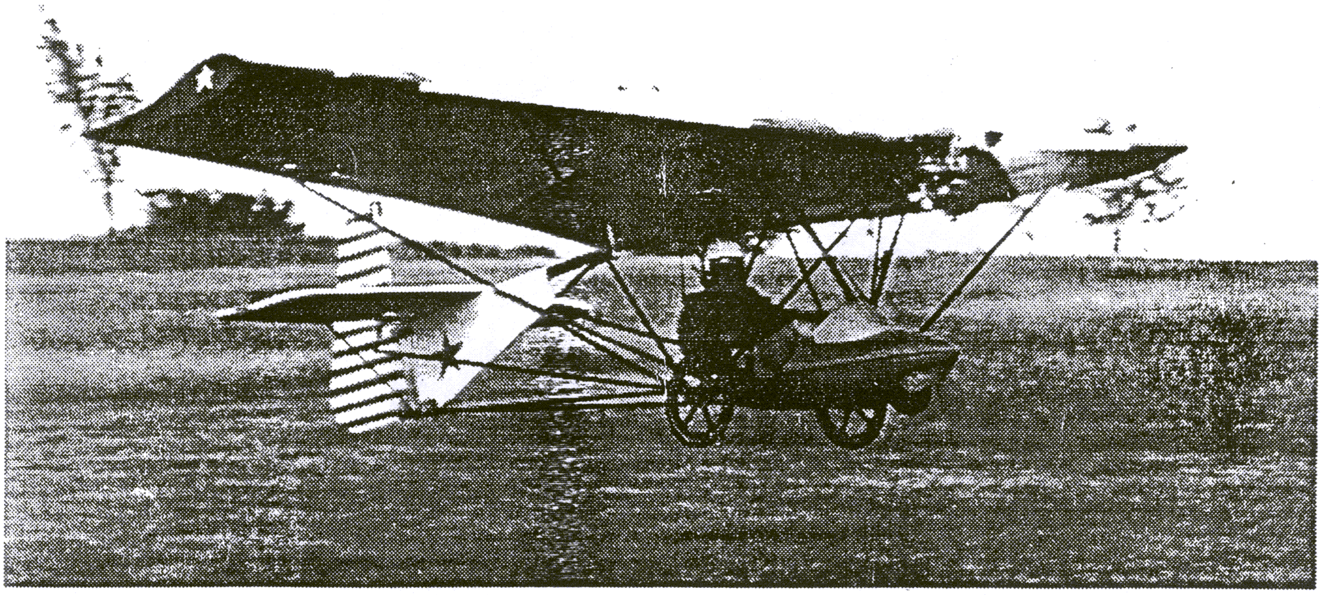
The Weedhopper ultralight is well known for design simplicity, ease of flight, and crash survivability. So at this point the question arises — why mess with a good thing? For the answer to that it must first be understood that all aircraft are designed to perform within parameters that are set according to weight limitations and developed thrust — in other words, for the most part, aircraft are designed around a specific engine. The Weedhopper was no different in it's conception. The Chotia engine that the plane originally had was not what anyone by todays standards would call a powerhouse. These engines, on the days when they performed well, which weren't very many, didn't have enough thrust to pull a soggy boot out of the mud.

To accommodate for the low thrust, as well as the high aerodynamic drag of the open frame, a very large and extreme airfoil had to be used. Otherwise the climb rate would have had to be measured in feet per hour rather than feet per minute. As it was, it still wasn't anything to brag about. But now, most Weedhoppers have Rotax 277's on them. This is such an increase in thrust over the old Chotia that the climb rate has become quite reasonable.

The other flight characteristics, however, didn't change by anywhere near the same percentage if at all. Since air speed is much more affected by aerodynamics than it is by thrust, air speed went up only marginally. The problem with the air speed of the original design is that the cruise speed is only 15 mph faster than the stall speed. Flying is much safer if there is a wider cushion range than that.

In addition, turbulence handling and crosswind landing ability, being directly related to the wing design, are still practically non-existent. But, after the initiation of the design changes described in this book, the Weedhopper will no longer fear moderate crosswind landings or turbulence. Air speed will be so enhanced that it will push the upper limits of FAR part 103. Maneuverability will border on stunt plane capabilities.

The only distinctive loss incurred with any of the newly instituted design changes is the power-off glide capability in regard to the clipped wings — the sink rate increase is estimated at 150 to 200 ft. per minute faster. So dead stick landings will change dramatically. If you are not comfortable with dead stick landings yet, maybe you had better wait on the clipped wings for awhile. But none of the other design changes should cause you any problems. In fact all others will make flying safer and more fun.

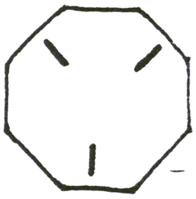


Notice in the above picture, the RC prop spinner, and the 20″ main wheels. The large wheels are there for the ease of take-off roll and extended crash safety. The higher the axle is from the ground — the more shock absorbing flex there will be in the axle during a crash. They could save you from a broken back. Bicycle wheels are lighter, but wheel barrow wheels are stronger and cheaper. However, the large wheels roll easier, creating more need for braking power (barbed wire is nasty stuff to run into). The prop spinner is there just because I thought it was sexy.

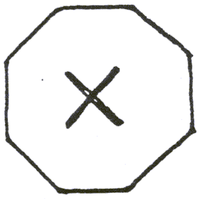
Safety

In regard to maintaining low failure rate of parts, as well as eliminating in-flight crises, it is necessary that persons undertaking repairs and modification to aircraft be constantly aware of the condition of structural parts and the presence of all hardware and their safety devices, as well as forethought of how installed parts are going to hold up or affect operation during not just normal conditions, but absolute worst case conditions such as extreme turbulence, or emergency situations. This calls for the absolute necessity of routine maintenance, painstakingly thorough preflight inspections, as well as regularly scheduled tear-down inspections.

The Weedhopper, as every aircraft, has it's own distinctive problems and wear characteristics. Weedhopper's high wear locations are dictated by the way vibrations are transmitted throughout the aircraft and the fact that it is not a rigid frame aircraft. Flexibility is a plus, in that the flexibility distributes loads over whole sections of the craft without concentrating excessive loads at any particular location. It is, however a detriment in that every joint and connection is going to move — this causes rubbing of parts. Tightening of hardware as it gets loose only accelerates wear — unless anti-wear devices are implemented. It is advisable to use thin plastic washers between tubes and brackets to prevent chafing (I make mine out of old oil bottles), and increase the size of all hardware along the boom tube to 5/16″. Because this size increase is to distribute vibrational loads over a larger area and not for lack of bolt or pin strength, and because of the subsequent strength over-kill, the use of SAE hardware (grade 5 only) will be admissible. Ordinarily, only aircraft hardware would be allowed. But, it is necessary to express that there should **never** at any time be in use, a bolt that allows the threads to be in contact with the components being joined (shear-load area). Only the shoulder of the bolt should carry this load — the threads must begin outside of the shear-load area. If the shoulder is too long to enable the tightening of the parts involved — it is permissible to use up to four washers per bolt to remedy this situation. It looks better if you don't put all four washers on the same end of the bolt. Another safety trick is to cut short (1/8″) lengths of plastic fuel hose to place on the pins between the safety rings and the tubes or brackets, to keep the rings from wearing in two. I've also seen them under the heads of pins. Works good!



SAE Grade 5 — three lines
(Society of Automotive Engineers)



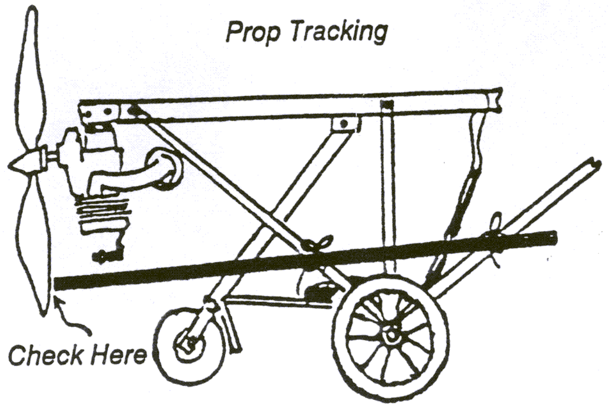
AN Bolt
(Army & Navy)

While no Weedhopper is ever going to attain zero vibration — it must be understood that it is the main culprit responsible for the wear and failure of air-frame parts in any aircraft. Vibration must be held to an absolute minimum. The pilot should be aware of any fuselage tube or wing strut that may be oscillating or shaking. This will most likely be caused by an out-of-balance or out-of-track prop. An engine that idles at too low RPM will also cause undue vibration and shaking of the plane as well as possible damage to the engine. The result of allowing these conditions to remain will eventually lead to cracking of structural members. This is due to metal fatigue — it's caused by a process called work hardening, like when you bend a piece of wire back and forth until it becomes brittle enough to break. The forward fuselage tubes are the most likely to incur this condition due to their attachment nearest the engine.

The best way to balance a prop is to have it dynamically balanced by someone experienced with balancing helicopter tail rotors. If this is not possible, find someone experienced with the use of a knife edge balancer — this is the FAA acceptable method.

To check the prop tracking, temporarily attach a rod or stick along the side of the fuselage tubes extending forward to just clear the back side of the prop near the tip. With the spark plug removed, rotate the prop to check for equal clearance distances on all prop blades. To remedy incorrect tracking, install shims under the hub and re-check.

Prop Tracking



Because of unavoidable vibrations, it is never a good idea to mount gauges or instruments rigidly — this will shake them into oblivion very quickly.

Major preventative maintenance should be done at least every 100 hours of flight or when a used plane is purchased. This inspection need not be accomplished all at once, but please read through it anyway, there are tricks here that will help you.
Inspections should be accomplished as follows:

1. ***Remove the wings*** — check sailcloth for strength (a stout finger poke in the darker sun exposed areas is sufficient). Check for frayed stitching at seams. It is necessary to remove the wing to gain access for a good inspection of tubing and hardware. Check tubes for elongated holes, cracks, and chafing

at brackets. Install plastic washers between tubes and brackets. You may iron loose sailcloth to shrink it back to near original size (most clothing irons don't get hot enough to melt dacron). Even if you have velcro enclosures or some other means of closing the rib (batten) pockets, the clips must be on the ends of the ribs to properly align the ribs with the trailing edge, and transfer loads carried by the ribs. The lack of clips will cause the sailcloth to stretch quickly, and the misalignment will accentuate the already extreme built-in flap. Much improved rib retainer clips can be purchased from Rix Trix (same address as this book). They look good and hold tight. A set of eight is $20.

2. ***Main axle*** — remove wheels and inspect axle for bends and cracks. Do not turn a bowed axle over — if it is too bad to use as it is, replace it. Reverse bending will create metal fatigue, and your life depends on this part. Check attaching brackets and hardware from the fuselage to the axle. Use white lithium grease, or anti-seize to lube the wheels.
3. ***Nose wheel fork*** — check hardware condition, inspect nose strut for cracks, and grease the wheel bearings. The upper part of the fork may be wrapped with plastic or coated with paraffin wax or anti-seize (grease becomes an abrasive when used between two aluminum surfaces).
4. ***Elevator and rudder (empennage)*** — check hardware, and tubes for cracks, especially check area of bushing contact, lubricate with white lithium grease or anti-seize. Check strength of sailcloth. If the holes in the rudder yoke where the cables attach are badly worn it is advisable to drill to ¼" and use larger pins. The clevises (if steel) can be drilled also. Small chain clevises or chain master-links can be substituted. Rudder hinge bolts will most likely become loose and require 5/16" bolts. If the sailcloth on the rudder is too loose it can cause it to flutter in flight. Either remove the cloth and iron it or place a long thin ¼" strip of some kind of foam material between the leading edge and the cloth. Styrene foam cut in a triangular shape has been found to work very well here.
5. ***Flight controls*** — check cables for fraying or rubbing, inspect elevator tube for cracks, inspect hardware, lubricate hinge points and rollers with anti-seize. If the rollers are no longer round, replace them. Especially check the elevator pitch horn (control lever) for wear at the control tube attachment. If not already present, install plastic washers between control tube and pitch horn on the connecting pin to prevent wearing. There is an AD (airworthiness directive) on this area in regard to an improved replacement part from Weedhopper.
6. ***Bolts and pins from***:
   - a. boom tube
   - b. axle
   - c. engine mounts
   - d. prop hub

Inspect for bends, cracks, *corrosion, and wear. ****Note***: FAA says if the cadmium (gold coating) is worn through on any bolt — it's trash. In high corrosion environments this should be complied with. Otherwise, zinc chromate spray is sufficient, unless the depth of wear can be felt, or seen. If bolts are bent — **do not** straighten them and re-use them. Remember metal fatigue. Not only should you replace the bolt, but re-drilling and using the next larger size bolt is advisable seeing as the current size was insufficient to carry the load.

7. ***Engine*** — remove the exhaust system and shake it to check for loose internal parts— if excessive, replace it. Remove the head, cylinder, and piston. Check *piston for cracks, *piston pin for radial movement in the hole and wear at the bearing surface, *pin bearing for cracked cage or broken needle bearings, *piston rod for vertical freeplay and wear at exposed bearing surface. De-carbon head, cylinder exhaust port, piston, and rings. Lightly sand cylinder with 320 wet/dry sandpaper to reseat rings and smooth any sharp edges around the ports. Carefully reassemble. Don't forget the pin retainer rings, and be sure the ring gaps align with the pins in the piston grooves. It is possible to safely run a Rotax engine without the lower piston ring — I broke one once while de-carboning, so I left it out. It ran just fine for a few weeks until I got the new ones. **Note:* any discrepancy is cause for replacement.
8. ***Fuel system*** — remove the fuel tank and dump it's contents, replace the fuel filter, remove the carburetor bowl and dump it's contents, check fuel lines for brittleness (if they are extremely stained it's probably time to replace them). Check fuel line routing to be clear of the wheels, not pinched or rubbing against any sharp edges or hanging down where it could get snagged on take-off. Use nylon wire ties to secure routing (every 12″). Secure all line ends (use two wraps of .032 stainless safety wire, pull and twist to make efficient, cheap clamps). Inspect throttle cable and housing condition, especially at carb top (evaporative air conditioner water supply tubing can be used for cable housing). To make a cheap air filter, purchase a foam wet-vacuum filter ring at any hardware store and some 28 gauge utility wire, cut a length long enough to make a 3″ diameter tube and cut a round piece from the remainder to cap one open end, sew the tube and cap together with the wire (it will poke through without a needle) and clamp the foam tube onto the carb. Total cost is under $5.00.

When securing the fuel line to the fuselage tube, use a ½″ piece of fuel line as a "stand-off". Wrap the wire tie around the fuel line then insert both ends through the stand-off, and then loop around the fuselage tube to attach. This will prevent smashing the fuel line. And besides that, it looks neat.

Engine Information

While I'll be referring to a Rotax 277 in this section, much of this will also be pertinent to two-stroke engines in general.

In order to get and keep these engines in optimum running condition it is necessary that some basics in regard to the cause of a few common ailments be understood. In any internal combustion engine three basic requirements must be present before it will run — compression, ignition, and fuel.

Compression is the result of the mechanical action of squeezing the fuel/air mixture into a small space. The ratio of the space when the piston is at it's farthest distance from the head, to the space left when the piston is closest to the head is the compression ratio. Improper compression can cause problems when it is either too high or too low. Too high a compression can only be caused by extreme carbon or fuel additive deposits. These deposits would fill in some of the space between the head and the piston top and cause the engine to detonate or ping under full power. However, most two-strokes won't run long enough under the too rich condition necessary to make deposits sufficient enough to raise the compression ratio. More than likely, if your engine is pinging under full power, it's due to low fuel grade.

The octane rating refers to the fuel's ability to withstand certain limits of compression, and not detonate. In other words, the higher the octane rating is, the less likely the fuel is to detonate in a high compression engine. Octane rating has nothing to do with power. All grades of gasoline contain the same amount of force. Although if your engine is detonating, it will not only lose power it can cause damage to your engine. The fuel is supposed to burn through the mixture in the combustion chamber creating expanding gases that force the piston to move. Even though the burning is complete before the piston travels very far, it's not supposed to explode. In the case of detonation, all of the fuel mixture explodes before the piston starts to travel away from the head. The explosive shock that this causes can crack pistons, break rings, or break the needle bearings on the piston pin. So, don't use low octane fuel.

Too low compression is caused by the loss of some of the fuel mixture that was supposed to be compressed. This loss can be caused by a leaking head gasket or lack of seal at the rings. Because of the excellent lubrication and natural internal cooling present in a two-stroke engine, rings almost never wear out. But, because of poor quality two-stroke oils and too rich fuel/air or fuel/oil mixtures, rings do occasionally stick. The spring of the ring is only there to start the sealing process of rings. The compressed air forces the rings down against the lower side of the grooves allowing air to get in behind the rings to force them outward against the cylinder wall — so as the compression increases through the compression stroke, so does the sealing force. But, if the deposits build up enough to block the entry of the air from getting behind the ring there will be insufficient sealing force and much of the fuel mixture will escape. However, in the last few years oils have gotten a lot better. And the advent of technology such as the Dykes rings and squish band design have much improved the performance and reliability of two-stroke engines.

The Dykes ring is the "L" shaped top ring now used in most high tech engines. It allows more surface and better entry for sealing pressure. It is almost always used in conjunction with a squish band combustion chamber design.

The squish band is what is formed when the dome shaped piston comes in close proximity to the lower edges of a bell shaped combustion chamber. The narrow clearance ring formed around the outside edge on the top of the piston is the squish band. The narrow clearance forces the fuel mixture into a much smaller and better shaped area that allows the mixture to burn more quickly and completely. At the same time this prevents fuel from burning near the rings and therefore prohibits the formation of deposits that would cause sticking. This design is not possible in a four-stroke engine and is a part of the reason why a two-stroke develops so much more RPM and HP than a four-stroke engine.

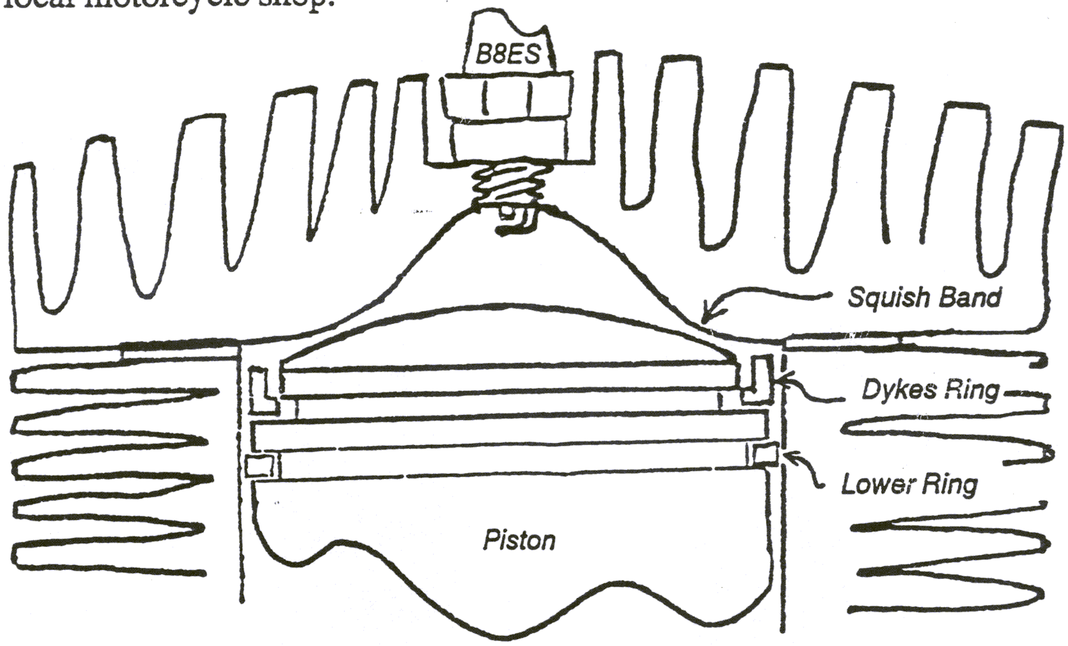
Ignition in Rotax engines is produced by a modified magneto system. Magnetically- induced current flow provides the source of power. However, the addition of the ignition dampening box is a bit of a head scratcher. I haven't heard a good answer as to its purpose, yet. But, I do know that it will run without it. It hasn't caused me any trouble in over 400 hours so I'll just keep on scratching my head about it.

While the system does have points like cars used to have, they don't carry anywhere near the electrical current that capacitor discharge systems did. So, the points in these engines will never burn up. The only real problem with points is if they get dirty. It doesn't take much dirt to cause them to insulate the low current flow. But, they are pretty well protected under the sealed fly-wheel. However, if you mix too much oil in your fuel, the excess oil can come through the crankshaft seals and get oil on your points. As the part of the points that rides on the cam wears down, the timing will change gradually. So the timing should be checked every 100 hours or so.

The external coil never gets very hot — it's got a big fan blowing on it, so it almost never causes any trouble.

Keep your wires bundled tight so they don't vibrate loose or rub anything.

The spark plug is the indirect reason for ignition failures about 95% of the time. I say "indirect" because more than likely the real problem is elsewhere — it only shows up at the plug. Nevertheless, the plug can tell you more about your engine than anything else. As far as normal maintenance, keep it changed about every 20 hours and gapped at 18 thousandths. The original equipment called for NGK B8ES, but the platinum tipped B8EV will last longer and is less likely to foul under less than optimum conditions. Like most everything that's better, it costs more too — about $3.50 at your local motorcycle shop.



Now for the lesson on how to read a spark plug:

1. If the tip is black it means that the fuel/air mixture is too rich.
2. If the tip is white or very light brown — the fuel/air mixture is too lean.
3. If the tip is grey — you're way too lean and you're starting to melt your piston.
4. If it's grey and has tiny little grey balls that keep fouling it out — you're way way too lean and you've just destroyed your piston.
5. While ideal is medium brown (cardboard colored), anywhere from medium to dark brown is acceptable.
6. If the tip is acceptable in color, but keeps breaking pieces of the insulator around the electrode, it's probably caused by detonation.

Fuel/air mixture in two-stroke engines, as you have probably already found out, can cause a grown man to cry. It can range anywhere from so rich that the engine only fires every other revolution (four-stroking). Or it can be so lean that it melts down it's internal parts. A two-stroke will, unlike a four-stroke engine, run so efficiently that just before melt down you wouldn't think any engine could run that good. And to make matters worse they change greatly according to weather conditions. Flooding in hot weather and starving in the cold. About the only time they run at optimum conditions is in the spring or fall.

The side draft Bing carburetors or the Mikuni carbs are practically identical in design. Whichever one you have, this section will apply.

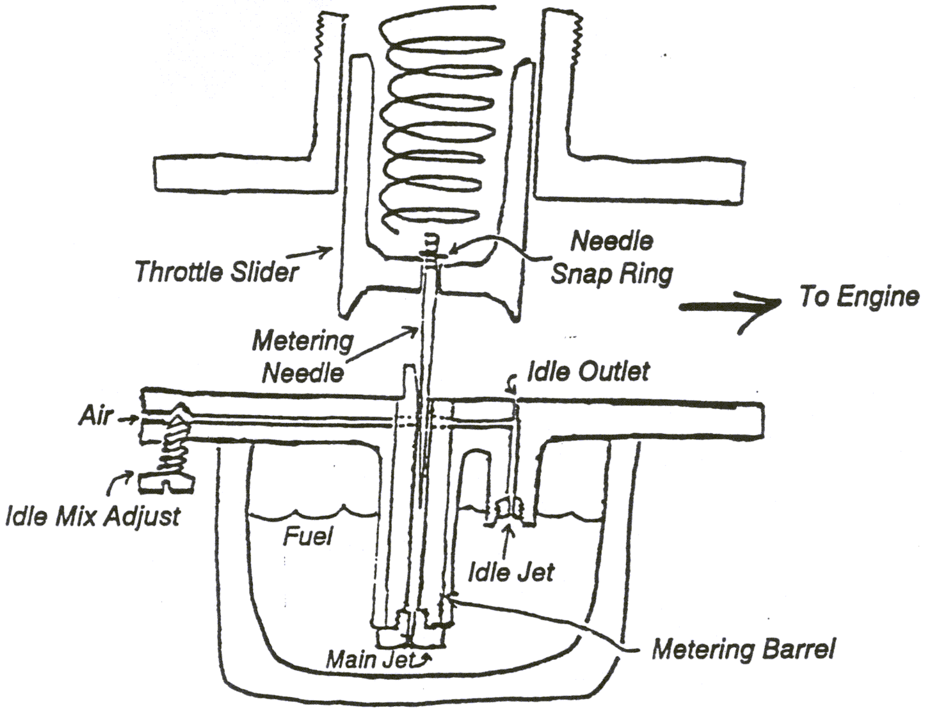
There are three ranges of operation that are controlled by three partially interdependent sections of the carb.

1. The idle section consists of a very small jet that is submerged in the fuel bowl. It is in one of two passageways that lead to a small hole located between the throttle slider and the intake port of the engine. Although the idle jet is a specifically sized orifice, it is not the only controlling factor involved. There is another passageway "T"ed into the idle section that leads to outside air. There is a screw in this passageway (idle mixture screw) that when tightened, closes off the air flow and causes more fuel to be drawn in at the jet. When its opened less fuel and more air is drawn in. This may seem backward to some people, but clockwise is richer.

   Adjust the idle mixture to maximum RPM, on the verge of being rich. As the RPM increases from the mixture adjustment, lower the engine speed with the slider stop screw to the lowest smooth RPM possible and re-check the mixture adjustment. Afterward, you will need to increase the RPM with the slider stop screw so that when it is started cold it doesn't buck at low speed (that's real hard on the rod and piston pin bearings).

   If your plane requires a lot of choke to start and it doesn't want to idle very well once started, and idle mixture adjustments haven't helped — check to see that the idle jet is not clogged. It's a small brass piece hidden in a hole visible from underneath (after the bowl has been removed). A small slot screwdriver will be needed to remove it. The orifice is very small, so clean it out with the smallest strand of wire you can find.

   If the total throttle range were divided into six divisions, the idle jet would only be functional in the first division.



2. Mid-range fuel mixture is controlled by the tapered metering needle protruding out of the bottom of the slider valve. As the slider valve is opened, air is allowed to pass across the top of the metering barrel which serves as a venturi. The venturi-developed vacuum in the barrel tube draws fuel up from the bottom of the barrel through the main jet, which is submerged in the fuel bowl. However, the main jet is not yet effective. The metering needle is inserted into the barrel and restricts the flow of fuel through the barrel by obstructing fuel flow variably. When the slider is down allowing little air flow, the widest diameter of the needle is allowing little fuel to flow. When the slide is raised allowing more air flow, the needle that is left in the barrel gets progressively narrower allowing more fuel to flow.

   The mid-range metering needle is effective in controlling fuel flow in the 2nd, 3rd, and 4th division of the earlier mentioned six division range.

   The metering needle is held in the slider by a tiny snap ring on the shank of the needle. There are a number of grooves that the snap ring can be placed in to either raise or lower the needle. Raising the needle will richen the mixture throughout the mid-range. Do this when your spark plug color is too light. Inversely, lowering the needle will lean the mid-range fuel mixture. Do this when the engine is four-stroking in mid-range or the plug color is too dark.

   The needle will rub the sides of the barrel and vibrate to cause it to wear over a long period of time. The effects of this wear will cause the mixture to richen gradually.

   It would be much easier to adjust to optimum safe limits if either a cylinder head temp. (CHT) or exhaust gas temp. (EGT) gauge were used.

3. The main jet is, as previously mentioned, at the bottom of the barrel. In fact it holds the barrel in place. It is a specifically sized orifice that should not be adjusted unless the aircraft has been brought into a radically different altitude from where it was previously based. To adjust the main jet you must purchase either a larger or smaller size jet. Smaller for higher altitudes, and visa-versa.

   Be sure that the protective screen and a good filter are used in the fuel system. A clogged main jet will cause the engine to die without warning. But even worse is a partially clogged main jet — that will cause piston melt-down.

   In these last two parts of the six division range, fuel/air mixture is determined by the variable air flow and resultant venturi effect on the main jet. The throttle setting is not the only controlling factor. As the plane's attitude changes, so does the RPM, and therefore the airflow through the carb — resulting in more or less vacuum and more or less fuel being drawn through the main jet.

Structural Load Distribution

In this section I hope to reveal some of the genius of John Chotia's design. I'm confident that after you know what each piece of the structure supports, you will understand and more fully appreciate why the Weedhopper has such a low structural failure rate. To my knowledge there have been none.

In regard to geometric design, loads are always concentrated at the connecting points at the ends of straight lines. This assumes that the material used in the actual construction of that line is strong enough to carry the load applied to it. With that said, it must also be understood that there is only one basic shape that is strong when loads are applied to it from any direction — and that is the triangle.

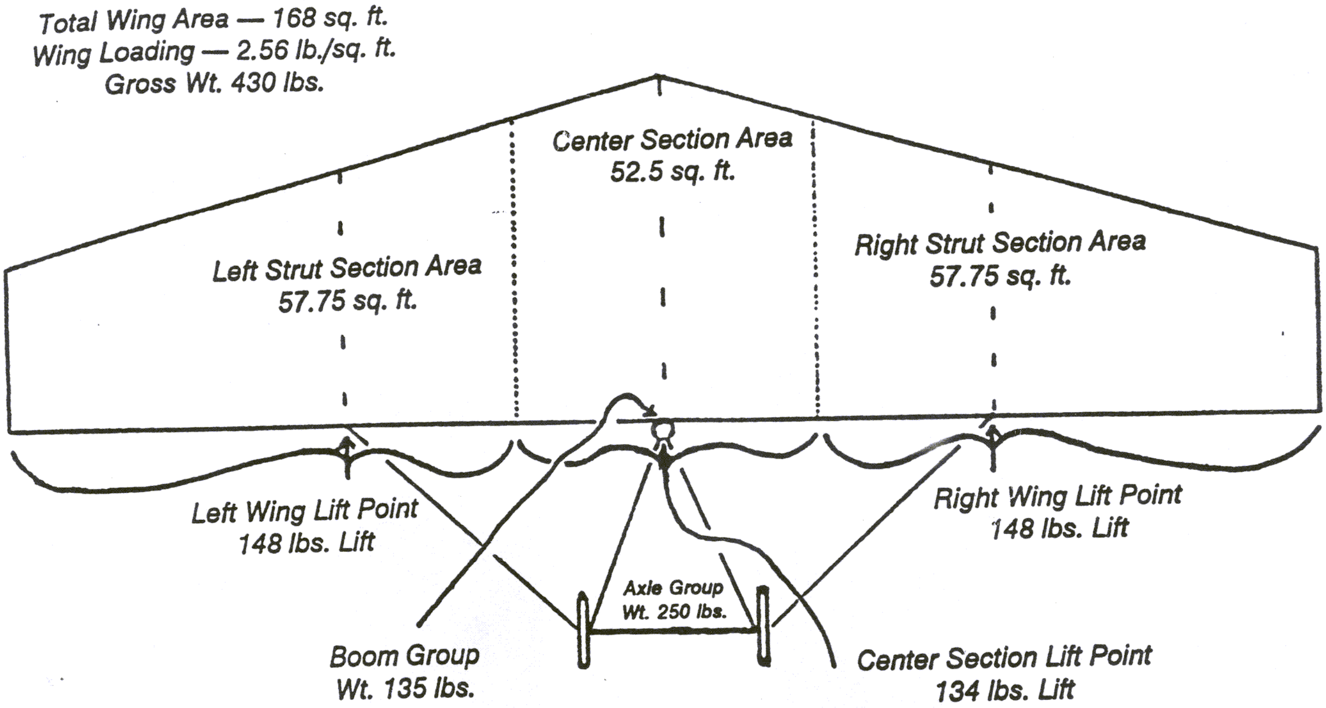
Almost every part of the structure of a Weedhopper is part of a triangle. That is the basis for the genius of the design. The engine is supported at the end of two triangles. The applied loads of the elevator are supported and distributed to the craft through two pairs of connecting triangles. The weight of the pilot and the fuel are supported by no less than seven triangles and depending on how you look at it — as many as eleven.

With this in mind you can start to see that it is going to be very difficult to calculate exactly how much load any one particular part carries. Nevertheless, the first principle that must be established is that in level flight, lift will always equal load. And not just overall, but within the separate lifting points as well. If one lifting point creates more lift than the weight of the group load that it is carrying — some of the weight from other group loads will transfer to it through the interconnecting structure.

In order to figure any of this, estimations as to the weight of the plane and the pilot must be made because each will vary. I'll start with a basic plane weight of 200 lbs. (no fuel). The weight sitting on the axle will be that of the pilot, his clothing, his helmet, fuel, tools, keys, etc. — 230 lbs. In order to establish this as a group load, I'm going to add to this last number the weight of the axle, the seat, and the main wheels; and call this, "the axle group", with an estimated weight of 250 lbs. That lowers the rest of the plane weight to 180 lbs. but the total (gross) weight will still be 430 lbs.

When we divide the gross weight by the wing area (168 sq. ft.) we get 2.56 lbs./sq. ft. wing loading. We will use this number to calculate where the lifting forces of the wings are applied. Laterally, there are three main lifting points — the point at the center where the wings attach to the boom tube, and the points on the wings where the struts attach.

The strut lifting points will share the weight of the axle group because that is the load that is most directly attached to it. In order to break it down into lifting sections



as applied to each point there must be a dividing line on the wings, midway between the boom tube and the struts. All of the wing area's lifting force, in-board of that line, will be applied to the center lifting point. And all of the wing area's lifting force out-board of that line will be applied to the strut lifting points. The center section has 52.5 sq. ft. that contributes 134 lbs. of lift. Each out-board section, with 57.75 sq. ft. each, adds the rest at 148 lbs. on each side.

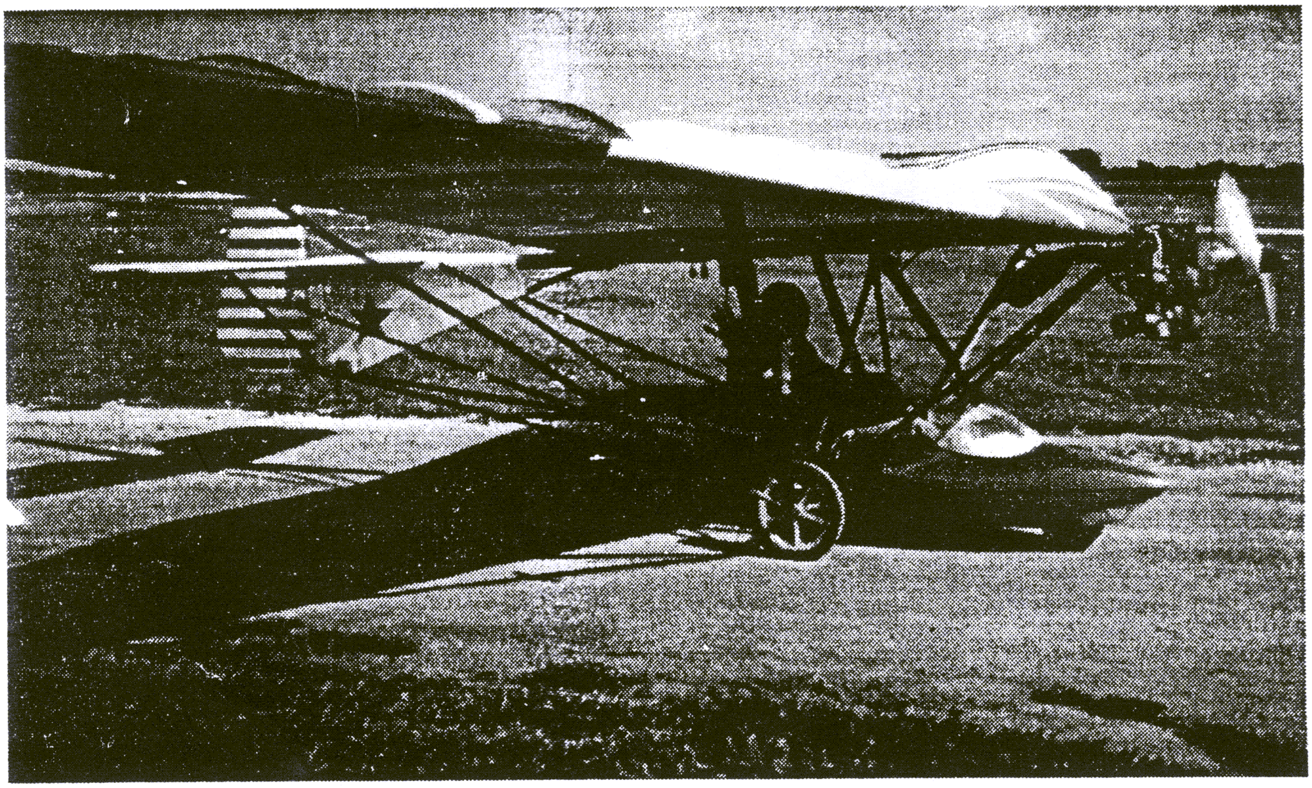
The wing is obviously lifting it's own weight, so I'll subtract 15 lbs. (tare) from each wing section, so that the wing weight will not be applied to any group load. As was done earlier with the axle group, the boom tube group must also be figured as a separate group load and it's weight is most closely attached to the center section lifting point. The weight of the engine, the empennage, the nose wheel and anything else attached to the boom tube that is not supported by some other lifting structure will make up the remaining 135 lbs. The gross weight of 430 lbs. has now been fully accounted for.

As you can see, the center section's lift is devoured by the weight of the boom tube section. The center section lift of 134 lbs. minus 15 lbs. tare and then the subtraction of the weight of the boom tube group make a minus 16 lbs. This demands that the lifting force of the out-board wing sections, by way of the struts, carry the weight of the axle group plus the additional 16 lbs. that the center section couldn't handle.

This all means that each strut carries about 66.5 lbs. and that the fuselage braces are under a compression load of about 8 lbs. However, the distribution of the 8 lb. load among the six fuselage braces is anybody's guess. Personally, I think the center braces would carry most of it because they are the most vertical and nearest to the center of gravity.

To further confuse the situation, there are several possible variables that may be cause for some re-distribution of weight. It is very likely that the center section creates more lift than the out-board sections due to the wings having more camber than the out-board sections. And, there is also increased air velocity over the center section from the prop that may create more lift. It is a possibility that the leading edge struts might carry more load than the rear because they are nearer to the cambered part of the wing which creates most of the pressure differentially developed lift. On the other hand, the trailing edge, with it's built-in flap, would carry most of the impact created lift.

It gets complicated — don't it?



In the above picture, the wings had not been clipped yet. Also, notice the 16″ wheels (prior to the 20″ers), and the strut fairings. The fairings were made of thin aluminum which didn't hold up very well and made strut inspection impossible, although they did reduce drag to a noticeable extent. Also notice that the fan cooled version 277 has had the shroud removed. That's because it has also had the fan impeller removed from the fly-wheel. It has never gotten hot and it increased available HP to the prop.

Modifications

Dihedral — This is the upward slant of the wing measured in degrees from an imaginary horizontal line radiating outward from the fuselage. In more visual terms it is the amount of V shape that the wings form when viewed from the front or rear of the plane. The Weedhopper has an enormous amount of dihedral. In flight it aids in stability (the ability of an aircraft to return to level flight after a disruption). The bad thing about having too much dihedral is that side winds tend to get under the upwind wing while taxiing and they turn the plane over on it's nose — almost always breaking the prop, and sometimes causing bruises to the pilot when he releases the seatbelt and falls on his head. To watch this is reminiscent of the old TV show, *Laugh-In* — when the guy in the trench-coat rides the tricycle into the fire hydrant, falls over and just lays there. From the pilot's point of view it feels real undignified.

As it turns out, you can drop the wing-tips about 6″ by re-drilling new holes in the strut tangs (lower end), 1″ down from the old holes, without noticeably changing the stability. It is also acceptable to drill new holes in the struts, but it doesn't look as good because the old holes are exposed. It's always best not to have any more holes than is necessary in the struts seeing as your life is hanging from them. And **never** any holes near the center of the strut because of the amplified effects of vibration at this location. However you do it, less dihedral will cause the ground wind handling to improve greatly, as well as crosswind landing ability. This should not be done to a new plane because the sailcloth is probably already too tight and this will tighten it even more. But, on an older plane the tightening effect of this will be a welcomed improvement.

Contrary to what you might believe, the wing ribs (battens) in a Weedhopper are not there to hold the cloth up (except before flying speed is reached) — they are there to shape the cloth and hold it down. Although, with the nine rib configuration, there is still quite a bit of billowing that takes place between the ribs causing excessive drag. The tightening effect of removing dihedral will eliminate some of this as well.

Almost all Weedhoppers are crooked one way or another because they most likely incurred at least one hard landing during pilot training. And usually, one side hit harder than the other. Intentionally landing hard on the other side so it will be equally bent is not advisable, and potentially embarrassing. Before you take out the excess dihedral — analyze your plane for straightness. You can compensate for a crooked wing at the same time, after you understand where and how severe your problem is. Keep in mind that the hole-to-hole lengths of the fuselage tubes are not really all that critical, they can be off from each other by quite a bit and the plane will still fly straight as long as the wings are adjusted equal to each other in regard to the following paragraph.

To visually analyze your plane — with it sitting on level ground, and the rudder centered, stand approximately 15 ft. behind it (some people like to do this from the front), center your eyesight so that the rudder appears in line with the boom tube. Now, raise up or down while watching one wing-tip until you can align the bottom of the leading edge with the bottom of the trailing edge, near the tip. Then shift your eyes to the other side to see if it's the same. Note the difference — which wing is higher on the trailing edge and by how much? Remember that the ratio of change at the tip, to the hole movement distance at the lower strut tang is about 6:1.

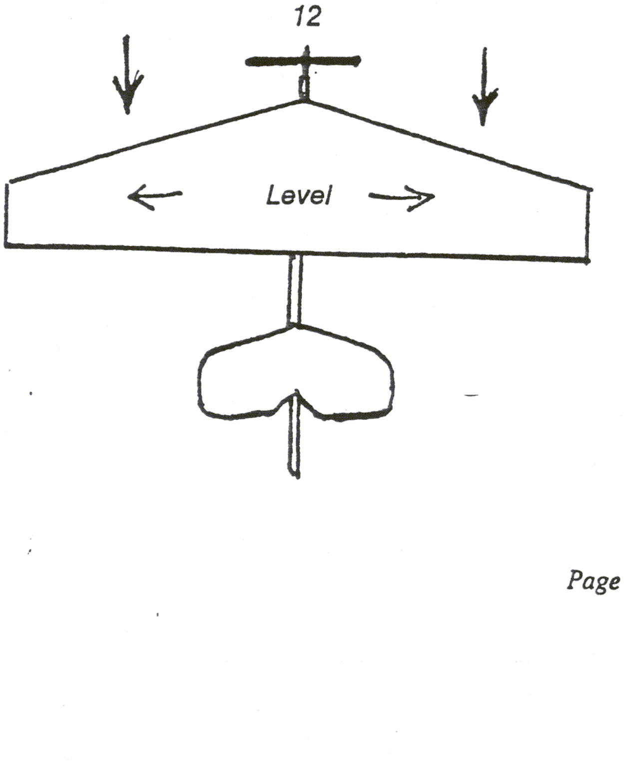
At this point you will notice that the wings appear to be twisted. It looks like, at the tip, they are lower in the front than they are at the back, when compared to the fuselage end of the wing. Right! They're supposed to be that way — it's called wash-out. This is done so that in a stall the tip of the wing is the last part of the wing to stop flying, thereby causing the plane to drop it's nose or fall through as it's called, and still maintain level status laterally (the imaginary line that runs from wing-tip to wing-tip is the lateral axis). Theoretically, this wash-out prevents the plane from spinning and makes recovery from the stall faster and safer. I said, "theoretically", because I'm not sure that it's possible, because of it's extreme leading edge wing sweep, to make a Weedhopper spin (sweep is what a delta wing design has a lot of). Even when it falls through, one wing low, it just does a gentle turning recovery that just happens to be pointed in a different direction than the pilot originally intended. Even with all the different mods that I've experimented with — and trying to make it spin — I have never been able to get it to. But none-the-less, the wash-out is there for a good reason. Although there is, like the dihedral, way too much of it. And having too much of it, is detrimental. It causes the plane to have to nose-up too far in order to create the lift that it needs to maintain flight. This extreme nosed up attitude creates way too much drag. But, if you are going to clip your wings, do not remove this wash-out. After the clip you will need what little you have left, because the part you remove causes the majority of the effect. But, for the full span planes, and especially two seaters, this should be all but eliminated, at least what appears present on the ground.

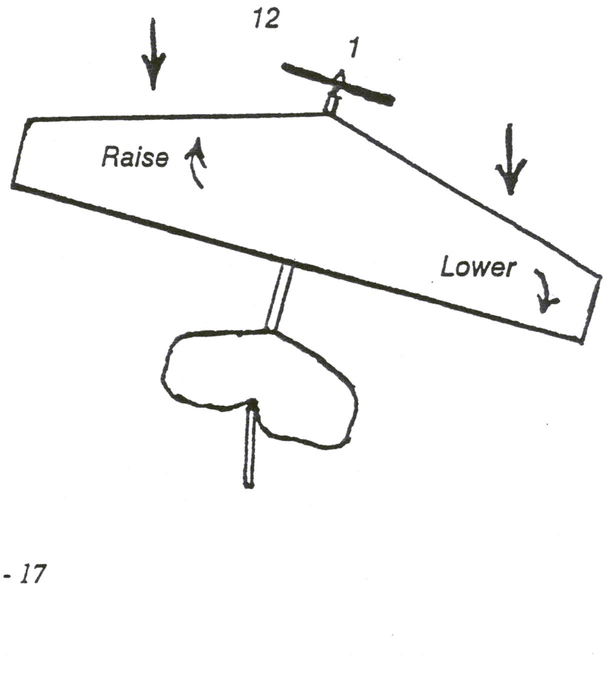
What wasn't taken into consideration in the original design was the in-flight flexing upward of the trailing edge tube from the strut attach point outward, while at the same time the leading edge tube does not flex at all. This is even more pronounced in a stall because the increased sink creates a more vertical air flow against the lower surface of the wing — causing it to flex even further. So, if you have zero wash-out visually apparent on the ground — you'll have a little in flight, and even more in a stall — which is where it was intended to be effective in the first place.

For the purpose of the clipped wing craft, the portion of the trailing edge that will be removed will eliminate any flexing. So, as far as clipped wings are concerned, in terms of wash-out — what you see is what you get.

In regard to straightening of wings due to a bent air-frame — **never** allow the trailing edge to remain lower than the leading edge. The wash-out must be apparent, in that the trailing edge should be between 0 and 1½" higher than the leading edge. For more accurate measurements, use a level to determine the difference of the angles between the boom tube and the wing-tips. The removal of wash-out is done by lowering the trailing edge — either by redrilling the tangs or the struts. Always leave at least a ¼" between holes. This translates to not less than a 1½" change at the tip. Unless you have adjustable struts, minor adjustments are impossible. For more precise adjustments, you can buy an adjustable strut end from Rix Trix for $36.

For the unmodified Weedhopper that is crooked and pulls to one side in flight there is a bit of a phenomena that occurs. But, before I can expound on it, it is necessary that I first explain how a Weedhopper with it's two axis control, develops the apparent automatic bank that occurs in a turn. This is possible due to the extreme amount of back sweep that was designed into the leading edge of the wing. Try to envision, the plane in flight as viewed from above. If you can, in your mental picture, let the plane stand still and superimpose lines representing the direction of air flow across the craft. In straight and level flight the nose heading would be 12:00. Now, with the input by the pilot of right rudder, the plane will rotate to the right with a new heading of 1:00. In actual flight everything seems to happen simultaneously, but for our purposes, we need to take a look at this process as if it were still-frames one at a time. Before the craft actually starts to travel at the new 1:00 heading, momentarily it is traveling through the air slightly sideways — this is commonly called a crab. At this point the air flow is more closely perpendicular across the left wing leading edge because of the sweep. Thereby, developing more lift to the left wing than the right and consequently the left wing will rise as the right wing looses lift and drops. There in a nut-shell is how the automatic bank is developed. The banking action causes the side-slip to cease and the new heading is attained.





Now for the phenomena. If a Weedhopper is bent sufficiently to cause one trailing edge to be lower than the other, a person would think that it would act as an aileron — causing that wing to raise and make the plane turn to the side opposite that wing. If it were on the right side, the aileron effect would cause the plane to turn, or pull to the left. Except that on a Weedhopper.....it don't — it does just the reverse. It pulls to the side with the lowest trailing edge. This substantiates the previous findings by Weedhopper that conventional ailerons on this delta wing don't work. But, this still doesn't explain why the plane pulls to the wrong side.

The clue to why this happens came serendipitously when I clipped my plane's wings. My original objective in clipping the wings was to increase turbulence handling capability — and it did, greatly. I was however, fully aware that it was going to be detrimental to climb rate and glide ratio. And that there might be a slightly noticeable increase in air speed due to the loss of some wing frontal area. And as it turned out, in terms of glide ratio, I was not too surprised that I was right. However, it was a nice surprise that the climb rate really didn't change too much. But in terms of air speed — boy, was I wrong. That thing took off like a scalded hound. But it really shouldn't have speeded up that much — unless there was something about those tips that I had removed, that created an inordinate amount of drag. And that is exactly what turned out to be the case. In a straight bird it's not noticeable because the drag developed on the tips is balanced and the plane flies without pulling to one side. But if the bird is bent causing an angle of attack (nosed up angle relative to the on-coming air) higher on one wing-tip than the other, the unequal distribution of forces exposes just how much drag is present at the tips. The side with the most drag will pull that wing back (crabbing) creating the same effect as rudder input as earlier described. I know it's a mind-boggler, but it's true — a Weedhopper will pull to the side with the lowest trailing edge tip, and will not have any noticeable aileron effect.

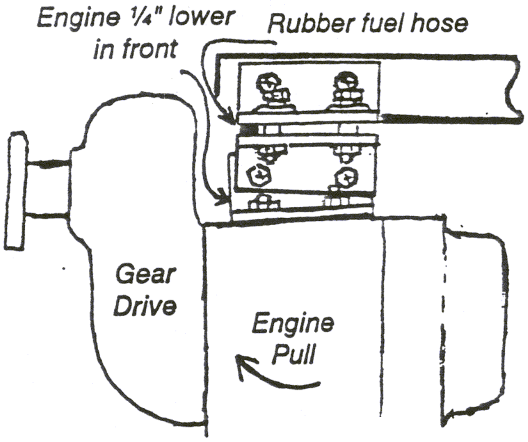
The problem of drag here, is created by the extreme angle of the sailcloth and the trailing edge tube's exposure to air flow at the tip. The reason why this was done this way is to prevent trapping any of the lower surface air flow that would cause undue upward pressure on the trailing edge tip.

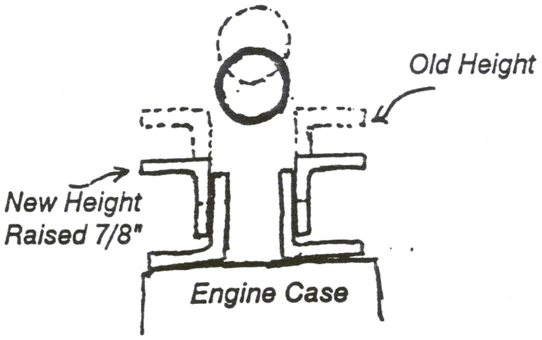
Therefore, the wing-tip tubes should never be bolted to the lower side of the trailing edge tube, but with the addition of a special tip plug, the attachment can be made into the center of the trailing edge tube. This will reduce much of the drag created by the extreme angle, and undue exposure of tubing to airflow that exists in the original configuration. And, besides the improved performance, it looks much more professional than the original overlapped joint. This plug and hardware kit (both sides) is available from Rix Trix for $24.

If your plane is straight, but it still pulls to one side, you should do a few tests to see if it pulls harder with the addition of more power, and does the pull stop when you are gliding at idle. If these conditions are present look to your engine mounting — the thrust line is probably off. The engine should already be pointed to the right some. But, by making the holes in the mounting plates oblong, where the large studs from the engine case protrude through, you can turn the engine more or less to the right (277s only). The nuts are large enough to maintain whatever adjustment is made, after the addition of a flat washer under each lock washer is made (don't forget to locktight these nuts after the adjustment).

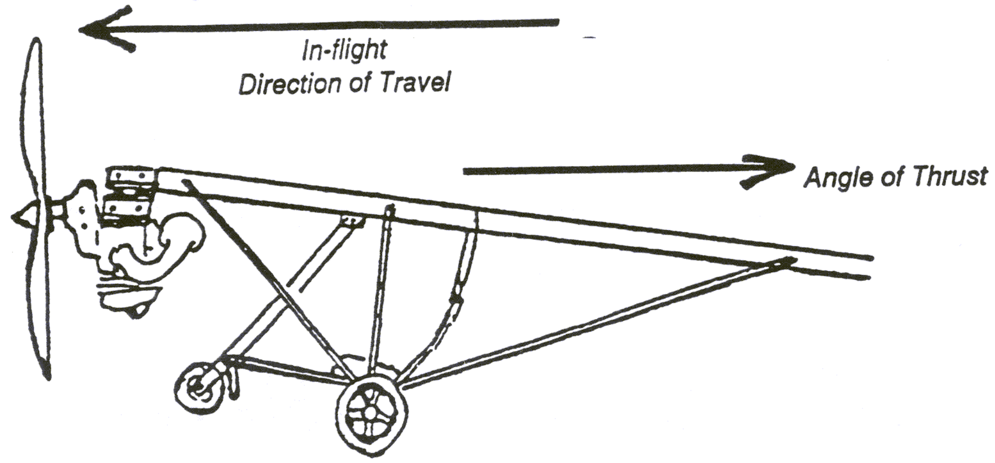
It is also possible to tilt the engine more or less downward in the front — it should already be down some. Most Weedhoppers with 277s, that I have seen, are not tilted down far enough — it makes them want to climb hard at full throttle.

In addition to these adjustments, you should raise the engine up as high as is possible in regard to the relationship between the upper and lower angle plates, without allowing the edges of the lower plate to extend above the top edge of the upper plates (these are just below the rubber mounts). This raising will help to remove angular stresses on the rubber mounts (sometimes called Lord mounts — it's a brand name) by moving the prop center-line closer in line with the mounts. At the same time that you raise the engine, you can simultaneously tilt the engine downward by making the front of the lower angle plate a ¼″ lower in the front when you drill the new holes. The mounting plate will still pull up pretty hard even with this change. So the addition of rubber stop pads is needed to prevent metal-to-metal wear. A couple of pieces of 5/16″ rubber fuel hose ¾″ long will fit over the rivet ends to prevent contact. Silicon adhesive will keep them in place but only glue the bottom side.





All of the previous paragraph is covered to compensate for the extreme angle of attack that the Weedhopper usually flies at and another really complex issue known as "P" factor. It's the air-frame reaction to propeller torque. The downward angle of the engine is to direct the thrust of the engine on a horizontal line opposite that of the travel of the plane. That line of travel is never parallel to the line formed by the boom tube. As far as the side turning of the engine — this is done to compensate for "P" factor and thrust line effect on the subfin. Because, no two planes are exactly the same, the best advice I can give here is — adjust to best performance.



CG — Earlier, I mentioned that in a stall, the plane should fall through, or nose down in order to recover. This effect is vital and the cause creating this effect should not be taken lightly. It is known as, "center of gravity", or CG — it is the location of the balance point along an imaginary line from the prop to the rudder, know as the longitudinal axis. Or in simpler terms, how nose heavy the plane is.

There are long drawn out procedures and mathematic formulas for finding the location of CG. And then, it's necessary to know the proper location and tolerances set down by the manufacturer, so you will know whether or not your plane is within those limits. I can't tell you what those limits are because the manufacturer, as far as I know, never published them.

I suspect that the CG is near the front edge of the seat. But, in the case of ultra-lights, the varying weight differences of pilots affects CG anyway. So, it can't be as "set in stone" for us as it is for heavier aircraft.

I don't know if they still do this or not but back in the early 80's when I started into Weedhoppers, when you bought a new one, they asked how much you weighed and accordingly they would give you a shorter or longer seat-back cable. I suspect that this was done to position the pilot's weight in the proper location. If you are around very many Weedhoppers you'll notice that no two seat-backs sit at the same angle. In my opinion, it really doesn't seem to make very much difference. Whatever the case, with all the different additions and junk that people seem to like to hang on their airplanes, it is critical to know if CG is anywhere near correct.

If the plane gets too nose heavy it will have a longer ground roll, and in a stall, the nose will fall through abruptly. Too light a nose weight will cause turns to be frighteningly quick, and have a strong tendency to climb, but worst of all and most dangerously, stalls will be either very slow to recover or in extreme cases the nose may not fall through at all, in which case the plane will be falling tail down — this is impossible to recover from. From experience, most Weedhoppers evolve toward nose heavy.

Some personal observations have noted ways of evaluating CG. First, with the pilot on board, if the tail falls easily to the ground with a manual, wheelchair type movement of the main wheels — it is too light on the nose. Next, if with the pilot on board leaning back in the seat, someone pushes the tail down and it will stay there (on level ground) — it is too nose light (or tail heavy), but, if the nose falls quick and hard down on it's nose wheel — it's too nose heavy. If correct, it should, according to the last scenario, fall lightly onto the nose wheel.

A more scientific method of checking this if there is any doubt, is to place a bathroom scale under the nose wheel (no pilot) and check the weight — it should be 25 to 30 pounds. Anything less than 20 is dangerous. Anything over 35 is too heavy. Heavier pilots should use heavier nose weights.

To compensate for improper CG, either add weight at extreme ends of the craft, or remove weight from the heavy end, or move existing weight accordingly. Unfortunately, the least desirable of these is usually the only one possible. And that is the first one mentioned — add weight. Notice that I stipulated, "at extreme ends of the plane", this is to limit the added weight as much as possible.

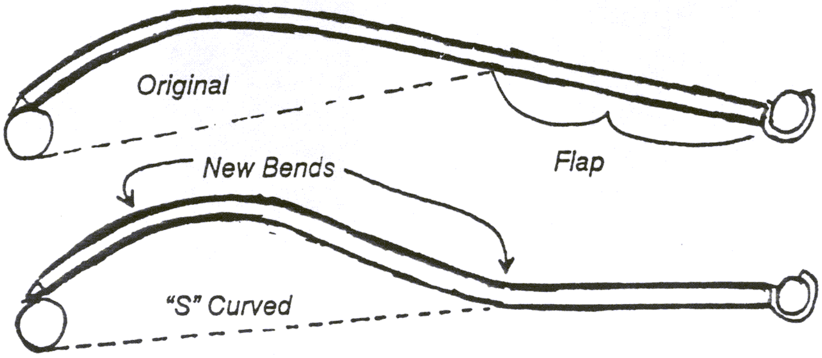
Wing ribs — Earlier I mentioned that the ribs form the shape of the wing. This shape is know as the air foil. For reasons earlier mentioned, we don't need the extreme lift airfoil that was necessary with the low thrust engine. So, the high drag flap that was designed into the shape of the Weedhopper wing can be partially removed. This downward angle of the trailing edge of the wing doesn't look all that extreme until one takes into account that the in-flight angle of attack and cloth billowing will be added to this angle. With this considered, the extreme angle and consequent exaggerated effect of this built-in flap now becomes apparent.

The flap can be easily diminished by the careful and calculated addition of two bends in each wing rib. One at the location of the single surface seam, where the double surface starts (this varies with each rib), and another at a point 10″ from the front of the rib.

The tubes can be heated with a propane torch to make bending easier, but be careful not to get it too hot — a propane torch **does** get hot enough to melt aluminum. Cool the tube after each bend with a wet rag to maintain most of the original temper (never heat load bearing structural tubes — their temper is too critical to mess with). These bends should be made to all ribs except the center rib — leave it in its original shape. The first rib on either side of the center rib should only be bent about half as much as the others in order to allow transitional contour and to prevent empennage turbulence. For double rib wings this applies to the first two ribs on either side of the center rib.

The bending process must be done with the use of a pipe or conduit bender. It seemed easier for me when the bender was mounted in a vise so I could see and control the amount and correct angle of the bend. And to spread the bend over the sufficient length so as not to kink the tube.

Each rib must be compared to it's mate from the opposite wing as well as it's neighboring ribs in order to maintain equal camber on each wing and contour between ribs. Don't be surprised if they are not the same even before you start bending. The rear bend, spread over not less than 6″, is going to cause the trailing end of the rib to raise upward so that the rib has a slight "S" shape. When done correctly and installed, this will cause the lower surface of the wing to be much flatter from front to back. Each rib must also have the tip bent down 2″. At a point 10″ back from the tip, make this bend over a 3″ length centering on the 10″ measurement. The purpose of this front bend is to raise the camber of the wing back up from the lowering effect of the bend done at the rear location. To check the newly bent rib for proper arch — place the straight end of the rib, flat on a table, with the arch up. When the bend is correct — the tip will not be more than 1/4″ from touching the table. Now compare it to it's mate and it's neighbors. It's easier than it sounds but it is time consuming — be patient and you'll be amazed with the results.



Tail tubes — I think that the newer Weedhoppers have as original equipment, lower tail support tubes instead of the cables that were on the older models. If your plane still has cables from the lower end of the empennage all-thread to either side of the axle — it should be updated. This takes much of the sloppiness out of the controls and greatly limits bending and twisting stresses on the boom tube.

This can be done with two straight lengths of 1″ outside diameter tube 110″ long (.032 wall thickness). It is not critical that these tubes be as substantial as the 6061-T6 seamless tubing that is used on the rest of the plane, cheaper aluminum alloys with seams will be adequate, but don't buy non-tempered tubing such as 1100, this is **not** an alloy, it is pure aluminum and too soft.

There are many different ways of attaching these, but the easiest in my opinion is to flatten both ends of each tube, parallel to each other 1" back from the ends and drill ¼" holes in the center of the flattened areas. Slightly bend the flattened ends opposite each other. Attach two small "L" brackets (with ¼" holes), on either side of the plane at the upper bolts of the axle/fuselage union braces. Bolt one end of the new tail tubes to these brackets. Use plastic washers between the tubes and brackets. Place a screw jack on blocks under the end of the empennage all-thread, raise the tail with the jack until the control cable tension is slightly snug with the elevator in the mid position. Raise the rear ends of the new tubes up to the sides of the lower rudder support tube (subfin tube), align the holes and mark the location for the ¼" hole. Drill the hole and assemble with rubber washers between all tubes and outside of the new tubes between steel washers (4 rubber washers, 2 steel washers). The bolt length is 2¼". It's easier to do it than it is to explain it.

Clipping the wings — This modification has caused more of a stir among local Weedhopper enthusiasts than I could ever have imagined. With the changes it has made to performance, the Weedhopper name no longer is looked down on by other aircraft owners. Many of them now can't keep up with me. On windy days when three axis aircraft used to be the only ones flying, now I can go right along side them. You should see the looks on their faces when they find out that their 447 (or bigger) powered "What's It" just got out ran by a 277 powered Weedhopper piloted by a 230 lb. fat boy. It feels so good to receive a little respect after so many years of being looked down on.

I'm not going to include the directions of how to do this project in this publication. One reason is that there are some special parts needed to accomplish this project, and another is that this project, once finished is irreversible. However, what I am going to do is try to give you enough information to let you decide whether you want to remove 10% of your wing area or not.

This project is called the F-1/11 modification. It requires that the dihedral and wing rib modifications also be accomplished as an integral part of it. As the name implies, flight characteristics will be greatly expanded. Although, just because a plane is capable of performing certain things doesn't mean that it has to be flown that way. Even with this mod, the F-1/11 will behave itself under more timid direction.

The limits of top speed, VNE, and stall naturally will fluctuate according to the variables of pilot weight, engine health, type of prop, and whether the wing has single or double ribs. So, before I blow your socks off with the stats, I'll bring you up to date on my configuration. The basic plane is an '83 C-model Weedhopper. It has a Mitchell Wing pod and windshield on it. And, it's had double ribs installed.

The engine is a 277 Rotax with 2.58:1 ratio gear drive. The prop is a 60/28 Prince "P" tip. The pilot is no midget at 6′ 1″ and 230 lbs.

OK, the first area to cover is climb rate. The loss of wing area did cost some in terms of climb, but not as much as expected. I'm getting about 400 ft./min. However, these results must take into consideration the propeller and pilot weight because they have the greatest affect on climb performance.

The Prince "P" tip is probably the highest thrust output prop on the market. I'm going to make a statement here that many people are not going to believe until they see it. The Prince prop almost provides as much increase in thrust over plain props as a 447 does over a 277. This makes it the safest prop that money can buy, because the effects of high thrust dramatically shortens the take-off roll and makes climb-out quicker. It is, in my opinion, the only prop, especially for a heavy pilot.

To give you some idea of the thrust of the prop and the speed of the plane. I'm going to tell you a true story. My best friend in the whole world, Steve Mock, has a son who is a natural pilot. His name is Doug. He learned to fly a few years ago when he was 14. The kid is quite a hot-shot. Doug, after a large meal and a bath with his clothes on, weighs maybe 130 lbs. Recently, I let him borrow my plane to show off for some of his friends. He wrung it out pretty good and then he came in and landed it. He was in awe — virtually amazed. He must have said, "WOW" a dozen times. After he calmed down a bit he said, "How do you know how fast you're going"? I said, "What do you mean"? He said, "Just after take off the disc in the Halls ASI went to the top and it didn't come down till I landed". After I explained to him that I preferred that he not do that anymore, I decided to try a hunch. I asked Doug to go up and do a power-on stall and pull it back as far as he could. When he got up to about 500 ft. he started pulling it up. It got steeper and steeper until he was nearly vertical, pointing almost straight up. He was hanging on the prop and the cloth was fluttering in the prop blast. When it finally came down, I thought that he had let it come down. But, later he said that at about 80° it fell through. It was so smooth — it was hard to tell that it had actually stalled. It never dropped below 30°.

During a different experiment, Steve and I wanted to see what the difference was in my Prince prop and his Peery "P" tip (which is significantly stronger than the plain tipped Ultra-prop that he had previously). We did a standing start take-off measurement with his plane, a stock "C" that's heavy (lots of goodies). We measured from start to lift off — we placed a marker where the wheels left the ground. We then removed his Peery and installed my Prince. Same plane, same weather, same pilot — 40 ft. shorter take-off roll. I can't imagine what the difference would be over a plain tipped antique style air flogger. We left the props switched for a few weeks and I'll have to admit that I think the Peery was faster at top speed than the Prince was. At least it seemed like it because I was getting a little more RPM than before, but I really did miss my climb. I honestly can't say what the top speed was, because my air speed indicator only goes to 55 mph. But then, I can peg it with the Prince too. However, I have been paced by reliable sources from cars. No wind, full power, straight and level — the results were in excess of 65.

It must be understood that speed is only slightly effected by thrust. This is due to the fact that the effects of drag increase exponentially with the increase of speed. Therefore, the most effective way to increase speed is to reduce drag. Increasing thrust, for the most part, only affects climb rate and take-off roll. For example, the 277 powered F-1/11 is as fast as a stock "C" airframe powered by a Rotax 503.

Another thing that the reduced drag of the F-1/11 will affect is dive and VNE. It has been said that the original configuration (no pod) would not exceed 76 mph even in a straight down, power-on dive. Well, don't try that with an F-1/11 — when you nose her over, expect to be impressed. Speed will increase at a mind-boggling rate. Luckily, the new configuration raised VNE such that it's probably faster than any experienced Weedhopper jockey will ever want to go. Unfortunately, I can't tell you how fast that is because, first, my ASI doesn't go that high and second, in an extreme dive, my plane, when it reaches a certain speed starts trying to nose up from turbulence across the elevator. My guess is, that it's in excess of 80 mph.

The F-1/11 will have a roll rate that will be at least twice as fast as before. It's very manageable and greatly appreciated in turbulence. This, plus the increased dive rate will allow the more accomplished pilot to perform some pretty impressive maneuvers. My favorite is a quick diving turn followed by an abrupt pull out — when done right, it looks somewhat like a split "S". When done wrong, you will be momentarily inverted. But, not to worry, the asymmetrical wing will not make pressure differential lift when inverted, (well it will, but in the wrong direction), so it falls through and recovers beautifully. Everyone will think you did it on purpose. Just make sure you have enough altitude.

Stall speed will increase about 5 mph. But landing speed will be about the same as before once ground effect is attained.

Take-off roll will increase about 30 ft. and as mentioned much earlier, the sink rate is probably the largest looser of the statistics at 150 to 200 ft./min. faster. This should be a real concern to any pilot that is not proficient enough to deal with dead stick landings. To thine own self — fess up! (or something like that).

Now that I have covered the area of danger, I'll get into the areas of safety increase. The thing that a conventional Weedhopper does worst and causes probably more bent birds than anything else is crosswind landings. The F-1/11 is capable of handling with ease a crosswind landing with winds up to 10 mph. The effects of crosswinds and turbulence have long been the nemesis of the Weedhopper. Those helpless feelings caused by a gust of wind that turns the plane suddenly sideways or when a thermal causes one wing to raise straight up and you have the stick all the way to that side and it still won't come down — that's the reason that I developed the F-1/11. Now, I can control those situations without pucker factor being more than my seat cushion can tolerate.

To perform the clipped wing project part of the F-1/11 modification, will require the skillful use of a drill, hacksaw, files, and a jigsaw. The specialty parts come as part of the kit, while the more common supplies must be purchased by the owner. Additional supply costs should be less then $20. The detailed instructions of this project kit, as well as the other kit's instructions, are easy to understand and follow. The cost of the clipped wing project kit is $49.

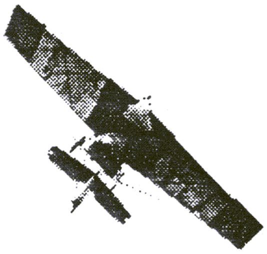
Also for sale from Rix Trix is a main wheel brake system kit. It has detailed instructions plus the specialty hardware needed to complete the project. Again, I'll let the buyer purchase the common stuff — it lowers the initial cost of the kit as well as the mailing cost. But, because Weedhoppers vary so widely as to fuel tank dimensions, pods, and wheel size — I'll need to know all these specifics so you get the right kit. Brakes can be a real lifesaver in short field emergency landing situations. The project kit price is $29.

In my most recent project, I've devised a simple way to make a nose wheel fork that works like conventional aircraft, (push right — go right). As part of the engineering process it became clear that by using the same technology I could also make a better original style nose wheel fork or custom forks that would fit any size wheel. If you are interested — write me.

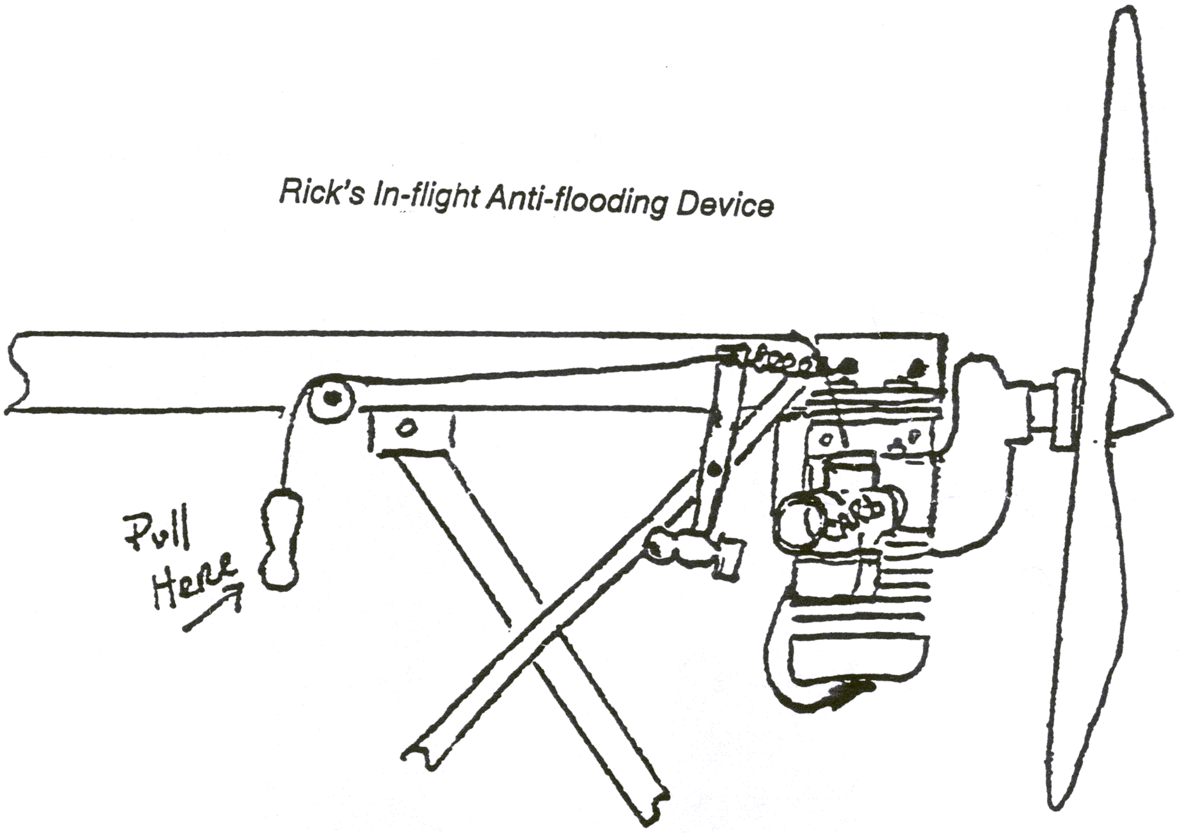
When ordering parts kits or project kits please send checks or money orders plus $3.00 shipping to:

Rix Trix
Rt. 2 Box 320
Bristow, OK 74010

Feel free to write to me about any questions you might have. Thank you for your purchases, and good flying.



Rick's In-flight Anti-flooding Device



(This is just a joke — **Please** *don't try this)*

It is imperative that any person using information in this publication be aware that they and ***not the author*** are responsible for the performance and safety of the aircraft to which alterations have been made. Varying degrees of craftsmanship and piloting ability make it impossible for the author to assume any liability. The ***owner/operator*** assumes ***all*** responsibility when the decision is made to undertake any deviation from the original design.